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Educational Brain Research as Compared with E.G. White's Counsels to Educators

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Andrews University

School of Education

EDUCATIONAL BRAIN RESEARCH AS COMPARED WITH E. G. WHITE'S COUNSELS TO EDUCATORS

A Dissertation

Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Linda Bryant Caviness

September 2000

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ABSTRACT

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by

Linda Bryant Caviness

Chair: Shirley A. Freed

ABSTRACT OF GRADUATE STUDENT RESEARCH

Dissertation

Andrews University

School of Education

Title: EDUCATIONAL BRAIN RESEARCH AS COMPARED WITH E. G. WHITE'S COUNSELS TO EDUCATORS

Name of researcher: Linda Bryant Caviness

Name and degree of faculty chair: Shirley Freed, Ph.D.

Date completed: September 2000

Purpose of the Study

The purpose of this study was threefold: to review current, education-relevant brain research; to review the educational writings of Ellen G. White for major emerging themes/principles; and to compare these findings for similarities and differences.

Method and Results

Using an inductive process, the synthesis and comparison revealed 15 themes from brain research and 12 principles from White's writings from the middle 1800s and early 1900s.

Comparison of the two lists revealed alignment on eight themes/principles, non-alignment on three themes/principles, and partial-alignment on seven themes/principles.

Aligned themes/principles included: body and mind function as one; exercise and movement are vital to cognition; health habits profoundly affect learning; emotions/neurochemistry unite body and mind; social influences structure cognition; plasticity and enrichment contribute to brain growth/change; stages of development provide optimal times for cognitive patterning; individualism typifies brain function.

Themes/principles not aligned included: the Bible is foundational for education; knowledge of God establishes contact with the source of all knowledge; and redemption and restoration of the image of God in humanity are the goals of education.

Conclusions

White defines true education as the harmonious relationship between physical, mental, and spiritual powers. Brain educators also draw attention to this three-faceted relationship; however, brain science tends to deal with this concept in a less integrated way than does White, though research on emotion appears to be promoting a more holistic attitude.

White suggests education is potentiated when this harmonious triad is empowered by God. Brain science says little about an outside vital power, though altruism is sometimes discussed in the context of new findings on the role of emotional/social functions.

Based on the comparisons/differences observed, this study postulates that this triad relationship is a fractal-like pattern that is replicated and operant in brain structure and function, educational practice, and other life processes.

To my husband, Larry Caviness,
whose heart inspires others,
especially mine,
and whose unselfish spirit of sacrifice
enabled me to succeed

To my children,
Talmadge (and wife Anna), Aaron Tad, and Andrea Leigh,
who engendered in me
greater ability to see the Love that surrounds us all

To God,
Whose Light and Life and Love
nurtured me
along this journey

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ACKNOWLEDGMENTS

Hillary Clinton suggests that it takes a village to grow a child. This dissertation is the product of a similar context of nurture and support. For this advantage, many deserve credit.

As a dissertation chair, Shirley Freed constantly motivated. Few give with more focus and interest than what she gave to this study. I am deeply grateful for her expertise and support. She invested entire days to this work and maintained great enthusiasm throughout. Her dedication to student nurture is superlative, and her model as an educational leader is a rare jewel. Truly Shirley Freed invests body, mind, and spirit in her nurture of doctoral candidates.

Marilyn Eggers was another enabler in this process. We swapped time to support each other as both of us wrote dissertations. Her technological skills, her wisdom and ability to understand the need for balance, and her intimacy with God were gifts to me as we grew together. With much enthusiasm for this study, Marilyn traveled from the Bay Area to L. A. more than once to help me meet several deadlines. For her troubleshooting ability via phone calls, her willingness to work with me through the long night hours on revisions, and her *faith-full* friendship, I am deeply grateful.

James Tucker, one of the masterminds of the Andrews University Leadership program, knows how to make limitations conquerable. He fans the fires of potential for students around the globe. At the end of this process, I can sincerely say that this is the

most gratifying and personally meaningful learning experience of my lifetime. Even if the program requires the equivalent of two dissertations, the journey was a reward in itself. Jim Tucker is a major impetus behind the dynamics of Leadership at Andrews. He initiates marvelous momentum to send Leadership graduates soaring.

George Akers taught me about educational philosophy during baccalaureate study and became my professional hero at that time. To have him on my dissertation committee was an honor. His Richard Nixon look-alikeness is not what makes him "presidential" in my mind. It is his deep understanding of what true education is all about that inspires me most. I am grateful he has been part of my training. In this study, Dr. Akers was one of the authorities on E. G. White.

Herbert Douglass, George Knight, and the E. M. Cadwallader dissertation also provided valuable input as specialists on E. G. White. They are known widely for expertise in this area, and it was a privilege to use their data.

The "brain educators" referenced throughout this document became my friends as I dialogued with their minds on a literary plane. Geoffrey and Renate Caine first introduced me to neuroscience as I began the search to understand Niemann Pick disease and our son Tad's difficulties.

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Carla Hannaford and her expertise in movement and learning played an important role in this study. Her writings offer much help for K-16 educators and children everywhere.

Jane Healy meets educational issues head on. She is not afraid to blow the whistle when children's needs are being compromised or violated. Her writings have benefited many.

Eric Jensen and his wife Diane are devoted to nurturing teachers everywhere by helping bridge the gap between neuroscience and educational practice. Eric began filling this professional need in the early 1990s when brain science and education began turning up in the same meeting places.

Candace Pert's research reveals how neurochemistry unites the body and the brain. Her writings and presentations played an important role in connecting all the parts of this study to form a cohesive whole. By personalizing her research with her own life story, she contextualizes biochemistry in learner-friendly format—a model for all educators.

Though alphabetically last in this list of brain educators, Robert Sylwester certainly is not least in regard to how much his studies meant to this research. His altruistic spirit transmitted over many miles via paper pages in a book.

To each of these brain educators I am grateful for the time and effort invested in teacher education. It has been my intention to represent each position accurately as I attempted to distill out the major points.

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I was only three and one-half, and my sister T'Lene only three months, when Mother died. Daddy (Earl Stanford Bryant), brothers (Jack, Donald, Lee, and Stan), sisters (Earline, Vera, Peggy, T'Lene), and significant others (Lois, Henry, Peanut, Joe, Bob, Carol, John, Aunt Gertrude, and Aunt Lois) have been my nurturers in her absence. Though great distances separate us, I sense their (and her) support and belief in me. To a great extent, we are what others have made us. I am grateful for a Mother's love that lives on in her offspring and continues to empower, though perhaps indirectly, in projects such as dissertations.

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Talmadge, Anna, and Andrea Leigh, our precious children, have been patient young adults as Mom was one with the computer. Their understanding and support made a mountain surmountable.

Son Tal took me with him to neuroanatomy lab and arranged for me to participate in brain dissections at the medical school where he studies. (Neuroscience is one more bond that binds our hearts and minds.) With deep gratitude and reverence, I held in my hands the brains of those deceased. What a privilege it was to study the organ that so represented who each of those individuals once had been.

Daughter Andrea's unique endowment of intuition and nurture inspire the best in me. I will always remember how she, though two years younger than her brother Tad, was his miniature, angel-like nurse as his neuromuscular abilities began to diminish. Her heart and mind read his with uncanny ability to perceive his needs and to proactively care. Our world needs more brains like hers.

Though Aaron Tad—our precious middle child—lies in a cold grave, the victim of a merciless disease, truly he deserves acknowledgement here, also. Tad's plight gave me the determination to find answers and to search the brain to know its secrets. His life continues to inspire mine. I will be forever grateful for the son who reminded us, "It's okay, Dad (and Mom), Jesus will fix it someday."

It is that faith in knowing that life is a journey with a bright tomorrow that I live and love and believe. I am thankful for a loving Heavenly Father who makes us able to succeed in projects such as this one.

CHAPTER ONE

INTRODUCTION AND METHODOLOGY

Introduction

This study examines and compares two large bodies of information—brain research as it relates to education, and the educational counsels of Ellen G. White, a writer from the late 19th and early 20th centuries. Why is a current body of information being compared with writings from 100 years ago? A preliminary review of current findings from neuroscience as applied to education seems to reveal similarities with educational counsels from the 1800s.

What inspired this rather unusual comparison? As an experienced, random-thinking educator intrigued by learning theory, brain science became especially compelling when our young son Tad was diagnosed with a degenerative brain disease—Niemann Pick. Physicians indicated that little was known about this terminal condition for which there was no treatment at that time. I began a self-directed study of brain anatomy and physiology. Having previously read the writings of Ellen G. White on education, this trek into neuroscience and its applications to education suggested interesting parallels with White's counsels to educators.

Though this study began informally as a quest to satisfy a personal need, it developed into a research project to determine the similarities and differences between these two bodies of information. This endeavor compares data influenced by two differing paradigms of thought (naturalism and creationism). It is the purpose of the study to add to the body of knowledge regarding how we learn.

Neuroscience and Education

Deeply rooted educational practice currently is subject to re-examination as a result of information coming from neuroscience research. For decades behavioral thought has strongly influenced American education (Caine & Caine, 1991, pp. 12-22; Jensen, 1998, p. 2; Sylwester, 1995, pp. 2-5). Today, however, as a result of technology's advances and contributions from neuroscience, the brain and how it learns are being viewed and studied from yet another level.

This onslaught of new data is providing a new rhetoric for dialoguing about learning. The new emphasis promotes the idea that brain "development, organization, and operation" (Sylwester, 1995, p. vii) can provide critical knowledge for better understanding and optimizing individual learning potential. By combining what we know about behaviorism, cognitive psychology, philosophy, etc. with the emerging neuroscience data, perhaps a more inclusive, comprehensive perspective will emerge (Caine & Caine, 1991, pp. 15-16; Jensen, 1998, pp. 1-4).

Behaviorists describe learning in terms of observable events that include environmental and behavioral factors (Sylwester, 1995, pp. 2-6). Similarly, social psychologists consider learning to be a social enterprise, "dependent upon interactions between the learner and his or her social cultural environment" (Driscoll, 1994, p. 7). These approaches provide valuable context for understanding how we learn. However, those who study brain physiology and education contend that there are additional critical pieces involved in learning that are not addressed in behaviorism and/or social psychology alone. Neuroscience is describing cognitive processes in terms of memory, attention, emotion, brain chemistry, neural function, and even physical movement (Caine & Caine, 1997; Damasio, 1994, p. 88; Diamond & Hopson, 1998; Goleman, 1997; Hannaford, 1995; Jensen, 1998; Sylwester, 1995).

Referred to as the 'decade of the brain' (Diamond & Hopson, 1998, p. 273), the 1990s introduced new descriptors for learning and teaching, such as: accelerated learning, brain-based instruction, brain chemistry, chemical learning, emotional intelligence, whole systems learning, etc. These terms and ideas come from a new data bank of biological information derived largely from technological advances in brain research, including: Magnetic Resonance Imaging (MRI), Magneto-encephalography (MEG), Positron Emission Tomography (PET), and spectrometers. These new techniques offer procedures for imaging brain activity and are revealing a vast complexity of inter-relatedness (networking) that is constantly at work during conscious and unconscious states of mind (Sylwester, 1995, pp. 6-8). They are the technical contributors to an exploding body of information. As a result of these innovations, educators have gained additional understanding of how the brain perceives, stores, relates, connects, and responds to sensory input (Jensen, 1998, pp. 2-5; 2000, p. 25).

The media has capitalized on the public's strong interest in knowing more about the brain. Books, periodicals, newsletters, professional organizations, websites, etc., are active attempts to satisfy the demand for this intriguing information. As if we had never seen ourselves in a mirror, we want to "see" and better understand our brains. Reflecting on this idea of a brain looking in on itself, Robert Sylwester (1995) quips, "It's [the human brain] the only mass of matter in the known universe than can contemplate itself—a true celebration of neurons" (p. vii).

With such widespread attention focused on the brain and neuroscience, it is not surprising to discover educators wondering about how these data inform classroom practice. Teachers typically have little exposure to neuroscience and brain physiology. In the past it has not been a major emphasis in teacher training programs. However, educational brain research classes are becoming more common in teacher education curriculum.

Not all are as enthusiastic about the burgeoning interest in neuroscience. Some have voiced concern over the legitimacy of these emerging scientific data and their relevance to educational practice or policy (Bruer, 1998, p. 14). They contend that the "new" information is not so new after all, that neuroscience has been aware of this information for "20 to 30 years." Embracing caution, Bruer (1998) suggests, "What we need to be critical of is not the ideas themselves, but how they are interpreted for educators and parents" (p. 14).

Robert Sylwester (1995) voices similar concern. He counsels educational leaders to develop a "functional understanding of these significant developments." There is a need to be able to: "comprehend the growing scientific and professional writing in this field; discuss, develop, and evaluate proposed educational applications; and effectively teach students about brain mechanisms and processes" (p. vii). Continuing, he adds, "Without such knowledge, our profession will become prey for educational hucksters who will propose expensive programs they claim to be compatible with current cognitive theory and research" (p. vii).

Fortunately, researchers with dual emphases in education and neuroscience are attempting to bridge the gap between these disciplines in efforts to provide help in translating scientific findings to the language of the humanities. Names that commonly appear in conjunction with this topic are: Marian Diamond (University of California, Berkeley), Robert Sylwester (University of Oregon), Geoffrey and Renate Caine (California State University, San Bernardino), Daniel Goleman (Harvard University), Candace Pert (Georgetown University School of Medicine), David Sousa (Rutgers/Seton Hall University), Pierce Howard (University of North Carolina), Jane Healy (Formerly of Cleveland State University), Michael Merzenich (University of California, San Francisco), Paula Tallal (Rutgers University), Carla Hannaford, Eric Jensen, Susan Kovalik, and Rita Smilkstein. Though this list is not exhaustive, it provides a broad sampling of writers who are focused on interpreting neuroscience for educators.

Do individuals such as those listed above concur on the major themes emerging from this educational brain research? Is a new educational paradigm emerging? Or is this new body of information merely old concepts couched in new rhetoric? These questions inspired this study at its outset and provided the impetus for research throughout the analysis of the literature, which follows in chapters 2 and 3.

Who *Is* Ellen G. White?

A review of her background reveals that Ellen White's earliest years provided little evidence that she would become an internationally read author of counsels to educators. However, though she was self-educated, frail as a child because of a serious injury, and considerably shy, her life accomplishments are considered by millions around the world as “inspired” and “epoch-making” as a spiritual leader (Douglass, 1998, p. xiii).

The Ellen G. White Estate website—www.whiteestate.org—(Ellen G. White Estate, 2000) provides a brief description of this woman, her accomplishments and recognition:

> In brief, she was a woman of remarkable spiritual gifts who lived most of her life during the nineteenth century (1827-1915), yet through her writings and public ministry she has made a revolutionary impact on millions of people around the world in the twentieth century. A large number consider her to have had the prophetic gift.

Ellen White was a student of the Bible. Her understanding of Scripture appears to have enabled her to become a significant contributor in the development of the doctrines of the Seventh-day Adventist church. She spent considerable time traveling to establish the presence of the Adventist church.

> As a young girl Ellen White suffered serious health problems which threatened her life, yet she lived a full life to age 87. She traveled widely in the United States, Europe, Australia and New Zealand. Her varied roles included speaking before audiences as large as 20,000. Her insights into healthful living continue to be remarkably accurate concepts widely accepted today by the scientific and medical community. She also helped to establish a system of hospitals, schools, and publishing houses that circles the globe. (Ellen G. White Estate, 2000)

White’s writings on health issues were so highly regarded, they provided a major impetus for the establishment of the Adventist Health system. Worldwide this health organization now has 162 major hospitals and sanitariums, 361 smaller clinics and dispensaries, and 102 nursing homes and retirement centers, and 21 orphanages and children’s homes—all as a direct result of White’s influence. Loma Linda University Medical School, one of the most highly recognized schools of its kind, also was established as a result of Ellen White’s influence (Seventh-day Adventist Yearbook 2000, 2000).

Ellen White's books are translated and distributed in more than 142 languages around the world. Internationally, 56 publishing houses and branches are responsible for producing and distributing her writings (Seventh-day Adventist Yearbook 2000). The Ellen G. White Estate (2000) explains that

> during her lifetime she wrote more than 5,000 periodical articles and 49 books; but today, including compilations from her manuscripts, more than 100 titles are available in English. She is the most translated woman writer in the entire history of literature and the most translated American author of either gender. Her writings cover a broad range of subjects, including religion, education, health, social relationships, evangelism, prophecy, publishing, nutrition, and management. Her life-changing masterpiece on successful Christian living, *Steps to Christ*, has been published in nearly 150 languages, with well over 100 million copies in circulation. Her crowning literary achievement is the five-volume "*Conflict of the Ages*" series, which traces the conflict between good and evil from its origin to its dramatic, soon-to-unfold conclusion.

Over 100 years ago, Ellen White wrote prolifically on many aspects of education. Fifteen of her 100 books are primarily focused on education. Today, her work is still regarded as the basis for sound practice in the schools of the world's largest, centrally-operated Protestant school system—the Seventh-day Adventist system. Internationally, it includes 90 universities and colleges, 1,014 secondary schools, and 4,450 primary schools (Seventh-day Adventist Yearbook 2000, 2000).

Purpose of the Study

The purpose of this study was to synthesize and compare the principles of educational practice emerging from brain research and Ellen White's writings on education. By systematically analyzing these two bodies of information on learning, major principles and themes emerged.

Philosophical Premises Compared

Is it reasonable to compare two bodies of information, each of which is founded on a different philosophical base? The body of data emerging from brain research appears to be predominantly grounded in naturalism. Diamond (1999), Jensen (2000), Sylwester (1995), and others commonly include descriptions of brain function and development with inferences to naturalistic concepts. Naturalism is founded on the belief that the brain evolved from a primitive state exclusive of supernatural influence (Mautner, 1999). In contrast, Ellen White's counsels to educators are deeply entrenched in theism and creationism.

Comparing two bodies of information that appear to be founded on two different philosophical positions is likely to create an interesting perspective and study results. In order to justly interpret these two bodies of data, it seems important to clarify the foundations upon which each body of information is premised.

According to University of California, Berkeley's Phillip E. Johnson (1995), "naturalistic rules . . . define rationality in the universities" (p. 8). The realm of reason is left to the agnostics, says Johnson. "This is true in every field of study, but especially so in natural science, the discipline that has the authority to describe physical reality for all the others" (p. 8).

Naturalism, as defined in the *Dictionary of Philosophy* (Mautner, 1999) "implies a rejection of traditional beliefs in supernatural beings or other entities supposedly beyond the ken of science" (p. 373). In the same reference source evolution is aligned with "Darwin's theory of natural selection and the survival of the fittest" (p. 185).

Naturalists tend to oppose the idea that the mind is dependent on anything other than matter and that no *vital force* is necessary to sustain life and its functions (Clark, 1993, p. 13). Naturalists believe that life has no purpose, no design, and is the "product of mere mechanical mechanisms," according to Johnson (1995, p. 9). Naturalists look at theistic beliefs as the "superstitions of our ancestors" (p. 65) and contend that "God exists only as an idea in the minds of religious believers" (p. 7).

The brain research literature reviewed for this document appeared to be consonant with naturalism and evolution as defined here. However, addressing the issues of naturalism and evolution was not the focus of these contributors. Robert Sylwester, more than the other seven brain educators referenced, came closest to specifically speaking to these ideas. In *A Celebration of Neurons* (Sylwester, 1995, pp. 14-21), he described the theories of Crick and Edelman as he addressed the theoretical base that "explains the relationships among the various elements in a researched phenomenon" (p. 14). Both Crick and Edelman approach the cognitive sciences from a biological stance.

Describing the work of Nobel Prize-winning Francis Crick, Sylwester (1995) explains that Crick "in his scientific career . . . has moved from identifying the DNA molecule in our cells that directs life to identifying the networks of cells in our brain that give conscious meaning to life" (p. 15). Continuing, Sylwester refers to Crick's (1994) book *The Astonishing Hypothesis: The Scientific Search for the Soul.* Crick's "astonishing hypothesis," says Sylwester, "is that everything that constitutes who each of us is as a human being involves nothing more than the behavior of a vast assembly of nerve cells and their related molecules." Sylwester (1995) explains Crick's position further.

> *Everything* includes all of our interior states—our joys and sorrows, memories and ambitions, our loves and hatreds, our sense of personal identify and free will. It's an astonishing hypothesis because it goes against the feeling that many, if not most, people have: that we're certainly more than a pack of functioning neurons, that we also have a *disembodied* mind, spirit, self. And it certainly goes against many religious beliefs. (p. 16)

Sylwester (1995) also refers to Gerald Edelman's "theory of neuronal group selection (or neural Darwinism)." Edelman, also a Nobel Prize winning brain scientist, "argues that our brain does operate on the basis of natural selection—or at least that natural selection is the process that explains instruction and learning" (p. 18).

Gazzaniga is yet another brain scientist to whom Sylwester (1995) refers as he describes the philosophical stances of outstanding contributors to neuroscience. Sylwester states,

> Gazzaniga (1992) argues that all we do in life is discover what's already built into our brain. What we see as learning is actually a search through our brain's existing library of operating basic networks for the combinations of those that best allow us to respond to the immediate challenge (much like college students in a library select and synthesize materials from various existing sources to write their term papers). (p. 20)

In all of Ellen White's writings reviewed, there was no evidence of her alignment with evolution or naturalism. In fact, positioning herself as a creationist, she assumes a contrastingly different position in regard to the origin and existence of life. This philosophical position permeates her writings. She seems to allow no room for question on this position—that a Divine Creator orchestrates and empowers humanity and has an in-place operating plan for assisting humanity in returning to a perfect state of mind/body/spirit function.

Theism, according to the *Dictionary of Philosophy* (Mautner, 1999) is

> the belief that there is one God, a personal being with every perfection (perfect power, perfect knowledge, perfect goodness, perfect justice, etc.); creator of the world, manifested in the world, interacting with the world, but nevertheless existing

> entirely separately from the world; a being that is the one and only proper object of worship and obedience. Theism is common to Judaism, Christianity and Islam. (p. 561)

Creationism as defined in the same source as that above (Mautner, 1999) is

> the view that the biblical account of the creation of the world is entirely correct, that it is incompatible with generally accepted scientific theories, and that these therefore ought to be rejected. (p. 116)

Creationists believe that a supernatural power provides the energy that sustains all forms of life on earth. Proponents of such biblical theology also tend to contend that there is a holy purpose for humanity's existence, and that humankind was placed on earth as part of a divine plan based on love, which potentiates the individual and benefits others as well. As mentioned above, theists propose that a Creator God oversees, nurtures, and sometimes intervenes in life experiences from a position of being all-knowing, all-present, and all-powerful.

While emerging from different philosophical perspectives, the two bodies of information considered in this document both focus on education and the ability to know, learn, perceive, remember, etc.—functions of the brain or brain/body network. The research questions for this study were:

The Research Questions

1. What themes or principles for instruction have emerged from current brain research as it relates to education?

2. What themes or principles for instruction have emerged from Ellen White's writings on education?

3. What common themes and/or principles in education surface when current brain research is compared with Ellen White's writings? In what ways do the bodies of knowledge differ?

Methodology

This research is focused on current education-relevant brain research and Ellen G. White's writings pertaining to education. Though Ellen White is an historical figure, the purpose of the study was not to do an historical, documentary analysis of the times in which she lived or the way in which that context may have influenced her writings. This study is an analysis of two bodies of knowledge and a comparison between them. In order to answer the research questions, a process to discover the major principles in each body of data was developed and refined.

The problem of how to approach this study was confounded by the fact that in the area of brain research the body of information is heavily influenced by fields of study outside of my expertise. Neuroscience, rather than educational psychology, is the major contributor to this mounting knowledge base. That fact led to a search for the experts—those individuals who have contributed time, effort, and expertise to integrating neuroscience findings with educational practice. It became clear that the principles would emerge from neuroscientists who were making applications of brain function to education and those educators who were taking the findings from neuroscientists and applying the findings. Ultimately, this study is about educational applications of brain research and not an analysis of brain research itself.

Dissertation abstract findings, journal articles, conference proceedings, and books provided abundant reference information about brain-based learning. To distill this body of information until the basic themes emerged presented a challenge, but it was obvious that many of the educational experts had developed their own "lists" of principles. These were sometimes shared in a "list" format and other times were organized by chapters in their books. Each of the basic principles (implied and explicit) was written on a card. Using an inductive reasoning process, cards were sorted into piles of similar ideas. Then, emerging concepts were searched in the educational brain research literature to discover other authors who discussed the topic or concept. Using this inductive, recursive process, 15 major principles, two neuroscientists (Marian Diamond and Candace Pert), and six educators (Geoffrey and Renate Caine, Carla Hannaford, Jane Healy, Eric Jensen, and Robert Sylwester) emerged.

I created a chart (see Appendix 1) organizing the major authors and principles as they surfaced. Each principle then was checked against other experts' books and articles in the field. In this way all principles and authors were cross-referenced. Only those principles and authors were retained who were referenced three or more times.

This inductive process has recently been popularized by the "late curriculum theorist, Hilda Taba, who developed a series of teaching strategies designed to help develop inductive mental processes, especially the ability to categorize and to use categories" (Joyce, Weil, & Showers, 1992, p. 116). Joyce, Weil, and Showers describe a "*TABA*" as a concept formation process that involves three steps: 1) "identifying and enumerating the data that are relevant to a topic or problem; 2) grouping these items into categories whose members have common attributes; and 3) developing labels for the categories" (p. 117). This process seemed a natural choice for organizing the data in both the brain research and Ellen White's principles.

Brain Research Themes

1. **Body and Mind.** Body and mind are integrally related in learning.

2. **Senses.** Learning is a multisensorial, integrated process, which involves the whole body, not just the brain.

3. **Exercise and Movement.** Physical exercise and movement empower learning.

4. **Health Habits.** Health habits profoundly influence the ability to learn.

5. **Emotions and Neurochemistry.** Emotions and neurochemistry are critical to mental processes and body functions.

6. **Music and the Arts.** Music and the arts facilitate learning.

7. **Attention.** The brain's attention—how it is gained and maintained—is driven by physiological factors as well as levels of motivation.

8. **Social Influences.** Community and environment strongly influence the developing brain.

9. **Plasticity and Enrichment.** Portions of the brain are plastic and exhibit ability to change with varying levels of nurture and with an enriched environment.

10. **Stages of Development (Critical Periods).** Brain development stages create optimal times for particular learning opportunities.

11. **Making Meaning.** Learning involves making connections within complex neural and chemical networks.

13. **Individualism.** The learner is a complex, unique individual.

13. **Language Development.** Language shapes culture, thinking, and brains.

14. **Motivation.** Both extrinsic and intrinsic motivation are powerful potentiators for learning, and both should be equally nurtured in the classroom.

15. **Memory.** Rather than being a fixed singular skill in the brain, memory is a process subject to constant change as a result of changing stimuli; and it may occur in locations within the body other than the brain.

The next challenge was to decide how to organize the various topics for discussion. This was difficult because all the principles seemed to be related to each other. To clarify ways the principles were related, a circular graphic was constructed. The 15 principles were arranged around the outside of the circle, and lines were drawn from each principle to other related principles. Without stretching the imagination, I found they were all connected. This was a revelation! Certainly the topics depicted a complex network and some kind of portrayal that the brain research suggests a dynamic, non-linear system. In order to capture this reality, chapter 2, which reports the brain research, is divided into three expanding sections: Mind/Body Connections, Mind/Body/Emotions Connections, and Mind/Body/Emotions/Social Connections.

Brain Research Contributor Identification

Following is a brief biographical profile of each of the eight major contributors referenced in the review of the brain research:

Renate and Geoffrey Caine

Renate Nummela Caine is Associate Professor of Education at California State University, San Bernardino (CSUSB). She also is Executive Director of the CSUSB Center for Research in Integrative Learning/Teaching.

Geoffrey Caine is a consultant specializing in adult learning. In addition, he is an Adjunct Member of the Faculty at the University of Redlands, California, Whitehead Center for Lifelong Learning, where he teaches management and law.

Some of the books the Caines have authored include: *Making Connections: Teaching and the Human Brain; Education on the Edge of Possibility; Unleashing the Power of Perceptual Change;* and *MindShifts.*

Marian Diamond

Marian Diamond is Professor of Neuroanatomy at University of California, Berkeley. For 30 years she has conducted research in brain plasticity. Dr. Diamond is married to Arnold Scheibel of University of California, Los Angeles, brain research fame. Though both are recognized worldwide as authorities on the brain, Dr. Diamond combines her focus on the brain with an emphasis on education as well.

Diamond authored *Enriching Heredity,* and co-authored *Magic Trees of the Mind,* with Janet Hopson. In addition to these publications, she has written numerous scholarly articles on the brain.

Marian Diamond is a seasoned educator in addition to her expertise as a neuroscientist. Until recently, she was director of the Lawrence Hall of Science, a popular museum/learning site just off the U. C. Berkeley campus where children, parents, and teachers experience science multi-sensorially. The brain and its functions has been a major emphasis at this learning site.

Carla Hannaford

Dr. Carla Hannaford is a neurophysiologist and educator with more than 28 years of teaching experience, including 20 years as a professor of biology and 4 years as a counselor for elementary and intermediate school children with learning difficulties.

Since 1988 she has been an internationally recognized educational consultant, making more than 500 presentations worldwide on the neural basis of learning and educational kinesiology. She was selected as a guest educator with the AHP-Soviet Project in 1988, has been recognized by Who's Who in American Education, and has received awards from the University of Hawaii and the American Association for the Advancement of Science for outstanding teaching of science.

Author of *Smart Moves: Why Learning Is Not All In Your Head,* and *The Dominance Factor: How Knowing Your Dominant Eye, Ear, Brain, Hand & Foot Can Improve Your Learning,* Hannaford concentrates on the body's role in thinking and learning.

Jane M. Healy

Dr. Jane Healy, is an educational psychologist, who currently is a learning specialist and consultant at the Vail Mountain School. A professional educator for over 30 years, she was awarded the Delta Kappa Gamma Society International Educator's Award in 1988 for *Your Child's Growing Mind* and again in 1991 for *Endangered Minds: Why Children Don't Think and What We Can Do About It.* She also is the author of *Is Your Bed Still There When You Close the Door? . . . and Other Playful Ponderings*, a guide to having creative and intelligent conversations with kids. Healy also lectures frequently to faculties and parent groups, and has appeared on *The Today Show, Parent Journal, Sonya Live,* and many other television and radio programs.

Eric Jensen

A former teacher and current member of the International Society of Neuroscience, Eric Jensen has taught at all levels, from elementary through university level. He is listed in Who's Who Worldwide. In 1981, Jensen cofounded SuperCamp, the nation's first and largest brain-compatible learning program for teens, now with more than 20,000 graduates. He wrote *Student Success Secrets, Brain-Based Learning, Brain-Compatible Strategies, The Learning Brain,* and *Super Teaching.* He remains deeply committed to making a positive, significant, lasting difference in the way the world learns. Jensen currently speaks at conferences, conducts training, and does consulting internationally.

Since 1998 Jensen has conducted brain conferences in San Diego and at other locations throughout the United States. Thousands participate in these 3-4-day sessions which feature outstanding presenters from colleges. universities, and other learning and research organizations.

Candace Pert

Candace B. Pert, Ph.D., is a Research Professor in the Department of Physiology and Biophysics at Georgetown University Medical Center in Washington, D. C., where she also conducts AIDS research. She was featured in Bill Moyers's book and PBS series titled *Healing and the Mind,* and she lectures extensively throughout the country.

Dr. Pert discovered the opiate receptor and its implications for profoundly influencing life processes. Her book *Molecules of Emotion* documents this discovery, and she translates this body of complex knowledge into pertinent and readable narrative that can be understood by those with and without expertise in biochemistry and brain function.

Robert Sylwester

Robert Sylwester, Professor of Education at the University of Oregon, focuses on the educational applications of new developments in brain/stress theory and research. He has written dozens of journal articles and made hundreds of conference and inservice presentations.

Author of *A Celebration of Neurons: An Educators Guide to the Human Brain*, Sylwester is an ardent supporter of educators in helping them become actively involved in discovering useful applications for brain theory and research in schools.

The E. G. White Principles

Once again the process of distilling three major books and numerous articles and other manuscripts containing White's primary educational principles was a challenge.

Having accessed experts in the area of brain research, it seemed logical to use a similar process to distill out the principles of Ellen G. White. Early in the process I began asking Seventh-day Adventist educational leaders for the names of authoritative individuals on Ellen White's counsels to educators. The following names emerged:

1. **George Akers**, former World Director of Education for the General Conference of Seventh-day Adventists, Silver Spring, Maryland

2. **E. M. Cadwallader**, author of *Principles of Education in the Writings of Ellen G. White*, a doctoral dissertation, published at Union College in Lincoln, Nebraska

3. **Eldon M. Chalmers**, author of *Healing the Broken Brain*, and former professor at the Andrews University Theological Seminary (Dr. Chalmers passed away before providing feedback.)

4. **Herbert Douglass**, author of *Messenger of the Lord: The Prophetic Ministry of Ellen G. White*

5. George Knight, Professor of Church History, Andrews University Theological Seminary, Berrien Springs, Michigan and author of *Philosophy and Education: An Introduction in Christian Perspective*

6. A. G. Lindsay, Professor of Theology at Avondale College, Cooranbong, New South Wales, Australia

7. Colin Standish, President of Hartland Institute, Rapidan, Virginia.

Four of these sources were able to provide lists of what they considered to be the major principles and issues in Ellen G. White's counsels on education: Akers, Cadwallader, Douglass, and Knight. All of these principles and issues were then coded for source, combined, and reorganized using an inductive process. (See Appendix 2.) Twelve themes emerged with at least two of the four input sources agreeing on each theme. Using these themes, the E. G. White online database was searched and related quotations were added to the research data.

Next, using words and phrases from the educational brain research themes, the database of E. G. White writings was searched for related ideas. Likewise, the Ellen G. White themes were searched for in the brain literature. Again, these quotations were synthesized and added topically to the research data.

Educational Principles That Emerged From Ellen G. White's Writings

1. Biblical Foundation. The Bible is foundational and contextual in education.

2. Knowledge of God. Knowing God—the source of wisdom, love, and life—allows the learner access to full educational potential.

3. Redemption and Restoration of the Image of God. The aim of education is to restore the image of God in humanity and to aid humanity in reaching full potential, including eternal life.

4. Power of Choice and Human Will. God sacrificially honors humanity's freedom to choose, and He expects education to honor the human will.

5. Character Development. A major objective in God's educational plan for humanity is character development.

6. Service to Others. Selfless service to others is a major objective in the education of the whole person.

7. Harmonious Development. True education is the harmonious development of the physical, mental, and spiritual powers (including emotional, social, moral, esthetic, vocational, and religious aspects).

8. Amusement and Recreation. Students develop best when amusement is minimized and useful work or re-creative activity is substituted as a means of securing recreation, relaxation, and healthful exercise.

9. Work and Practical Functions. A primary objective of education is to provide training and nurture that are practical as well as cultural and academic.

10. Health Habits. Health is a major factor in the success of the student; therefore, the school, parents, and the student should be concerned with health principles.

11. Parental Influence. The parent's role as educator is supreme over all others; the parents are the primary teachers; and the home is the primary school.

12. Teacher Characteristics and Influence. Committed Christians, who are scholastically well-qualified individuals, best fill the role of teacher; and teachers profoundly influence the quality of learning.

Definition of Terms

Typically, educators are not required to master scientific terminology referring to the brain. In the past, classroom practice has not dictated that need. However, as the study of education-relevant brain research becomes increasingly more influential, understanding basic brain research terminology will be more relevant, useful, and needed.

Scientific terminology used in this paper is education-context related. Exceptions to these definition parameters are annotated or specified. A glossary of terms for this study appears in the reference pages. For readers who sense a need for additional background, Appendix 4 provides a more in-depth presentation of brain physiology.

Organization of the Study

Chapter 1 includes introductory context, direction for the study, statement of the research questions, description of the methodology for the research, biographical briefs on the major contributors referenced, and an explanation of the organization for the study.

Chapter 2 reports literature review findings relative to major principles that occur in current, education-relevant brain research.

Chapter 3 reports on major themes found in the review of Ellen White's writings.

Chapter 4 compares results from chapters 2 and 3. This data is analyzed for similarities and differences in relation to educational practice.

Chapter 5 analyzes and summarizes the findings of chapter 4.

Summary

This study of educational brain research and the writings of Ellen G. White on education evolved out of a personal interest in brain research and a curiosity that developed when parallels were seen in comparing these two bodies of information. A study of this type becomes meaningful and relevant as it helps to contextualize new data aimed at altering current educational practice.

A new rhetoric for discussing cognition now exists as a result of neuroscience's advances in defining brain function. The "decade of the brain"—the 1990s—ushered in new ways of understanding how the brain perceives, stores, relates, connects, and responds to sensory input. As a result of these advances in brain research, many now believe that describing learning in behavioral and social psychological terms alone is restricted and less than comprehensive.

Not all educational professionals are comfortable with science's attempt to inform educational practice. Some contend that the new information may or may not have relevance to instructional efficacy. Others recognize the need for educators to become better informed and qualified to interpret the new data and to translate it into useful practicum.

Ellen G. White wrote volumes of counsels to educators. These counsels are widely read and have resulted in an international educational system. Each of these bodies of information—Ellen White's writings and educational brain research—is established on a different philosophical base, yet, their objective is the same—how can learning be enhanced. The purpose of this study is to identify similarities and differences between these two bodies of information.

CHAPTER TWO

REVIEW OF BRAIN RESEARCH LITERATURE

Introduction

This chapter is a review of the major themes and issues surfacing in the findings of brain research that are related to education.

In order to be true to this large topic, I have organized the information into overlapping themes—mind/body connections, mind/body/emotion connections, and mind/body/emotion/social connections.

The information that appears in this chapter is not intended to be exhaustive on any particular theme or issue. Rather, the information selected from the large pool of available literature is offered:

To clarify the theme or issue,

To provide evidence that concurrent agreement exists among those who are translating findings in brain research into educational practice, and

To provide commentary on practical application for educational environments.

Mind and Body Connections

Introduction to the Issues

This section on *Mind and Body Connections* presents findings within the literature that suggest body function is critical to cognition—that mental function, in fact, is quite dependent on input from the body.

Three major subsections are included here: *the senses, learning and motor function,* and *health practices*. In the first of these three sections, the science of the senses is discussed in reference to how they physiologically impress the brain and influence the mental process. Next, considerations of how physical activity affect brain function are discussed. The final section includes information on how diet and nutrition, water, oxygen, and sleep influence body and brain function.

What is the relationship between mind and body? How does sensory input integrate with mental processes? What factors enhance or diminish the quality of sensory input? For centuries the mind and body relationship issue has been discussed. Does brain research now offer new and useful information for the educational profession?

Throughout current brain research literature, reference to body and mind connections is common (Armour, 1991; Caine & Caine, 1991; 1998; Childre, 1994; Damasio, 1994; Diamond & Hopson, 1998; Gardner, 1983; 1991; Hannaford, 1995; 1994; Healy, 1990; Jensen, 1998; Lacey & Lacey, 1978; Pert, 1997; Sylwester, 1995; Watkins, 1995). The contributors referenced here provide specific focus on how the mind and body are connected and how they complement each other in cognition as a dynamic, complex network.

The authorities referenced in this chapter tend to use the terms *brain* and *mind* interchangeably. However, the term *brain* seems to be used most often to refer to the physical organ, and the term *mind* seems to be used to refer to the coordinated functions of the brain interacting with the body. Candace Pert (1973) suggests that the usage of such terms is undergoing semantic evolution as new information accumulates to substantiate the intimate relationship between the brain and the body, which she terms *bodymind.* This term, she posits,

> reflects the understanding, . . . that the body is inseparable from the mind. And when we explore the role that emotions play in the body, as expressed through the neuropeptide molecules, it will become clear how emotions can be seen as a key to the understanding of disease. (p. 187)

Pert continues to explain that

> We know that the immune system, like the central nervous system, has memory and the capacity to learn. Thus it could be said that intelligence is located not only in the brain but in cells that are distributed throughout the body, and that the traditional separation of mental processes, including emotions, from the body is no longer valid.
>
> If the mind is defined by brain-cell communication, as it has been in contemporary science, then this model of the mind can now be seen as extending naturally to the entire body. Since neuropeptides and their receptors are in the body as well, we may conclude that the *mind* is in the body, in the same sense that the mind is in the brain, with all that that implies. (pp. 187, 188)

The term "body and mind" implies a differentiation between these two entities. Typically, "body" refers to function at sites other than within the brain. "Part of the reason for the outdated separation of mind and body comes from simple observation. If the brain is in the head and the body is below the head, how could there be any links?" reasons Jensen (Jensen, 1998, p. 3). However, brain research reveals data that suggest the body and the brain are more *in oneness with* rather than *in separateness from* each other. Hannaford (1995) states:

> We have attempted to explain the mind from the glimpses and pieces we are able to put together as we focus our attention and research on the brain. But we have missed a most fundamental and mysterious aspect of the mind: learning, thought, creativity and intelligence are not processes of the brain alone, but of the whole body. Sensations, movements, emotions and brain integrative functions are grounded in the body. The human qualities we associate with the mind can never exist separate from the body. (p. 11)

Hannaford (1995) explains that because of some of our deeply rooted cultural beliefs, based on the "notion that intellectual activity can somehow exist apart from our bodies" (p. 11), we tend to ignore important elements of the learning process. Such thinking in educational theory and practice yields less successful learning outcomes and makes learning harder for students. She continues to suggest that societal prejudice "tends to downgrade physical achievement and minimizes its importance in 'serious' endeavors like work and school. Like other deeply held assumptions about the brain . . . beliefs about the distinctiveness and superiority of *human reason have long colored attitudes towards the physical basis of thinking*" (p. 97, italics supplied).

Candace Pert (1997) suggests that the "old Newtonian mechanistic view" framed our thinking regarding mind and body in terms of energy and matter. This view described the thinking process as a linear pattern—a reactive process with not much room for "flexibility, change, or intelligence" (p. 185). Pert contrasts this old thought paradigm with current thinking.

> With information added to the process, we see that there is an intelligence running things. It's not a matter of energy acting on matter to create behavior, but of intelligence in the form of information running all the systems and creating behavior. (p. 185)

Caine and Caine (1997a) argue that it is critical "to grasp the fact that the body and the brain are not separate" (p. 87). They explain that peptides—chemical molecules–literally link the nervous system, the endocrine system, and the immune system into a single psychosomatic network.

Pert (1997) intimately links body and mind in the context of her studies in neurochemistry. She speculates that "what the mind is the flow of information as it moves among cells, organs and systems of the body" (p. 185). This information flow in the body can be both conscious and unconscious. As unconscious flow, "we see it in operation at the autonomic, or involuntary, level of our physiology." Though the mind is "immaterial, . . . it has a physical substrate, which is both the body and the brain" (p. 185). It also has a "non-physical substrate" (p. 185) that involves information flow. What holds the networks of the mind and body together is the mind–"often acting below our consciousness, linking and coordinating the major systems and their organs and cells in an intelligently orchestrated symphony of life" (p. 185). Pert (1997) further explains the relationship between mind and body:

> We might refer to the whole system as a psychosomatic information network, linking *psyche*, which comprises all that is of an ostensibly nonmaterial nature, such as mind, emotion, and soul, to soma, which is the material world of molecules, cells, and organs. Mind and body, psyche and soma. (p. 185)

Damasio (1994) concurs that

> despite the many examples of such complex cycles of interaction now known, body and brain are usually conceptualized as separate, in structure and function. The idea that it is the entire organism rather than the body alone or the brain alone that interacts with the environment often is discounted, if it is even considered. Yet when we see, or hear, or touch or taste or smell, body proper *and* brain participate in the interaction with the environment. (p. 224)

Sylwester (1995) echoes this concept.

> Similarly, we've tended to think of a body/brain split: our brain regulating body functions, and our body providing support services to our brain. Scientists have now replaced this duality with an integrated body/brain system. (p. 75)

Pert (1997) indicates agreement with Sylwester. She adds a summative thought to the concept that mind and body are intimately connected:

> Let me summarize the basic idea I have been developing. The three classically separated areas of neuroscience, endocrinology, and immunology, with their various organs—the brain; the glands; and the spleen, bone marrow, and lymph nodes—are actually joined to each other in a multidirectional network of communication, linked by information carriers knows as neuropeptides. There are many well-studied physiological substrates showing that communication exists in both directions for every single one of these areas and their organs. Some of the research is old, some of it is new. For example, we've known for over a century that the pituitary gland spews out peptides throughout the body. But it's only been a few years that we've known that peptide-producing cells like those in the brain also inhabit the bone marrow, the place where immune cells are "born." (p. 184)

Throughout this chapter, when terms such as body/brain, body and brain, body/mind, body and mind, or similar constructs are used, they are indicative of current reference to the intimate relationship between the body and mind or body and brain. This is due to the recent findings that indicate that emotions and neurochemistry act as a uniting factor in these network

In the following sections, three major brain research themes are discussed: The role of sensory input, learning via exercise and movement, and health principles that affect mind and body function. Each relates specifically to mind and body connections.

The Senses

During the past 20 years much brain research-related information accumulated to support the importance of making learning a holistic experience, involving multiple sensory input (Ayers, 1972; Campbell, 1997; Damasio, 1994; Diamond, 1988; Hannaford, 1995; Hendrickson, 1969; Hopson, 1979; Restak, 1979, 1988; Sprenger, 1999; Suplee, 1994; Sylwester, 1995; Tomatis, 1991).

Considering the neuronal structures in the brain, which receive and transmit information to all organs and systems within the body, there are three main types of neurons: sensory, intermediate, and motor. Sensory neuron function is the focus of the following section; however, it is recognized that a vast connective system unites all three.

From all over the body, sensorial input is received into sensory neurons. This input stimulates the body and the brain to respond in some way. Incoming information is translated into meaningful messages that activate mind/body systems. The skin, eyes, ears, tongue, nose, and proprioceptors provide a continuous flow of information to the brain and Central Nervous System. As described earlier by Pert, this information flow becomes the *mind*. Following is a description of each of the senses and how each contributes to this process.

Proprioceptors and the Vestibular System

"Proprioceptors are sense organs that relay information about muscle position or tension or activity of joints and equilibrium. The proprioceptors are located throughout muscles, tendons, joints and mechanisms of the inner ear" (Hannaford, 1995, p. 19). They feed information into the reticular system in the brain stem.

Typically, when we think of sensory input, we consider five senses—sight, smell, sound, touch, and taste. However, proprioception and the vestibular system are also significant sensory inputs that affect learning and understanding.

Considered by some as the body's sixth sense, proprioception provides the body with a sense of itself (Sacks, 1987, p. 43). Proprioception is directly related to the Reticular Activating System (RAS) in the brain stem—the system that carries messages from the medulla oblongata and pons to the neocortex, thus enriching ability to respond to other sensory stimuli coming in from the environment.

Diamond and Hopson (1998) describe the reticular system as "a set of nerve tracks in the brain stem" (p. 125). "It is now known that the reticular formation of the brain stem can inhibit or facilitate motor activity and muscle tone, influence the respiratory and circulatory systems and affect transmission of sensory impulses to higher centers" (Diamond, Scheibel, & Elson, 1985, p. 4).

Proprioceptors are intimately linked to our sense of balance. According to Hannaford (1995) they are constantly aligning the parts of our body in an effort to maintain balance. When children experience growth spurts, there is often an accompanying awkwardness in balance as proprioceptors realign and adjust to the body's sense of itself in space (p. 44).

The vestibular system is centralized in the mastoid bone and part of the inner ear. It is responsible for maintaining balance and equilibrium, and it carries impulses to the cerebellum and the Reticular Activating System (RAS) located in the brain stem. The RAS is critical as an alerting mechanism to prepare the brain to receive sensory input.

Minute changes in amount and quality of fluid and otoliths in the semicircular canals of the vestibular system lead "to changes in the muscles of the neck, trunk, limbs and musculature of the eye" (Hannaford, 1995, p. 35).

Movement and stimulation of the vestibular system during fetal development, and after birth through crawling, walking, and running, are all important as they contribute significantly to brain processing and learning patterns. Hannaford (1995)further explains how the vestibular system links to the neocortex to promote learning:

> The vestibular nuclei, a plexus of neurons lying in the medulla oblongata and pons, carries impulses from the semicircular canals and cerebellum to the Reticular Activating System (RAS) in the brain stem. The RAS gets us ready to take in and respond to our environment and to learn. This connection between the vestibular system and neocortex as well as the eyes and core muscles is highly important to the learning process. When we don't move and activate the vestibular system, we are not taking in information from the environment. (p. 35)

Hannaford (1995, pp. 42-44) further explains that when proprioception functions abnormally, the learner has difficulty relating to life in general—lack of balance, dizziness, problems with orientation, etc. Consequently, learning becomes more challenging and difficult. A healthy vestibular system and proprioceptors are important sensory elements as we grow and learn.

A close relationship exists between eye function and equilibrium maintenance. According to Homer Hendrickson (1969, p. 4), as cited by (Hannaford, 1995), "About 20 percent of the messages from the eyes, from the retina and extraocular muscles, go to areas of the brain concerned with balance mechanisms. Each of the subsystems must match and check with the other subsystems to produce consistent static and dynamic balance against gravity" (p. 35).

Vision

The senses are intimately related to and dependent on each other as they provide information to the brain from outside the body. An example of this interconnectedness can be seen in the sense of vision. Only about 10% of the vision process occurs in the eyes. "The other more than 90 percent of vision takes place in the brain from association with touch and proprioception. As babies touch their environment, they learn dimension, texture, line and even color. A complete visual picture emerges at about eight months after birth. Touch is very important to vision" (Hannaford, 1995, p. 45).

Sylwester (1995) reports that our eyes contain 70% of our body's sensory receptors, which "begin the cognitive process of transforming reflected light into a mental image of the objects that reflected the light" (p. 61). This process is vastly complex and efficient in normal vision.

Sylwester (1995) states:

> The one million fibers in the optic nerve of each eye carry a summary of the vast amount of data that the 127 million rods and cones receive. Half the optic fibers from each eye cross over to the opposite side of our brain, joining the remaining fibers from the other eye and continuing to the thalamus, our brain's initial sensory-processing area and relay center (located in the middle of our brain). Thus each side of our brain receives visual information from both eyes. (p. 62)

"Our eyes are designed to move and accommodate for light, to give us as much sensory detail about our world as possible. The eyes must be actively moving for learning to occur," states Hannaford (1995, p. 46). Further, Hannaford comments on what we now know about learning and dimensional representation in vision:

> In a three-dimensional environment, such as outdoors, the eye is in constant motion gathering sensory information to build intricate image packages necessary for learning. The brain integrates these image packages with other sensory information like touch and proprioception to build a visual perception system. The eyes are equipped with different kinds of visual focus, of which three-dimensional focus is vital for learning, yet we emphasize two-dimensional focus in learning situations. (p. 47)

Diamond (1998) explains three-dimensional vision seems to develop as early as 4 months of age when a "sudden improvement of vision" occurs. According to Peter Huttenlocher (1987), a neurologist at the University of Chicago, the visual cortex shows a radical profusion in synaptic connections between 2 and 4 months of age. This sudden, explosive production of dendritic connections seems to be related to the increase in visual ability. This increase appears to peak around 8 months of age, stays high until around 4 years, and then gradually declines until approximately age 10. This drop in synaptic density is called *synaptic pruning*. Diamond describes this as a "sculpting" of the "visual cortex." She explains that though there is a drop in synaptic density, "the dendritic branches within that cortex layer continue to lengthen and sprout, and new synapses can flourish where the growing branches contact other neurons" (1998, p. 51)

Learning, of course, is not totally dependent on vision. Individuals who are blind can function well as learners and doers; however, learning is enriched through vision. The brain is set up marvelously to receive integrative sensory data of which vision plays a major role, and the brain is amazingly adaptive when vision is lost.

Hannaford cautions that, during early elementary grades, children should not be expected to perform tasks that strain the eyes. Prior to a child's beginning school, the child develops three-dimensional and peripheral vision. This results from the nature of activity exposure. Activities at home are more likely to integrate vision with kinesthetic function in the natural processes of play and unrestricted interaction within the home environment. But when children enter school, school activities tend to require up-close, foveal eye function, which is two-dimensional, common paper work. School performance expectations are often abrupt, overtaxing, and unnatural (1995, p. 104). Hannaford explains why this problem often occurs:

> Before approximately age seven, the ciliary bodies (muscles that shape the lens of the eye) are short, causing the lens to be thin and elongate. With the lens in this shape, the incoming image is spread out across the retina, bringing into play maximum rod and cone stimulation. This lens shape easily accommodates three-dimensional, peripheral and distance vision. At about age seven, these muscles lengthen, allowing the lens to round out and more easily focus the image only on the fovea centralis of the retina for natural foveal focus. Children who have looked at books in the home may have already acquired some foveal focus if the process was their choice and free of stress and pressure to perform. (p. 104)

Regarding when the eyes are ready for reading, Hannaford suggests that by age 7 or 8, "as the frontal lobes of the cerebrum mature, fine motor coordination of muscles throughout the body naturally develops" (p. 106). Before this development takes place, the child has good peripheral and depth vision, however, the eyes are not ready for heavy two-dimensional processing before this happens. When the "frontal eye field of the frontal lobes matures, enough eye teaming is possible for two-dimensional focus" (p. 106).

Hearing

Our ears provide what Robert Sylwester (1995) calls "our brain's 24-hour monitoring service." He partially describes how external sounds are translated meaningfully in the brain:

> Hearing is a three-phase action that creates useful cognitive information out of the pitch, volume, and timbre of complex sound waves that vibrate through air, bone, and fluid, The process begins in our outer ear, where sound waves strike our ear drum and cause it to vibrate. Our middle ear increases the strength of these vibrations about 22 times through the mechanical actions of the three smallest bones in our body(commonly called the hammer, anvil, and stirrup). They relay the increased vibrations to the cochlea, a fluid-filled tube in the inner ear shaped like a snail shell. Each of the 25,000 hairlike receptors in the cochlea is tuned to a specific sound frequency. If the sound wave moving through the fluid bends a receptor, it activates a neural message at a specific frequency that the auditory nerve then sends to the temporal lobe of our brain. (p. 60)

According to Diamond (1998), most of the critical events in the development of the hearing organ take place 4 to 5 weeks after conception. During this critical stage of development, the embryo's aural sense can be permanently damaged if the mother "catches certain kinds of infections or takes certain kinds of drugs" (p. 60). The risk of the baby being born deaf or hard of hearing becomes a greater possibility.

Diamond (1998) reports that "Neville and her colleagues have discovered that the main hearing part of the brain, the auditory cortex, remains plastic for up to four years in a child, and that input from the ears—and surprisingly, from the eyes, as well—can contribute to how the brain becomes hardwired for hearing and seeing" (p. 60).

Overexposure to noise pollution not only can destroy hearing acuity, it may also increase attention deficit. Hannaford (1995) states that

> noise pollution (loud and/or constant sounds over a period of time) especially in the upper sound range, destroys these delicate hair cells of our "inner keyboard," thus reducing our hearing acuity. Dr. Tomatis discovered that these upper vibrations of sound also play an important part in maintaining alertness and energy within the

> system. He noticed, for example, some surprising consequences when monasteries in France dropped their Gregorian chanting in an attempt to modernize in the 1960's. These chants provided the upper register vibration and harmonics (overtones) that maintained alertness. As a result, the men in these monasteries needed more sleep, were less productive, and tended to get ill more often. Tomatis equated this to the experience of factory workers who had also lost the upper range of hearing because of constant factory noise, and similarly became listless and non-productive. Overly loud music or exposure to constant sounds at the same vibration can cause damage. Protecting our wonderful hearing mechanisms is important, not only for survival and active listening, but to provide the alertness that comes with the higher vibrations—all of which assist learning. (p. 38)

The educational implications of hearing are discussed in detail under language development in the third section: brain/body/emotional/social connections.

Smell

At birth the sense of smell is already well developed. According to Hannaford (1995), "Smell is strongly linked to memory and plays an important role in the baby's early learning and throughout life" (p. 39). She refers to a German developmental expert who "claims that memory can be greatly assisted by rubbing the nose prior to learning something you really want to remember" (1995, p. 39). To explain why this might be true, Sylwester's describes how the olfactory sense registers in the brain.

> Our nose processes our sense of smell through two postage-stamp-sized mucus membranes at the top of the nasal air passages. Each membrane has millions of hairlike neural endings that project into the mucus. These receptors interact with odor-bearing molecules that have entered our nose and are trapped in the mucus. Our sense of smell is unique, therefore, in that its receptors are bare neural endings; when we smell something, our brain is in direct chemical contact with the outside world. The system is also unique in that the neurons projecting into the mucus membrane are the only neurons that can regenerate themselves (and they do so every few weeks). (1995, p. 65)

Further, Sylwester (1995) explains that all other sensory input passes through the sensory relay center in the thalamus, but the olfactory sense does not. However, the olfactory sense does "have major connections with the limbic system, our brain's emotional center. Smell plays an important role in the formation and recall of emotion-laden memories" (p. 66).

Both Sylwester and Hannaford write about pheromones and their potential influence in the learning environment. Sylwester (1995) provides the greater application:

> Pheromones are powerful hormonelike molecules that animals and humans release from their skin into the air. They enter the tiny vomeronasal organ in our nose, but they are not part of our sense of smell. Rather, we might consider them a sixth sense. They trigger behavior and levels of comfort and self-confidence. A female moth emitting pheromones can draw male moths to her from miles away. In humans, pheromones have been tentatively associated with such curiosities as the allure of certain perfumes, the attraction of truffles (and their relationship to underarm sweat), and the tendency of women who live together to develop synchronized menstrual cycles. The cheek area next to our nose contains many pheromones, and this may explain why we humans like to kiss by nuzzling our nose into that pheromone-rich area. Although scientists currently know little about human pheromones, one can muse on their possible effects on hundreds of adolescent students, bound together for hours in the enclosed environment of the school. (p. 66)

Taste

Sylwester (1995) describes the tongue as "a four-inch long mobile slab of muscle with 9,000 taste buds arranged in groups of about 100 on raised projections (papillae) located mostly on the perimeter of its upper surface" (p. 66). Saliva is necessary in order for taste buds to detect flavor. Sylwester reports that "taste buds report only on food that is soluble in water" (p. 66).

The sense of taste is significant in the learning process of infants, but there is evidence that taste sensation is active even before birth. Sylwester states, "The early maturation of this important sensory integration is evident in the behavior of infants, who examine almost everything they pick up by putting it in their mouth. Fetal taste buds respond to amniotic fluid chemicals by the third trimester" (p. 67).

Not much is said in the literature relative to the sense of taste. However, Sylwester (1995) links the importance of taste to affective sensation. He portrays the eating experience as celebratory and "a rich mix of the senses: the cooking aromas, the tactile crunch of celery and apples, the attractiveness of the food on the table, the sounds of popcorn, and the flow of conversation" (p. 67). "Educators," he continues, "should use the kind of imaginative thinking that transforms mundane multiplication tables into interesting activities to transform hurried, assembly-line cafeteria meals into experiences that celebrate rather than denigrate our sensory system" (p. 67).

Touch

Sylwester (1995) explains that the sense of touch (skin) and other senses as well are merely extensions of the brain—where the brain meets the outside world. In this respect, the mind and the brain are intricately networked as one. They depend upon each other for conscious and subconscious (autonomic) function.

> Our skin has more than half a million nerve endings that provide our brain with immediate information on just about anything that touches our body, even a mosquito landing. Our hand has 1,300 nerve endings per square inch. Across our body, a patch of skin the size of a quarter averages more than 3,000,000 cells, 250 sensory receptors, 100 sweat glands, 50 nerve endings, and 3 feet of blood vessels. Our body's 6-pound, 20-square-foot, two-layer mantle of skin is the largest and least-compact of our sense organs. While the other sense organs are only inches away from our brain, information from the skin on our feet, for instance, travels several feet to reach our brain. (pp. 63-64)

This sophisticated sensing system constantly transmits messages to the brain to maintain health, safety, and well-being. Sylwester (1995) explains how these messages are represented in the brain.

> Touch information and motor output are initially processed in the cortex in two adjacent narrow bands of neural tissue that spread from ear to ear across the top of our cortex. The right side of these sensorimotor bands processes touch and motor activity from the left side of our body, and vice versa. The bands also represent our

> body areas upside down: sensorimotor activity in our toes is processed at the top of our head, and activity in our tongue is processed down near our ears. Further, the area devoted to a body part is proportional to its sensorimotor complexity and importance, not its size: our hands and face and especially our thumb and tongue get the most space. Macho types may be shocked to discover that their thumb and tongue are their most important appendages, but that's the way things are in the world of brain properties. (1995, pp. 64-65)

The birthing process is important in activating the skin as a functioning organ. As the body squeezes through the narrow birth canal, the layers of skin experience a sensory integration process (Sylwester, 1995). The child who experiences the inability to tolerate touch often also has learning disorders. Physical therapy for such a condition often involves efforts to more appropriately activate the touch receptors (Hannaford, 1995, p. 40).

As the normal child continues to develop, the sense of touch is stimulated by the environment in many ways that are necessary for development. Manipulative toys and activities; freedom to play in the wind, rain, sand, etc.; and positive physical contact all contribute to normal development. In order to understand their world, children must have opportunity to interact with it physically through hands-on activities (Ayers, 1972; Hannaford, 1995; Sylwester, 1995).

Hannaford (1995) refers to the life-sustaining relevance of the sense of touch during the earliest times of a child's life.

> Touch right after birth stimulates growth of the body's sensory nerve endings involved in motor movements, spatial orientation and visual perception (as well as touch). If these nerve endings are not activated, the RAS that awakens the neocortex will not operate fully. This leads to impaired muscular movements, curtailed sensory intake, and a variety of emotional disturbances and learning defects.
>
> The absence of touch may so slow nerve development that essential bodily function development may not occur, and death ensues. In a study done in orphanages in France during World War II, orphans that were not touched exhibited high premature death rates. Even negative touch (spanking or beating) resulted in a much reduced death rate. Joseph Chilton Pearce talks of a program ("Project

> Kangaroo") where premature babies were carried around in a pouch on the front of the nurse or mother, next to the skin. This constant touch has greatly decreased the mortality rate in these preemies. Touch alone stimulates sensory-motor growth, nerve net development and gives the baby a fighting chance at life. (pp. 40-41)

Just as other sensory organs are embedded in the skin, in another "sense," touch is embedded in other organs in favorable learning experiences. "Whenever touch is combined with the other senses, much more of the brain is activated, thus building more complex nerve networks and tapping into more learning potential" (Hannaford, 1995).

A gentle touch of the teacher's hand on the shoulder of a student can do much good. Unfortunately in society there is fear that touch will be used inappropriately. Indeed, a teacher becomes vulnerable to litigation when risk is taken to touch a student. Though such political issues create constraints, the value of supportive touch has much to do with learning and development.

The Senses and Emotion

Sensory input into the brain passes through the limbic area (the emotion center) before moving on to the cerebral cortex (Jensen, 1998). It has long been recognized that the limbic area has been significant in this process. However, Candace Pert's research adds a new dimension to this cache of knowledge. She describes how the senses impact brain processes even before the messages enter the brain. This happens as a result of chemical carriers that respond to sensory input at the site of reception, which can be outside the parameters of what is typically considered the brain organ. Pert (1997) explains,

> We have discovered other anatomical locations where high concentrations of almost every neuropeptide receptor exist, locations such as the dorsal horn, or back side of the spinal cord, which is the first synapse within the nervous system where all somatosensory information is processed. (p. 141)

Pert elaborates on this concept:

> In fact, we have found that in virtually all locations where information from any of the five senses—sight, sound, taste, smell, and touch—enters the nervous system, we will find a high concentration of neuropeptide receptors. (p. 142)

The receptor regions are called "nodal points," which means "hot spots," Pert says, because they are places where a high concentration of information is coming into the body and brain. These nodal points can be "accessed and modulated by almost all neuropeptides as they go about their job of processing information, prioritizing it, and biasing it to cause unique neurophysiological changes" (p. 142), she adds. "Depending on what neuropeptide is occupying its receptors, feelings related to sexual arousal or bathroom functions can be switched or modified, made unconscious, or moved to the most urgent priority" (p. 142)

What is the significance of this finding? Pert explains that "emotions and bodily sensations are . . . intricately intertwined, in a bidirectional network in which each can alter the other" (p. 142). "The efficiency of the filtering process" at the nodal point is determined by the "quantity and quality of the receptors at these nodal points." And that is determined by your previous experiences—yesterday or during childhood. Even the food you had for lunch can be a determiner. As the brain filters and stores this "sensory input," it also associates it with other events or "stimuli occurring simultaneously at any synapse or receptor along the way." This is what learning is all about (p. 142).

In summary, our thinking is shaped by experience, and experience is created through the senses. Hannaford (1995) credits Albert Einstein as having said, "Learning is experience. Everything else is just information" (p. 29).

Exercise and Movement

Movement and Cortical Function

Learning happens as a result of body and mind capacities that interact with each other and with the environment outside the body/mind. Commenting on the growth of body and mind capacities through which we learn, Hannaford (1995) links motor functions as an integral part of these processes. She explains that

> intelligence, which is too often considered to be merely a matter of analytical ability—measured and valued in I.Q. points—depends on more of the brain and the body than we generally realize. Physical movement, from earliest infancy and throughout our lives, plays an important role in the creation of nerve cell networks which are actually the essence of learning. (p. 12)

Hannaford (1995) "seeks to illuminate the many ways that movement initiates and supports mental processes" (p. 12). She concentrates heavily on the importance of merging educational principles with what we know about the physiology of the body and its movements and their influence on brain function. Other brain educator contributors referenced in this study support Hannaford's rationale on the importance of movement to heighten learning potential; however, they do not elaborate on this rationale to the extent Hannaford does.

Carla Hannaford (1995) indicates that "in a study of more than 500 Canadian children, students who spent an extra hour each day in gym class performed notably better on exams than less active children" (p. 101).

The Vanves and Blanshard study in Canada suggests that as much as one-third of the school day should be devoted to physical education. In the research they observed, when students were given this advantage, academic scores improved (Martens, 1982).

Sylwester (1998) uses the tree metaphor to further emphasize the links between movement and cognition and their importance in the classroom.

> Because we humans are mobile throughout life, we need an intelligent cognitive system that can transform sensory input and imagination into appropriate motor output—to decide whether to move or to stay. Mobility is central to much that's human—whether the movement of information is physical or mental. We can move and talk. Trees can't. Misguided teachers who constantly tell their students to sit down and be quiet imply a preference for working with a grove of trees, not a classroom of students. (p. 32)

Jensen (1998) indicates agreement with the concept that movement may take the lead in directing cognition more than previously believed. He graphically depicts brain research reported by Brink (1995).

Jensen (1998) indicates that "projections of axons are far greater *from* areas associated with the storage and production of movement to areas of cognition than the reverse. This suggests that movement may influence cognition more than earlier believed" (p. 86).

Movement Central to Life Functions

With accumulating data and the gradual acceptance of the integral link between movement and cognition, movement's rank is gaining status. Rather than being perceived as a supplement or complement to cognition, there is speculation that movement may be more significant in holistic function than we have previously considered. Gardner (1983) comments on a possible role reversal in this consideration:

> While studies of perception and language have dominated published treatments in neuropsychology, the saga of the brain's role in physical activity proves to be as intriguing as reports about the aphasias or as accounts of the detection of edges, lines, colors, and objects. And indeed, even as bodily intelligence may have been taken for granted, or minimized in importance by many researchers, motor activity has been considered as a less "high" cortical function than functions subserving "pure" thought. Yet, as Roger Sperry, the doyen of American neuropsychologists, has shrewdly pointed out, one should look upon mental activity as a means to the end

> of executing actions. Rather than motor activity as a subsidiary form designed to satisfy the demands of the higher centers, one should instead conceptualize cerebration as a means of bringing "into motor behavior additional refinement, increased direction toward distant, future goals and greater overall adaptiveness and survival value." (p. 210)

Sylwester (1998) classifies movement as central to life itself. He explains that "We have a brain because we have muscle systems that allow us to move toward opportunities and away from danger" (p. 32). Trees outlive us, but they have no brain, and they are incapable of changing their location. Sylwester draws additional attention to this idea through the example of the sea squirt "which initially swims about until it permanently attaches to a rock or coral. It then begins the rest of its immobile life by eating its now superfluous brain" (p. 32). This somewhat comical comparison is Sylwester's (1998) introduction to the serious consideration of the importance of movement to the human brain. He elaborates on the integration of mind and body via motor function:

> Although a cognitive decision to move may involve billions of neurons, only about a half-million motor neurons activate the muscle groups that make up almost half our body's weight. Our jointed motor system, with its complex brain-muscle connections, provides our brain with a remarkably effective external mechanism for action. It comprises the toe/foot/leg system that's about half our body's length, the finger/hand/arm system that extends our reach about two feet beyond our body, a flexible neck that increases the geographic range of our head's sensory receptors, and a remarkable mouth that begins digestion and also communicates through both sound and expressive facial movements. (p. 32)

Movement and Neurochemistry

Physical exercise also facilitates the body's production of necessary neurochemicals needed to maintain emotional stability, which in turn helps the brain function better at learning and remembering. Emotional stress contributes to increased endorphin levels in the system and potential imbalance among neurotransmitters.

Hannaford (1995) states:

> Balanced aerobic activity, where we don't go beyond our bodies' messages and secrete endorphins, increases oxygen intake so important to learning. Aeorbic exercises such as swimming, walking, running, and cycling that use the large muscles of the body, mainly legs, are healthful activities that keep the heart rate up. The President's Council on Physical Fitness and Sports recommends a minimum of half an hour per day for physical and intellectual health. Doctors and psychotherapists dealing with stress in patients are now recommending exercise, particularly walking (the Cross Crawl), as a highly effective stress-management therapy.
>
> Non-competitive, co-operative physical education programs that encourage student input are fun for everyone. They decrease the stress and, therefore, increase learning power. Taking the unnecessary competition out of our lives will render them less painful and decrease the need for endorphins. (p. 174)

Jensen (1998) cites research that highlights benefits of physical exercise and its positive effects on the body's neurochemistry and cognitive function. Giving an overview of these studies, Jensen states:

> Neuroscientists at the University of California at Irvine discovered that exercise triggers the release of BDNF, a brain-derived neurotrophic factor (Kinoshita, 1997) This natural substance enhances cognition by boosting the ability of neurons to communicate with one another. At Scripps College in Claremont, California, 124 subjects were divided equally into exercisers and nonexercisers. Those who exercised 75 minutes a week demonstrated quicker reactions, thought better, and remembered more (Michaud and Wild, 1991). (p. 86)

Coordinated Movement and Learning

Motor function throughout the body requires a high level of coordination. The ability to swallow, to track the eyes, to maintain balance, to walk, to speak, and the many other functions common to life are extremely complex and require tremendous precision. Jensen (1998) describes this complexity and the required inter-relationships among varying systems and organs:

> Our brain creates movements by sending a deluge of nerve impulses to either the muscles or larynx. Because each muscle has to get the message at a slightly different

> time, it's a bit like a well-timed explosion created by a special effects team. This amazing brain-body sequence is often referred to as a spatiotemporal (space-time) pattern. Researcher William Calvin calls it a cerebral code. While simple movements like gum chewing are controlled by basic brain circuits nearest the spinal cord, complex movement, like those with sequences, are controlled at the subcortical levels, like the basil ganglia and cerebellum. But novel movements shift focus in the brain because it has no memories to rely on for execution. Suddenly we engage the prefrontal cortex and the rear two-thirds of the frontal lobes, particularly the dorsolateral frontal lobes. This is an area of the brain often used for problem solving, planning, and sequencing new things to learn and do (Calvin 1996). (p. 85)

Hannaford (1995) alludes to the problem lurking in schools that is counterproductive to empowering learning through movement. Specifically, she discusses the potential harm that can result when educators' expectations for students are not aligned with motor development and readiness.

> From the earliest grades, school children are taught not to move their bodies during class. They are also taught not to move their eyes beyond a blackboard or their desk. But these restrictions ignore the fact that seeing and "lens resiliency" are intimately connected with movement. The eye ball is not completely shaped with collagen fibers until approximately age nine. Therefore, long periods of reading without relaxing the focus into the distance could possibly cause inflammation and the enlargement of the eyeball leading to myopia or near-sightedness. (p. 105)

Hannaford (1995) explains that eye movement, a seemingly simple, minor movement procedure, is profoundly influential on how knowledge is accessed and perceived. Similarly, she addresses the complexity and importance of infantile motor skill acquisition and its powerful impact on overall learning ability. Gardner (1993) also emphasizes the profound relationship between motor function and perception:

> By the same token, the individual's perception of the world is itself affected by the status of his motor activities: information concerning the position and status of the body itself regulates the way in which subsequent perception of the world takes place. In fact, in the absence of such feedback from motor activity, perception cannot develop in a normal way. (p. 211)

"The more closely we consider the elaborate interplay of brain and body, the more clearly one compelling theme emerges: movement is essential to learning," Hannaford

(1995, p. 96) explains. Hannaford's message is that brain function is promoted by physical activity. She continues with this thought:

> Movement awakens and activates many of our mental capabilities. Movement integrates and anchors new information and experience into our neural networks. And movement is vital to all the actions by which we embody and express our learning, our understanding and our selves. (p. 96)

Jensen (1998) echoes Hannaford's emphasis on the importance of movement. He explains that the part of the brain that is significantly involved with motor function is the cerebellum. That organ "takes up just one-tenth of the brain by volume, but it contains *over half* of all its neurons. It has some 40 million nerve fibers, 40 times more than even the highly complex optical tract" (p. 83). Further describing the importance of the cerebellum, Jensen (1998) says,

> At the 1995 Annual Society of Neuroscience Conference, W. T. Thatch Jr. chaired one of the most well-attended symposiums: "What is the Specific Role of the Cerebellum in Cognition?" He's a researcher at the Washington University School of Medicine who's been pulling together data for years. The 800 attendees listened carefully as the panel made a collective assault on a neuroscience community blinded by years of prejudice. Nearly 80 studies were mentioned that suggest strong links between the cerebellum and memory, spatial perception, language, attention, emotion, nonverbal cues, and even decision making. These findings strongly implicate the value of physical education, movement, and games in boosting cognition. (p. 84)

Movement and Other Benefits

Jensen further suggests that ample physical activity in schools could reduce violence and behavior problems. "With sufficient supply of the needed 'drug' of movement, the child is fine. Deprive him or her of it, and you get problems" (p. 85).

"In the same way that exercise shapes up the muscles, heart, lungs, and bones, it also strengthens the basal ganglia, cerebellum, and corpus callosum, all key areas of the brain" (p. 85). In addition to developing the structures of the brain, Jensen, citing Brink

(1995), says that "exercise fuels the brain with oxygen, but it also feeds it neurotropins (high-nutrient food) to enhance growth and greater connections between neurons. Aerobic conditioning also has been known to assist in memory" (p. 86).

Music and the arts are other forms of physical movement that are discussed among the brain educators referenced in this study. Sylwester (1998) and Weinberger (1998) discuss the advantages of these activities in promoting brain growth and stimulation. This will be discussed further in another section.

This overview suggests that though physical education and the arts may be among the first programs cut from school curricula when budget constraints present themselves, they possibly should be among the last to be cut. Neuroscientists concur that physical activities of many kinds are critical to brain and body function and to learning environments. (Jensen, 1998, p. 82; Sylwester, 1998, p. 31; Weinberger, 1998, p. 36)

In summary, exercise and movement profoundly stimulate: mental function, neurochemistry needed to support body and brain activities, development of coordinated abilities upon which life skills and knowledge acquisition depend, and other important functions that contribute to holistic development. The body and mind clearly function in a connected, complex relationship that is vital to cognitive processing and body function, as well.

Both brain and body are significantly affected by the health habits that are practiced. This is the focus of the next section.

Health Habits

Healthful practices are purported to benefit overall brain function including: cognition, learning, memory, plasticity, longevity, brain/body tissue structure, neurochemical balance, immunity, attention and alertness, brain-positive blood pressure, systemic balance, early developmental effects, and attitudinal and emotional posture (Diamond & Hopson, 1998; Hannaford, 1995; Healy, 1990; Jensen, 1998).

As previously established, an interconnectedness exists between mind and body. The brain and body are mutually dependent entities that cannot function independent of each other. Subsequently, it seems logical to assume that health practices–ways we care for the body–would directly affect brain health as well as body health.

Diet and Nutrition

"Proper nutrition can definitely boost thinking and learning" (p. 72), Jensen (1996) observes, and Barbara K. Given (1998), Graduate School of Education Professor at George Mason University, suggests that "You think what you eat." The "building blocks of the brain and body" are made available through the intake of food and nutrients.

In the past 30 years we have come to understand the importance of vitamins and minerals for optimal health. But how are these related to learning? Jensen (1996) reports a number of studies where

> multivitamin supplements showed a significant increase in visual acuity, reactive time and intelligence over those who took a placebo. . . . Over half of his [Levy's Alzheimer] patients showed significant memory improvement after drinking two milk shakes daily containing 35 grams of lecithin, an acetylcholine booster. . . . Folic acid and selenium were discovered to reduce depression and boost learner performance. . . . Boron, iron and zinc supplements improved mental activity. (pp. 73-74)

Nutrition is important for many body functions. First, food supports body chemistry—for direct supply of chemical substances, for elements needed for chemical conversion processes, and for triggering systemic functions. The body's neurochemistry profoundly influences all body functions and at varying levels. Some of the nutritional input the body receives is translated into neurotransmitters of which there are three types—classical, steroid, and peptide. Of these three, peptides outnumber the others by 95% (Pert, 1997, pp. 24-25). Candace Pert describes the expansive influence of peptides.

> As investigations continue, it is becoming increasingly apparent that the role of peptides is not limited to eliciting simple and singular actions from individual cell and organ systems. Rather, peptides serve to weave the body's organs and systems into a single web that reacts to both internal and external environmental changes with complex, subtly orchestrated responses. Peptides are the sheet music containing the notes, phrases, and rhythms that allow the orchestra—your body—to play as an integrated entity. And the music that results is the tone or feeling that you experience subjectively as your emotions. (p. 148)

So where do we get peptides? Peptides are made of amino acids which come from proteins. When protein foods are consumed, enzymes in the stomach trigger the release of different amino acids (Wurtman & Stuffes, 1996/1997).

> Tyrosine and tryptophan are two examples. The first enhances thinking; the latter slows it down. Your brain uses tyrosine to make the neurotransmitters dopamine and norepinephrine, two electrically charged chemical messengers that are critical to alertness, quick thinking and fast reactions. These neurotransmitters can help your brain to perform calculations, increase attention span and increase conscious awareness. (Jensen, 1996, pp. 72-73)

In this process, appropriate neurotransmitters are dispersed from the midbrain to hundreds of thousands of cell receptors. When this happens, feelings of alertness, attention, motivation, and mental energy are realized (Pert, 1997, pp. 21-31).

Diamond (1998) reports on the research of Pollitt, who along with four other researchers from the United States and Central America, studied

> [two-thousand] children in four Guatemalan villages for nearly a decade. In two villages, they supplied the mothers and children with a hot maize gruel full of protein and vitamins to supplement their normal meals. In the other two villages, the mothers and children received a high-calorie vitamin-filled fruit drink but no extra protein. By tracking the children's progress for eight years, they found that fetuses, infants, and children on the protein supplement grew and developed skills faster, had more energy, and made better social and emotional progress than children the same ages consuming less protein. With an enrichment program of tutors and counselors to help the children learn games, social skills, and preschool activities, both groups did

> better than without the enrichment. The well-fed youngsters, however were able to play, experiment, and explore their environment more fully, and this, in turn, promoted their brain growth. (pp. 84-85)

When excess protein is consumed, it is stored in muscles and can be used later. However, when not enough protein is available in the system, the individual may crave or desire foods that will supply the pleasant feelings experienced when adequate nutrition is available. Desire for caffeine, alcohol, chocolate, etc., can result from this lack of needed protein (Restak, 1993/1994). For children who experience these deficits, behavioral problems can result and learning can be thwarted (Given, 1998).

A major energy source for our bodies is carbohydrates, the main ingredients in vegetables, fruits, and grains (and dairy sugar). Carbohydrates in their natural form are complex sugars, which the body must digest or break down to simple sugars for use in the brain. Complex carbohydrates are more efficiently used in the body because they require a longer period of time to process through the digestive process. This more lengthy process yields a slow release of usable sugar. With refined sugar, the utilization of the sugar happens more rapidly because the sugar has already been broken down to its simpler state. In that situation the sugar level in the blood rises and falls quickly, leaving the host with a let-down feeling, often accompanied by irritability and decreased overall function. Hannaford (1995) adds additional detail to this carbohydrate breakdown process:

> Each of these sources [grains, fruits, vegetables and dairy sugar] contains two simple sugars, one of which is a molecule of glucose—the main source of energy for the brain. This is the molecule that is broken down (oxidized) by oxygen to yield energy that is then trapped in ATP, leaving carbon dioxide (CO2) and water, which are exhaled to be recycled by plants back into more food. Carbohydrates are essential, but they must be balanced with proteins and fats. (p. 152)

In identifying some "stressors people face in their lives that limit frontal lobe development," Hannaford (1995) lists "inadequate amounts of proteins, lack of essential amino acids and fatty acids, high carbohydrate and sugar diets" as nutritional stressors (p. 136). She says that when asked what she would do immediately to assist learning, one of the things she suggests is to "decrease or, better yet, eliminate simple sugars in people's diets" (p. 152).

Without balanced nutrition the body is compromised for maintaining its dynamic, complex functions. Cars and people cannot function without a source of energy—fuel. When necessary nutrients are absent, the body may attempt to draw those nutrients from its own cellular structures. Malnutrition during pregnancy is especially harmful to the unborn child. Low birth weight and thinner cortex are two of the indicators of affected development because of malnutrition. However, in such a situation, these affects can be almost reversed if intervention occurs before the age of 3 and if the child is provided with an enriched environment (Diamond & Hopson, 1998).

The basic building blocks the body requires from nutritive input include protein, carbohydrates, and fats. These are the raw materials needed for healthy bodies and nervous systems. Hannaford (1995) cautions that eating the wrong things, like refined sugar, can compromise the body's "ability to protect and restore itself" (p. 151). She elaborates on the advantages of proper intake of the needed nutrients:

> Proteins and fats provide the major building blocks for the membranes of all the cells in our body. Specifically, they form the structure of the dendrites and developing nerve networks. Proteins also form the structure of the sodium-potassium pump to maintain polarity and assure proper nerve transmission throughout our system. In addition, they are involved in the hemoglobin structure (which enable blood to transport oxygen), in the contractile elements in muscle fibers, and serve as antibodies, hormones and enzymes. (p. 151)

Nutrition is an important part of brain function and learning. A well balanced diet includes a large variety of fruits, vegetables, and grains; appropriate amounts of protein (based on body size and age; and controlled amounts of fat, calories, cholesterol, sugar, and salt (Craig, 1993, p. 5). Without vital nutrients, mental and physical functions diminish proportionately according to intake. And Jensen (1995) suggests that the "brain runs better on a nibbling diet" (p. 159). He suggests that "too much time in between eating can cause loss of concentration and decreased alertness" (p. 158). Educational environments can benefit student performance by promoting sound nutritional principles as part of curriculum and programming (Craig, 1993; Diamond & Hopson, 1998; Given, 1998; Hannaford, 1995; Healy, 1990; Jensen, 1996).

Water

Water is a fundamental building block of the body. "It makes up from 45% to 75% of our total body weight. . . . Water comprises more of the brain (with estimates of 90%) than any other organ of the body, with muscles next at 75%, and then kidneys," says Hannaford (1995, p. 138).

Jensen (1995) summarizes the research by saying that

> Dennison, Ward, and Daly assert that the average learner is often dehydrated. This dehydration leads to poor learning performance. Hospitals have reported improved patients when they are encouraged to drink up to 20 glasses a day. Athletes have learned to boost water consumption for peak performance. Performers in theater have learned to keep a pitcher of water nearby for their best effort. More and more educators have found that pure water does help learner performance.
>
> Brain specialists recommend from 8-15 glasses per day, depending on your body size, weather and your activity level. Nutritionists recommend pure water to insure that it is free of contaminants. It's also better to have pure water than coffee, tea, soft drinks or fruit juices. This is because the caffeine and alcohol found in many of them serve as diuretics and your body needs even more water to make up the deficit. (p. 157)

Hannaford (1995) provides the biological explanation by showing that water is essential for the electrical transmissions within the nervous system. It is these transmissions "that make us sensing, learning, thinking, acting organisms" (p. 139).

> Water plays a critical role in the maintenance of proper cell membrane polarity. The water/electrolyte balance is so critical to the living system that if the membrane potential within the cells drops to –30 mv and remains there, death will ensue. This can occur through radical dehydration or malnutrition. (p. 140)

Clearly, adequate water is basic to optimal body function.

Oxygen

"Oxygen is, of course, critical to the brain. The brain uses one fifth of the body's oxygen. If the blood supply [the carrier of oxygen] to the brain is interrupted, we lose consciousness in seconds," states Jensen (1998, p. 10) (brackets supplied). Where do we get oxygen? It comes from the air we breathe and is carried in the bloodstream in the red-blood cells. Inadequate movement and therefore shallow breathing are connected to lowered levels of available oxygen. Jensen (1998) and Hannaford (1995) both report on a national study that found only 36.3% of school children in America have daily physical education classes. The implication here is that without the bodily exercise that physical education requires, deep breathing activity is less likely. Hannaford (1995) says, "It takes a physically fit body to supply the massive oxygen needs of the brain. Movement is not only essential for nerve net development and thought, but also for adequate heart and lung development to support brain function" (p. 146).

Why is oxygen so important? It is necessary for many body functions. Oxygen is a critical element in the process of breaking down food particles and releasing energy for production of ATP—that element that "traps energy from food and makes it available to structures within the cell" (Hannaford, 1995, p. 146).

Clearly, some brain educators are advocating that children and adults need copius amounts of clean, fresh air. Hannaford (1995) reports that

> smoking during pregnancy is implicated in low birth weight babies and a higher percentage of children with learning disabilities. Preschool children whose mothers smoked heavily (ten or more cigarettes daily) during pregnancy scored significantly lower (an average of 9 points) on standardized IQ tests than kids whose mothers did not smoke. Also smoke-exposed children may not reach their full intellectual potential. Cigarette smoke contains an estimated 2,000 to 4,000 chemicals, some of which could damage developing nerve cells. (p. 147)

Recent research on sudden infant death syndrome (SIDS) reveals that infant exposure to secondhand smoke increases the risk of sudden infant death (Jones, Riley, & Dwyer, 1999; Nachmanoff et al., 1998; Storm, Nylander, & Saugstad, 1999; Tanaka et al., 1999). This research cited here indicates that cigarette smoke negatively affects cardiac, respiratory, and brain function. In addition, smoking during pregnancy is believed by some to cause deficits in growth and bone mass in prepubertal children (Jones et al., 1999).

In summary, students perform better when they have an abundance of fresh air and opportunities to exercise in order to promote deeper breathing.

Sleep

Sylwester (1995), Jensen (1995, 1996), and Hannaford (1995) all suggest the need for deep sleep. The "science" of sleep unfolds with a mixture of ideas about cycles of REM (rapid eye movement) and non-REM sleep and the dreams that occur during REM and what they mean. Jensen (1995) suggests that "the brain has its own particular cycles of functioning and requires deep, non-threatening rest so that it can utilize the REM stages properly for dreams and down-time processing" (p. 55).

Sylwester (1995) believes that during sleep the brain "reconstructs and resets the memory networks that have emerged out of the day's events" (p. 98). Hannaford (1995) says that "dreaming is important for the processing of emotional events and even appears to assist in the release of emotionally stressful situations" (p. 68). In Jensen's (1995) research summary he credits Hopfield (1983) with the idea that "sleep gives your brain time to do some 'housekeeping' and rearrange circuits, clean out extraneous mental debris and process emotional events" (p. 52). Jensen (1995) adds that

> Hopfield suggests that the real reason for this may be a concept called "unlearning." Using complex mathematical and computer modeling, he discovered that neural networks can become much more efficient when certain memories are "unlearned." In fact, in his research, the role of REM sleep was critical for the brain to process the days events. By eliminating unnecessary pathways or information, the brain becomes much more efficient. (p. 52)

In summary, "sleep enhances the creation, editing, and erasing of memories" (Sylwester, 1995, p. 98). So how might that affect learning? Jensen (1995, 1996) suggests that sleep-deprived learners may be able to remember rote material but that more complex ideas and higher-level problem-solving exercises will be more difficult.

The research on educational applications of optimal sleep is limited, but it seems inevitable that memory researchers will continue to try to sort out the role that sleep plays in the development, maintenance, and retrieval of long-term memory.

Summary of Mind and Body Connections

In the past the mind has been considered as an entity separate from the body. However, neuroscience suggests that the two are so intimately related, the concept of separateness does not fit. Sylwester (1995) describes this intimacy in regard to the relationship between skin and brain, for example, when he says, "We might therefore consider our skin the outside layer of our brain because it's where our brain meets the outside world" (p. 57). The brain's borders are not confined to the skull. Its neural networks reach into all parts of the body.

Through the senses the brain communicates with the outside world. The greater the sensory input, the better the outside world is represented in the mind.

Health habits affect the quality of brain function by enhancing or dulling sensory reception. Proper diet, adequate water, fresh air, ample sleep, and physical exercise are critical to keeping body tissues healthy and functioning well. These factors directly relate, also, to the brain/body's neurochemistry, which is a major issue in the following discussion of *brain/body/emotion connections.*

Mind/Body/Emotions Connections

Introduction to the Issues

The previous section provided evidence that the relationship between brain and body can no longer be accurately viewed from a reductionist, fragmentary, and linear perspective. Mind and body are linked as one in the processes of cognition. Another component is now added to this dynamic twosome to further develop the concept of cognition—*emotion.*

Because of recent research findings involving the nature of emotion and its relationship to the learning process, the word *emotion* is semantically changing in educational environments. In the general population, emotion is thought of as the opposite of rational, logical thought. In an article in the *Journal of Moral Education,* Barrett (1994) discusses emotion as "a lapse from rationality." For many the word *emotion* tends to conjure up thoughts of uncontrollability, flightiness, whimsical function, and sometimes even a sinister affect (Jensen, 1998, p. 72).

Webster's College Dictionary (Braham et al., 1999, p. 430) reflects the polarity *emotion* elicits in the following definition:

> 1. an affective state of consciousness in which joy, sorrow, fear, etc., is experienced, as distinguished from cognitive and volitional states of consciousness. 2. any of the feelings of joy, sorrow, hate, love, etc. 3. a strong agitation of the feelings caused by experiencing love, fear, etc. (p. 430)

Historically, in some cultures more than in others, emotion is considered a distraction to learning. "Some still believe that learning and emotions are at opposite ends of the spectrum" (Jensen, 1998, p. 71).

Evidence of emotion is often viewed as a sign of weakness or of evil and is equated with female characteristics; whereas, rational, less emotional thought is related to strength and to male characteristics. These notions of gender differences and tension between rational thought and emotion are sometimes discussed in the broader context of power and communication (Cole, Engestrom, & Vasquez, 1997, p. 15). Emotion carries strong meaning culturally and politically.

Emotion has long been categorized with subjectivity, and rationality with objectivity. Traditionally quantitative research—considered to be logical-rational attempts to objectify the world–has dominated academic studies. However, more recently qualitative research has received higher recognition in the academic community. This increase in popularity seems to have occurred simultaneously with the rise in appreciation for the role of emotion in the cognitive process.

Caine (1999) discusses emotion's historical past:

> Scientists' conception of the role emotions play in learning has vacillated. At times in the early part of the century, for example, emotions were largely ignored because the inner workings of the mind tended to be disregarded. Behaviorists were interested in observable, quantifiable phenomena and emotion. Since then, at least in the field of education, emotions have been treated as important but basically separate

> from thinking. Separating emotion from thinking has been the educational profession's way of acknowledging both while not effectively addressing the ways that they operate together. (p. 30)

As data have accumulated to provide a better understanding of emotion and cognition, early commentary suggested that emotional thinking took place on the right side of the brain, and rational thought was common to left-brain function. Current research does not support this assumption. In her dissertation research at California School of Professional Psychology, Katherine L. Bowman (1990) found evidence of lateralization of emotional function in the brain. However, the results of her study did not indicate that right-hemisphere lateralization was responsible for emotional stimuli.

Even though emotion may have been misaligned in the past, as brain research accumulates, *emotion* is being redefined. The verity of emotion's new definition is evidenced in the writings of those who review current brain research. After her review of what neuroscience has to say to educators, Alice Brand (1999), a presenter at the Conference on College Composition and Communication, contends that cognition without emotion would preclude memory and learning. Brand describes emotion in terms of its relationship to cognition by referring to it as an "emotional/cognitive continuum." She also references an element of sequencing in emotion's influence on cognition. Brand indicates that there are nerve pathways that lead directly to the amygdala. Signals traveling to the amygdala arrive there about 40 milliseconds before they reach the intellectual part of the brain. The amygdala influences memory and intellectual processing in the brain. I reads emotion before it is processed in the cortex, according to Brand (1999).

As a result of research done by LeDoux (1996), Damasio (1994), Pert (1997), Restak (1995), and others, emotion is becoming recognized as an integral part of cognition. "Emotion and cognition interact, energize, and shape each other. It is useful and appropriate, at times, to speak of them separately, but they are inseparable in the brains and experiences of learners" (Caine, 1999, p. 30).

Educational assimilators of brain research and pedagogy, such as Caine (1991), Hannaford (1995), Healy (1990), Jensen (1998), Kovalik (1998b), Sylwester (1995), Wolfe (1998), and others are recognizing, redefining, and reconceptualizing this new body of information to fit with instructional practice. However, changing previous "beliefs is not easy and can involve significant emotional volatility" (Caine, 1999, p. 31).

Robert Sylwester (1995) describes emotion as "the glue that bonds the body/brain integration" (p. 75). This concept is developed in the following section.

Three major sections are included below: *the physiology of emotions; emotion's profound influence on cognition*, and *Music and the Arts in Education..* In the first section, the science of mind, body, and emotion is discussed in context of how the brain/body's neurochemistry affects brain function and how emotion creates in the heart cavity brain/body messages that profoundly influence systems throughout the brain and body. The second section discusses how emotion affects learning and how music and the arts function to create emotion-rich learning advantages.

The Physiology of Emotions

In the previous section on body and mind, a major focus was the idea that what happens to and throughout the body is part of the cognitive process. Sylwester (1995, p. 75) suggests that our body and brain are integrally linked as a mutually beneficial biochemical system involving brain, immune, and endocrine systems that affect heart, lungs, stomach, skin, and all other organs and systems throughout the body. Emotion plays an important role in this parallel-processing (rather than linear), biochemical system (Sylwester, 1995, p. 18).

For many years a big question among neurochemists has been, "Where does emotion originate—in the body or in the brain?" (Pert, 1997, p. 135). In the 1970s an answer began to emerge for Candace Pert, who at that time was doing research under the tutelage of Solomon H. Snyder at Johns Hopkins University and later at the National Institute of Health. As she sought to know more about how certain drugs function within the body's cell structures, she made observations which suggested new concepts about emotion's origins. Pert found evidence that cells throughout the body, not just in the brain as previously believed, contain receptors that translate neurochemical messages into neuron activation. Pert ties her findings to relationships between thinking and feeling and acting. In her book *Molecules of Emotion*, Pert (1997) explains emotion in terms of biochemistry that originates at cellular receptor sites throughout the body. "Peptides are the sheet music containing the notes, phrases, and rhythms that allow the orchestra—your body—to play as an integrated entity. And the music that results is the tone or feeling that you experience subjectively as your emotions" (p. 148).

Pert (1997, p. 137) concurs with the idea that mental and emotional functions are parallel, simultaneous functions, like traffic on a two-way street. She suggests that this process cannot be described adequately as a linear process and refers to the relationships between the body's neurochemistry and the body's physiology as a symbiotic, mutually dependent process. Neurochemistry transfer among cells throughout the body carries emotional messages that actually drive learning.

> I'd say that the fact that memory is encoded or stored at the receptor level means that memory processes are emotion-driven and unconscious (but, like other receptor-mediated processes, can sometimes be made conscious). (p. 143)

Receptors referred to here are the sites on cells that receive neurochemicals available in body fluids. These receptors and their function represent a "new theory of information exchange outside the bounds of the hardwired nervous system, [a new theory] focused on a purely chemical, nonsynaptic communication between cells" (1997, p. 138). Prior to Pert's findings, brain function was described in linear terms—as a transfer of messages at the synapse, a part of neuronal (axon-dendrite) activity. Such a description is accurate, but incomplete. Pert discovered an additional, complementary communication system within the body and brain, which alters, refines, prioritizes, and/or biases the sensory input taking place in neuronal and cell activity. These findings indicate that cells are capable of communicating with each other via neurochemical exchange, not limited to synaptic function.

Pert (1997) explains that not just in the brain is sensory input received, but at locations at other specific sites throughout the body.

> In fact, we have found that in virtually all locations where information from any of the five senses—sight, sound, taste, smell, and touch—enters the nervous system, we will find a high concentration of neuropeptide receptors. We have termed these regions "nodal points" (or, colloquially, "hot spots") to emphasize that they are places where a great deal of information converges. The information is carried by axons and dendrites from many nerve cell bodies that are passing near or making synaptic contact with each other. (p. 142)

Pert suggests an intimate relationship exists between emotion and peptide (neurochemical) function in the body. "Emotions and bodily sensations are thus intricately intertwined, in a bidirectional network in which each can alter the other" (p. 142). She further explains:

> And when we focus on emotions, it suddenly becomes very interesting that the parts of the brain where peptides and receptors are richest are also the parts of the brain that have been implicated in the expression of emotion. I don't remember whether it was Michael [Ruff] or I who said the words first, but both of us had the gut feeling that we were right: "Maybe these peptides and their receptors are the biochemical basis of emotion." Finally, we were looking at the implications of the fact that the limbic system had the densest concentration of these receptors. Could it be that what we were seeing were the molecules of emotion? (p. 178)

Pert defines learning in relation to the process of neurochemical message transfer taking place throughout the body, not just in the brain.

> Think of the brain as a machine for not merely filtering and storing this sensory input, but for associating it with other events or stimuli occurring simultaneously at any synapse or receptor along the way—that is learning. (p. 142)

Further, Pert more specifically describes how emotions function in the body's neurochemistry and in learning. (She defines a ligand as "any natural or manmade substance [drug] that binds selectively to its own specific receptor on the surface of a cell," p. 24.)

> One extremely important purpose of emotions . . . is to help us decide what to remember and what to forget. . . . Clearly, just as drugs can affect what we remember, neuropeptides can act as internal ligands to shape our memories as we are forming them, and put us back in the same frame of mind when we need to retrieve them. This is learning. In fact, we have shown that the hippocampus of the brain, without which we can not learn anything new, is a nodal point for neuropeptide receptors, containing virtually all of them.
>
> Emotional states or moods are produced by the various neuropeptide ligands, and what we experience as an emotion or a feeling is also a mechanism for activating a particular neuronal circuit—simultaneously throughout the brain and body—which generates a behavior involving the whole creature. (p. 145)

Clearly, throughout Pert's writings, she strongly suggests that mind, body, and emotion are all three critical elements in cognition.

Emotion's Profound Influence on Cognition

In the middle 1980s educators began to focus attention on emotion as it relates to the educational process. Current commentary on emotion-related brain research and its relevance to education seems to indicate that a better understanding of emotion can help educators facilitate learning. (Caine & Caine, 1991; Campbell, 1997; Diamond & Hopson, 1998; Goleman, 1997; Hannaford, 1995; IHM, 1997; Jensen, 1998; Kagan, 1994; LeDoux, 1996; McCraty, Atkinson, Tomasino, & Tiller, 1997; Pert, 1997; Sylwester, 1995)

Interestingly, in a paralleled way Sylwester (1995) pulls this connection between emotion and cognition toward application in the classroom by using the same association that Pert (1997) used—the binding nature of emotion.

> Think of our emotions as the glue that bonds the body/brain integration—and peptide molecules and emotion mechanisms as the physical manifestation of the bonding process. We could also imaginatively think of emotions as the glue that could help us make an integrated curriculum out of a curriculum composed of separate, logically defined disciplines. (Sylwester, 1995, p. 75)

Just as the limbic (emotion and memory) center of the brain is crucial to mental processes, learning situations that allow students to subjectively *and* objectively experience knowledge acquisition is highly recommended. Reiterating the need to treat emotion as an integral part of cognition, Sylwester (1995) adds:

> By separating emotion from logic and reason in the classroom, we've simplified school management and evaluation, but we've also then separated two sides of one coin—and lost something important in the process. It's impossible to separate emotion from the important activities of life. Don't even try. (p. 75)

Kagan, Damasio, LeDoux, Pert, and others contribute to what is known about emotion and how it affects the way the brain functions and learns. In addition, R. Caine and G. Caine (1999; 1991; 1994; 1997; 1997a), Diamond (1988; 1998), Hannaford

(1995), Healy (1990), Jensen (1995; 1996; 1998), Kovalic (1998a; 1998b), Smilkstein (1998), Sylwester (1994; 1995; 1997; 1998), and others have translated and continue to translate this neuroscientific data into practical application.

Diamond (1998, p. 123), Jensen (1998), and Pert (1997, p. 132) reference the research of Jerome Kagan. Kagan warns against oversimplifying, misinterpreting, or sensationalizing new data on body/brain neurochemistry and their possible implications for medical or political dilemmas. These cautions are appropriate and apply to education as well. Education professionals work with large numbers of people. In this position they can benefit many with additional applied knowledge; however, there is a need for reliable translation of neuroscience findings into educational terminology.

Pert (1997) refers to decentralized memory capability throughout the body by explaining:

> We know that the immune system, like the central nervous system, has memory and the capacity to learn. Thus, it could be said that intelligence is located not only in the brain but in cells that are distributed throughout the body, and that the traditional separation of mental processes, including emotions, from the body is no longer valid. (p. 187)

Further, Pert (1997) adds:

> Using neuropeptides as the cue, our bodymind retrieves or represses emotions and behaviors. Dr. Eric Kandell and his associates at Columbia University College of Physicians and Surgeons have proved that biochemical change wrought at the receptor level is the molecular basis of memory. When a receptor is flooded with a ligand, it changes the cell membrane in such a way that the probability of an electrical impulse traveling across the membrane where the receptor resides is facilitated or inhibited, thereafter affecting the choice of neuronal circuitry that will be used. These recent discoveries are important for appreciating how memories are stored not only in the brain, but in a psychosomatic network extending into the body, particularly in the ubiquitous receptors between nerves and bundles of cell bodies called ganglia, which are distributed not just in and near the spinal cord, but all the way out along pathways to internal organs and the very surface of our skin. The decision about what becomes thought rising to consciousness and what remains an undigested thought pattern buried at a deeper level in the body is mediated by the

> receptors. I'd say that the fact that memory is encoded or stored at the receptor level means that memory processes are emotion-driven and unconscious (but, like other receptor-mediated processes, can sometimes be made conscious). (p. 143)

Again, Candace Pert's discovery of the opiate receptor, and receptor cites throughout the body that are intimately connected with the neurochemistry of the brain, has led the way for additional confirming research which empirically and integrally links emotions with body function, learning, and health.

Brain research data support the use of humor in learning environments because of the effect light-hearted emotion has on releasing neurotransmitters which lessen stress and promote more optimal conditions for learning.

"Freeze-Frame" is a technique developed by Institute of HeartMath (IHM) to help individuals reestablish coherence and entrainment mode when strong emotions are adversely influential. It involves a specific method of redirecting thought to positive feelings of care, love, appreciation, etc., and sustaining those thoughts for 10 seconds or more. Educators who are using IHM techniques do so to help students learn to control emotional extremes which are counterproductive to overall health, behavior, and acquisition and retrieval of memory stores.

Marian Diamond (1998) refers to research done at the Institute of HeartMath, an organization that delves into the connections between heart and brain function. Pribram and Rozman

> have found additional evidence for how parental behavior may influence a child's brain development. They recorded the effects of love, care, and other positive emotions in creating coherent electrical patterns in children's heartbeat rhythms. They also measured the effects of stress, anger, and negative emotions in creating jagged, incoherent electrical patterns. Heart rhythms, they say, feed back information to the developing amygdala, and this region, along with its connections to the frontal lobes and other areas, comes to register the emotions that feel familiar and comfortable to the child—whether disharmonious and accompanied by jagged heart patterns, or harmonious with coherent patterns. Like many experts, Pribram and

> Rozman consider the first few years of life to be crucial in this "imprinting" of emotional brain regions. (p. 127)

Presenting at a White House Conference on Early Childhood Development and Learning, Karl Pribram, M.D., Ph.D., of Radford University Department of Psychology, and Deborah Rozman, Ph.D., of IHM, described the biology of heart/brain communication and its relationship to learning:

> The heart has an electrical field that is very strong, and the coherence of the heart's rhythms can change the coherence of brainwave patterns (EEG). The heart sends electrical information about one's emotional state (as measured by coherence) to the cardiac center of the brain stem, which in turn feeds into the intralaminar nucleus of the thalamus and thence to the amygdala. . . . Thus, the intralaminar complex can serve as a focus for relating emotional to cognitive processes in early childhood development as well as later in life. (Pribram & Rozman, 1997, pp. 1-2)

Pribram and Rozman (1997) state, "The heart and blood pressure systems serve as a 'booster' to . . . learning. A Russian scientist expressed this as follows: 'an ounce of emotion is worth a pound of repetition'" (p. 2).

If a young child is exposed to excessive states of incoherence, this can affect future learning and social relationships, say Pribram and Rozman (1997).

> In short, the amygdala organizes what becomes "familiar" to the child, whether coherent or incoherent. If patterns generated by the heart and blood pressure control systems are disordered and incoherent, the baby learns to expect disharmony as the familiar; thus, the child comes to feel "at home" with incoherence, which will affect learning as the child grows. This incoherence also affects peer selection: the child will feel "comfortable" only with incoherence, that is, discomfort among peers. (p. 2)

Students who seem to enjoy acting out and being *at odds* with the world may have been conditioned for this state of mind as a result of having learned to survive in an environment of disharmony and incoherence, Pribram and Rozman suggest.

Summarizing the importance of emotion as a profound influence on cognition, there is strong concurrence within the literature to suggest that a broader understanding of mental processes is needed. According to Hannaford, Damasio, Sylwester, Pert, and others, movement, emotions, and inter- and intra-communications between and among organs and systems throughout the body are as much a part of thinking as is higher-order thinking in the brain's cortex. Recent research findings seem to confirm that body, mind, and emotion operate as synergistic, complementary, and mutually dependent functions. This holistic attitude toward thinking and learning provides reason to consider that the Newtonian-Cartesian paradigm, which describes cognition as a linear, mechanistic process, is limited in representing how thinking and learning take place.

Emotion and neurochemistry are more influential in learning than previously believed. Learning now appears to be dependent on the limbic area (emotion center) of the brain for information processing and for memory storage and recall. This concept is discussed further in the section titled "Making Meaning."

In the next subsection, music and the arts are discussed in the context of providing avenues for incorporating affective (emotional) elements into learning environments.

Music and the Arts in Education

In the United States, Horace Mann focused on the importance of music and the arts in education as early as 1844. By the early 20th century, music was a part of public school education; however, the mode of presentation was often shifted away from performance to "appreciation," and instruction "was often overly structured, the teachers dryly academic" (Campbell, 1997, p. 185).

Music instruction in schools progressed through influences with varying emphases: listening, composing, and performing. Campbell explains that "today, most programs have evolved from European and Japanese teaching methods that synthesize movement, improvisation, and solfege (sight-singing theory)" (p. 185).

Music study and performance incorporate holistic involvement of mental, emotional, and physical processes.

Music and the Arts—Empowerment for Learning

Educational practice in the United States tends toward relating to music and the arts as add-on enrichment for the culturally advantaged child. However, neurophysiologists today are finding more and more reasons to classify the study of music and the arts as foundational for academic and career success. Jensen (1998) proffers that

> for most of the twentieth century, a strong arts program meant you were raising a culturally aware child. But today's biology suggests that it's the arts that lay the foundation for later academic and career success. A strong art foundation builds creativity, concentration, problem solving, self-efficacy, coordination, and values attention and self-discipline. (p. 36)

According to Jensen (1998), music serves to empower learning in at least three different ways: (1) for arousal, (2) as a carrier of words, and (3) as a primer for the brain's neural pathways (p. 37). Explaining these three avenues to cognition, Jensen states:

> Arousal means the music either increases or decreases the attentional neurotransmitters. An example of "perk up" music could be the theme from "Rocky." Relaxing music might include a waterfall or soft piano melodies. This type of music can significantly affect the states of the learners. And that, of course, can affect the learning. A study of 8^{th} and 9^{th} graders reported in *Principal* magazine showed that students' reading comprehension substantially improved with background music (Giles, 1991).
>
> A second use of music is as a carrier. In this case, the melody of the music acts as the vehicle for the words themselves. You may have noticed how easily students pick up the words to new songs. It's the melody that helps them learn the words. How did you learn the alphabet? Most likely it was through the alphabet song. You heard that song over and over as an infant. When it was time to learn the letters, you simply "glued" the letters to the notes of the melody. The result was a quickly learned alphabet.
>
> There is a third, and quite powerful, use of music. It can actually prime the brain's neural pathways. Neurons are constantly firing. What distinguishes the

> "neural chatter" from clear thinking is the speed, sequence, and strength of the connections. These variables constitute a pattern of firing that can be triggered or "primed" by certain pieces of music. . . . Music may, in fact, be critical for later cognitive activities. (p. 37)

Throughout the literature, music and the arts in education are associated with emotional function as part of the learning process. Though this concept is promoted by those who appreciate the dynamic relationship between mental, physical, and emotional function, others are not so appreciative. In an article that appeared in the *Journal of Aesthetic Education*, Maria Spychiger (1995) alludes to the tension between rationality and emotion as she discusses the value of the arts. In Europe and North American, the status of music education is low, Spychiger indicates. Because in Western society there is perceived to be a strong relationship between emotional activity and music, music is not valued highly. Rationality and thought are more dominant, she suggests.

In his book *A Celebration of Neurons,* having already established the critical role emotion plays in learning, Sylwester (1995) speaks of the power music has in communication. He suggests that musical intelligence is an effective way to communicate beyond the confines of the written or spoken word. In his words,

> Songs go far beyond words in their ability to insert emotion into communication. . . . Music doesn't even need words to communicate emotion. Symphony orchestras, jazz combos, and marching bands play dramatically different styles of music without lyrics, evoking a unique emotional response from each listener. . . . Still, most of us tend to recognize certain tonal sequences and chords as music, and consider others to be mere noise, so music does have a culturally related sense of sequence and grammar to it, albeit one very different from that for any written or spoken language. (pp. 109-110)

Often a subconscious function, emotion forms attitudes and sets mental direction (Goleman, 1997; LeDoux, 1996; Pert, 1997; Sylwester, 1995). Through conscious effort, subconscious emotion is expressed in music and in art. Campbell (1997) refers to this movement from unconscious to conscious thought. "Music mysteriously reaches the depths of our brain and body that call many unconscious systems into expression" (p. 193). Through conscious thought we are better able to reflect on our mental, emotional, and physical processes. "George Bernard Shaw suggested that we use a mirror to see our face and the arts to see our soul" (Sylwester, 1998).

Sylwester suggests that even though physical survival is not contingent on "this aesthetic search for our soul, the visual, aural, and movement arts have long been prominent in human life," and "visual, auditory, and motor systems are essential to cognition" (p. 31).

Music is beneficial for more reasons than just the development of performance skills. The brain is equipped to process the fundamental elements of the language of music. "Neurons (brain cells) are specifically sensitive to pure tone pitch, complex harmonic relationships, rhythm, and melodic contour" (Weinberger & McKenna, 1988). Weinberger (1998) posits that "making music actively engages the brain synapses, and there is good reason to believe that it increases the brain's capacity by increasing the strengths of connections among neurons" (p. 38). He cites that performing music flawlessly is not what is important. What is more important is the "simultaneous engagement of senses, muscles, and intellect." Weinberger (1998) explains that "brain scans taken during musical performances show that virtually the entire cerebral cortex is active while musicians are playing" (p. 38) Making music is an excellent way to exercise the brain.

Music and the Arts Promote Cognition

Norman Weinberger (1998), founding member of the Center for the Neurobiology of Learning and Memory and Professor for the Department of Psychobiology at the

University of California, Irvine, regards "music and the arts as essential, not optional, components of education" (p. 36). Weinberger comments on the benefits of music:

> Music has the ability to facilitate language acquisition, reading readiness, and general intellectual development; to foster positive attitudes and to lower truancy in middle and high school; to enhance creativity; and to promote social development, personality adjustment, and self-worth (Hanshumaker, 1980). (p. 36)

Further emphasizing the importance of music in the curriculum, Weinberger stresses music's significant relationship to other cognitive processes. "The functional architecture of the brain honors music as much as it honors language" (p. 38). Both hemispheres are involved in the study and performance of language and music. Weinberger (1998) states:

> Learning and performing music actually exercise the brain—not merely by developing specific music skills, but also by strengthening the synapses between brain cells. Literature in neuroscience now strongly supports the conclusion that synapses grow stronger through use and become weakened through disuse. Which major functional systems of the human brain depend on synaptic strength?
> • The sensory and perceptual systems: auditory, visual, tactile, and kinesthetic;
> • The cognitive system: symbolic, linguistic, and reading;
> • Planning movements: fine and gross muscle action and coordination;
> • Feedback and evaluation of actions;
> • The motivational/hedonic (pleasure) system; and
> • Learning memory.
> By making music, we engage all these systems. (p. 38)

Lamb and Gregory (1993), Frith (1985), and Hurwitz (1975) cite support for the position that music training improves reading performance. In these studies musical sound discrimination and listening skills were encouraged. Positive reading effects resulted in each of the three studies.

Rauscher and her colleagues (1997) conducted experiments on preschool children (ages 3 and 4) to determine the spatial-temporal reasoning effect of making music on musical keyboarding as compared to use of the computer keyboard. Matched groups were studied. One group learned to use the keyboard to produce music. The other group received equally frequent individualized instruction in computer use.

Concluding test scores showed no improvement in spatial-temporal reasoning ability for computer users, but significant improvement for those using the musical keyboard. Results of this study led the researchers to conclude that learning keyboarding can increase potential for learning spatial-temporal reasoning subjects such as mathematics and science. Rauscher classifies these results as a causal relationship, not a correlation.

The Arts, Movement, and Sports

When the arts promote movement, multiple learning benefits result. Jensen (1998, p. 87-88) cites studies which suggest that the arts, movement, and sports activities may benefit learning in other disciplines:

1. Three countries (Japan, Hungary, and Netherlands) ranking near the top in math and science scores "all have intensive music and art training built into their elementary curriculums" (p. 87).

2. "In Japan, every child is required to play a musical instrument or be involved in choir, sculpture, and design" (p. 87).

3. As reported by Jenny Seham of the National Dance Institute in New York, "positive self discipline, grades, and sense of purpose in life" (p. 87) are exhibited by students who study dance.

4. Stimulating the inner ear through physical exercise helps "physical balance, motor coordination, and stabilization of images on the retina" (p. 87).

5. Spinning activities lead to "alertness, attention, and relaxation in the classroom" (p. 87).

6. "After a strong arts curriculum was added" (p. 87) to the Aiken, South Carolina, Redcliffe Elementary School curriculum, test scores went from ranging in the "lowest 25 percent in the district" to the top 5% (p. 87). This took place over a 5-year time period.

According to Jensen (1998), including movement arts in the curriculum produces positive affective responses in students. When children enjoy learning, sensory-motor experiences are feeding "directly into their brains' pleasure centers. This is not of trivial importance; enjoying school keeps students coming back year after year" (p. 88).

Arts and athletics are a powerful combination to promote learning. Carla Hannaford (1995) offers:

> Artistic expressions—in drama, music, dance, visual art, literature—represent highly skilled use and integration of body, thought and emotion. Artistic expression is immensely valuable to overall personal development and cognitive understanding.
>
> The same could be said for sports. Athletic activities integrate many different kinds of knowledge with skilled muscular coordination—knowledge about space and time and human dynamics like teamwork, motivation, goal seeking. Educators should not lose site of their value. Arts and athletics are not frills. They constitute powerful ways of thinking and skilled ways of communicating with the world. They deserve a greater, not lesser portion of school time and budgets. (p. 88)

Movement is a common factor in both life and the arts. Hannaford (1995) is a strong proponent of movement as a vital component of learning. To this concept, she aligns the importance of music and the arts. Performance is an important component in the learning process.

> Real learning—the kind of learning that establishes meaningful connections for the learner—is not complete until there is some output, some physical, personal expression of thought. Much of learning involves the establishment of skills that enable us to express our knowledge. Speaking, writing, computing, drawing, art,

> playing music, singing, moving gracefully in dance and sports: the development of our knowledge goes hand in hand with the development of the skills that support and express that knowledge.
>
> As we build these skills we use the muscles of our bodies, establishing neuromuscular routes as well as their ties to cognitive routes. Learning is not all in your head. The active, muscular expression of learning is an important ingredient of that learning. . . . It is through expression that we advance and solidify our understanding. (pp. 87, 88)

Sylwester (1998) suggests that movement, often demoted in importance in traditional education practice, is a critical part of cognitive function. According to him, that alone establishes a legitimate place in curriculum for arts that encourage movement. However, Sylwester carries his logic even further to embrace not just musicians, dancers, and other aesthetic performers but athletes, as well.

> Our sensitive sensory system and finely controlled movements are also central to the visual, aural, and movement arts, whether it's the fine-motor control of a painter, the practiced pizzicato of a violinist, or the choreographed pick-and-roll of an NBA team.
>
> Consider the cultural significance of virtuosity in our three bottom-to-top motor systems (the movers, the handlers, and the talkers): the legs of skaters, runners, and dancers; the expressive hands of pianists, artists, and mimes; the mouth of speakers, singers, and horn players. Our culture values them all because they so celebrate what are otherwise simple, ordinary movements. How can one promote a curriculum that reduces the acceptable movement of this magnificent appendage system to one hand laboriously writing words on a playing field the size of a sheet of typing paper? It's bizarre. (p. 33)

Attention

Recent neuroscience findings support the assumption that emotion drives attention and that attention drives learning (Goleman, 1997; LeDoux, 1996; Pert, 1997; Sylwester, 1998). However, the reigning mental model in education continues to favor reason and logic over emotion and attention (Caine & Caine, 1991; Damasio, 1994; Hannaford, 1995). Recognizing cognition as a dynamic, whole-system process that relies on balanced function between emotion and logic aligns with current research findings.

As maintained previously, Sylwester states, "We know that emotion is very important to the educative process because it drives attention, which drives learning and memory" (, 1995, p. 72). Sensory input from the environment goes directly to the emotion center of the brain—the limbic area. Sylwester explains that the amygdala is especially involved in the processing of "primary emotions; and specialized cortical networks in the right hemisphere and frontal lobes" are involved in secondary emotions "and for modulating the more primal emotional responses of the limbic system" (p. 73).

To try and separate emotion from cognitive processing would be impossible. Cognition is an integrated, holistic process that involves all of the brain (and much of the body), especially the emotions (Sylwester, 1995, pp. 71-75).

According to Sylwester, for individuals to function well in school, a number of emotion-related factors should be considered:

1. Balance between rational processes and emotion is needed.
2. Metacognitive activities should be included.
4. Social interaction should be promoted.
5. Activities that provide emotional context should be used.
6. Emotional stress should be avoided.
7. The relationship between emotions and health should be recognized (pp. 75-77).

Throughout the literature reviewed, unanimous consensus was apparent in respect to the importance of emotion for attention and construction of meaning. Rather than viewing emotion as insignificant, or even counterproductive, to learning, it is recognized as central to cognitive processing. Cortical areas of the brain, where higher-order thinking takes place, receive information for processing *after* it has first passed through the emotion center. And the limbic area again processes much of the information that leaves the cortex and goes to other parts of the brain/body (Hannaford, 1995; Jensen, 1998; Sylwester, 1995).

Attention is governed by internal and external, conscious and subconscious influences. Though the brain seems largely intent on maintaining a comfortable level of homeostasis, it is capable of rapidly adjusting to change when necessary in order to maintain balance. Robert Sylwester (1995) describes the brain's attentional focus:

> Our brain is organized to respond to a wide variety of challenges from its inner and outer environments. We seem most comfortable when we're in the cognitive center, where things are neither too simple nor too complex and emotion reigns supreme, where trees meld easily into the forest and we're satisfied with the focus of our attention, where the present is comfortably continuous with the past and the future. (p. 54)

Jensen (1998) suggests four considerations critical to understanding how the brain focuses and maintains attention:

1. Attentional systems are located throughout the brain.
2. The contrasts of movement, sounds, and emotions (like threat) consume most of our attention.
3. Chemicals play the most significant role in attention.
4. Genes also may be involved in attention (p. 42).

Each of these considerations represents a considerable body of data; but because each has been discussed previously in greater detail, only brief comments are included here.

Attentional systems are located throughout the brain. "Paying attention" is often associated with what students do—or, perhaps, should do—in the classroom. In actuality, this function is what we do from the time we wake up in the morning, until we go to sleep at night. Jensen (1998) suggests that the average person makes attention decisions about

100,000 times a day and that they can be "external or internal, focused or diffused, relaxed or vigilant" (p. 42). Maintaining focus of attention in the classroom tends to be governed by relevance, level of engagement, and interest on the part of the learner.

As sensory information comes into receptor sites throughout the body, it is transferred, chemically and electrically, to the limbic areas of the brain; and in non-life-threatening instances it moves on to the neocortex, where it is processed and sent to other parts of the brain and body. This grossly simplified description does not include many other parts of the brain that contribute to this process. Jensen graphically represents the greater involvement of other brain parts when attention is gained and maintained. (See Figure 1.)

Describing the simple act of seeing violets in the springtime, Carla Hannaford (1995) explains how many functions are involved in even the simplest acts of attention:

> In order to see the violets, the body and eyes must move into position and focus. This act requires gross motor integration in the brain stem, orchestration through the basal ganglion in the limbic system and fine motor coordination in the frontal lobe of the neocortex. Further movement occurs as the iris muscles contract to accommodate for light, and the ciliary muscles on the lens accommodate for distance.
>
> Light reflected from the violets registers on the photosensitive cones and rods of the retinas of both eyes. The cones and rods send specific neurological messages via sensory neurons to the primary visual area of the occipital lobe of the cerebrum. This allows us to "see" the violets.
>
> The frontal eye field coordinates eye teaming, allowing us to track our eyes over the violets. The lines and shape are integrated into structure and three-dimensionality through associative images with the proprioceptive areas of the sensory cortex of the parietal lobe. From there the impulses diffuse out across nerve net pathways, pulling together information from associative areas in the parietal and temporal lobes.
>
> The combined images from throughout the brain give us a concept of violets including their name, function, where and what they are doing in this time and space, how they smell and taste and some memory of their physical and emotional relationship to us. From this memory we can make new associations, like gathering the violets and making cards from the pressed flowers, extracting the dye, putting them in a salad, drawing them, or figuring out how many are in an area of lawn. These new associations can stimulate us to solve a puzzle, make a decision, create something new or physically employ the object in our lives. The brain can then

> prompt various muscular responses, like picking the violets, pressing them in a book, eating them, jumping over them, etc.
>
> The activation of all the brain areas in an associative, integrative dance allows us to play with the violets (or any object) in our minds, thus generating new, creative ideas of what can be done with and to the object. (pp. 77-78)

During focused attention, the back and forth flow of information to and from various parts of the brain/body is what Jensen (1998) calls "a two-way balancing act of construction and feedback-maintenance of stimuli" (p. 43). This process may take place simultaneously with the brain's efforts to shut down other available inputs. "Selective attention depends on suppression of irrelevant data and the amplification of relevant data" (p. 43).

Though the above-mentioned processes are described as complex, neuroscience cautions that our current understanding of such mental processing is incomplete and known to be more complex than is presently understood. What *is* known is that mental processes such as paying and maintaining attention involve many simultaneously functioning areas and systems throughout the brain and body.

Contrasts of movement, sounds, and emotions (like threat) consume most of our attention. Commenting on the effect of contrast for maintaining attention in the learning environment, Jensen (1995) states,

> If you want attention, provide a strong contrast from what you were just doing. We get used to a new smell within seconds, so it takes a new one to again get our attention. Teachers who raise their voices in an already too-noisy classroom may get frustrated. It makes more sense to use a highly contrasting signal system like a desktop bell, a raised hand, a playground whistle, or a dramatic change of location. (pp. 43-44)

Sylwester (1995) explains that teachers intuitively have known that they can give students an *attention* advantage if they schedule "individualized skill subjects in the morning and less precise, more socially engaging subjects in the afternoon" (p. 83). He elaborates that student attention levels are chemically lower in the afternoon and that it is smart to schedule activities that are more interesting and require less "precision and sustained attention" during that time frame. Social interaction is more likely to provide higher levels of contrast as compared to individualized activity.

The human brain has an attentional system with a "built-in bias for high contrast, novelty, and emotional overtones" (p. 83), says Sylwester. But the typical curriculum usually presents a "predictable universe." This represents a classroom dilemma. Contributing to this problem are cultural trends that place students at odds with typical classroom expectations. "Routine, low-contrast curricular tasks tend to bore students who spend hours with video games and TV programs, which too often emphasize the bizarre and violent—high-contrast behaviors that attract active attention" (p. 83).

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Wise teachers counteract these counterproductive factors by creating high-contrast situations in the classroom. For example: "a math relay game is an active and fun-filled complement to the tedious task of mastering multiplication tables" (Sylwester, 1995, p. 83).

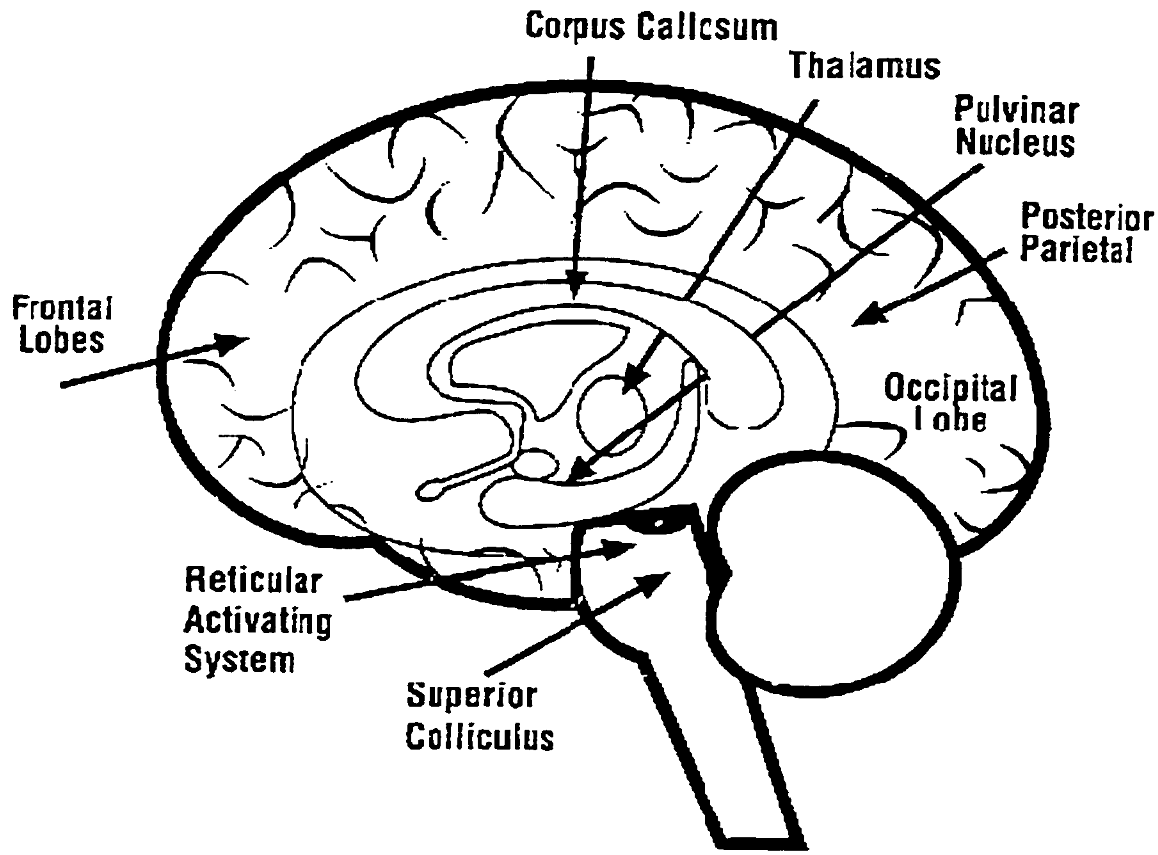

Figure 1. Areas of the brain affected in gaining and maintaining attention. From *Teaching with the Brain in Mind* (p. 43), by Eric Jensen, 1998, Alexandria, VA: Association for Supervision and Curriculum Development. Copyright 1998 by Eric Jensen. Reprinted with permission.

Helping students learn to "consciously manage the adaptable aspects of their attentional system" is a major challenge for educational practitioners. Because our attentional system focuses on separating "foreground from background," without conscious effort to "control the decision about what's important, the system will revert to survival needs," according to Sylwester (1995, p. 84). Part of helping students become critical thinkers is nurturing them to recognize the contrast or difference between foreground and background. Sylwester lists ways educators can encourage this contrast recognition:

1. Graphing to identify gradual trends
2. Multicultural programs to celebrate unity and differences of human race
3. History to explain how the past gradually became the present
4. Drama to demonstrate how simple gesture can replace a page of script
5. Literature to allow us to look behind social facades
6. Discussion, debate, storytelling to help students learn to hold bits of information in their mind so they can communicate with others on the same subject
7. Cooperative learning to oblige students to attend to others' contributions
8. Simulations, role playing, games to compare real world with a created world
9. Metaphoric stories and dramas to provide outlines and force students to add details
10. Metacognitive discussions to compel students to confront their own thought processes (p. 85).

Jensen's (1998) suggestion that emotion plays a significant role in focusing and maintaining attention has been previously established. However, a reiteration of caution in regard to emotional stress or threat in the learning environment seems appropriate. Emotion can be a productive factor in creating contrast to maintain attention, but high levels of stress and threat are not conducive to educational objectives. What gets stored in memory as a result of these factors tends to be information other than what was intended in the curriculum (Diamond, 1998; Healy, 1990; Jensen, 1998; Sylwester, 1995). Sylwester (1995) cautions:

> Emotion obviously dominates reason in many attentional decisions, and a stressful situation can chemically trigger an intense focus on something unimportant—such as when we work on an unimportant task to avoid facing a looming deadline on an important project. (p. 80)

When *stress* and *threat* are high in the learning environment, higher levels of cortisol, vasopressin, and endorphins are likely to occur in the brain (Jensen, 1998). With high levels of these chemicals present, undesirable behaviors may present themselves. Such considerations relate to a third factor in attentional focus—brain chemistry.

Chemicals play the most significant role in attention. According to Jensen (1998), "Our brain's chemicals are the real lifeblood of the attentional system and have a great deal to do with what students pay attention to at school. These chemicals include neurotransmitters, hormones, and peptides" (p. 44).

Adding another dimension to the concept of chemistry and attention, Sylwester (1995) writes about how these *brain chemicals function in cycles*. "Our ability to maintain attention is affected by normal cyclical fluctuations in the efficacy of the neurotransmitter molecules that chemically regulate attention" (p. 81), he says. Further describing these cyclical patterns, he adds:

> These fluctuations occur in 90-minute cycles across the 24 hours (Hobson, 1989). People differ in their rhythmic patterns, but at about 6 a.m. many people experience a sharp rise in the availability of these attentional molecules (which causes us to wake up), and the average level of the molecules remains relatively high during the morning. The average levels begin to decline during the afternoon, and reach their lowest levels after midnight, when sleep becomes almost inevitable.
>
> Unexplained curiosities abound—for example, our tendency to doze off around 3 p.m., when we should be awake, and to wake up at 3 a.m., when we should be asleep. Generally, however, we follow our body's predictable rhythms. We tend to do the things that we *have* to do during the morning, when it's easiest to maintain attention—and the things that we *want* to do in the late afternoon and evening, when it's more difficult to maintain attention without the emotional support of personal interest. (p. 81)

Jensen also refers to cyclical functions in chemically induced brain processes. He speaks of the brain/body's 90-minute, rhythmic cycles as ultradian rhythms, and suggests that these natural "high and low arousal-rest cycles" that happen during sleep time may also be present during daytime activities. He cites the research of Klein, Pilon, Prosser, and Shannahoff-Khalsa (1986). Jensen explains, "The brain shifts its cognitive abilities on those high and low cycles. There's literally a change in blood flow and breathing on these cycles that affects learning" (p. 44). Testing students at the wrong time may put them at a physiological disadvantage. Jensen suggests that this information makes a case for portfolio assessments "which are compiled over time, are more inclusive and accurate than a 'snapshot' test" (p. 44).

Down time, when the brain has opportunity to internalize new information without being bombarded with overload data, is important. Times of inattention can benefit overall mental processing. "Generally, the brain does poorly at continuous, high-level attention. In fact, genuine 'external' attention can be sustained at a high and constant level for only a short time, generally 10 minutes or less" (p. 45), Jensen offers (1998). Focused activity time should be followed by down time, when the brain has opportunity for "diffused activities like reflection," he continues. This allows the brain time to process consciously, to create new meaning, and to imprint learning within neuronal connections (p. 46). Further, Jensen states:

> New physical skills can take up to six hours to solidify. Henry Holcomb of Johns Hopkins University asserts that other new learning contaminates the memory process. "We've shown that time itself is a very powerful component of learning," he adds (Manning, 1997). Our visual capacity, measured by bits per second and carried by the optical nerve, is in the tens of millions (Koch, 1997). That's far too much to process consciously (Dudai, 1997). In order to either proceed or figure it all out, a student must "go internal" and give up that "external" attention. We can't process it all consciously, so the brain continues to process information before and long after we are aware that we are doing it. As a result, many of our best ideas seem to pop out of the blue. As educators, we must allow for this creative time if we want new learning to occur. (p. 46)

Though Hannaford (1995) does not use the term *down time,* she certainly embraces the concept as she reports on her research findings. Hannaford's conviction that physical activity should play a more important role in learning interfaces with the importance of down time. She suggests making down time an opportunity to include physical movement in learning:

> McKim goes one step further in contending flexibility is the key to productive thinking. He believes it advisable to stop thinking consciously about a problem, relax, take a walk or sleep on it, allowing the thinking to proceed unconsciously without stress. In school we must allow movement and integration time to insure high level problem solving. (p. 195)

In order for the brain to maintain attentive focus and thereby increase ability to remember and to reason, it must block out non-important information. Hannaford, Jensen, and Sylwester describe the function of the neurotransmitter GABA (gamma-aminobutyric acid) as important to maintaining attention. GABA, according to Hannaford (1995), "blocks out unimportant stimuli by hyperpolarizing the membranes of post-synaptic neurons, increasing the membrane's polarity . . . to the point that it will respond only to specific chosen stimuli" (p. 175). Activities which engross attention, like reading an intensely interesting book, exemplify times when GABA allows the brain to "maintain complete focus." At night, when we are able to "block out light, sounds and the feel of the bed on our bodies so we can sleep," is another example of how we activate neurons that secrete GABA to bring about this effect. "With GABA, the system can choose its focus rather than react, as it does with adrenalin, to all the stimuli around it" (p. 175). Commenting further on the brain's ability to consciously activate this neurochemical, Hannaford adds:

> GABA gives us the control to be fully present, mentally and emotionally, thus overriding the adrenalin reaction. We learn to secrete it through practice, in an environment with good models, where quiet, focused time is encouraged. People who have not acquired this highly important mind/body skill, are among those likely to be labeled "hyperactive." They tend to take in and react to all the stimuli around them, but cannot selectively choose when it is appropriate to ignore certain stimuli. They haven't fully developed the ability to calm and focus their own system. (p. 175-176)

Attention Problems

Attention Deficit Disorder (ADD) and Attention Deficit Hyperactive Disorder (ADHD) are two common discussion issues in schools today. The brain strategically focuses and "unfocuses" attention as it functions normally. When it fails to maintain a natural balance in this respect—not paying enough attention or paying too much attention—a condition of "attention deficit" is assumed. Either of these extremes in focus of attention is considered to be a problem, because resulting behaviors tend to be abnormal. In the classroom, children with attention deficit may be hyperactive or hypoactive (Sylwester, 1995). Addressing possible causes for the extremes in attention, Sylwester notes:

> ADHD [Attention Deficit Hyperactive Disorder] probably emerges at least partly from lower metabolic activity and specific neurotransmitter deficiencies in brainstem and limbic system structures that (1) regulate motor inhibition and control and (2)

> project into the areas of the frontal lobes that organize and regulate goal-directed attentive behavior. (p. 82)

Ritalin and other specific stimulant drugs can "increase the availability and activity of such neurotransmitters as serotonin, norepinephrine, and dopamine" (p. 82), Sylwester believes. The medications "seem to inhibit distracting stimuli and impulsive behavior, and thus improve the student's ability to attend to appropriate stimuli—to separate foreground from background information and attend to the foreground" (p. 82).

Sylwester cautions that the "diagnosis and treatment of ADD is still a controversial matter, however, because of the side effects of prescribed drugs on some children" (p. 82), and he references the work of G. W. Hynde et al (1991), as a source of additional information on this matter.

The notion that ADD "is a specific medical disorder" is not without controversy, according to Jensen (1998). He offers that other researchers "believe that the label masks many other more narrowly defined problems like poor hearing, bad eyesight, or inadequate nutrition" (p. 49). Noting additional possible causes of ADD, Jensen says:

> The current research on the biological underpinnings of ADD associates the disorder with several factors. A large sample of 102 children diagnosed with ADD found evidence of smaller attentional structures in the outermost right frontal lobe areas and basal ganglia (Wilder, 1996). Those two areas are thought to be esssential for directing focus and blocking out distractions. Second, there's evidence of faulty regulation of glucose metabolization and of the neurotransmitter norepinephrine. Finally, S. Milberger, Joseph Biederman, and their colleagues at Massachusetts General Hospital have discovered a striking connection between ADD and maternal smoking (George, 1996). (p. 49)

Speaking about the common use of medication for ADD and ADHD, Jensen (1998) reports that

> 1 of 20 children aged 6 to 10 and about 3 percent of all children under 19 are on ADD [Attention Deficit Disorder] medications like Ritalin or Cylert. Prescriptions are currently at 1.5 million and climbing dramatically (Elias, 1996). Some schools have as many as 10 percent on Ritalin. (p. 49)

Along with Jensen, Hannaford (1995) voices concern over increasing use of medication for treatment of ADHD. Dopamine levels affect emotion, movement, and thought, and Ritalin is believed "to activate increased dopamine production within the brain, causing a decrease in hyperactive movement. However, if the brain reacts to Ritalin as it does to other researched stimulants (Thorazine, endorphins, marijuana, and cocaine), there may be long term side-effects" (p. 200). Hannaford explains why potential side-effects and other complications may result:

> Studies show a feedback mechanism in the brain that adjusts brain chemistry in response to these stimulants. The feedback mechanism will attempt to rid the brain of excess stimulant by reducing the amount of its own natural production. The mechanism is so overstimulated that when the stimulant is discontinued, the natural brain levels may be left even lower than before, exacerbating the situation. Though these studies did not include Ritalin, this same mechanism may be occurring. Parents complain of children going into depression and showing even greater hyperactivity when taken off Ritalin on weekends. As an addictive stimulant, Ritalin can cause withdrawal symptoms which include depression and irritability. Unaware of this withdrawal reaction, parents may feel the child should be put back on the drug.
>
> Danger also lies in the long-lasting changes in brain chemistry that may result from long-term use. Since Parkinson's disease is related to low dopamine production, children who are medicated for hyperactivity may be more at risk of Parkinson's Disease in later life. (pp. 200-201)

Jensen (1998) suggests that teacher awareness of how the brain focuses and *unfocuses* attention may provide help for managing discipline problems that result from attention deficits. He suggests:

> Cut the length of focused attention time expected or required. Remember that the human brain is poor at non-stop attention. As a guideline, use 5-7 minutes of direct instruction for K-2, 8-12 minutes for grades 3-7, and 12-15 minutes for grades 8-12. After learning, the brain needs time for processing and rest. In a typical classroom, this means rotating mini-lectures, group work, reflection, individual work, and team project time. (pp. 48-49)

Hittman (1996), as sited in Jensen (1998), reports research which indicates there may be a genetic factor involved in personality functions—such as novelty-seeking, quick-temper, and inattention—and the dopamine receptor gene. Dopamine is one of many neurotransmitters that signals the body to "Do it or Don't do it!" says Sylwester (1995, p. 36), depending on the level of the neurotransmitter. It is possible, according to Hittman, for a student's behavior to be the result of genetic influence more than acquired behavior. Teachers might diminish behavioral problems for these students by providing more physical activity throughout the day.

Nutritional deficits impact attention levels

Diamond (1998), Hannaford (1995), Healy (1990), and Jensen (1998) focus heavily on the importance of nutrition and its relationship to brain function, especially attention and motivation to learn. Poor quality or no breakfast, too much sugar, and too little protein are some of the most commonly discussed nutrition factors in discussions centered on learning and attention deficit problems.

Even though sugar is brain food, the brain/body prefers its sugars in complex carbohydrate form (Diamond, 1999). "Depending on the biochemistry of the individual child, heavy doses of carbohydrates may cause a 'sugar buzz'; more often, however, the aftermath is lethargy" (p. 166), says Healy. She adds:

> One of the leading authorities in the field, Dr. Keith Conners, author of *Feeding the Brain,* has been particularly interested in the effects of sugar on learning (Connors, 1989). In conducting extensive experiments with both "normal" and "hyperactive" children, he discovered that high-protein breakfasts (two eggs, in these experiments) could counteract sugar's negative effects and possibly even improve learning and memory in the brain's chemical transmission system. On the other hand, no breakfast or a high-carbohydrate one (two pieces of toast in this case) was a recipe for trouble in some children. (p. 167)

Protein is a necessary nutrient for brain cell function especially at the receptor sites, according to Diamond (1998, 1999). At a national convention of educators in 1999, Diamond designated half of her presentation time to the brain's need for proper nutrition.

Regarding cell function, she addressed the specific need of several nutrients. Showing a slide as a visual aid, she commented:

> The pre-synaptic terminal is filled with chemicals and when an electrical impulse comes down, those chemicals are discharged into the cleft. There are receptors on the post-synaptic membrane which open . . . channels [to] allow, in this case perhaps, calcium to come in [to] do many things—activate enzymes, which will activate genes, which will activate protein synthesis to make a bigger terminal. . . .
>
> What happens if you don't get enough choline [a form of protein]? The nerve cell will cannibalize its membrane to make acetylcholine. . . . The sources [of choline] are many . . . soybeans and their products, such as tofu . . . egg yolks . . . peanuts . . . and liver. These are just some examples of choline. (p. 9—audio transcript)

During this same presentation, Diamond included a summative statement that seems relevant to this discussion on nutritive deficiencies in brain function. Though she discussed many important nutrients for the brain, she especially emphasized two nutrients in particular. "If you're going to just remember two words associated with brains and nutrition, [remember] the B vitamins and . . . choline. B6 [is] important in brain functions such as metabolism of amino acids—this is for . . . proteins that your nerve cells need to produce their neurotransmitters. . . . [B6 is] vital to creating neurotransmitters." Previous to this comment, Diamond had already discussed the importance of B12 as "vital to the production of myelin"—the white fatty (lipid) coating on the axon of the nerve cell which speeds up message transmission. B12 is also "important in the production of red blood cells," she added. "Nerve cells don't function without the oxygen brought through the vascular system via the red blood cells. Vitamin B12 deficiency [causes] memory loss, confusion, fatigue, loss of balance, decreased reflexes and severe deficiency in myelin."

As a result of the organization of this study, these data on nutrition relate to the *Diet and Nutrition* information included in the previous section on *Mind and Body*. Each section builds on the previous parts of the document.

Stress and Threat Affect Levels of Attention

Caine and Caine (1991) refer to an attentional problem that occurs when stress and threat interfere with thinking. They call this altered state of thinking downshifting.

In the context of discussing how the brain deals with stress, the Caines explain that downshifting is the brain's way of preserving its integrity when stress levels threaten to interfere with brain function or threaten survival. Considering stress and its effects on the body and brain, they explain the existence of two types of stress: One, distress, is "accompanied by a sense of pervasive threat related to a sense of helplessness," and the other is "accompanied by a sense of resolution or challenge—[and it] is crucial" (p. 66).

Distress, Caine and Caine further indicate, "interferes with our health and our emotions" (p. 66). When a condition of distress exists, the body/brain has two solutions for counteracting the negative effects of this kind of stress.

"One [solution] is a continuing and appropriate degree of relaxation that maintains the system in a state of well-being generally (and maintains general low levels of cortisol). . . . The other is the eustress, or excitement, that accompanies an appropriate degree of personal challenge" (p. 66). Linking downshifting to this process, the Caines explain that

> distress not only interferes with health and physiological functioning, . . . [it] also inhibits cognitive functioning. It impedes our capacity to think, solve problems, and perceive patterns because of the inseparability of body, emotion, and intellect. *Downshifting, in fact, is actually one aspect of distress.* (p. 66)

Elaborating on this connection between downshifting and distress, Caine and Caine (1991) write:

> Hart (1983) refers to the constriction of brain function as "downshifting" because, in terms of MacLean's model of the triune brain, we are literally shifting "down" from the neocortex into the older, more automatic limbic system and reptilian complex.

> The R-complex does not reason, it reacts. Hart states, "Downshifting is always to more traditional, more familiar, cruder behavior—to what we would do if we had much less brain." (p. 67)

When the brain shifts its processing to "lower" areas in the brain, thinking is less conscious and flexible than when it occurs in the neocortex (Caine, 1991, p. 67). In such a state as anxiety, extensive cognitive function is affected, and the possibility of a switch from intrinsic to extrinsic motivation seems to increase. The Caines (1991) describe research which supports this concept:

> Spielberger (1972) reports that anxious humans appear to experience many of the following: an increase in "cautiousness, perseveration, rigidity, [and] stereotyped thinking" and behavior, as well as reduced responsiveness to the environment. In addition, human subjects experiencing anxiety were also unable to perform "complex intellectual, problem solving, achievement and learning activities." They also become much more attentive to reinforcement by others through rewards and punishment. In effect, they *prefer* external forms of motivation and lose sight of intrinsic motivation. (p. 70)

In addition, the Caines suggest that anxious individuals tend to "fulfill goals formulated by others, as opposed to looking for connections that are personally meaningful." Perhaps this may explain "why those with generally low abilities appear to prefer—in fact, report learning more from—skills approaches." Furthermore, "individuals experiencing anxiety also became more preoccupied with themselves instead of what they were attempting to learn. This also resulted in their being less aware of possibilities that could help them in their learning" (p. 70).

"The stress of constant testing diminishes the ability to see problem solving in a larger context," Hannaford (1995) says. "It turns education into a numbers game where competition, rather than cooperation, is encouraged and information is not moved to applicability or creative thought" (p. 194).

Jensen (1998) adds to this discussion and explains how stress and threat affect brain chemistry, which in turn has a profound effect throughout the brain and body. "When we feel stressed, our adrenal glands release a peptide called cortisol. Our body responds with cortisol whether it faces physical, environmental, academic, or emotional danger" (p. 53). When levels of cortisol are chronically high, Jensen indicates, death of brain cells occurs in the hippocampus, "which is critical to explicit memory formation" (p. 53).

Other effects of stress and threat on learning, according to Jensen (1998), are:

1. "Chronic stress also impairs a student's ability to sort out what's important and what's not (Gazzaniga, 1988)" (p. 53).

2. "Thinking and memory are affected under stress; the brain's short-term memory and ability to form long-term memories are inhibited (Jacobs, 1985)" (p. 53).

3. "Chronic stress makes students more susceptible to illness" (p. 53).

4. "More test stress means more sickness, which means poor health and missed classes, which contribute to lower test scores" (p. 53).

5. "School stress causes vision problems. . . . Under stress, the eyes become more attentive to peripheral areas as a natural way to spot predators first" (p. 54).

6. "Social situations can be a source of stress, too. While stress hormones like cortisol are commonly released during stress, serotonin levels are affected, too. Diminished serotonin levels have been linked to violent and aggressive behaviors" (p. 54).

Jensen (1998) and LeDoux (1996) indicate that stress and threat activate the amygdala in the limbic area of the brain. The amygdala tends to usurp focus of attention to concentrate on incoming messages from the "thalamus, sensory cortex, hippocampus, and frontal lobes. Neural projections then activate the entire sympathetic system" (Jensen, 1998, p. 55). This biological defense system is "great for survival," Jensen says, "but lousy for learning" (p. 57).

Children who come from homes where violence was a common part of their lives often have difficulty focusing attention. Jensen (1998) describes these children as shifting their voice and vision constantly, "scanning the room for potential predators or 'prey.' They often swing or swat at other students as a way of establishing 'rank'" (p. 56). Because their brains have adapted to "survival-oriented behavior" they tend to be territorial and to have difficulties relating well socially as well as academically.

Teachers have limited influence on the home environments from which students come, but they should be able to create safer, less stressful learning environments for students while they are at school. Jensen (1998) cautions teachers that stress on at least three different levels should be considered when addressing how to help students manage stress: "threats from outside of class, threats from other students, and threats from yourself" (p. 59). He offers these helpful suggestions:

> There are two approaches for reducing stress for students. One is to manage the conditions that can induce it, and the other is to use personal strategies that mediate and release it. Help students learn about what induces stress and what to do about it. Teach them stress management techniques like time management, breathing, the role of down time, relationships skills, and getting peer support. In the classroom, stress might be released through drama, peer support, games, exercise, discussions, and celebrations. Physical exercise triggers the release of a brain-derived neurotropic factor (BDNF) that enhances neural communication, elevates mood, and assists in long-term memory formation (Kinoshita 1997). A neurotropic factor is any agent that affects brain functioning. These include internal factors like hormones or external agents like caffeine or valium. (p. 59)

Healy (1990) proffers that knowing what causes attentional problems and how to remediate them is only partially understood at this time. The challenge remains to improve our understanding of how the brain and its many functions affect levels of attention and attentional problems that result when imbalance in brain chemistry or negative environmental influences take their toll on the individual. Accumulating data suggest hope for confronting these challenges to learning. Providing help for children subject to these difficulties is critical to engendering and maintaining positive attitudes toward learning environments and motivation to learn.

Summary of Mind/Body/Emotions Connections

Clearly there is consensus among brain researchers to suggest that cognition is dependent on input from the body and from the limbic structures of the brain—the emotion and memory center. Further, there is evidence that suggests emotion and memory are not confined to the limbic area. The heart and other areas throughout the body where sensory input is taken in are also sites of memory and emotion formation and transmission.

Rather than defining rational thought and emotion as separate functions, according to the research cited, a more logical description portrays the mind, body, and emotions as a unified whole in synchronous function. Each part has distinct differences, but each is necessary for attention, memory, and cognition.

It appears that study and performance in music and the arts can powerfully integrate movement, emotion, and cognition into neural patterning that promotes holistic brain function. This exercise seems to encourage brain potentiation which spills over into and benefits brain performance in other disciplines, as well.

Learning environments that emphasize physical, mental, and emotional expression and internalization are more likely to facilitate learning and to develop brain potential. Embracing this position may require schools to reconsider the mental models that drive curriculum.

Mind/Body/Emotions/Social Connections

Introduction to the Issues

Previous sections and subsections have established the importance of the vital connections that exist between mind, body, and emotions. Now another component is added—the social or environmental affect on the brain and learning.

Mind, body, and emotions are brain functions that involve internal processing; however, that internal function is dependent on stimuli coming into the body from the environment via the senses. “Our brain is not a part of the external environment,” Sylwester (1995) says. “Imprisoned and protected within the darkness and silence of our skull, it depends on its sensory and motor systems for external access” (p. 55).

What happens in the social environments we inhabit becomes part of who we are—mentally, physically, and emotionally—as environment shapes the brain (Sylwester, 1995, p. 126). Hannaford (1995) describes the reciprocal effect of environment on the brain and the brain on the environment:

> What we know, feel, learn, and think is shaped by how we know, feel, learn, and think. How we do these things is in turn dependent on the sensory-motor systems through which all our experience of the world and of ourselves is mediated. These sensory-motor systems shape our experience, and are shaped by it. So the story of how these systems unfold is a vital key to understanding learning. (p. 29)

This section addresses varying environmental effects on mind, body, and emotions. Animate and inanimate influences contribute to this dynamic relationship. Social influences especially provide complex ways of stimulating or truncating brain growth and function (Diamond & Hopson, 1998; Healy, 1990; Jensen, 1998). There is much concurrence that what a child experiences even before and after birth increases the brain's capacity to think, know, and feel (Diamond, 1998). This concept has long been a point of discussion and debate.

Historically, the focus of the *nature versus nurture* debate has been, Which is more important in brain development, heredity or environmental influence? This issue is important because the discussions and theories that arise out of these considerations, Sylwester (1995) says, raise "fundamental issues about our professional assignment [education]" (p. 15). "We had better understand them [the theories]," he continues. Sylwester adds that education traditionally has focused on the *nurture* side of this matter, but current emerging theories are emphasizing *nature*. He believes that theories relating to this issue "will become controversial because they will require reconceptualizations of such concepts as parenting, teaching, learning, intelligence, identity, free will, and human potential." He cautions, misuse of the theories "can result in support of racist, sexist, and elitist beliefs. Certainly those who reject Darwinian evolution will be disturbed by the evolutionary base of the new theories" (p. 15)

Not all brain educators voice the same concern as does Sylwester. The majority of emphasis within the literature is focused on study results that confirm the equitable balance between heredity and enrichment. Healy (1990) comments, "Overall, the experts continue to assign heredity and environment each about half of the responsibility for the final outcome of intellectual ability" (p. 264).

Diamond, Rosenzweig, Greenough, and other brain researchers have contributed much data to suggest that the brain can change and grow as a result of exposure and involvement with enriched environments. They denounce the once held belief that the brain does not change.

Enriched environments "feed" the brain. In response to environmental input, the plastic mental organ grows and develops. This idea is a relatively new one. It stands in marked contrast to the previously held belief that the brain with which you are born, once it matures, is what it is, and it does not change (Diamond, 1988, 1998, 1999). Diamond (1998) states,

> The story of enrichment research is expansive as well as populous—rooted in the nineteenth century but branching into the intricate knowledge and practice of the late twentieth century. More than 150 years ago, insightful scholars of the human brain guessed that exercising our organ of thought could cause it to change and grow. Not until the 1960s, however, would a group of researchers from the University of California at Berkeley, with a colony of laboratory rats, prove this idea and overturn the tenacious dogma that, once developed in a child or adult, a brain can never change! (p. 2)

Though the Berkeley findings are now decades old, Diamond (1998) says, "The average person on the street has no inkling that the brain can change and no idea of how to stimulate it for best effect" (p. 3)."Neurologists, the group of life scientists specializing in brains and nervous systems," says Diamond, "created the theory . . . that the brain is equipped at birth with all the nerve cells it will ever have, and that a portion of these inevitably die off during life" (p. 15). This idea was firmly seated in societal belief.

> Schoolchildren in the 1960s learned to recite the dictum, "You lose 100,000 brain cells every day." And nutritionists of that era focused on the body but ignored the head. They reasoned that nothing, including diet, was going to alter the gelatinous mass with the "gray ceiling"—an intelligence level fixed at birth and immutable throughout life save for the inescapable decay of senses and reason. (p. 15)

Diamond (1998) seems convinced that with the research findings on brain plasticity and the confirmed importance of enrichment, the nature versus nurture issue would be more appropriately treated as a discussion—not a debate—on nature *and* nurture, rather than nature *versus* nurture. She says:

> The old nature-versus-nurture dichotomy may have made sense thirty years ago before we learned how profoundly experience shapes the brain. Today, though, we

> see the influences as more circular: Genes influence behavior, and behavior, in turn can influence how the genes function and how the child grows and develops. (p. 249)

Jensen (1998) agrees with Diamond. His studies suggest a recognized balance between the two influences—nature and nurture. Jensen states:

> The pendulum has swung over the last 100 years. For many decades, those who believed character and intelligence are mostly up to our genes ("nature") argued for their position and dominated national debates. They quoted studies about the "spelling gene," the "music gene," and even a "math gene." But in time, those convinced of the influence of the environment ("nurture") raised their voices long enough to garner public attention for their cause.
>
> Today, consensus tells us that heredity provides about 30 to 60 percent of our brain's wiring, and 40 to 70 percent is the environmental impact. Why the variation? It depends on what specific trait or behavior you're considering. (pp. 29-30)

Caine and Caine (1991) imply concurrence with Diamond and Jensen. They speak of the changing brain as a result of having assimilated "experiences from the day before." They state, "Learning is, in fact, a physiological process, and every day *can* make a difference" (p. 25). Again, referring to brain plasticity and the constantly changing nature of the brain, they proffer that "the physical structure of the brain changes as the result of experience" (p. 27), and that "the brain maintains its plasticity for life." Further, they state, "it is apparently also possible to selectively modify one or another region of the cortex, depending on the particular program of enrichment used" (p. 29).

Sylwester (1995) adds a twist to this apparent lineup of consensus. He says,

> The new biologically based brain theories focus on the developmental relationship between a brain's ancestors and its current environment: the "nature versus nurture" issue. Our profession has tended to think of the *nurture* side as dominant, but these new theories argue that *nature* plays a far more important role than previously believed—or that the dichotomy itself is now an irrelevant issue. They also suggest that many current beliefs about instruction, learning, and memory are wrong. (p. 15)

Sylwester (1995) believes that it is critical for educators to understand the strong forces developing in two major brain-science theory camps because, "when these brain theories and their strong supporting evidence shortly reach the awareness of the general public, educational leaders will be asked to comment on them" (p. 15).

The two bodies of information Sylwester spotlights are the works of two Nobel laureates—Francis Crick and Gerald Edelman—whose brain-theory works have attracted the scientific community's attention "and will probably attract much controversy as [they move] into the educational community and general public awareness" (p. 15).

Sylwester explains that Francis Crick, of DNA-molecular-structure-discovery fame, suggests memory is transferred from generation to generation via DNA genetic information. This Nobel prize-winning concept provided a basis for Crick's subsequent studies on "memories that a brain processes in its lifetime." "Consciousness and free will—how and where we are aware of what we know and what we do" became Crick's special interests, Sylwester says. Crick and Mitchison "felt that consciousness would have to be an essential element of any global brain theory," Sylwester adds (p. 15).

> His [Crick's] astonishing hypothesis is that *everything* that constitutes who each of us is as a human being involves nothing more than the behavior of a vast assembly of nerve cells and their related molecules. *Everything* includes all of our interior states—our joys and sorrows, memories and ambitions, our loves and hatreds, our sense of personal identity and free will. It's an astonishing hypothesis because it goes against the feeling that many, if not most, people have: that we're certainly more than a pack of functioning neurons, that we also have a *disembodied* mind, spirit, self. And it certainly goes against many religious beliefs. (p. 16)

Gerald Edelman's 1972 Nobel Prize was "in physiology or medicine for a major discovery about how our immune system operates," (p. 17) Sylwester explains. Like Crick, he also turned his attention to the brain, and Sylwester informs that as of 1995 he was Director of the Neuro-science Institute and Chairman of the Department of Neurobiology at the Scripps Research Institute.

Sylwester (1995) says that "Edelman's move from our immune system to the brain isn't as strange as it may seem. Our immune system is a sort of loose brain" floating free in our body, "while our brain's neurons function within a highly interconnected web." Both are "highly integrated systems that recognize and respond to a wide variety of potentially helpful and hurtful stimuli" (p. 17). The brain responds to sensory input, creates an internal representation of what it perceives, and responds to the sensory stimuli in a positive (friend) or negative (foe) way. The immune system "examines the shapes of antigens that invade our body, and then destroys those that pose dangers to our body" (p. 17).

According to Sylwester (1995), Edelman's Nobel Prize discovery was that

> the immune system doesn't operate through an instruction/memory model, as had been thought, but rather through evolutionary natural-selection procedures. The earlier belief was that generic antibody cells *learned* to recognize harmful antigen invaders, such as bacteria and viruses. The immune system then destroyed the antigens, and the system *remembered* the shape of the invader in the event of subsequent invasions. Edelman, however, found that through natural-selection processes occurring over eons of time, we are born with a vast number of specific antibodies, each of which recognizes and responds to a specific type of harmful invader that shares our environment. (p. 17)

Edelman wanted to know if the brain, like the immune system, functions on natural selection, instead of instruction and learning. Sylwester reveals Edelman's conclusion:

> His controversial theory, the theory of neuronal group selection (or neural Darwinism, as it's more commonly called) argues that our brain does operate on the basis of natural selection—or at least that natural selection is the process that explains instruction and learning. (p. 18)

The simple model that is often used to describe the complex function of the brain is the computer. However, Sylwester speaks of Edelman's opposition to the use of that metaphor. "Edelman (along with other brain theorists) argues that it's an inappropriate model because a computer is developed, programmed, and run by an external force, and our brain isn't" (p. 18). In the computer model, teachers and parents are *programmers* for other people's brains, and that concept does not fit with Edelman's model. Sylwester describes why the computer metaphor is inadequate to represent brain function Edelman-style.

> A computer model biases our thoughts toward filing and operating systems that differ significantly from the way our brain processes information. For example, most brain memories appear to be stored in the same locations that carry out current operations. Further, the powerful role that emotion plays in regulating brain activity, and the preponderance of parallel (rather than linear) processing in our brain, suggest to Edelman that a useful model for our brain must come out of biology, not technology. (p. 18)

Sylwester explains that Edelman considers a jungle to be a better metaphor for brain development and operation. It has rich layers of ecology, "no external developer, no predetermined goals," and "it's a messy place characterized more by organic excess than by goal-directed economy and efficiency" (p. 18). Continuing to describe this jungle metaphor for the brain, Sylwester says:

> No one organism or group runs the jungle. All plants and animals participate in the process, each carrying out a variety of ecological functions. A tree is a single organism, but it also participates in many symbiotic activities with other organisms (e.g., insects, birds, vines, and moss). It doesn't develop its limbs as a nesting site for birds, but birds use the limbs for that purpose.
>
> Further, the jungle environment doesn't instruct organisms how to behave in an ecologically appropriate manner, for example, by teaching trees how to position their limbs and roots to get sunlight and soil nutrients. . . . All trees have the innate capacity to reach the sun and soil nutrients, and those that succeed in doing so will thrive and reproduce. The others die, and other organisms take their place. An environment doesn't tell its organisms how to change so that they will increase their ability to survive. (pp. 18-19)

Edelman argues that the brain's function is much like the jungle. With considerable detail, Sylwester aligns Edelman's jungle metaphor with brain processing. In this descriptive process, he explains further Edelman's position and his theory of neural Darwinism (pp. 19-20). Sylwester implies that a major point throughout Edelman's position is the strong influence of genetics on learning. Sylwester (1995) explains:

> Our DNA couldn't possibly encode our brain's networks for every possible combination of sights, sounds, smells, textures, tastes, and movements that our brain can process, so instead it encodes a basic developmental program that regulates how neurons will differentiate and interconnect. The fetal brain thus develops general areas dedicated to various basic human capabilities within a certain range of variation, such as our ability to process language. Infant brains are born capable of speaking any of the 3,000 human languages, but they're not born proficient in any of them.
>
> When infants begin to interact with the local language, their brain can already recognize the sounds of the language. The larger neural networks that process the specific language(s) they'll speak form as the various combinations of sounds in the language(s) occur frequently. The amount of use selectively strengthens and weakens specific language networks. The networks for sounds that aren't in the local language may atrophy over time due to lack of use, or they may be used for other language purposes. Scientists call this process neural pruning. We can see its results in the difficulty that most older Japanese adults have with the English *l* and *r* sounds, which aren't in the Japanese language. A Japanese adult who learned English as a child would have no trouble with the two sounds. (p. 20)

Interestingly, Sylwester concludes his discussion of Edelman's theory of Neural Darwinism with emphasis on the importance of both heredity and environment on brain function. He summarizes:

> Thus, learning becomes a delicate but powerful dialogue between genetics and the environment: the experience of our species from eons past interacts with the experiences we have during our lifetime. Our brain is powerfully shaped by genetics, development, and experience—but it also then actively shapes the nature of our own experiences and of the culture in which we live. Stimulating experiences create complex reciprocal connections among neural networks. A limited sensory input can thus trigger a wide range of memories, but such memories can also trigger internal fantasies and external explorations. (p. 21)

As mentioned by Sylwester, Crick's and Edelman's position on the mind and materialism is not embraced by all, especially those who hold a higher regard for the role of the spiritual element in cognition. Commenting on Francis Crick's position that the mind is no more than a product of brain chemistry, Phillip E. Johnson (1995) comments that

> whatever common sense may have to say about the matter, the deconstruction of the mind advocated by Crick is implicit in the metaphysical materialism and naturalism that dominate the scientific community. Most biologists who express opinions on the subject in public take for granted that living organisms contain no "vital force" or other nonmaterial component, that complex organisms evolved from simpler predecessors by Darwinian selection, and that the human mind is therefore a product of material forces that valued nothing but success in reproduction. Given that understanding of things, what could the mind and its thoughts conceivably be but a product of the biochemistry of the brain, whatever the unlearned might think? (p. 64)

Johnson suggests that not all in the scientific community agree with Crick and Edelman on this point. Citing comment made by Arthur Kornberg, a famous Stanford biochemist, Johnson (1995) explains that Kornberg alludes to this concept:

> Kornberg complained to a 1987 meeting of the American Academy for the Advancement of Science, it is astonishing "that otherwise intelligent and informed people, including physicians, are reluctant to believe that mind, as part of life, is matter and only matter." (p. 65)

Public opinion polls, says Johnson, indicate that

> the vast majority of Americans are *theists*, which means they believe (or at least say they believe) that we were created by God, a supernatural being who cares about what we do and has a purpose for our lives which is to be fulfilled in eternity. (p. 7)

However, "the most influential intellectuals in America and around the world are mostly naturalists, who assume that God exists only as an idea in the minds of religious believers" (p. 7), Johnson adds. This discussion over the nature of the mind, as Sylwester suggests, will likely precipitate heated dialog sociologically. In his case against naturalism in science, law, and education, Johnson (1995) explains that

> in our greatest universities, naturalism—the doctrine that nature is "all there is"—is the virtually unquestioned assumption that underlies not only natural science but intellectual work of all kinds. If naturalism is true, then humankind created God—not the other way around. In that case, rationality requires that we recognize the Creator as the imaginary being he always has been, and that we rely only on

> things that are real, such as ourselves and the material world of nature. Reliance on the guidance of an imaginary supernatural being is called superstition. (p. 8)

Johnson's admission to the powerful societal influence of naturalism in institutions of higher learning suggests that a naturalistic bias is likely to be prevalent throughout the brain research literature. Creationism and theistic perspectives for the most part are non-existent in the literature reviewed for this document.

Language and the *Nature Vs. Nurture* Debate

Healy (1994) indicates that the *nature versus nurture* debate also rages around the issue of how language is acquired. She says, "Experts have waged intellectual fisticuffs about whether it [language] is preprogrammed or determined by input into specialized areas of the brain. As usual, the answer lies somewhere in between" (p. 157).

Indicative of the strong polarization that has existed in the past on this topic, Marian Diamond refers to respected linguist, Noam Chomsky, and his influence in this area. "Chomsky," Diamond says, "considered language acquisition to be an automatic human endeavor" (p. 133). She quotes Chomsky in his 1988 work *Language and Problems of Knowledge*: "Language learning is not really something that the child does. It is something that happens to a child placed in an appropriate environment" (p. 133). In response to this statement, Diamond asks, "But why does language learning 'happen to' a child? And what is the appropriate environment?" (p. 133). To answer her own question she cites Steven Pinker of MIT, who Diamond says agrees with Chomsky's position: "In his 1994 book *The Language Instinct,* he [Pinker] asserts that language is a human instinct, based on genetic instructions and on the maturing of language centers in the child's brain" (p. 133).

Speaking of the seemingly innate ability of children to grasp grammar principles, Diamond cites studies done by Karin Stromswold, a Rutgers University psychologist. Diamond says, "Surprisingly the children she [Stromswold] studied picked up the different aspects of grammar in virtually *the same order* (unaware, of course, of either the linguistic rules or their esoteric labels like 'datives' and 'preposition-stranding constructions')" (p. 171). The children referred to here are 4-year old children. Surprisingly, by age 4, according to Stromswold (1995), "the majority of their utterances are completely grammatical" (p. 171). Diamond believes this innate and preprogrammed ability to utilize grammar "appears spontaneously" around the age of 4—before the child has studied or even appears to be able to objectively understand grammar's function (p. 171).

Support for both sides of the *nature and nurture* issue is evident throughout the literature, and especially in light of the new findings in brain studies. Sylwester (1995) says, "New brain theories argue that we're not born with an essentially blank brain shaped entirely by the environment. Rather, many key brain areas are already genetically dedicated to general human problems and their solutions, though they may not be functional at birth" (p. 107). Sylwester explains how typical infant development exemplifies the strong influence genetics has on language development:

> An infant brain doesn't have to learn how to recognize specific sounds and line segments; such basic neural networks are operational at birth. We don't teach a child to walk or talk; we simply provide opportunities for adaptations to an already operational process. . . .
>
> To those who argue that they taught their child to speak a language, the theories [theorists] ask, in effect, "And when and how did you *teach* your child your native accent, prepositional phrases, and the rules for forming the past tense?" Children master most of the complexities of grammar with practically no explicit instruction from their parents, although extensive parent-child verbal interactions obviously provide an important environment for the effective development of a language.

> Thus, learning becomes a delicate but powerful dialogue between genetics and the environment: the experience of our species from eons past interacts with the experiences we have during our lifetime. Our brain is powerfully shaped by genetics, development, and experience—but it also then actively shapes the nature of our own experiences and the culture in which we live. Stimulating experiences create complex reciprocal connections among neural networks. A limited sensory input can thus trigger a wide range of memories, but such memories can also trigger internal fantasies and external explorations. (pp. 20-21)

Jensen (1995) writes about how stress and violence in the home, which often come in the form of disturbing language, are capable of imprinting on the individual's brain. He cites multiple studies which indicate that "bad parenting" can imprint negatively for a lifetime on a child's brain and even on their genes (p. 231).

Overall, there appears to be strong consensus among brain research and education synthesizers that genetics, development, and environmental influences all play a significant role and are mutually dependent in language development.

In summary, the nature component in the *nature versus nurture* discussion once sat at the pinnacle of intellectual evaluation when IQ reigned as the brain-quantified standard of mental capability. However, research has dethroned IQ in favor of shared esteem between nature and nurture. Clearly, there is concurrence among researchers that enrichment and heredity are equally important for learning and brain growth.

How does the environment shape the brain? That is the topic of the next section.

Plasticity and Enrichment

Plasticity of the brain now is a common term among brain researchers, and increasingly it is becoming more common to educators as a result of accumulating data. Educational synthesizers of brain research (Caine & Caine, 1997, pp. 8-10; Diamond & Hopson, 1998, pp. 56-64; Gardner, 1983, pp. 38-45; Hannaford, 1995, p. 17; Healy, 1990, pp. 47-82; Jensen, 1996, pp. 143-146; Sylwester, 1995, pp. 126-133) are using their cross-disciplinary expertise to translate into educational application scientific findings on the importance of brain plasticity.

The Physiology of Plasticity

What is plasticity, and how does it relate to the brain? Plasticity in neuroscience refers to the brain's ability to change and reshape as a result of growth or injury.

Neurons are the cells in the brain with the capability of transmitting electrical and chemical messages throughout the neural network (Diamond, 1999). Diamond metaphorically represents the neuron using the hand. The palm of the hand represents the cell body, the arm (axon) the process which takes the information away from the cell, and the dendrites are the fingers—reaching out to make connections with other neurons. "So the basic units of any nerve cell will be dendrites, cell body, and an axon" (p. 3). As the environment stimulates cortical processes, the dendrites grow and begin to look like a "wild forest of trees." As the branching increases, "the cortical thickness" increases. With this growth activity, the white myelin sheath (a lipoprotein) on the axon increases—"directly proportional to the dimensions of the axon" (p. 3). Diamond explains that myelin speeds up the electrical signal transmission passing through the neuron.

In addition to dendritic growth and myelin thickness, Healy (1990) says that supporting glial cells also increase in number as a result of the types of stimulation in the environment (pp. 66-67).

According to Hannaford (1995), plasticity is a property of our body/mind which enables us to adapt to and function well in our environment (p. 17). She states:

> Neural plasticity is an intrinsic, beneficial characteristic of the nervous system which gives us both the ability to learn, and the ability to adapt in response to damage—to

> relearn. From shortly after conception and throughout a lifetime, the nervous system is a dynamically changing, self-organizing system. It follows no single master plan and is never static. We develop our neural wiring in direct response to our life experiences. (p. 17)

The plasticity of the brain is a concept that has developed largely as a result of neuroscientists' experimentation with rats in laboratory settings such as the one Diamond oversees at University of California, Berkeley.

For over 30 years of experimentation with rats, Diamond and Greenough have studied different types of rat groups under various conditions. Referring to these study results, Jensen (1996) states,

> They divided the experiment into three groups: control groups, those in impoverished environments and those in enriched environments. Time and again, for over 30 years of varied experiments, the rats in enriched environments grew better brains. Greenough found that he could increase the number of connections in animal brains by 25% by exposing them to an enriched environment. (p. 143)

In her laboratory at U. C. Berkeley, Diamond and her associates have shown that *within 4 days, significant dendritic growth occurs* in the cerebral cortex if rats are actively involved in an enriched environment—living with other rats, and provided with interesting objects with which they can interact. Conversely, if the toys within the enriched environment are not changed regularly, rats become bored; and rats existing in a boring environment show significant dendritic atrophy also within 4 days.

Diamond describes three levels of enrichment in her work with rats:

1. First level—provides no stimulation. The rat lives alone in a cage with no toys or assists for physical activity.

2. Second level—provides enriched stimulation. Rats live together in a cage with toys and other objects that promote physical activity.

3. Third level—provides optimal enrichment. Rats live in a natural environment.

James Connor, a student in the Diamond laboratory, observed the effects of social isolation on rat brains (Diamond & Hopson, 1998):

> First, Connor saw that the spines resembled either three-dimensional lollipops with a ball on a stalk (like Tootsie Pops), or else they were short, squat nubbins with no stalk. Second, he found that older rats housed alone had lots of nubbin spines on their dendrites. (p. 27)

Diamond (1998) reports that Richard Coss, a researcher at University of California at Davis, made similar observations when he studied "the tiny brains of honeybees" (p. 27).

> The Coss team found a number of spine shapes—not just lollipops and nubbins—depending on the bees' level of stimulation from the outside world: Young bees that had never flown had lollipop spines, with small heads on tall stalks. In bees that had made a single flight, many of these lollipops had grown bigger heads! In the forager bees, with their extensive real-world navigating experience, the spines had very large heads and very short stalks. We think of this latter shape as umbrellalike because it can be cupped, line an inside-out umbrella; flattened, like a decorative Japanese umbrella; or rounded, like a standard British bumbershoot.
>
> Experience—even just an hour or two's worth of flying through the meadow—obviously had a dramatic enlarging effect on a bee's dendritic spines. . . . A third group found that young mice that ran on exercise wheels had more dendritic branching and many more spines than littermates prevented from moving around. (pp. 27-28)

Diamond (1998) correlates these findings with learning and memory. She says, "Only with repeated use will the spines' shape change and the transmission of information become easier" (p. 28). Relating this to the importance of enrichment, Diamond indicates that the more experience (or practice) an individual develops in an enriched environment, the longer will be the delay in dendritic atrophying (Diamond, 1999); and the more stimulating the animal's environment, the more extensive the arbor [of dendritic growth in the cortex]" (p. 29).

Researchers in Diamond's laboratory have also studied dendritic growth in infant rats:

> Animal studies carried out in the Diamond lab at U. C. Berkeley revealed that infant rats less than twenty-eight days old and just before weaning show an enlarged cerebral cortex after even a short enrichment period. Diamond's team placed three mothers and a total of nine pups in either a large cage without toys (the control group), or a large cage with toys (the enriched condition), and then compared both to a single rat family housed alone in a small cage sans playthings. In as little as eight days' time, the enriched youngsters developed a cortex from 7 to 11 percent thicker than in the other infants. After two weeks in the enrichment cage with toys, one particular brain region involved in integrating sensory information grew 16 percent thicker in the enriched pups—the biggest increase in any brain region at any age! (p. 104)

Jane Healy (1990) cautions regarding transference of research findings in animal studies to human function.

> As a teacher, I invariably think of some of my students when I read studies like these. We must always be cautious, however, in applying such research to human learning. First, while facts about nervous system development can be extrapolated from one set of neurons and glia to another, it is quite another matter to start drawing parallels between animal and human behavior in complex learning situations. (pp. 71-72)

What evidences indicate that the *human brain* has ability to change (plasticity) similar to that evidenced in animal studies? Healy (1990) questioned Diamond on this matter. Healy asked,"Do neuroanatomists believe that the brains of children, like those of the rats, can be changed by their environments" (p. 48)? Diamond responded:

> To those of us in the field, there is absolutely no doubt that culture changes brains, and there's no doubt in my mind that children's brains are changing. . . .Whatever they're learning, as those nerve cells are getting input, they are sending out dendritic branching; if you lose the stimuli, they stop branching. It is the pattern of the branching that differentiates among us. The cortex is changing all the time—I call it 'the dance of the neurons.' This is true in the brains of cats, dogs, rats, monkeys, or man. (Healy, 1990, p. 49)

Diamond's husband, Arnold Scheibel, formerly head of brain research at UCLA, also has pondered transferability of animal research findings to human application. Diamond (1998) says:

> Scheibel remains convinced that the human brain responds to stimulation. "It's always going to be more problematic to study human enrichment," he concedes,

> "because you don't do experiments" that deliberately control and manipulate a person's environment, as one can with lab animals . . . he [Scheibel] finds "a correlation between dendritic complexity and the length and levels of education and of vocation in life." (p. 35)

Plasticity in Humans

Considering whether or not animal study findings apply to humans, Jensen (1996) refers to the research of UCLA neuroscientist Bob Jacobs (1993). Jacobs confirms that research on brain enrichment does "translate directly to human brains."

> He [Jacobs] found that in autopsy studies on graduate participants, there were up to 40% more connections than with high school dropouts. The group of graduate participants who were involved in challenging activities, showed over 25% more overall "brain growth" than the control group. Yet education alone was not enough. Frequent new learning experiences and challenges were critical to brain growth. The brain of graduate participants who were "coasting" through school had fewer connections than those who challenged themselves daily. Jacob's research on cortical dendrite systems in 20 neurologically normal right-handed humans (half male and half female) evaluated:
> • total dendritic length
> • mean dendritic length
> • dendritic segment count
> • proximal vs. ontogenetically later developing distal branching. (p. 144)

Marian Diamond speaks of her opportunity to examine a portion of Albert Einstein's autopsied brain. She states that she and her team "hypothesized that he would have more glial cells than the average male, and we found in one area that he did" (Diamond, 1999, p. 2). In another reference regarding the same study (Hutchison, 1991), Diamond suggests that a high ratio of glial cells to neurons may play a part in the intellectual superiority of certain geniuses, like Albert Einstein. This high ratio may result from plasticity stimulation.

Describing Diamond's 1955 autopsy on Einstein's brain, Hutchison (1991) states,

> She found that indeed Einstein's brain contained more glial cells per neuron in all four of the brain areas studied, compared with samples from the brains of eleven normal males ranging in age from forty-seven to eighty. "We don't know if Einstein

> was born with this or developed it later," Diamond points out, "but it tells us that in one of the highest evolved areas of the brain, there is evidence that he had greater intellectual processing." (p. 29)

Simonds and Scheibel (1989) at UCLA studied brain specimens of "children who had died between the ages of three months and six years of age" (pp. 104-105). Though they were uninformed on the kinds of learning environments in which the children had been raised, they learned some interesting things about "experience and the very young cerebral cortex" (p. 105)

> They found that at birth, most neurons in the baby's cerebral cortex have only 'first-' and 'second-order' branches. That means the dendrites, the living antennae that receive incoming nerve signals, usually grow long and split once into two branches then once again into four branches, but stop there. (p. 105)

In contrast, Scheibel and Simonds saw that soon after birth, when sensory inputs were being received from a more varied environment, third- and fourth-level branching occurs. When the child reaches the age of 2 or 3, fifth- and sixth-order branching is present.

"Could one say that the branching of the lower-order dendrites is determined by a person's genes and the higher-order branching pattern by interaction with their environment?" Diamond (1998) asks of Scheibel. "It's not quite that tidy," he replies, "but it's in that direction" (p. 24).

These studies seem to indicate that enrichment encourages higher-order branching. Referring to the Simonds and Scheibel autopsy studies of children's brains, Healy (1990) looks at a reciprocal advantage in the *branching* data. She speaks of the possibility of higher-order branching being more ready *to receive* environmental input. She says, "Patterns of dendrite branching in these brains appear to have an age-related order of development which is responsive to environmental enrichment. Later-branching systems appear to be most susceptible to environmental input" (p. 131).

Diamond's (1998) concluding statement on the ordered branching aspects of enrichment is: "Clearly, higher-order branches result from experience *unless* survival requires them to be present at birth in certain parts of the brain (p. 24).

The extensive branching of dendrites, resulting from enrichment, creates almost infinite numbers of connection possibilities within the neural networks. Diamond (1998) describes this condition with artistic flare. She describes the mind as

> tangled forests of branching, treelike nerve cells that interconnect at a million billion contact points and converge into a living fabric of consciousness. Electrochemical currents ripple through groves of these neural trees like wind stirring a shady thicket. And from these stirrings our human faculties arise: the generation of images, thoughts, words, feelings, and music. (p. 1)

Explaining further the amazing potential for brain growth and use, Diamond (1998) says the brain is the "most complex matter in the universe," and it contains "100 billion nerve cells or neurons." Ten times as many supporting glial cells "surround and nourish the neurons." When enrichment stimulates the nerve cells, a network of "1,000 trillion potential synaptic contact points is available." This is a number "far greater than all the stars and planets in all the galaxies" (p. 37).

The neurons in the brain are structured to communicate with each other, Diamond (1998) reports, and they are specialized to "receive information about the state of the outside environment. . . . Further, [they] are designed to interpret these states and orchestrate responses," like fleeing, eating, or "understanding a sentence" (p. 25). "The more stimulating the animal's environment, the more extensive the arbor [of dendritic growth]" (p. 29), and the thicker the arbor [cortex], the greater the number of possible connections (Diamond, 1998).

Healy (1990) and others comment on the differentiated nature of the neural "wiring" in different parts of the brain. At this point in time, it seems that areas of the brain which control "functions such as physical drives, reflex movements, and balance . . . are mainly 'hardwired' into systems underlying the neocortex, whose convoluted surface covers the rest of the brain like an elaborate layer of gray frosting" (p. 56). In contrast, Healy comments that the cortex appears to be "softwired," perhaps because of the dynamic nature of its function.

> The cortex is the control panel for processing information at three levels:
> 1. receiving sensory stimuli
> 2. organizing them into meaningful patterns so that we can make sense out of the world
> 3. associating patterns to develop abstract types of learning and thinking. (p. 56)

Healy describes the cortex as the area of the brain that is probably "most plastic of all" because of its critical importance "for planning, reasoning, and using language to express ideas" (p. 56). It is her belief that "structure and function are inseparable," and she implies that this contributes to the body of evidence for the plasticity of the cortex (p. 51).

In Elliot Eisner's spirit, Diamond (1998) interlaces the science of the mind with classical allusions as she qualitatively describes the relationship between brain plasticity and the environment.

> The brain with its complex architecture and limitless potential, is a highly plastic, constantly changing entity that is powerfully shaped by our experiences in childhood and throughout life. In Charles Dickens's novel *David Copperfield,* Mrs. Micawber conveys her father's sage advice that "Experentia does it" to young David, twisting the phrase of the Roman historian Tacitus: "experientia docet" (experience teaches). Nevertheless, Mrs. Micawber's malapropism was uncannily, unwittingly perfect for

> our modern-day tale of discovery. For when it comes to the brain, *experience does it*: Our collective actions, sensations, and memories are a powerful shaper of both function and anatomy. What's left for the wise parent or teacher, hoping to promote their children's healthiest mental development is to pick the *right* experiences at the *right* time. (pp. 2-3)

This thought—the right experiences at the right time—provides an apt transition to the next consideration concerning enrichment: What do enriched environments look like?

Nature of Enrichment for Humans

"It doesn't take money to create a climate for enchanted minds to grow," Diamond (1998) says. "It just takes information, imagination, motivation, and effort." She goes on to simplify the concept of enrichment: "Once the habit of active involvement is entrained, experience will take over and those stimulated minds will do the rest for themselves in surprising and delightful ways" (p. 9).

In an attempt to provide a more concrete example of enrichment, Diamond (1998) offers a list of enriched environmental qualities: An enriched environment:

> • Includes a steady source of positive emotional support
> • Provides a nutritious diet with enough protein, vitamins, minerals, and calories
> • Stimulates all the senses (but not necessarily all at once!)
> • Has an atmosphere free of undue pressure and stress but suffused with a degree of pleasurable intensity
> • Presents a series of novel challenges that are neither too easy nor too difficult for the child at his or her stage of development
> • Allows for social interaction for a significant percentage of activities
> • Promotes the development of a broad range of skills and interests that are mental, physical, aesthetic, social, and emotional
> • Gives the child an opportunity to choose many of his or her own activities
> • Gives the child a chance to assess the results of his or her efforts and to modify them
> • An enjoyable atmosphere that promotes exploration and the fun of learning
> • Above all, enriched environments allow the child to be an active participant rather than a passive observer. (p. 108)

Diamond (1998) recognizes a "long-running experimental program" aimed at breaking the "cycle of disadvantage" for children at risk because of impoverished environments. This program starts these children "in an enrichment program in early infancy, [continuing] through their pre-school years, then [going] on providing some of them educational support through early grade school" (p. 157). Craig Ramey, James Gallagher, Frances Campbell, Joe Sparling, Isabelle Lewis, Earl Schaefer, and others at the University of North Carolina in Chapel Hill developed and carried out this study, which they called the Abecedarian Project, "because it means 'learning fundamentals, like ABCs'' (p. 157). The project has produced impressive results in boosting cognitive abilities through enrichment. Describing the enriched environment this project promoted, Diamond (1998) says:

> After nearly thirty years of designing children's enrichments, the Rameys [Ramey & Ramey, 1992] have distilled the "essential daily ingredients for improving a young child's everyday life. This list is short and it echoes what we suggested earlier for infants and toddlers: Adults must encourage children to explore; show them basic skills; praise their accomplishments; help them practice and expand their skills; protect them from disapproval, teasing, or punishment, and surround them with a "rich and responsive language environment." (p. 160)

Jensen (1998) writes about some of the qualities he considers to constitute an enriched environment:

1. The learning is challenging.
2 Experiences provide interactive feedback.
3 Novelty is important (changes in the classroom—décor and instruction).
4. Reading and language opportunities are abundant and age-appropriate.
5. Motor stimulation is a major part of instruction.

6. Thinking and problem solving are encouraged.

7. Music and the arts are honored, encouraged, and may be required (pp. 32-39).

Caine and Caine (1991) discuss the importance of environment as part of what they call "expansion of natural knowledge." They posit that "all learning is experiential. What we learn depends on the global experience, not just on the manner of presentation." Because they feel "we do not . . . automatically learn enough from our experience," in order to be effective in "teaching for the expansion of natural knowledge," students must have "appropriate experiences and must be helped to capitalize on the experiences." The Caines suggest "three interactive elements" as "essential to this process" (p. 104):

> 1. Teachers need to *orchestrate the immersion of the learner in complex, interactive experiences* that are both rich and real. A good example is the use of immersion in the teaching of a second language (Dolson 1984).
> 2. There must be a personally meaningful challenge. This is the intrinsic motivation that is part of the state of mind that we identify as *relaxed alertness.*
> 3. There must be intensive analysis so that the learner gains insight about the problem, about the ways in which it could be approached and about learning generally. We call this the *active processing of experience.*
>
> This is not, we should add, a linear model. Each element contributes to the other two, and the three are constantly interacting. (pp. 104-105)

Also focusing on pedagogy, Jensen (1998) advises that teachers distinguish between enrichment activities that *exercise* and those that *stimulate* the brain. He says, "Exercise is doing what we already know how to do," and "stimulation is doing something new" (p. 13). In enrichment both activities are abundant. The exercise strengthens the neural pathways and encourages myelination so that the brain gets more efficient. Stimulation serves to establish new synapses (Jensen, 1998). "As you vary the type of environment, the brain varies the way it develops" (p. 31).

Jensen (1996) promotes the idea that "novelty is critical to brain enrichment." He supports this position by looking to Dr. Arnold Scheibel, former director of the brain research institute at UCLA. Scheibel states, "Unfamiliar activities are the brain's best friend." Jensen explains this:

> The fact that the brain is so stimulated by novelty may be a survival response; anything new may be threatening the status quo (potential danger). Once we have grown accustomed to an environment or situation, it then becomes routine. Over time, the reticular formation operates at progressively lower levels and the brain gets less and less stimulation. Do something new, and once again, the reticular formation is alerted. This starts the brain growth; more messages are carried by nerve cells and novelty encourages more dendritic branching. That branching triggers new connections, called synapses. It's as if you can almost "grow" your brain at will. (p. 145)

Novelty is also an important factor for children before they begin school—infants and toddlers. Healy (1990) explains:

> Researchers have found that stimulating playthings are more important for cognitive development after age one than in earlier months. Availability of interesting and challenging play materials in children's homes after the first year correlates with later IQ and school achievement in reading and math. As in infancy, a child's firsthand involvement with objects and experiences is a catalyst for brain growth.
>
> Playthings start to become important at about six months of age, but toys should encourage the child to manipulate, interact, or figure something out. When there is only one "right way" to play, opportunities for experimentation and new discovery are limited. Common household objects, tools, cooking utensils, and gadgets are particularly fascinating because adults use them. Nesting and stacking toys or objects, containers for dumping and pouring, require active handling by the child and also teach about relationships: top, middle, bottom; small, big, bigger, biggest. Many experts believe that wooden unit blocks, in graduated sizes and shapes, are the best toy of all. (pp. 42-42)

Healy (1990) reflects on parental intelligence and possible influence on offspring enrichment even before the child is born. She refers to research Diamond reported in her rat studies.

> Can *intellectual* stimulation for parents have *physical* effects on the later learning abilities of their offspring? Recent studies have shown that enriching the cognitive environments—and thus enlarging the brains—of parent rats causes them to have smarter offspring, even when they don't raise the babies themselves.
>
> In her book *Enriching Heredity,* Dr. Marian Diamond discusses the "lasting effects of both maternal care and enrichment in utero." As an example, she recounts some experiments in which parent rats lived in the sort of enriched cages described in chapter 3 (in which food and water are kept constant and "enrichment" consists of

> cognitively stimulative toys and companionship). The parents were also trained in maze learning. Their babies were born with slightly larger brains than those of matched controls and also performed better on maze-running tests. (p. 264)

"Enrichment ideas and brain research are inspiring an entire education reform movement," according to Diamond (1998).

> Some dismiss it, others embrace it. But the proof is in the children who are learning to read with better comprehension, to work math problems with real understanding, and to like school for the first time, based on new teaching methods influenced by brain research. (p. 8)

Diamond's optimism reflects the potential advantage enrichment and brain-based instruction can provide in classrooms. But Healy (1990) identifies learner passivity as a threat to academic performance, even when enriched environments are provided for students. She states,

> Any activity which engages a student's interest and imagination, which sparks the desire to seek out an answer, or ponder a question, or create a response, can be good potential brain food. Particularly in an age when we need "enriched minds to grapple with increasingly complex problems, we should not encourage, or even condone, large doses of passive observing or absorbing for growing brains. Yet it is happening—not only in front of the TV, but in too many day-care centers, schools, after-school activities, and even in homes. How much does this learner passivity contribute to lagging academic skills? A great deal! (pp. 72-73)

Healy (1994) comments that "studies show that children who are heavily managed by caregivers may lack both initiative and thinking skills" (p. 21). These lacking characteristics can thwart student self-confidence and willingness to participate even in enriched settings.

Jensen (1998) joins in cautioning educators to encourage learner involvement and to avoid excessive teacher-directed classroom activities.

> If learning is what we value, then we ought to value the process of learning as much as the result of learning. Our brain is highly effective and adaptive. What ensures our survival is adapting and creating options. A typical classroom narrows our thinking strategies and answer options. . . . Good quality education encourages the exploration of alternative thinking, multiple answers, and creative insights. (p. 16)

In contrast, Diamond and Healy refer to parental *hothousing* of children. This term refers to attempts to force a child's development. An example would be attempting to teach a child to read during infancy. In an effort to enrich their child's development, parents sometimes attempt to rush natural processes before the child indicates developmental readiness. Diamond (1998) refers to David Elkind's position on hothousing:

> The biggest critic of early academic training, whether at home or in preschool settings, is surely David Elkind, a professor of child studies at Tufts University. Elkind in his books *The Hurried Child* and *Miseducation: Preschoolers at Risk* warns parents and educators about the dangers he sees in teaching academic subjects to young children. Over the short-term, he says, young children stressed by educational pressure tend to show fatigue, decreased appetite, lowered effectiveness at tasks, and psychosomatic ailments. Over the long term, says Elkind, the children can show less interest in learning, less ability to work independently to judge their own progress, and the tendency to worry and compare their intelligence with other children's. As fervently as some parents believe that a child's potential is wasted by letting her play until she reaches school age, David Elkind insists that exposing her to anything other than self-directed activities can be harmful and dangerous. (p. 167)

Healy addresses the potential ramifications of "forced learning and functional mix-ups" in the context of learner readiness and the brain's myelination process. She states:

> Before brain regions are myelinated, they do not operate efficiently. For this reason, trying to "make" children master academic skills for which they do not have the requisite maturation may result in mixed-up patterns of learning. . . . As we have seen, the essence of functional plasticity is that any kind of learning—reading, math, spelling, handwriting, etc.—may be accomplished by any of several systems. Naturally, we want children to plug each piece of learning into the best system for that particular job. If the right one isn't yet available or working smoothly, however, forcing may create a functional organization in which less adaptive, "lower" systems are trained to do the work. (p. 67)

Such unnatural adaptation can establish patterns of brain and body function that are difficult to eliminate or to retrain. Healy comments, "It is much more difficult, however, to reorganize the brain than it is to organize it in the first place. 'Organization inhibits reorganization,' say the scientists" (p. 53).

Healy cites an example of how "lower system adaptation" may occur:

> As an example, I think of the many children we see in second and third grade who grip their pencil in the most peculiar ways; some crumple their fingers around it in weird arrangements that make letter formation difficult and cause their hands to tire quickly; some use the base of their fingers instead of the tips to guide the pencil so that the process of handwriting resembles a fencing match more than a fine motor activity; some clutch it in their fists like a weapon. Any teacher will tell you that trying to correct "habits" like these is an uphill—and usually unsuccessful—battle. The reason would seem to be that a strong network of synaptic connections has already formed around these maladaptive patterns, making them automatic and difficult to change because they are now built into the system. (p. 68)

Along this same line, Healy (1994) comments further:

> Since myelin formation enables more efficient brain use, making demands on undeveloped areas may be a real mistake. We have very little information on ways to speed the growth of myelin; although it is age-related, the schedule varies widely among individuals, and it is unclear how much—or if—the process can be accelerated. It seems evident that our efforts to stimulate learning must be tempered by patience until the child's mental transmission systems are equal to the task or we risk frustration, inferior skill development, and an abiding distaste and incompetence for the activity. We may even be programming in bad habits and negative motivation at a neurophysiological level. (pp. 75-76)

Though nutrition has been discussed previously in other sections, it is again mentioned here because of its importance as part of an enriched environment. The contribution nutrition makes to learning potential begins even before a child is born. Nutritional enrichment of the womb is critical to healthy brain growth and development (Diamond, 1988, 1998; Hannaford, 1995; Healy, 1990, 1994; Jensen, 1996, 1998; Sylwester, 1995). Healy (1994) describes the ill effects on fetal development when poor nutrition is a part of pregnancy:

> The growing brain is highly susceptible to structural, chemical, and hormonal influences. For example, some researchers believe that specific academic abilities, such as reading or math, may be affected by hormones secreted during pregnancy.

> Poor maternal nutrition or substance abuse during pregnancy tends to produce premature babies and later physical and intellectual problems. (p. 9)

Nutrition is not the only influence that can rob an enriched environment of its potential advantage for the developing mind. Diamond (1998) cites research done by Karl Pribram and Deborah Rozman regarding how parents emotionally nurture their young and how that can promote or diminish a child's intellectual capacities. As referenced previously, the research of Pribram and Rozman seems to support the idea that the heart and the brain are intimately connected, and both have a profound influence on the developing child. Even though this reference occurs in a previous section, it is again offered here because of its potential influence as a social determiner of cognitive development.

> Brain researchers Karl Pribram of Virginia's Radford University, and Deborah Rozman of the HeartMath Institute in Boulder Creek, California, have found additional evidence for how parental behavior may influence a child's brain development. They recorded the effects of love, care and other positive emotions in creating coherent electrical patterns in children's heartbeat rhythms. They also measured the effects of stress, anger, and negative emotions in creating jagged, incoherent electrical patterns. Heart rhythms, they say, feed back information to the developing amygdala, and this region, along with its connections to the frontal lobes and other areas, comes to register the emotions that feel familiar and comfortable to the child—whether disharmonious and accompanied by jagged heart patterns, or harmonious with coherent patterns. Like many experts, Pribram and Rozman consider the first few years of life to be crucial in this "imprinting" of emotional brain regions. (p. 127)

In summary, as long as the brain is provided with enrichment from the social environment, it will continue to grow. Diamond (1998) describes the potential for lifelong learning:

> Throughout adolescence and all during adulthood, the dendrites continue to branch, grow, and form new synaptic connections as a person learns and experiences more of the world. Underused synapses will go on disappearing, even after the major pruning years are over at sixteen to eighteen. But as long as new ideas, sensations, and experiences continue to stimulate the brain, the growth and loss of connections is at least a zero-sum game. At best, lifelong enrichment will promote continued

> branching and growth of dendrites and with that, continual thickening of the cerebral cortex. (p. 255)

Stages of Development

Many scientists portray critical periods of development. In this section their contributions are discussed according to author since their various "models" are quite different. This section also considers factors that potentially can truncate or promote critical periods of development.

Emerging Models of Critical Periods

Howard Gardner

Howard Gardner (1983) speaks of critical periods and enrichment in brain development. He establishes five principles which relate to *plasticity during early life.*

1. The first principle addresses flexibility of the earliest years of life.

> Consider one example, which can stand for many others in the literature. As explained by W. Maxwell Cowan, neurobiologist at the Salk Institute, both the forebrain and the neural part of the eye develop out of the head end of the neural plate. If, at an early stage in development, one removes a small piece of ectodermal tissue, neighboring cells proliferate, and the development of both the brain and the eye should proceed normally. But if the same operation is performed a little later, there is a permanent defect either in the forebrain or in the eye. . . . Studies by other neurobiologists such as Patricia Goldman, confirm that, during the earliest period of life, the nervous system can adapt flexibly to severe injury or experimental alteration. (p. 40)

2. The second principle discusses the "critical periods" of development.

> In the cat there is a critical period in visual development from the third to the fifth week postnatally. If, during this time, one eye is deprived of form or light, then the central connections of the eye change and the ill-seeing eye will be suppressed from functioning. Such interference seems to be permanent. As a general point, it seems that the most vulnerable time for an organism occurs during these sensitive periods. Irreversible damage to the central nervous system seems particularly likely to occur in the wake of even mild restrictions during such a critical period. Conversely, rapid development will occur if the proper conditions obtain during the critical period. (p. 40)

3. A third principle deals with the differing degrees of flexibility exhibited across the regions of the nervous system.

> Regions that develop later in childhood, such as the frontal lobes or the corpus callosum, turn out to be more malleable than those that have developed in the first days and weeks of life, such as a primary sensory cortex. The surprising degree of uncommittedness which characterizes regions like the corpus callosum seems to reflect both the need for a high degree of modifiability for certain cortical connections and also the importance of specific postnatal experiences in determining the kinds of connection which will ultimately be made. Indeed, when it comes to the most complex of human capacities, such as language, the individual can withstand even massive damage, including the removal of an entire hemisphere, during the first few years of life and still acquire the ability to speak in a reasonably normal fashion: this recovery suggests that large portions of the cortex remain uncommitted (and thus available for diverse uses) during early childhood. (pp. 40-41)

4. The fourth principle considers factors that affect development.

> An organism will fail to develop normally unless it undergoes certain experiences. . . . If proper stimulation is lacking, or if inappropriate stimulation is supplied, the usual developmental goals will not be achieved, and the animal will fail to function properly in its environment. (p. 41)

5. The fifth principle explains how the nervous system can be injured by long-term effects.

> While some injuries exert immediate and evident effects, others may be invisible at first. Suppose, for example, that a region of the brain which is destined later in development to assume an important function, happens to be injured at an early point in life. It may well be that the consequences of the injury will not be observed for some time. (p. 41)

Gardner refers to the nature versus nurture debate by stating, "Consideration of these five principles should confirm that any simple verdict on the issue of determination versus flexibility is impossible. Strong pressures favor each factor, and both therefore exert considerable influence on the development of the young organism" (p. 42).

Hannaford

Carla Hannaford (1995) speaks of stages of development in the context of brain hemisphere and brain area development. In chart form, she offers proximal ages aligned with benchmarks of brain development—a process that begins at conception and ends when we die. Hannaford cautions: "We all naturally develop at our own pace in our perfect time." Charts of this type provide a "'ballpark' rather than exact developmental picture" (p. 82). See Table 1 for Hannaford's age and stage development.

Hannaford's developmental schedule is, of course, only one representation of the maturation process in terms of brain function. Other "timetables" may be less definitive, but one characteristic seems apparent in the various models: Exactness in timeframes is non-existent. In Healy's words (1994), "Children run on different developmental timetables" (p. 66).

> By age six, teachers should expect a four-year span in maturation among students of the same chronological age. Moreover, each child has a unique profile of strengths and weaknesses—physical, emotional, intellectual, and social. One of the hardest things for everyone to understand is that *bright children are not necessarily on the fastest train.* Many problems of "underachievement" result from an incongruity between the child's neurological pattern or timetable and the expectations of the family and school. (p. 66)

Diamond's and Fisher's model stages

Diamond (1998) believes that putting definition to stages of development in respect to specific areas of the brain remains a challenge to neuroscientists. She explains:

TABLE 1

HANNAFORD'S (1995)
STAGES OF DEVELOPMENT

Age (approximate) and Description	Development
Conception-15 months • Basic survival needs—food, shelter, security and safety • Sensory development starting with vestibular system, then hearing, tactile, smell, taste and finally seeing—rich sensory activation • Motor development moving from reflexes to core muscle activation, neck muscles, arms and legs leading to rolling over, sitting, crawling and walking—motor exploration	Reptilian Brain
15 months-4 1/2 years •Understanding of self / others, self / emotions, self / language • Emotional exploration • Language exploration / communication • Imagination • Gross motor proficiency • Memory development • Social development	Limbic System / Relationship
4 1/2-7 years • Whole picture processing / cognition, • Image / movement / rhythm / emotion / intuition • Outer speech / integrative thought	Gestalt Hemisphere Elaboration
7-9 years • Detail and linear processing / cognition • Refinement of elements of language • Reading and writing skills development • Technique development –music, art, sports, dance, manual training • Linear math processing	Logic Hemisphere Elaboration

Table 1—*Continued.*

Age (approximate) and Description	Development
8 years • Fine motor development—skills refinement • Inner speech—control of social behavior • Fine motor eye teaming for tracking and foveal focus (2-dimensional focus)	Frontal Lobe Elaboration
9 – 12 years • Whole brain processing	Increased Corpus Callosum Elaboration & Myelination
12-16 years •Learning about body, self, others, community, and meaningful living through social consciousness	Hormonal Emphasis
16-21 years • Whole mind/body processing, social interaction, future planning and play with new ideas and possibilities	Refining Cognitive Skills
21+ • Global / systems thinking • High level formal reasoning • Refinement of emotions—altruism, love, compassion • Insight • Refinement of fine motor skills	Elaboration and Refinement of the Frontal Lobes

Note. From *Smart Moves: Why Learning Is Not All in Your Head* (pp. 82-83), by C. Hannaford, 1995, Arlington, VA: Great Ocean Publishers.

> Someday neuroscientists will be able to match many of a baby's budding behaviors with growth in specific regions of the brain. In general terms, researchers can connect things like the four-month-old's ability to focus and see at a distance for the first time with the surge of synaptic connections in the visual cortex. They can also link the growing coordination between eye and hand movements, like picking up a rattle and bringing it to the mouth, with connections between the visual cortex and its counterpart in the motor cortex. However, measuring a specific connection between one particular column of maturing cells in the prefrontal cortex and success on the hidden toy test are a higher-order of association; these will await new ways of studying the brain. (p. 118)

Diamond (1998) cites several different research studies that relate to the critical periods of development. One such study is that of "Kurt Fischer, a Harvard University educator who is a 'neo-Piagetian' as well as cognitive neuroscientist" (p. 113). Fischer has developed a model for conceptualizing the cognitive developmental timetable. He approaches this schedule from a Piagetian perspective; and he promotes the idea that environmental effects and organic change are partners in a child's development, and that even a little environmental input can create dramatic change in brain function growth curves (Diamond & Hopson, 1998, p. 113).

> In Fischer's model, the brain develops by fits and starts throughout childhood, with what he calls "growers" (developing brain functions and behaviors) accumulating and spurring each other's further development. He attributes the growth of particular brain regions—and in turn, behaviors—to mechanisms we've already seen—myelin accumulation, dendritic branching, synaptic formation, and the pruning of weak or unused connections. Fisher's scientific papers feature mind-tangling strings of algebraic equations describing the cyclic action and interaction of "growers" upon each other. The high points, however, are fairly straight-forward: Between a child's birth and his twenty-first birthday, his brain exhibits a series of growth spurts, reflected in head growth, brain activity (measured through EEG recordings of brain waves), and the density of synaptic junctions between dendritic branches. (p. 114)

In Fischer's model when a child is ill or is deficient in the nutritional energy needed for brain growth and development, the system stops for a while. One of the observations Fischer documents relates to his study of his infant son. He observed a disruption in the pattern of head growth measurement when his son was ill with a cold for a 2-week period—age 17 to 19 weeks. Diamond states, "Fischer found that his son's head (and presumably the brain inside) failed to grow at all during the illness" (p. 113), even though incremental growth had been charted up until that time, and growth resumed after the illness.

Fischer theorizes that as an infant experiences brain growth spurts, new skills develop. In turn, the brain registers these new skills as experience, and experience aids the brain in moving to the next growth level. This reciprocal function continues as the development moves to higher and higher levels. Diamond describes Fischer's model at stages beyond infancy:

> Fischer's model goes on to describe brain growth spurts and newly emerging skills at three and a half to four and a half years, six to seven years, ten to twelve years, fourteen to sixteen years, and eighteen to twenty years. . . . It's no coincidence that many of the spurts, especially in the first few years, are synchronized with the accumulating myelin in various parts of the brain, the explosion of synaptic junctions, and the booming activity other researchers have seen in very young children's brain cells. (p. 115)

Another study which Diamond cites proffers an unusual model for understanding brain developmental stages. Robert Thatcher, a University of South Florida researcher, theorizes a road-map model for charting a child's brain at certain ages. His model is based on the concept of a "traveling wave."

> Based on EEG studies of over five hundred children, Robert Thatcher has created a model for how a "traveling wave" of a growth-stimulating hormone could "sweep" through the brain in slow spiral waves involving first the left hemisphere, then the brain's center, then the right hemisphere. Each sweep would take approximately five years, he theorizes, then begin again, in the left-center-right pattern. If Thatcher's model is correct, the left hemisphere is stimulated at ages eighteen months to two and a half years (coincident with the language "explosion"); both sides are growing at three years of age, and from four to five years, a period of heightened imagination, the right hemisphere is most stimulated. Another five-year-cycle sweeps from left to right between ages five and ten, another from ten to fifteen, and so forth throughout

> adulthood. Each wave may stimulate synapses to form, he suggests, and any that are not needed or used are eventually pruned away. Thatcher sees his cycles as the "engine that drives" the growth spurts at the various ages Kurt Fischer outlines. (pp. 118-119)

Diamond says, "If these spurts and spirals are confirmed, we may have a new way to understand the major thinking, learning, and personality shifts of childhood, adolescence, and adulthood" (p. 119).

Normal infant behaviors and movements are critical to systems and ability development. Crawling is a good example. Diamond (1998) cites another study done by "two psychologists from University of Illinois, Roseanne Kermoian and Joseph Campos. . . . They confirmed that crawling detonates an explosion of brain development" (p. 116).

> The two researchers divided more than one hundred babies into three groups: those that had not started crawling, those that had, and those that could not yet crawl but could scoot around in a plastic baby "walker." They found that the mobile babies could also easily locate keys, toy watches, and other treasures that the researchers had hidden beneath a cloth. In infant terms, this ability equals spatial intelligence—the more mobile the eight-month-old, the more likely he or she will be to find the hidden object. Nonmobile babies, on the other hand, were usually stymied by the test, and failed to find a key or watch concealed beneath a handkerchief. (p. 116)

Marian Diamond (1998) describes the brain's accumulation of neurons. During embryonic and fetal development, rapid production of neurons takes place in the brain. However, the rapid development appears to come to a halt even before the baby is born.

> By twenty-eight weeks of gestation, the phenomenal proliferation of neurons has ceased, and some natural cell death has taken place among unneeded neurons. Depending on the individual's body size, however, and whether they "use or lose" their mental faculties, the number of nerve cells will then remain about the same from seven months' gestation until seventy or eighty years of age. *The branches and spines on those neurons, however, continue right on growing.* (pp. 51-52)

After the child is born, it seems apparent that the number of neurons in the cortex remains the same; but the brain appears to expand neuronal capacity through dendritic growth, thus increasing the numbers of potential connections for thought transmission.

In summary, Gardner, Diamond, and Fischer concentrate on evidences of critical periods of development based on evidences revealed from studies of neural functions within the brain's interior. Diamond and Fischer also join Hannaford in looking at behavioral indicators of development. All seem to concur that there are critical periods of development and that those critical periods vary with the individual.

Critical Periods of Neural Development

The brain is a dynamic and adaptable organ, especially in early childhood. When debility occurs in one area, another area may attempt to compensate (Diamond, 1999). The research of Neville (1995) Hubel and Wiesel (1970, 1979), and others focuses on this possibility. Their research also strongly suggests that there are critical periods of neural development in the early years that can liberate or truncate the brain's developmental potential.

Helen Neville's (1995) research on how auditory function develops, and the critical periods involved in this development, indicates interconnectedness between the auditory cortex and the visual cortex. Neville, a professor at the University of Oregon in Eugene, and director of the Brain Development Lab at that site, explains that deaf people often develop high-level acuity in peripheral vision. The plastic nature of the brain makes this possible. Referring to Neville's research, Diamond (1998) explains how this happens for a deaf person:

> Although most of us don't know it, . . . people really have two visual systems, and one is directly linked to our hearing, at least until age three. We have a "*where* visual

> system," says Neville, concerned with locating objects and events, with focusing our attention, and with perceiving motion. And we have a "*what* visual system," good at picking out forms and colors but not good at motion or location. Our peripheral vision is part of our "where" system, not our "what" system. Neville thinks that after we are born, because of our overpopulation of synapses and connections between brain cells, parts of the "where" visual system are wired to parts of the *hearing* system. If you make a noise near a six-month-old baby, she says, and measure her brain waves, "you get a big response in *both* the auditory cortex *and* the visual cortex." That effect stops at about age three, however, unless a child has been deaf during those years.
>
> In a child with normal hearing, she explains, the extraneous connections from the eyes to the hearing system would disappear as sound input comes in; sounds would compete for the contact points in the hearing cortex . . . and beat out the weaker synaptic connections from the eyes. But in a three-year old child deaf since birth, Neville continues, there has been no competition from auditory input, since no nerve impulses travel from the ears to the brain. Therefore, the visual hookups remain in the hearing brain and give the deaf child a more sensitive "where" visual system, including better peripheral vision. A child that becomes deaf after age four, however, doesn't show this heightened "where" vision and that, says Neville, suggests that the environment's critical shaping of hearing takes place by about age three or a little older. (pp. 61-62)

As the brain develops its varied functions, each is programmed to develop on its own time schedule. The longer the critical period of development, the greater is the likelihood that function will be modified by experience (Neville, 1995).

Diamond (1998) suggests that the critical periods of development for vision, hearing, and language are not as subject to modification by experience over as long a period of time as are some other functions. However, not all phases of visual, hearing, and language function are as susceptible to the timetable as are others. For example, the ability to perceive color is acquired during a critical period that may differ from the critical period to perceive motion. Other phases of these acquired abilities may be "open to lifelong modification" (p. 63).

Critical periods of development are not limited to the first few years after birth. Diamond (1998) suggests that some areas of the brain still indicate that neural patterning is taking place up until age 30. And before birth, the brain is especially susceptible to environmental influence both inside and outside the uteral confines.

Diamond (1998), Hannaford (1995), Healy (1990), and Jensen (1998) all comment on the importance of aligning learning expectations with the unique, developmental schedule of each individual learner. Healy speaks of potential harm that can result when a child is forced to learn before the neural networks are ready for that experience. As an example, she refers to children who are forced to do handwriting too early. Consequently, these children develop awkward pencil-holding techniques that easily fatigue the hand. When the more optimal time arrives for learning this ability, ill-adapted neural processing has already been established and is almost impossible to retrain.

Marian Diamond (1998) refers to possible complications that can occur when the natural processes of development are disturbed. These disruptions can impact the child's ability to construct meaning, to focus attention, and other functions critical to learning.

> In the human fetus, as in other mammals and in birds, there is a set order for the onset of the senses, for example. Sensation in the skin appears first, then balance, then taste, then smell, then hearing, and finally vision. Researchers in Virginia [Sleigh & Lickliter, 1995] designed a test with bobwhite quail to see whether they could artificially change the order with stimulation. They lifted a small piece of shell from hundreds of quail eggs and exposed the chicks inside to bursts of flickering light. The chicks would normally encounter direct light only after hatching and this early exposure seemed to trigger early visual development. It also disturbed the chicks' ability to imprint correctly on their mothers' movements and voice, and instead of following her, they walked around looking dazed. (p. 94)

Diamond pulls this implication—that disrupted developmental processing can profoundly impact future function—into application for the human subject. She speaks of premature infants born "sometimes as much as three months too soon" (p. 94).

> Their early birth thrusts preemies into a world of light, unfiltered sound, direct touch, and general sensory overload. Pediatric researcher Heidelise Als [1995], who studies preemies at Children's Hospital in Boston, notes that 400,000 babies arrive more than a month too early each year, when their brains are growing at the fastest possible rate. Children delivered weeks too early, she says, can (but by no means always) exhibit learning disabilities, lower IQ scores, attention deficits, impaired eye-hand coordination, and speech problems, and they tire and distract easily, lack self-esteem and self-control, and act vulnerable and impulsive. This, writes Als in a recent article, suggests that early sensory stimulation may present unexpected challenges to brain development and may distort it by triggering sensitive periods at a time when the brain can't incorporate visual, touch, or other kinds of stimulation. (p. 94)

The critical periods of development provide optimal times for neural patterning that can benefit or limit future brain function. For some sensory development these critical periods last longer than for others, but there appears to be a delicate, natural balance that must be maintained between all systems and the timing of these processes in order for normal development to occur (Diamond, 1998; Healy, 1990; Hannaford, 1995).

A child's ability to relate to the world in meaningful ways is influenced by many factors, including genetic endowment, maturation level, environmental factors that both empower and limit normal function, and internal processes that affect states of mind (Caine & Caine, 1991; Diamond, 1998; Hannaford, 1995; Healy, 1990; Jensen, 1998; Sylwester, 1995). The next section considers the complex function of the brain's ability to focus and maintain attention.

Critical Periods of Language Development

There are critical periods for language acquisition, say Marian Diamond (1998), Steven Pinker (1994), and Karin Stromswold (1995). Citing multiple supportive studies, Diamond suggests grammar is innate to human brain function and that there are critical periods for activating this innate ability. If the child is deprived of that activation, language acquisition will be profoundly truncated. Diamond explains, "Linguists offer even more startling evidence to prove that grammar is both innate and is preprogrammed to appear spontaneously around preschool age and then to become extremely difficult if not impossible to learn after a certain age" (p. 171).

Diamond describes how normal language acquisition develops certain areas of the brain—especially the left hemisphere and its front temple area and the rear areas of both hemispheres. When normal development does not occur during critical periods for language exposure, profound, lifelong effects are realized. In feral development (not domesticated because of developmental deprivation) or "deaf children deprived of language stimulation between ages four and seven or eight" (p. 173), normal area specialization in the brain does not occur. When remediation is provided, these children "never catch up completely to children their own age who weren't deprived of language" (p. 173) during these critical periods.

Language is sensed during our earliest days of life. Citing research done by Dr. Alfred Tomatis (1991) using fiber optic cameras, Hannaford (1995) says, "At five months the fetus responds to phonemes of language (varying vibrations of sound such as the vowel sounds) that it hears through the amniotic fluid, spoken by the mother." Hannaford explains:

> The fetus will move a specific muscle, in the arm or leg for example, when it hears a specific phoneme. The particular muscle moved varies in each fetus studied, but each time the same phoneme is sounded, the same muscle will move. This early connection of a muscle response to sound suggests the significance of anchoring sensory input with action for learning to occur. . . . This sensory-motor response to phonemes allows the fetus to begin the process of learning language in utero. (p. 36)

Diamond (1998) defines developmental periods in language acquisition. She explains that most babies say their first words by the age of "nine to twelve months and then slowly build up a vocabulary of about fifty words by fifteen to twenty months." This level of attainment seems to "set off a veritable language A-bomb," she says. "After learning the first fifty words, the child starts accumulating fifty new words *every week or so* and continues at this astonishing pace throughout most of grade school." This pace of new word acquisition is accompanied by the child's beginning to string words together in "two-word phrases, then three-, and for a while, they continue to sound like encoded telegrams: 'Bernie want apple.' 'Where Barney?'" (p. 170).

Just when it seems likely that these "word piles and word strings" will get tangled up in each other without some system of order for making meaning, an innate sense of grammar seems to kick in to provide "rules for word order, tense, endings, connectors, and so on" (p. 170). Diamond describes this phenomenon in context of Pinker's (1994) and Stromswold's (1995) research:

> The ability to pick up grammar appears to be both speedy and innate. By age three, the preschooler is starting to get words into meaningful order—"Why is he leaving?" The verb tenses, Pinker [believes], may continue to be a bit rough: "I'm gonna full Angela's bucket." By the time children have reached four, writes Rutgers University psychologist Karin Stromswold, "The vast majority of their utterances are completely grammatical." Even more surprisingly, the children she studied picked up the different aspects of grammar in virtually *the same order* (unaware, of course, of either the linguistic rules or their esoteric labels like "datives" and "preposition-stranding constructions"). (p. 171)

As described above in Diamond's (1998) developmental benchmarks, when the sequential patterning of the brain does not occur, the learner probably will be language impaired in some way. One of the examples Diamond uses to demonstrate this is that of a rural area California woman "with average intelligence who was born deaf . . . yet was misdiagnosed as retarded instead of hearing-impaired." She had been schooled in neither American Sign Language nor in English. When her need was discovered, at age 32, she was fitted with hearing aids and was given intensive language training. The results:

> She was able to pick up two thousand words. She was, however, completely unable to apply any of the grammar linguists tried to teach her in adulthood. She continues to use her vocabulary in sentences like "Banana the eat," "Orange Tim car in," and "The woman is bus the going." Apparently, because she learned no language at all as a youngster, her innate grammar capacity slipped away unused and eventually was irretrievable. (p. 171)

Jensen (1998) describes the loss of ability to internalize grammar and other aspects of language after optimal periods for language acquisition have passed:

> Before puberty, most children will learn any language without a "foreigner's accent." The supply of cells and connection in the brain are ready and available to be used for it. There are enough for us to learn even the lightest nuances in pronunciation.
>
> But after puberty, the connections have almost disappeared, and the potential cells for language have been usurped by other more aggressive cells for other functions. Schools ought to expose children to larger, more challenging vocabularies and to foreign languages by age 12. Neuronal loss and synaptic pruning make the acquisition of second languages more difficult with each passing year. (p. 34)

Robert Sylwester (1995) explains how second language acquisition is affected by the optimal periods of language development:

> The fetal brain . . . develops general areas dedicated to various basic human capabilities within a certain range of variation, such as our ability to process language. Infant brains are born capable of speaking any of the 3,000+ human languages, but they're not born proficient in any of them. When infants begin to interact with the local language, their brain can already recognize the sounds of the language. The larger neural networks that process the specific language(s) they'll speak form as the various combinations of sounds in the language(s) occur frequently. The amount of use selectively strengthens and weakens specific language networks. The networks for sounds that aren't in the local language may atrophy over time due to lack of use, or they may be used for other language purposes. Scientists call this process neural pruning. We can see its results in the difficulty that most older Japanese adults have with the English *l* or *r* sounds, which aren't in the Japanese language. A Japanese adult who learned English as a child would have no trouble with the two sounds. (p. 20)

In light of what brain research is revealing about optimal times for language learning, Jensen (1996, p. 315) suggests that schools reconsider timing in offering second language instruction. More emphasis during the elementary years better fits with brain research findings, as opposed to waiting until high-school years to offer foreign language classes.

Potential Barriers to Critical Period Development

Critical periods of development begin long before the child's birth. Throughout her 30-year career in neuroscience, Marian Diamond has been an advocate for educating parents about factors—even before conception—that can impact the brain development of the unborn.

> The basic parts of the brain and nervous system originate and grow quickly and in the first weeks and months after conception they are susceptible to permanent damage by a range of things the mother and father may eat, drink, breathe, smoke, pop, sniff, or even carry home on their clothing and hair from industrial exposures. The mother's emotions affect the fetus, and so do her general habits and the parents' physical environment. (Diamond & Hopson, 1998, pp. 66-67)

A child's ability to realize his/her potential to construct meaning may have been impacted negatively even before the child was conceived. Diamond (1998) stresses the importance of the parents' role in providing optimum advantages for their offspring's brain development.

> One recent study of American children reveals that as many as one in five have problems with learning, behavior, or emotions stemming from the effects of their physical and emotional environments before and after birth. Nicholas Zill, a psychologist from Child Trends, Inc., in Washington, D.C., an organization devoted to monitoring problems that impact children, estimates that 42 percent of American families with children have one, two, or three socioeconomic factors that contribute to developmental problems: a mother who gives birth to her first child before finishing high school, and/or is under twenty, and/or is not married to the father. . . . These and other factors can lead to an emotional climate that actually alters the baby's brain structure. Other factors common to the families that fit Zill's profile—poverty, poor nutrition, drugs, alcohol, and violence—can have a direct physical effect on eggs and sperm even before a child is conceived. (Diamond & Hopson, 1998, p. 67)

The negative effects of drug use, emotional extremes, nutritional imbalance, etc., on the developing child's brain can be profound, according to Marian Diamond, Arnold

Scheibel, and other presenters at the U. C. Berkeley Brain Symposium, held in 1998. The full effects of such influences are not known, but the accruing evidence is convincing that such influences can impact the brain's potential development structurally and functionally.

Young children are often deprived of physical activity necessary for brain stimulation during critical periods of development. Jensen (1998) explains, "Today's infant is 'baby-sat' by television, seated in a walker, or strapped in a car seat for hundreds of precious motor development hours" (p. 21). Much needed "crawl time" is not available for the child because of so much time in a car seat. Jensen states that "in 1960, the average 2-year-old spent an estimated 200 hours in a car. Today's 2-year-old has spent an estimated 500 hours in a car seat!" (p. 21).

Jensen expresses concern that such restraint on children will permanently affect their brain growth and development. He refers to research which suggests that "irreversibility [in neural patterning] sets in by age four" and that by that age, the "brain's infrastructure is now in place" (p. 22).

Expressing similar concern for children during "enrichment prime time—ages six to twelve," Diamond (1998) says, "Some are 'over-programmed' with multiple activities; some are thriving in unexpected ways; some are channeled into high performance levels in sports or music; and some sit for hours in front of Nintendo, television, or computers" (p. 7).

The dominant role television and other electronic media play in a child's life is commonly mentioned among the brain educators as conducive to developing passive learners. Caution in this area is strongly suggested (Diamond, 1998; Hannaford, 1995;

Healy, 1990; Jensen, 1998). "I strongly agree," says Carla Hannaford (1995), "with Joseph Chilton Pearce's stand and Jane Healy's suggestion that TV be banned before the age of eight so that imagination and language skills have a chance to be established" (p. 66). A contributing factor to Hannaford's concern over too much sedentary, vision-intensive activity is her belief that vision development can be impaired by lack of proper visual stimulation. Hannaford (1995) posits,

> Considering the ratio of cones to rods, it strikes me that we were not designed to sit for long hours engaged exclusively in foveal focus activities, like reading, and watching TV or computer screens. The eyes need to actively experience the world as a whole for vision to develop fully. Active sensory and motor functioning of the eyes helps to entrain the body on shapes and movement of natural forms and to develop the spatial awareness necessary for clear perceptions and thought. (p. 48)

What causes school readiness is a question Healy (1994) poses and attempts to answer in context of when a child is ready for school. She says that

> for many years experts told us that school "readiness" resulted from "neural ripening," which they insisted would unfold despite environmental influences. We now know that a child's life experiences interact with the developmental schedule of the nervous system in five separate areas:
>
> 1. Physical well-being and motor development.
> 2. Social and emotional growth.
> 3. Approaches toward learning.
> 4. Language development.
> 5. Cognition (thinking skills) and general knowledge.
>
> In some cases these forces conspire to make children unready for school at the scheduled time because they are late bloomers, have a learning pattern that is different in some way, or both. (pp. 67-68)

Jensen (1998) stresses the importance of recognizing that "school readiness starts at conception." He explains that "drugs, smoking, nutrition, and heredity all affect the embryo (Van Dyke & Fox, 1990). The most important things a pregnant woman can do are eat well, avoid drugs, and keep the stress down" (p. 19).

Again, referring to fetal development, Jensen states:

> Most brain cells are produced between the fourth and seventh month of gestation. Those fast-developing cells, called neurons, form a vast network, connecting to other cells. A newborn has more than a trillion connections in the brain.
>
> At its peak, the embryo is generating brain cells at the rate of 250,000 a minute, or 15 million cells per hour. (p. 19)

These brain facts and accumulating knowledge about the ill effects of drugs, poor nutrition, stress, etc., provide us with valuable information on how to give children, even the unborn child, improved advantages during their most critical periods of development.

Do windows of opportunity close tight at specific times and preclude future learning? The answer to this question is both 'yes' and 'no.' Hubel and Wiesel (1979) provide data to suggest that to some extent windows of opportunity do close permanently in certain extreme situations. However, for the typical individual learning opportunities continue throughout the lifetime. Marian Diamond (1998) provides encouraging words to this effect.

> With very few exceptions, the normal, healthy brain can still absorb all types of information and a person can acquire all sorts of skills and experiences at any age. It may be more taxing to take up tennis at thirty-seven rather than seven, more time-consuming to learn the flute at forty than at ten, and less successful to start a foreign language after adolescence. But we all know friends and relatives who have taken up new hobbies, languages, sports, even careers in adulthood and triumphed. The brain doesn't snap shut or fill up. (p. 4)

Making Meaning

The brain's ability to construct meaning—to learn—is a complex, dynamic process. Information coming in from the environment via the senses is processed in varying locations throughout an intricately networked, multi-layered system with billions of possibilities for connections with memory stores, present relevance, and recognition of useful future purpose. Jensen (1998) elaborates on this astounding potential for connections:

> It is estimated that we use less than 1 percent of 1 percent of our brain's projected processing capacity. Each of your 100 billion neurons ordinarily connects with 1,000-10,000 other neurons. But they could theoretically connect with far more. Since each neuron has several thousand synapses, your entire brain has trillions of them. Your brain is capable of processing as much as 10 to the 27th power bits of data per second (Hobson 1994). However, Paul Churchland (1995) postulates that the total possible configuration is 10 to the 100 trillionth power. That number far exceeds the number of known particles in the universe. Our brain is, indeed, quite a miracle. The brain is what we have; the mind is what it does. In other words, the "mind" is not a thing; it's a process. (p. 15)

Facilitated by means of electrical current and an equally (if not more) complex system of neurochemistry, all this connecting takes place on the conscious and subconscious levels simultaneously (Caine & Caine, 1991; Diamond, 1998; Hannaford, 1995; Healy, 1994; Jensen, 1998, Sylwester, 1995).

In addition to the many specialized areas for dealing with incoming data, the brain has two hemispheres, each containing duplicate structures for most of its processes. However, in spite of the apparent structural similarity of the two hemispheres, their overall function is significantly different in many respects. Sylwester (1995) speaks of the brain's dual functions in synthesizing and analyzing the environment—both critical to balanced conceptualization. He explains these two processes as relative to coordinated brain hemispheric function:

> Thus, our brain must have one set of mechanisms that instantly see the forest—that *synthesize* the background or context by gathering a little bit of high-contrast information from each of many units in our sensory fields. Synthesis provides a quick, general sense of what's out there and how all those units are related. For most people, the right hemisphere specializes in this task. It's been called our metaphoric mind because metaphors, parables, maps, graphs, cartoons, and so on provide only the outlines of a broad concept that can be experienced and interpreted in many ways.
>
> Conversely, the left hemisphere of most people contains the mechanisms that *analyze* the individual foreground elements of our broad sensory fields—by carefully examining the lower contrast details of an individual tree, while the right hemisphere monitors the entire forest. This analysis must be done sequentially, because our brain can't simultaneously examine several individual trees in different areas of our visual

> field. Thus, our left hemisphere is designed to process information that must be processed sequentially. (p. 50)

The two wrinkled hemispheres are the most common visual image used to represent the brain. However, what is contained inside these two parts is a complex of substructures critical to meaning construction. To understand how the brain makes meaning, it is important first to consider the structural aspects of the brain that contribute to this process. The next subsections provide an overall description of the major properties of the brain that are critical to making meaning.

Geoffrey and Renate Caine (1999) write about the significance of social relationships in regard to how we make meaning out of our world. Through socialization we construct meaning in different ways, such as: (1) by learning to imitate others, (2) as a result of reinforcement when we elicit responses from others, and (3) by adopting role models and taking on their characteristics both peripherally and unconsciously (p. 79).

> It is through others that we master language, experience the magic of reading, learn to value other people and animals, model behavior, see ourselves as lovable, capable, and intelligent, or not. Much of our self-image develops according to the feedback we get from others. The development of a self-image is driven further by biologically based drives to communicate, relate, and belong. (p. 80)

Jane Healy (1990) especially concentrates attention on the social aspect of communication and how that contributes to constructing meaning. "The person who teaches your child to talk also teaches a way of thinking. The ideas, values, and priorities of a culture are borne along on the stream of language that flows between generations" (p. 89). More emphasis on the role of language in knowledge construction will be addressed in a subsequent section.

Jensen (1998) refers to "two types of meaning: reference and sense meaning" (p. 91). Others refer to "'surface' or 'deeply felt'" meaning, he suggests (p. 91). *Reference* or *surface* meaning refers to "a sort of pointer meaning," as in a dictionary definition. But *sense* or *deeply felt* meaning involves personal experience and connection to previously acquired knowledge, emotion, an activity (Jensen, 1998, pp. 90-98).

Thomas Hatch and Howard Gardner (1997) graphically represent the relationship between cultural, local, and personal forces and cognitive processes with concentric circles. Personal forces are positioned at the center of the circle, and local and then cultural forces move outward. (See Figure 2.)

Hatch and Gardner explain that "intelligence can no longer be conceptualized as an isolated property located solely inside a person's head" (p. 167). "It is proper to think of intelligence as shared by individuals and all the human and nonhuman resources they use" (p. 168).

Referring to the concentric model, Hatch and Gardner describe the embeddedness of intelligence "in all of a person's activities, past and present, and embedded in the local settings and cultures in which those activities are carried out" (p. 171).

> From this perspective, cultural, local, and personal forces are interdependent. An individual's intelligences, interests, and concerns are formed in interactions with peers, family members, and teachers, constrained by available materials, and influenced by cultural values and expectations. (p. 171)

Enlarging the concept of distributed cognitions, Ann L. Brown et al. (1997) emphasize the importance of physical interaction with the environment. They state that "knowledge is situated in activity" (p. 188). Referencing Lave (1988), Brown suggests there is a connectedness between mind, body, and social relationships.

> The point is not so much that arrangements of knowledge in the head correspond in a complicated way to the world outside the head, but that they are socially organized in such a fashion as to be indivisible. "Cognition" observed in everyday practice is distributed—stretched over, not divided among—mind, body, activity and culturally organized settings (which include other actors). (Lave, 1988, p. 1)

"Understanding and experience are in constant interaction—indeed, are mutually constitutive," state Lave and Wenger (1991, p. 52). They suggest that learning occurs as a result of active involvement.

Learning can occur even as we relate to inanimate objects. Jensen (1998) discusses the effect of environmental surroundings on the mind. Though he stresses that "enrichment comes from challenge and feedback, not artistic merit or aesthetic enjoyment" (p. 39), this does not mean that the environment contributes little or nothing to learning. To the question, "Does it matter what we look at?" he sites a controlled study in which Urich (1984) found that patients in a hospital "with a 'view room' recovered faster than those who stared at a brick wall." Apparently, the stimulation "affects more than well-being; it also feeds the brain" (p. 39). On this basis, Jensen suggests that "a rich classroom environment full of posters, mobiles, maps, pictures, and graphic organizers will be taken in at some level by most students" (p. 39).

Hannaford (1995) speaks of "images derived from our sensory experience" as the "stuff of thought and creativity" (pp. 30-31). She explains,

> From these images we make sense of new learning, tie remembered images together in different ways and come up with new ideas. Broad-based knowledge depends on these intricately woven, yet separate multi-sensory complexes of images that have been put together and reworked over and over again from our sensory experiences. (p. 31)

Mental, physical, and emotional aspects of brain function all come together to interact with the environment through individual and community relationships. In *Distributed Cognition,* Gavriel Solomon (1997), of the University of Haifa, Israel, School of Education, editorially introduces the idea that cognition is profoundly influenced by

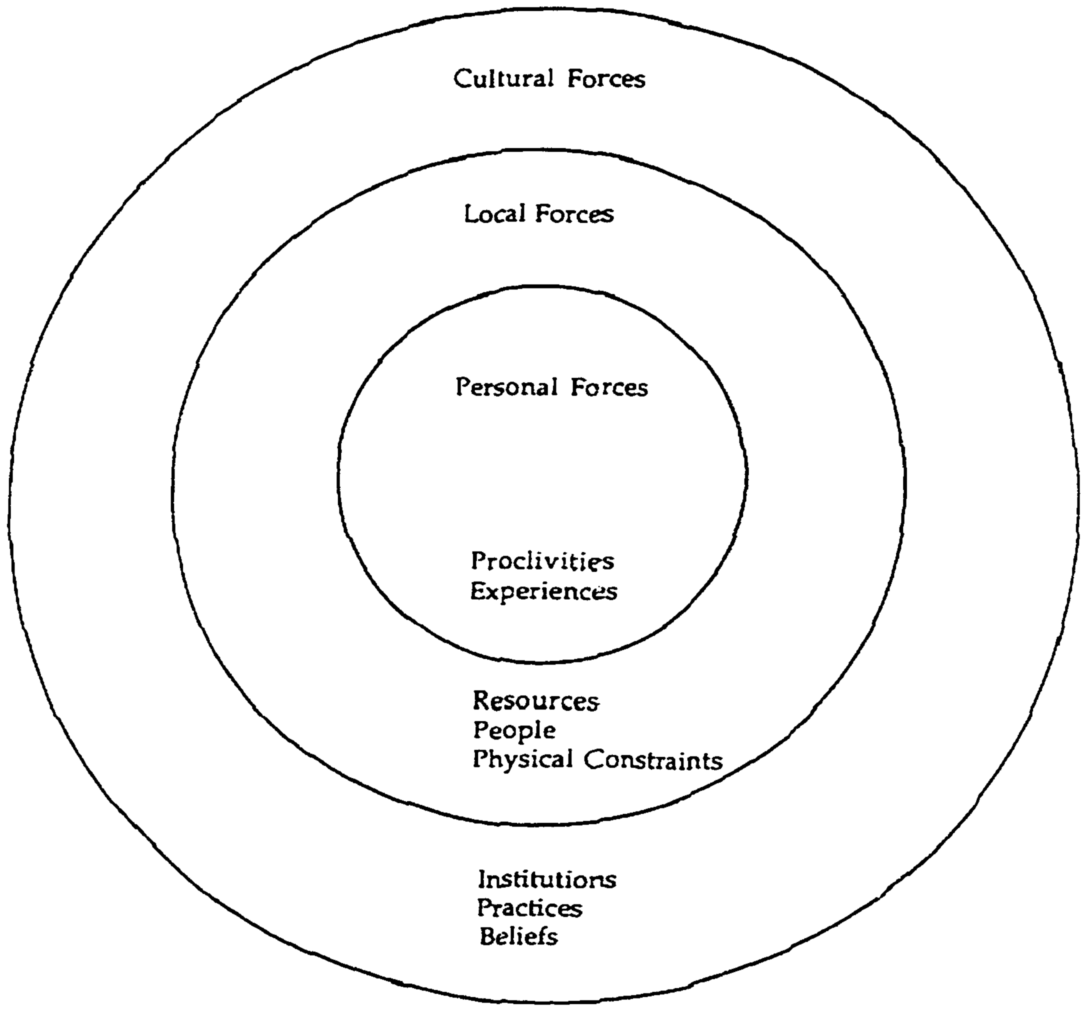

Figure 2. Forces that affect cognition. From *Distributed Cognitions: Psychological and Educational Considerations,* (p. 166), Edited by Gavriel Salomon, 1993, New York: Cambridge University Press. Copyright 1993. Reprinted with permission.

relationships with the environment, whether animate or inanimate. Though he argues that "not all cognitions are *constantly* distributed" (directly interactive with the environment), they are influenced by the environment via "mental representations (or their equivalents)" (p. xviii).

Solomon describes this interaction as a "spiral-like dynamic view of how 'solo' and distributed cognitions interact over time, affecting each other and developing each other" (p. xviii). He asserts that "people appear *to think in conjunction or partnership* with others and with the help of culturally provided tools and implements" (p. xiii).

D. N. Perkins (1997), of Harvard University's Graduate School of Education, describes individualism as a set of "interactions and dependencies" (p. 107). Referring to the works of Piaget and Vygotsky, he writes about the mutual importance of interaction with the environment.

> People select and build their physical and social environments, and do so in part to support cognition. In this sense, there is mutual assimilation and accommodation between the person and the surround – a complex equilibration process, if you like, in the person-plus. (p. 106)

Addressing the importance of organizing classrooms to "create a system for teaching and learning in which the teacher takes maximum advantage of the students' interests and knowledge," Luis C. Moll et al. (Moll, Tapia, & Whitmore, 1997) stress the significance of social relations in mental activity. Moll, a professor at University of Arizona's College of Education, states that "persons and their social and cultural worlds are inseparable, thoroughly imbedded in each other, and, as such, . . . their thinking is irreducible to individual properties, intelligences, or traits" (pp. 161-162).

Though Marian Diamond (1998) does not use the term *distributed cognition*, she does discuss environmental and social influences that affect brain development. Her greater emphasis is on relationships and how they enrich or diminish our brain development. Diamond approaches this concept via consideration of an individual's natural bent toward being outgoing or reticent to socialize.

Diamond (1998), Davidson (1994), and Dawson (1994) note that relationships exist between frontal lobe activity and reticent/explorer behaviors—that the brain is involved in social functions.

Referring to temperament in terms of introversion and extroversion, Diamond suggests that such seemingly innate characteristics may be evident in measurable "differences in a baby's frontal lobe" (p. 123). Further, she implies that social and emotional experience in the first year or two of a child's life can strongly influence neural patterning. She cites studies done on large populations of children to determine whether temperament differences are evidenced in brain function and/or structure.

Richard Davidson (1994) of the University of Wisconsin in Madison observed 10-month-old babies' tendencies to cry when their mothers left the room. Approximately half the children cried, and the others seemed unbothered. Davidson and his associates then did EEGs on the babies. EEG results showed more activity in the frontal right lobe of the brain of those babies who cried. However, the non-criers showed more activity in the frontal left lobes (pp. 123-124).

Davidson followed up with a study of 400 children aged 30 months. This time he observed characteristic differences between children who tended to be reticent—to hang back—as compared to children who were explorer types. Again, the study results indicated more frontal right lobe activity for the hangers-back and more frontal left lobe activity for the children prone to explore (Diamond, 1998, pp. 123-124).

Diamond (1998) cites additional research which seems to support Davidson's findings:

> A colleague of Davidson's, Geraldine Dawson of the University of Washingrton, has found . . . that the activity patterns in a baby's frontal lobe respond to the *mother's* moods and parenting style. A depressed mother who smiles less, plays less, and makes less eye contact with her baby than does a nondepressed mother will affect her baby's brain waves: Her baby is much more likely to have right frontal activity, associated with inhibitions, even while the two are playing peekaboo, than the baby with the happier mother.
>
> All of these findings on babies' temperaments help us better understand how a child's brain develops and how we can enrich this growth and increasing ability. That is because *the parts of the brain that process emotion grow and mature relatively early in a child and are very sensitive to parental feedback and handling.* (p. 124)

These studies indicate frontal lobe involvement in temperament and emotion; however, Diamond clarifies that multiple areas of the brain also are involved in emotional/social functions.

> Researchers know that normal emotional responses involve (1) circuits in the frontal cortex, the brain's seat of planning and organizing; (2) additional circuits in the amygdala, hypothalamus, and thalamus—all part of the limbic system that governs emotion and memory; and (3) others in the brain stem's reticular formation, which controls alertness. (p. 125)

The influence of emotion and social involvement profoundly affect the ability to relate, to learn, and to construct meaning. Limbic portions of the brain are majorly involved with these functions. However, as has been mentioned before, the brain is a dynamic, parallel, simultaneously functioning organ. As such, the limbic areas also "govern sleep, appetite, alertness, sexual behavior, and emotional reactivity (including aggression and impulsiveness), as well as the ability to form attachments to other people, to feel emotions like joy, anger, and love, and to help regulate one's own reactions"

(Diamond, 1998, p. 126). The holistic nature of brain function is reflected in the interconnectedness and multifunctional aspects of various parts of the brain. People and things in the environment are significantly involved in these dynamic mental functions.

> As tiny infants, long before we have words to describe our feelings, our experiences with parents, siblings, and caregivers—loving or harsh, supportive or destructive—help establish a mental map that will guide our emotional life, and, in turn, its influence on all of our thinking processes. (Diamond, 1998, p. 126)

As reference in two previous sections, Diamond (1998) sites the work of Institute of HeartMath in Boulder Creek, California. IHM documents studies indicating that a parent's influence on a child may be evidenced in the electroencephalographic and electrocardiographic readings of a child's brain and heart activity.

The frontal lobes of children subjected to physical neglect and emotional abuse show differences when compared with the brains of normal children, according to Bruce Perry, child psychiatrist and developmental neurobiologist at Baylor College of Medicine in Houston, Texas. If this neglect or abuse occurs during the first 3 years of life when affective development is critical, the frontal lobes may fail to develop normally (Diamond, 1988, pp. 128-129).

Affective retardation can result when children in their earliest years are exposed to violence in their personal surroundings. In such cases children can lose their ability to control themselves. Citing Perry's work, Diamond states:

> Add alcohol to the equation [effect of exposure to violence during earliest years], and their behavior becomes "literally subhuman. You read about crimes where kids get drunk and go out in packs, find somebody, beat the hell out of them, cut them up, set them on fire, and stab them fifty times. So much of it," Perry signs, "is facilitated by an affective retardation, an attachment retardation. They never got what they wanted when they were young, so that the value of another human being to them, literally, is about the same as most of us would feel about a squirrel or a toad. It is remorseless violence." (p. 130)

The mental deprivation resulting from abuse and neglect that is referenced here is not uncommon in the United States. Approximately 3 million children are subject to this kind of treatment in this country every year. Diamond (1998) continues,

> If the trauma comes early in childhood, [Bruce Perry] says, the impact is greater on the brain stem and limbic structures, and upon basic functions like sleep, anxiety, and impulsiveness. If the trauma comes between ages two and five, it is more likely to affect brain regions that regulate mood and thinking. Girls are more likely to react by dissociation—daydreaming, fantasizing, and going numbly inward, while boys are more likely to become aggressive. But in either case, says Perry, their own emptiness and lack of attachment can get passed on to their children. They've never gotten love and attachment, he says, "so they don't feel it. The neglect gets passed on generation after generation, and there is actually a diminution of that capacity across generations." (p. 131)

Diamond (1998) explains that "the generational transmission of abuse" is not absolute. "Less than half of abused children engage in serious antisocial behavior as adults, and a little more than half suffer long-lasting emotional effects" (p. 131).

> It is not clear how much restoration is possible once a young child has suffered short periods of intense abuse and neglect, or longer periods of lower-level trauma. It is clear, though, that a very young child who is deprived of love, attention, physical affections, and affiliations—heart connections—is living in a deprived environment that may feed back, through direct experience, to produce short-or long-term changes in the brain. It is also clear that one of the best ways to enrich an infant or toddler is through unstinting amounts of affection, to build security and self-esteem that will influence all the child's other experiences, and all further enrichments, throughout life. (p. 132)

Speaking of the importance of social and emotional learning, Robert Sylwester (1995, pp. 75-77) suggests six related areas that benefit children as they learn:

1. Accepting and controlling our emotions
2. Using metacognitive activities
3. Using activities that promote social interaction
4. Using activities that provide an emotional context
5. Avoiding intense emotional stress in school

6. Recognizing the relationship between emotions and health.

Sylwester (1995) supports the importance of educational models such as cooperative learning and multiple intelligences because these methods match up with the brain's natural processes for acquiring knowledge. Sylwester explains,

> If we consider Gardner's seven intelligences, we can easily see that much of our brain's capability is tied up in processing activities that are chiefly social and cooperative. It's difficult to think of linguistic, musical, and interpersonal intelligence out of the context of social and cooperative activity, and the other four forms of intelligence are likewise principally social in normal practice. (p. 117)

Daniel Goleman (1997) concludes his treatise on *emotional intelligence* with comments regarding social and emotional factors as they relate to "character, morality, and the arts of democracy." He introduces this concept this way:

> There is an old-fashioned word for the body of skills that emotional intelligence represents: *character*. Character, writes Amitai Etzioni, the George Washington University social theorist, is "the psychological muscle that moral conduct requires." And philosopher John Dewey saw that a moral education is most potent when lessons are taught to children in the course of real events, not just as abstract lessons—the mode of emotional literacy. (p. 285)

Referring as far back as Aristotle's days, Goleman says that "the bedrock of character is self-discipline," and self-discipline is "based on self-control." That involves being able "to motivate and guide oneself. . . . The ability to defer gratification and to control and channel one's urges to act is a basic emotional skill, one that in a former day was called will" (p. 285). Quoting Thomas Lickona (1991), Goleman says, "It takes will to keep emotion under the control of reason" (p. 285).

Pulling these thoughts on emotion and self toward social relationships, Goleman says:

> Being able to put aside one's self-centered focus and impulses has social benefits: it opens the way to empathy, to real listening, to taking another person's perspective. Empathy . . . leads to caring, altruism, and compassion. Seeing things from another's perspective breaks down biased stereotypes, and so breeds tolerance and acceptance

> of differences. These capacities are ever more called on in our increasingly pluralistic society, allowing people to live together in mutual respect and creating the possibility of productive public discourse. These are basic arts of democracy. (p. 285)

Should schools involve themselves in teaching moralistic values? Goleman thinks so. He suggests that schools have a central role in "inculcating self-discipline and empathy, which in turn enable true commitment to civic and moral values" (p. 286). Serving others is a natural outcome of such a position, Goleman suggests. "It is not enough to lecture children about values: they need to practice them, which happens as children build the essential emotional and social skills" (p. 286). This substantiates the importance of emotional intelligence and the role of emotional literacy. When emotional literacy goes "hand in hand with education," character, moral development, and citizenship are nurtured (p. 286).

Marian Diamond (1998) references Howard Gardner's *intrapersonal intelligence* as she discusses the role of emotion and social aspects in cognition. "Intrapersonal intelligence," she says, "is a capacity for self-awareness, morality, responsibility, even spirituality. Today social environments are not as conducive to these qualities. It becomes the task of parents to model these traits of character" (p. 209). She continues:

> Children can also be directly encouraged to develop these traits by carrying out age-appropriate chores around the house; by taking part in family discussions about current events, movies, or books; and by volunteering alongside their parents. The work ethic, once established in children, can be a source of great satisfaction throughout life. (p. 209)

Individualism

That "no two brains are alike" is commonly agreed upon throughout the literature on brain-based learning. Hannaford (1995) contributes:

> The unique set of connections which each of us makes from the very first moment we encounter the world, shapes our understanding of the world and of ourselves. Indeed, these connections are our selves, constantly moderating our experience of the world, constantly changing as experience is integrated with connections we have already made. And they are expressed and embodied in the knowledge, competencies and skills which make every human being unique and irreplaceable. (pp. 70-71)

Continuing, Hannaford describes the virtues of the neocortex and its total interdependence with the body as a whole—movement, senses, and emotions—while at the same time following "its own timetable in unfolding and developing. . . . We all naturally develop at our own pace in our perfect time" (p. 82), she quips. Stressing the importance of honoring such individuality, Hannaford asserts, "Understanding this process gives us a much clearer view not only of our enormous capabilities—particularly in the area of learning—but also of the ways the development of these capabilities can be impeded or helped to flourish" (p. 71).

Educational practices in recent decades have begun to broaden in honor of individual learning needs. Referring to behaviorism and its past influences on education, David Kolb (1984) wrote,

> In the over-eager embrace of the rational, scientific and technological, we lost touch with our own experience as the source of personal learning and development. The learning process must be reimbued with the texture and feeling of human experiences shared and interpreted through dialogue with one another. (p. 2)

Kolb's concerns over sociological, psychological, and affective aspects of individualism remain relevant today. However, the biological study of brain function is providing even more reasons for honoring learner individuality. Jane Healy (1994) offers an interesting observation in this regard. Getting down to the basic neuron, she describes how myelin forms on the axonal structures and how this formation prepares the brain for increased maturational function. She cautions,

> Since meylin formation enables more efficient brain use, making demands on undeveloped areas may be a real mistake. We have very little information on ways to speed the growth of myelin; although it is age-related, the schedule varies widely among individuals, and it is unclear how much—or if—the process can be accelerated. It seems evident that our efforts to stimulate learning must be tempered by patience until the child's mental transmission systems are equal to the task or we risk frustration, inferior skill development, and an abiding distaste and incompetence for the activity. We may even be programming in bad habits and negative motivation at a neurophysiological level. (pp. 75-76)

Speaking about the educator's responsibility to respect the individual, Caine and Caine (1991) insist,

> Students must have choice and variety. Teachers must relax their control, to provide for individual differences and intrinsic motivation. If students are to be predominantly self-motivated, they must be given the opportunity to focus on their areas of interest and to participate in activities they find interesting. . . . Children lose when they restrict themselves to what was taught and ignore their own natural abilities and knowledge. (p. 123)

The Caines stress the importance of students *actively processing* new information as they relate it to what they already know and to real-life experience. The Caines explain that *active processing* "is the consolidation and internalization of information, by the learner, in a way that is both personally meaningful and conceptually coherent. It is a path to understanding, rather than simply to memory" (p. 147).

Parents often recognize their children's individual learning needs more readily than do teachers faced with simultaneously meeting the needs of many individual learners. Hannaford (1995) offers a touching letter from an Aboriginal mother, concerned that her child's ethnic background and individuality be honored:

> Dear Sir/Madam
>
> Before you take charge of the classroom that contains my child, please ask yourself what you are going to teach Aboriginal children.
> You will be well advised to remember that our children are skillful interpreters of the silent language, the subtle, unspoken communication of facial expressions, gestures, body movement and the use of personal space. They will know your feelings and attitudes with unerring precision, no matter how carefully you arrange

your smile or modulate your voice.

They will learn in your classroom, because children learn involuntarily. What they will learn will depend on you. Will you help my child to learn to read, or will you teach him that he has a reading problem? Will you help him to develop problem solving skills, or will you teach him that school is where you try to guess what answers the teacher wants? Will he learn that his sense of his own value and dignity is valid, or will he learn that he must forever be apologetic and "try harder" because he isn't white?

Can you help him acquire the intellectual skills he needs without at the same time imposing your values on top of those he already has?

Respect my child. He is a person. He has a right to be himself.

Yours very sincerely

An Aboriginal Parent. (p. 197)

Language

Language is not just a means for communication, it is much more. Learning theorist Jerome Bruner (1986) describes it as "our most powerful tool for organizing experience and, indeed, for constituting our social realities" (p. 8). Healy calls it both "artifact and architect" in that it documents our culture as well as shapes it. The Russian psychologist, Alexander Luria, (1968), says:

> Language is not only a means of generalization; it is at the same time the source of thought. When the child masters language he gains the potentiality to organize anew his perception, his memory; he masters more complex forms of reflection of objects in the external world; he gains the capacity to draw conclusions from his observations, to make deductions, the potentiality of thinking. (p. 85)

Language is the individual's way of representing itself, its thought, its being to the world in which it exists. "Language shapes culture, language shapes thinking—and language shapes brains," says Jane Healy (1990), who goes on to describe critically important language development during childhood years:

> The verbal bath in which a society soaks its children arranges their synapses and their intellects; it helps them learn to reason, reflect, and respond to the world. The brain is ravenous for language stimulation in early childhood but becomes increasingly resistant to change when the zero hour of puberty arrives. Severe deprivation of language during early years guarantees lasting neural changes that noticeably affect speech and understanding. More subtle forms of language

> deprivation do not show up in such dramatic ways, but may ultimately affect abilities to think abstractly, plan ahead and defer gratification, control attention, and perform higher-order analysis and problem-solving—the very skills so much at issue in American schools today. (p. 86)

The brain's ability to decode, interconnect, translate, and encode minute bits of sensory data into a codified system for multi-level communication is only one of the dynamic, complex functions of the amazing mental organ. Sylwester (1995) describes this process at a rudimentary level:

> The phonemes and letters that constitute the primary units of spoken and written language are meaningless in themselves. Linguistic information is coded into the sequence of the units and the length of the chain, thus permitting our language to use fewer than 100 meaningless sounds and written symbols to efficiently process an incredible amount of meaningful information. Our brain's ability to very rapidly processes [process] linguistic information enhances our ability to think through and discuss complex problems. The various forms of storytelling . . . provide a practical format for stringing together and recalling related objects and events that would otherwise lose their context and relatedness, and thus not be readily available for the efficient solution of problems that involve them. (p. 108)

Sylwester defines the areas of the brain most responsible for language function—the seat of language intelligence:

> Our linguistic ability is a remarkable form of intelligence that in most people is centered in the left hemisphere. Two especially important interconnected structures in that part of the brain are *Wernicke's Area* in the temporal lobe, which links language and thought (word comprehension), and *Broca's Area* in the frontal lobe, which processes grammatical structures and word production. A bundle of nerve fibers called the *arcuate fasciculus* connects these two structures, and when it develops (at about age two) children begin to speak in sentences. (pp. 108-109)

Prior to the child's beginning to speak in sentences, gradually s/he will have stored bits of critical information in memory as a result of hearing language within the culture, beginning as early as during prenatal development (Diamond & Hopson, 1998; Hannaford, 1995; Healy, 1994; Jensen, 1998; Sylwester, 1995). This will be discussed later in greater detail.

Sylwester (1995) stresses the importance of an enriched oral language environment for stimulation of language intelligence. "Children tend to develop oral competence in language prior to written competence," he says, "and they must master an average of about ten new words a day to reach a high school senior's vocabulary of about 60,000 words" (p. 108).

Lifelong benefits result from providing children with enriched language environments. Such opportunities pattern the brain for future success and further brain growth. By pushing the brain to think in complex language patterns, the more capable the brain becomes to perform such functions. Research at UCLA seems to indicate that higher level linguistic functions, such as are required more and more the higher the individual goes in the educational process, create higher level dendritic growth and function. Diamond (1998) describes the research which suggests this possibility.

> A graduate student in Scheibel's lab, Bob Jacobs, along with colleague Matthew Schall, looked at the area of the human cortex responsible for understanding speech, so-called Wernicke's area. The team found that the higher a person's educational level, the more fourth-, fifth-, and sixth-order branching they could observe and document in the dendritic trees. Perhaps, their data suggest, by learning and using more words and complex ideas, the more highly educated person stimulates Wernicke's area dendrites to grow and branch. (p. 34)

Hearing, relating to, and producing language are experiences that cause the human brain to grow, even at the earliest stages of development. Diamond describes her husband's (Arnold Scheibel) and Roderick Simond's (1989) autopsy findings on 17 children who had died between the ages of 3 months and 6 years of age.

> At three to six months of age, before a baby starts talking, the dendrites on the right side of the brain are longer and "branchier" than on the left, especially in the brain areas that control sucking, swallowing, smiling, crying and other expressions, but not speech. As the baby learns to speak between eight and eighteen months, however, the dendritic trees in the left hemisphere (the side of the brain that controls language in most people) grow longer and branch more luxuriantly than the right. This left-

> side branching, Scheibel speculates, may be not the *cause* but the *response* to the baby's learning and using of words. It is therefore a classic case of dendritic growth in response to environmental stimulation—in this case, presumably, the parents' talking, singing, and reading to the baby. (p. 105)

Scheibel touches on the *nature and nurture issue*, indicating strong reason to confirm the importance of enriched environment in the nurture of language development. Healy (1994), Jensen (1996), Diamond (1998), and Sylwester (1995) express consensus on this matter.

Reading and Writing Readiness

Jensen (1996) stresses the importance of parents reading to children because this patterns the brain for later reading skills. Even when a child does not understand the words, they [parents] "are contributing to the development of syntax, vocabulary, and meaning." He says, "Studies suggest babies listen to words even though they cannot yet speak" (p. 23). Early exposure to reading (being read to) is an important part of programming a child to be a successful reader.

When is the best time for children to learn to read on their own? Even though there are critical developmental periods for acquiring language, Jensen (1998) says "there is no absolute timetable for learning to read. Differences of three years are normal. Some children will be ready to read at 4 years; others, just as normal, will be ready at 7 or even 10 years" (p. 23).

Diamond (1998), Healy (1990), and Jensen (1998) are concerned because once children do learn to read, they do not read enough. Reading is an activity that reinforces grammatic representations in the brain. This must take place in order for neural networks to be strengthened during the optimal time for language learning. Jensen says that "three out of four adults say kids are 'too distracted' by television to read" (p. 23). Citing the

"Reading at Home" (1996) survey results, Jensen states that "82 percent of all parents say they don't encourage reading at home." In addition, he cautions that "90 percent of children age 9-13 play video games"—"43 percent for under an hour, and 27 percent for 2 to 6 hours a day" (p. 23).

At the overemphasis end of the spectrum, Healy (1994) speaks of her concern that parents may urge reading skill development before the child is ready:

> The human brain can be trained to do almost anything, if the task is simplified enough and one is willing to devote the necessary time and energy. Yet the brain power—and possibly the neural connections—are stolen from the foundation of real intelligence. Reading becomes a low-level skill, and there is a danger that it will remain at the level where it was learned and practiced.
>
> I believe that formally teaching reading to preschoolers is a serious intrusion on natural mental growth. Only a few, who *spontaneously*, motivated by their own curiosity, teach themselves to read *because they want to find out the meaning*, are true early readers. Pushing others to call out words is a grossly oversimplified version of a complex intellectual feat. If we get children to "read" words before they have ideas, thoughts, and language to make reading interesting, we hand them a key to the door of an unfinished garden. (p. 238)

Writing readiness is a matter of concern to Carla Hannaford and Jane Healy. Hannaford indicates that too many school settings do not honor the developmental schedule of the normal brain. She states:

> In the usual course of development, children are accessing gestalt function at the time they traditionally begin attending school, at about five years of age. The gestalt hemisphere begins development and enlargement between the ages of four and seven, while the logic hemisphere doesn't enlarge until ages seven to nine. The most natural way, then, for children to learn when first in school at age five and six is through image, emotion and spontaneous movement. (p. 83)

Typically, a child entering kindergarten is wonderfully imaginative and has a large vocabulary. However, American education "begins alphabet and number recognition, with reading following in quick order," comments Hannaford (1995). "This might not be a problem if we involved image, emotion, and movement, and built on the student's imagination and vocabulary" (p. 84), she continues. Instead, we endorse another mode of practice which requires children "to 'sit still,' learn letters and numbers in a linear fashion (that includes printing, a very linear, logic hemisphere process), and read books with simplistic vocabulary, no emotion and few images" (p. 84). Hannaford comments further on her own work as a classroom teacher of the very young:

> At age five we teach a child to print which, in my estimation from my work with children, is the origin of many writing blocks in people today. At this early age, children have to work very hard at printing since it defies the natural development of brain functions. After age seven, when the brain is developed enough to accommodate the discrete and linear operations necessary for printing, we then teach them cursive. It is a crazy game that only serves to maintain high stress levels in the child and leads to "learned helplessness." This learned helplessness occurs when the person decides that whatever they do will be wrong. So they quit, make only a marginal effort, or just give up. (pp. 85-86)

In American schools it is common to teach block printing as the first exposure to handwriting; however, educators alert to brain research findings are not convinced this is the best approach to facilitating writing skill. Young children "usually write in a pretend cursive style, because they are mimicking grown-up writing, and because they enjoy the natural rhythm and flow of it" (p. 84) says Hannaford. But educators meet the learner on disenchanted ground, when they expect a child to perform outside of the parameters of brain readiness and relevance. Hannaford suggests that "anchoring learning in a holistic way . . . could be an excellent point of departure for new learning" (p. 84).

> I am surprised there hasn't been more research done on the comparative effects of the ways writing is introduced in different school systems worldwide. Educators in Germany have told me they are finding that students are now having more difficulties with language since they have switched over to teaching block printing as the first step to language. (p. 85)

Hannaford (1995) is not alone in recognizing the mental block toward writing that is often established early on in formal education. This recognition is not a new one. Kids do not like to do it, and teachers do not like to teach it, according to Susan Florio (1979) writing in 1979 for the Institute for Research on Teaching, Michigan State University, East Lansing, Michigan. Florio suggests that writing is the most troublesome of all the language arts, and even though the value of literacy is recognized, it is not given the attention in schools that is needed. Meaningfulness in writing evolves when students are allowed to write to an intended audience with something real to say and in expectation of a real response.

Healy (1994) contextualizes writing and classifies it as inclusive of low- and high-level thought processes.

> "Writing" means several different things which span the range of mental functioning. First, there's *handwriting*, which I regard, quite frankly, as a lower-level skill. Writing itself runs the gamut from copying all the way up to getting original ideas down on paper, certainly one of the highest-level processes demanded of children. Original writing requires integrating several mechanical skills (handwriting, spelling, punctuation) with sequentially organized thought and language. No wonder it causes trouble! (p. 262)

Healy cautions that educators can form illegitimate expectations of student capability. When a child performs exceptionally well in one area, it is quite natural for a teacher to expect that the child will perform equally as well in other areas. However, brain research suggests that "separate neural circuits" develop for different aspects of language skills. An exceptionally good writer may not shine as well in reading or spelling or speaking. "It's not necessarily because they aren't trying, but because those separate skills have different systems of wiring," (p. 263) says Healy.

Suggestions for Nurturing Language Development

When it comes to enrichment during the earliest stages of life, two ingredients are imperative, according to Marian Diamond (1998). "Emotional security may be the number one target for enrichment in infants and toddlers, but language is a close second" (p. 133). In concurrence, Healy (1994) similarly advises that during the earliest stages of language development, loving physical care is important, but that in addition "exposure to language is necessary." By *exposure to language* Healy refers to "good language" modeling. She counsels parents to exercise caution in choosing caregivers:

> Check out grammar, vocabulary, and voice quality as carefully as you check on health and reliability. Don't have your child encouraged to "be quiet" for convenience, given poor models of speech, or cheated out of a rich vocabulary. Find someone who enjoys conversation and reading, who will discipline with words rather than physical action. Likewise, when choosing day-care settings, put good language near the top of your list of "musts." (p. 162)

Healy (1994) provides several lists of guidelines for parents and teachers to help ensure that children receive sound nurture in acquiring language skills during their most impressionable years. She cautions parents to be aware of warning signals that may be evident if a child is developing abnormally. She says:

> All children show some problems with language as they grow. If you notice several of these signs, however, you should obtain a professional evaluation of your child's language development. (Premature infants may be expected to show some delay because of immaturity.)
>
> • Absence of cooing or babbling during first six months
> • Repeated failure to make eye contact with caregivers.
> • Persistent difficulty with turn-taking games
> • Trouble with sucking, chewing, or swallowing
> • Excessive drooling
> • Persistent difficulty imitating tongue movements
> • "Strange-sounding" voice (may result from physical causes)
> • Acquiring single words and phrases and then stopping all speech
> • No single words by eighteen months
> • "Echolalia": repeating set phrases, such as TV commercials instead of spontaneous speech; inappropriate repetition without intentional communication
> • Stuttering that is severe or that persists more than one year
> • No two-word combinations by thirty months or three-word sentences by age three
> • Persistent pronoun confusion after age three
> • Delayed or absent asking of questions
> • Use of language only to label or request things rather than to comment on activities or events in the environment after age three
> • Frequent articulation or grammatical errors persisting after school age
> • Frequent word substitutions; difficulty retrieving familiar words
> • Frequent irrelevant responses ("What do you like to do at school?" "Sally goes to my school but we have different teachers.")

- Persistent inability to come to the point
- Difficulty with abstract meanings of words
- Purposeful withholding of speech (pp. 186-187)

Diamond (1998) and Healy (1994) both provide additional lists of recommended activities for ensuring that children have access to enriched environmental advantages during their critical periods of development. Those lists are not provided here but may be found in *Magic Trees of the Mind* (Diamond, 1998), and *Your Child's Growing Mind* (Healy, 1994).

A Dark Side of Language Emphasis

In discussing the importance of language in the learning process, Hannaford (1995) expresses concern that language can be overemphasized to the detriment of other critical components in the learning equation .She believes language can be stressed too much in educational environments.

> Many of our educational practices derive from the unexamined assumption that people will learn best if given lots of information in either lecture or two-dimensional written form. And in order to learn they must sit still, keep their eyes forward and take notes. We have only to look at the glazed eyes and vacant stares of students in a lecture hall or classroom to know that this is a belief that needs to be abandoned.
>
> In general, our system of formal education relies too much on language as the medium of instruction. What's wrong with that? To answer that question I would like to refer back to Einstein's maxim, "learning is experience. Everything else is just information." Words, though important, are only bits of information. They are not experiential and only poorly substitute for the directness and freshness of hands-on learning. (pp. 48-49)

Hannaford (1995) points out the importance of maintaining balance between the brain's mental representation of words, the body's physical representations of movement and experience received through the senses, and the affective element that takes place in the emotions—the result of neurotransmitter function, as she cites in later discussion (p. 54). She states:

> Words can only be understood when they provoke some kind of image in the mind of the learner. If students cannot access the underlying images, the words are not comprehensible. A lot of confusion is introduced when students miss the meaning of the teacher's words. Experiences, on the other hand, are direct and real. They involve the senses, emotions and movements, and engage the learner fully. Real things happen when we experience with our senses, and in the experiencing we observe, relate to past experiences and notice patterns. Words are useful in this process, they help us to organize our thoughts about the sensations. But they are no substitute for the force and vividness of actual experience. (p. 49)

Hannaford (1995) fully supports the importance of language in the process of learning; however, her concern focuses on too great an emphasis on passive involvement, rather than active participation. When the learner is required to use language in the context of critical thinking and real-life experience, the quality of learning will likely increase. This concept is one Healy promotes, also.

Talk Is Important

Healy (1990) counsels, "The person who teaches your child to talk also teaches a way of thinking. The ideas, values, and priorities of a culture are borne along on the stream of language that flows between generations" (p. 89). Healy stresses the critical importance of getting kids to talk and to dialog with adults, but cautions that most children do not get enough of this activity either at home or at school. Alluding to the tendency to provide children with things from which they can learn, rather than dynamic conversations and interactions between caregiver and child, Healy cautions: "Not even designer toys substitute for good-quality conversation" (p. 91).

Talk between mother and child sets the stage for academic success. Research of Olson and others (as sited in Healy 1990) focused on this possibility:

> Looking specifically at the behavior of the mothers in one typical study, researchers found that "frequent, responsive mother-child language interaction" was the most critical factor in raising mental ability, rather than "overall level of maternal stimulation," i.e., how well the mother physically cared for the child. (p. 91)

Healy suggests that when children process language deeply as in having to construct their own definitions, ideas, stories, etc., they tend to do better academically than when they perform at a cognitively less deep level, as in mimicking the "behavior of a talk-show host interviewing an adult for four minutes" (p. 91). To substantiate her position, Healy cites Harvard's Dr. Catherine Snow's research that compared levels of language skills with performance on standardized testing. "Some language skills . . . are much more valuable than others in academic terms" (p. 91).

Pictureless Words

Telling stories over and over and elaborating on characters and events in the stories, discussing ideas and issues at the dinner table, and encouraging children to verbalize their original definitions of words are some of the ways parents can prepare children for school success, according the Dr. Catherine Snow of Harvard University. This kind of rich dialog stimulates the brain, and "any activity that helps children use their brains to separate from the 'here and now,' to get away from pictures and use words to manipulate ideas in their own minds, also helps them with the development of abstract thinking" (p. 92), Healy adds. Referring to a large British study (Wells, 1985) of preschool and elementary children, Healy says, "Dr. Wells and his colleagues found that the most powerful predictor of their school achievement was the amount of time spent listening to interesting stories" (p. 92).

Pictures and illustrations may attract the young child's attention, but pictureless stories stimulate imagination. Healy again refers to Wells research:

> Wells believes that such experiences [listening to stories] teach children first about the way stories (and later, other things they read) are structured, as well as the types of language that may be expected in a variety of types of written text. Even more important, however, is understanding words alone as the *main source of meaning*.

> Because the words do not come with pictures attached, the child must come to grips with the "symbolic potential of language"—its power to represent experience independent of the context of the here and now.
>
> Experiences with pictures attached, even when they involve looking at picture books and learning new words, are not as valuable, says Wells, because the child needs to learn "sooner, rather than later" to go beyond just naming things that can be seen. (p. 92)

Language Coaches

"Parenting and teaching are probably something like *facilitating agents*" (p. 21), says Robert Sylwester (1995). Healy (1990) speaks of the profound influence parents have as "one-to-one language coaches" built into their children's lives from birth. With seemingly "built-in knowledge" of how to coach their children in language, parents unknowingly instill within the child the basic elements needed for language development. Parents seem to innately know "just how to pull the youngster's language up a notch by using forms in their own speech that are just one degree above the child's current level" (p. 94).

> Some parents mistakenly believe the first year is not important for language stimulation, yet during these months basic synapses of the language system are constructed by such "simple" means as nontalking games (pat-a-cake, peekaboo) between infant and caretaker. Turn taking, even without words, is an important first lesson. During early months the brain also takes in its lasting repertoire of sounds for speaking and listening to the nuances of its native language. (p. 93)

"Children master most of the complexities of grammar with practically no explicit instruction from their parents, although extensive parent-child verbal interactions obviously provide an important environment for the effective development of a language" (p. 21), Sylwester counsels. Without this nurture, the risk increases for developing gaps in language function.

This is the dark side of the naturally occurring phenomena of language acquisition. Healy (1990) explains that the "ideal scenario [of nurturance] is increasingly missing . . . even in homes where parents expect to see their child on top of the academic heap" (p. 94). Healy elaborates:

> At this writing, the majority of babies born in the United States are placed in full-time day care within a year, commonly within two or three months, so their mothers can return to work. American preschoolers spend a great deal of time watching television—missing both personal interaction and language content tailored to each child's developmental schedule. We don't know how many children are being encouraged to *be quiet* by overburdened caretakers, by parents who are pressed for time, or by hired baby-sitters who have poor mastery of English and would rather watch the soaps. (p. 94)

Even in highly regarded school settings, children's language skill development is being sacrificed because of high student-to-teacher ratio and/or lack of knowledge or interest on the part of teachers (Healy, 1990). It is a serious issue to "neglect verbal interaction during the apex of the brain's sensitive period for language acquisition," Healy says. Interactive talk is highly important. Healy cites research done in two well-regarded child care centers in the United States:

> The children spent most of their time in teacher-directed large-group activities, and . . . most of their language behavior was receptive, such as listening to and following teachers' directions. Although teachers provided adequate oral language models, they were not active listeners, did not encourage curiosity about language, and did not spontaneously expand on children's vocabulary or concepts. (p. 95)

Environments that best promote language development in children are rich in opportunities for the child to think about, experiment and practice, and reflect on what they have spoken, read, heard, or written (Caine & Caine, 1991; Diamond & Hopson, 1998; Hannaford, 1995; Healy, 1994; Sylwester, 1995). Each child is unique in his/her development schedule and in the ways he processes incoming information.

Coaches should encourage active production of language, not just passive listening. When children are actively involved in producing their own language, they are more likely to learn better. Caine and Caine (1991) explain:

> The more children can talk about what they are doing (Cohen 1984) and the more their teachers use the appropriate vocabulary in teaching, the greater the learning (Harste 1989, Moraes 1986). The learner needs to be engaged in talking, listening, reading, viewing, acting, and valuing. Brain research supports this. (p. 6)

Can the use of language increase the brain's ability to think? Healy (1994) asks that question and provides her own answer:

> Neuropsychologists now believe that "inner speech"—the silent conversation that most of us carry on with ourselves—creates physical connections in several important parts of the brain. If you want your child to be a success in school, this ability may be the most important one of all. The best way to teach it is by example. (p. 188)

Healy (1994) describes the process of inner speech as a means of helping the child assume an objective role in relation to how they are thinking and performing. This is a form of metacognitive processing that helps the child project needed action and reflect on their own processing. By talking out loud what she is thinking, the parent can model inner-speech process for young children. As the child ages, questioning can promote this type of activity. Healy provides examples.

> Let's say your toddler is trying to sort different-colored plastic chips into piles. If you demonstrate saying, "Blue, green, yellow" as the chips are sorted, your child should be able to sort them faster and learn a valuable lesson about the power of words in guiding actions. From the age of about four, you can show a child the magic words: "First I will . . . and then I will . . ." Ask a school-aged child who has difficulty with a math problem, "What is the question that you're supposed to answer? What steps could you take to get it?" Very often this simple process results in, "Oh, I get it now!" (p. 188)

Healy offers a five-step process for guiding children—especially impulsive children—through inner-speech function:

> 1. What do you have to do? (Identify the problem.)
> 2. How do you think you should go about doing it? (Evaluate the method for attacking the problem.)
> 3. What will you need to do first? (Plan the attack.)
> 4. Are you following your plan? (Check the progress.)
> 5. Did you finish what you had to do? (Check the outcome.) (p. 189)

According to Healy, the more practice children get with this process, the better connections are made in the brain. She suggests that parents and teachers be creative in encouraging inner speech in ways such as: ask the child to "teach" the parent or another student, or group children/students in twos "sitting on either side of a 'wall' where they can't see each other" and yet are required to instruct (verbally) the partner to perform a task. "Any activity that mediates actions with words can be regarded as brain-building material" (p. 188).

Good coaches nurture learner metacognition. "People learn instinctively, but what we learn and how we view ourselves as learners very often depends on how we are treated by instructors and other role models in our life" (Hannaford, 1995, p. 197). How we view ourselves as learners is sometimes referred to as a function of metacognition—thinking about thinking.

Metacognition is a form of inner speech or reflective intelligence that helps the brain rehearse and reflect on its own functions. Healy (1994) cautions educators to avoid producing students who only regurgitate back factual data. It is more important to help students learn to "think deeply about issues," she says. Higher education demands "something called 'mindfulness'—the ability to stand back and view information from many angles, to examine one's own beliefs and understandings, and to evaluate them critically" (pp. 222-223).

Citing concurring proponents (Perkins, 1995; Schon, 1987) on the importance of metacognition, or reflective intelligence, Caine and Caine (1997) suggest that this reflective processing goes on both from an objective and subjective stance. Objectively, we look back at our own past actions; and subjectively, we view our actions from an in-process, monitoring stance—"a person's capacity to observe his performance while it is going on, to assess what is happening, and to make changes midstream" (p. 135).

Public speakers, comedians, musicians, and athletes all do this "anticipating what needs to happen and assessing 'on the run'" (p. 135), say the Caines. Students can benefit from learning to do the same. And for that matter, so can teachers. The Caines refer to a letter received from a K-12 teacher: "[A] teacher [is] not a fixed entity. We must constantly listen, predict, risk, observe, dictate, orchestrate, etc., as must the students. We are all in this together" (p. 135).

Healy cites examples of how metacognition can benefit learning in the classroom:

> Skilled teachers now ask students in math classes to write about and discuss *how* they solved a problem in addition to getting the right answer. Research also shows that poor readers often don't know what it is that they don't understand; teaching them to ask themselves critical questions as they go through the text increases both understanding and retention. (p. 223)

When students and teachers are openly conversant about their metacognitive processing, they increase the likelihood of understanding each other's expectations in the learning environment.

Language and Hemispheric Function

Language for most people is majorly a function of the left hemisphere of the brain; however, both hemispheres contribute to this process. "So-called right- or left-brained thinking actually fluctuates on a continuum between these two extremes: Linear, Analytic, Sequential (Left) vs. Holistic, Global, Simultaneous (Right)" (Healy, 1990, p. 124). Healy describes what is thought to be the functions of right and left hemispheres in relation to language processing:

> Right Hemisphere
> • in language processing, is well adapted for:

—understanding general meaning and some aspects of word meaning (e.g., content words)
–getting the "gist" of the speaker's intent
–picking up the contours and melodic pattern of spoken language (prosody)
–gesturing and "body language"
–thinking metaphorically

Left Hemisphere
• in language processing, it mediates:
—fine distinctions between sounds (phonology)
–the order of sounds in words
–the order of words and their relationships (syntax)
–some types of word meaning (e.g., function words)
–other aspects of language comprehension. (pp. 125-126)

Sylwester (1995) describes major differences between hemispheric functions as providing both objective and subjective input.

> The left hemisphere (in most people) processes the objective content of language—*what* was said—while the right hemisphere processes the emotional content of facial expressions, gestures, and language intonation—*how* it was said. By processing related information from different perspectives, the hemispheres collaborate to produce something that becomes a unified mental experience. (p. 49)

Both hemispheres "work in tandem," Healy (1990) says. They volley thought back and forth in the thinking process. "Some educators have suggested children today are more 'right brained' because they rely too heavily on abilities commonly associated with the right hemisphere to handle academic 'balls' that should be fielded by the left," Healy adds. School typically requires activities that "depend heavily on left-hemisphere systems, but they cannot be accomplished without the help of the right." More important than asking whether children are right- or left-brained, is the question, Are their environments "equipping them to use both hemispheres interactively" (p. 126).

Healy (1990) is concerned that contemporary environments exercise the right brain to such an extent that left brain specialization does not get strengthened. This can be problematic considering the language-specific functions the left brain must perform.

Jensen (1998) refers to left brain specialization for language and adds a word of concern regarding gender difference, as well:

> The left side of the brain processes rapid auditory information faster than the right. That skill is critical in separating the sounds of speech into distinct units for comprehension. The left hemisphere, usually responsible for language development, develops slower in the male brain. Thus, males usually develop more language problems than females. (p. 23)

The rate of processing language sounds may be responsible for learning difficulties. Paula Tallal (1996) of Rutgers University in New Brunswick, New Jersey, and Michael Merzenich (1998) of University of California at San Francisco have given much attention to studying children with language learning impairment (LLI) (Merzenich, 1996). They believe that children with this condition experience an approximate 500% delay in the amount of time it takes to distinguish basic phonemic sounds. The delay interferes with the child's ability to understand or to say simple word constructs. Tallal suggests that as many as 20 million American children suffer from this condition. She believes many children classified "dyslexic" are LLI subjects.

Tallal, along with Michael Merzenich and others, have developed what they call "ear glasses" to remediate this problem. This electronic equipment stretches out the aural sounds and allows the child extra time to decipher meaning. At a brain symposium conducted at U. C. Berkeley by Marian Diamond, Merzenich reported on the success of this program. He explained that children who received this electronic therapy for several hours a day for 1 month's time showed an approximate 2-year gain in language skills. Tallal and Merzenich believe that this remedial help can possibly benefit many dyslexic children. They are planning to test this assumption soon in upcoming research.

Diamond mentions Tallal's speculation that "chronic middle ear infections during the first year or two of life may prevent children from imprinting" language sounds they hear at home—sounds critical for the brain to distinguish in order to internalize well their language. When such a delay in differentiating language sounds occurs, children may get tagged "dyslexic" (Diamond & Hopson, 1998, p. 200).

Referring to this same body of research, Jensen (1998) writes about a possible physiological abnormality within the brain that may relate to language learning impairment and the need for remediation such as Tallal and Merzenich have addressed.

> The brains of children with language disorders are too balanced. That's not good, says language expert Paula Tallal. When both sides are equal, the left hemisphere is underpowered; the left side should be physically bigger and more active than the right hemisphere. A bigger, faster left brain means it can make fine distinctions in the sounds heard. This means words are distinct, not like a running stream of watery noise. That's what dyslexics hear—words that run together. (p. 34)

Commenting on the left hemispheric specialization in language development, Diamond says, "The more exposure to conversation, books, rhymes, poems, stories, and plays, the more the left hemisphere (in most children) specializes in receiving and producing words, and the thicker grows the speech areas of the cerebral cortex" (p. 197-198).

Heredity, gender differences, hemispheric function, timing in sound perception, and environmental conditioning all seem to impact the ways language is acquired and produced and the styles with which children approach learning. Referring to these influences, Healy (1990) concurs that learning styles and strategies that children develop result from both environmental influence and heredity. She explains:

> Neuropsychologists believe that these different "styles" for learning come both from inherited differences in the brain and from the way a child's experiences train it to work. During development, neurons in both hemispheres must compete for synaptic

sites, so the type of input growing brains receive is undoubtedly important for its final hemispheric balance. Learning that builds both analytic and holistic abilities is doubtless good for the brain, but many schools, unfortunately, focus heavily on stuffing in fragments of knowledge at the expense of more general comprehension, e.g.:

- phonics drills without meaningful reading
- repetitive pages of math "facts" lacking word problems or any connection to real objects
- memorization of lists of isolated facts, dates, names, etc. (p. 127)

Healy is concerned that common activity in "contemporary life" focuses more on "holistic and visual skills, often at the expense of language and analysis" (p. 127). Such activities include:

- video games with lots of novelty and movement
- fast-changing scenes on TV
- music in which lyrics are secondary to the "feel" of the music
- gestural, telegraphic speech. (p. 127)

How language is perceived and produced is intimately tied into hemispheric function, and hemispheric function is often associated with learning style preferences. Because of these associations, learning styles are touched on now within the context of language.

Learning styles discussions tend to evoke perplexing questions from those who face the task of facilitating learning equally well for all students. "Do contemporary environments condition children for failure in complying with school's expectations?" "Should school adjust curriculum to more adequately meet the thinking styles children bring to the classroom, or should children be required to expand their abilities by learning to comply with school's expectations?" "Are the media-conditioned states that are so often reflected in today's school child states that best prepare the individual for mental function and future success?"

Questions like these challenge educators. As yet, these questions have no definitive answers from brain research. Regarding such queries, Healy (1990) says, "Since the research offers interesting clues but no conclusions, we can only speculate on the basis of what is known" (p. 132). Following is a list of points Healy believes are pertinent to *how children process information* and *how schools may have to relate to learner differences:*

1. Most researchers agree that the hemispheres are specialized differently at birth. What develops is the ability to recruit the most efficient and appropriate strategies for solving the problems the environment sets.

2. High-level thinking in any domain requires using the most appropriate hemispheric strategies and shifting flexibly between strategies when needed.

3. Inability to achieve coordination between hemispheres may jeopardize academic success.

4. The development of each hemisphere as well as their balance of power and their ability to communicate effectively with each other are affected by the growing child's experiences at certain times during development.

5. Higher-level language skills, particularly syntax, use of function words, and the ability to use language analytically, can be accomplished by the left hemisphere and depend on specific types of input during development. These skills are integral to the elaborated codes used in traditional academic learning.

6. Language that always comes with pictures attached will produce different brain organization than that which must be processed only through the ears.

7. The experiences of children today may be predisposing them to deficits both in effective coordination between hemispheres and in higher-level linguistic and organizational skills of the left hemisphere. They may particularly lack practice in the use of left-hemisphere systems of auditory analysis and in the skills of logical, sequential reasoning.

8. The language of a culture inevitably changes, but current change is accelerated by widespread media communication. The trend toward use of less elaborated codes appears to be creating a severe mismatch between students and their schools. How successfully these skills can be taught to brains that may have passed a "sensitive period" for syntactic development is unknown, but it is presumed to take longer than if input is received during more appropriate times in development. (pp. 132-133)

In a later writing, Healy (1994) provides additional suggestions to help educators relate to the issues of *language, thinking styles,* and *hemisphericity.* Though there is some redundancy between the previous and the following list, enough additional information is included in the more recent writing that it was deemed important enough to include here.

> 1. *Hemispheric specialization* probably is present from birth, but development is shaped by the demands and input to the brain. Heavy auditory-verbal stimulation may increase left-hemisphere capabilities and vice versa. Deaf children, for example, show a pattern of hemispheric organization different from that of hearing children. In *endangered Minds* I suggest that diminished language use and less time for reflection in the lives of children today may be diminishing left-hemisphere development.
>
> 2. *Lateralization* means the pattern in which abilities such as language are distributed between the two sides.
>
> 3. *Hemispheric dominance* is one side's tendency to determine the style of processing to be used for a job. In our highly verbal society, the side with language in it, usually the left, is more often dominant, but for visual, holistic thinking, the right may need to be the leader.
>
> 4. Individuals vary in their ability to activate the appropriate hemisphere for different demands. Such flexibility may be a major factor in intellectual ability.
>
> 5. *Hemispheric style* is a term used to suggest an individual's preferred way of processing information when there is a choice of strategy to be used. For example, in putting a puzzle together, you can use a predominantly analytic strategy by naming each piece and assembling them in a logical order, or you can work from the whole outline, using mainly visual clues. Although both hemispheres are working, one may set the tone.
>
> 6. Younger children may tend to use a right-hemisphere style, acting on situations globally without analyzing them; as verbal demands increase, the left side takes over more often. An activity such as reading may be handled in different ways at different ages.
>
> 7. Plasticity of the hemispheres probably declines by the beginning of adolescence. (pp. 130-131)

Commenting on the left hemispheric specialization in language development, Diamond says, "The more exposure to conversation, books, rhymes, poems, stories, and plays, the more the left hemisphere (in most children) specializes in receiving and producing words, and the thicker grows the speech areas of the cerebral cortex" (p. 197-198).

Dyslexia

Dyslexia is a condition which manifests itself as difficulty in reading, writing, and other language and communication-related functions. It is another common condition that relates to attention levels, and according to Sylwester (1995), it is treated with limited success. As with ADD and ADHD, causes of dyslexia are uncertain; however, research continues to address this condition. Sylwester reports on some of these studies:

> Livingstone and others (1991) have found that dyslexia may be at least partly a result of a coordination problem in the timing of the fast and slow visual pathway systems. Normally, the fast system processes the background (where objects are located), and the slower system processes the foreground (what the objects are). In people with dyslexia, however, the fast system appears to be sluggish; it doesn't erase the previous fixation quickly enough when the eyes move rapidly from word to word in reading, resulting in blurred and fussed words. Lenses that absorb certain light frequencies may be able to improve the coordination, but scientists don't know for sure. Similar patterns of sluggishness may cause some auditory attentional problems (Galaburda, 1993). (p. 82)

As mentioned previously, the research of Michael Merzenich at U. C. at San Francisco and Paula Tallal at Rutgers University has created a "neuroscience-based training strategy" that focuses on learning problems among special education children. Together with artists at Scientific Learning Corporation in Berkeley, they have developed a novel strategy to remediate language learning impairments in young school-age children. Children are provided with audio headsets that slow down and clarify the language they hear. This remediation is continued in an effort to retrain neural networking. Merzenich (1998) explains that within 5-6 weeks of training (on the average), this training has helped children improve by about 1.5 years. Merzenich compares this auditory remediation with fitting children with glasses when they need corrective lenses.

Another term for dyslexia is "learning disability" or LD. Healy (1990) comments that in light of knowing that "all kids' brains are unique," diagnosis and treatment of LD cases will be an elusive task:

> Each [brain] responds individually to different types of tasks, and each is potentially better at making synaptic connections for some kinds of learning than for others. The basic neuronal wiring diagram is determined both by the genetic blueprint and the environment in the womb; the postnatal environment helps determine how the connections get hooked up—according to how the child uses them. By definition, a specific "learning disability" occurs only when the child takes that special brain into a learning situation, batters his neuron assemblies against a certain kind of demand—and fails. In an extreme example, let us imagine that a child with a brain ill-equipped for reading went to school in a society where all information was conveyed pictorially or by storytelling. The "learning disability" would never materialize!
>
> Even in preschool years, a child's mental life and motivation interact with basic brain structure to shape specific talents for learning. By the time children enter school, each has a singular pattern of abilities, disabilities, and interests. Some children's patterns fit neatly into the classroom; others' talents show up more clearly on the playground, in the art or music room, in interpersonal politics, or when someone needs a friend. But these skills don't earn stars on the spelling chart—or many A's on the report card. (pp. 141-142)

Healy advises that popular American culture should "take a hard look at its own curriculum":

> Because the kind of 'coaching' provided by early environments has so much to do with a child's adjustment to school learning, everyone has an obligation to our children—and to their future teachers—to provide them with experiences likely to build the skills they will need in the classroom. (p. 143)

Healy does not suggest that parents "should prepare lesson plans for infants, expect preschoolers to read, or drill kids on math facts when they are in their high chairs," but she does stress the importance of helping children "learn to listen, direct their own thinking, and use language effectively" (p. 143). One of the ways Healy (1990), Diamond (1998), Jensen (1998), Hannaford, (1995), and others recommend for helping children better prepare for school's expectations is by limiting the amount of time children spend with technology like video games, computers, and television. Such activities, Healy says, when used in excess, can deprive the brain, "in early years when . . . brain connections are forming," of the stimulation it needs "to understand and retain discourse" (p. 144)—functions that are critical to success in school.

Language, Body, and Emotion

Language is the individual's way of representing thought. In this respect, it is intimately related to mind function. Language representation is mutually dependent on physical and emotional aspects of brain function. Though Hannaford (1995) balks at education's tendency to place language in an elevated or superlative position over other vitally important factors in learning and cognition, she recognizes language's important role in learning. She describes language as "perhaps the most spectacular example of integrative processing that engages body, mind and emotion." Language enables us to "powerfully orchestrate and develop our capacity to think" (pp. 88-89), she says. However, Hannaford maintains that without motor function and emotional affect, language would be ineffective or perhaps impossible. She proffers,

> Movement, through the motor cortex, is very much a part of verbal expression. . . . Almost half of the motor cortex deals directly with vocalization. The motor cortex stimulates muscular movements of the larynx, tongue, mouth, jaw, facial muscles and eyes that form and give expression to the words. Muscular memory of how to form the words appears to be housed in the basal ganglion of the limbic system [figuratively, the brain's seat of emotion]. (p. 89)

Language is an important component in the educational process. However, it is only one part of the even more important wholeness in educational development—the nurture of the mental (language), physical (body), and emotional (spirit). This concept is mentioned repeatedly throughout the literature.

Language is the medium by which the being—mind, body, and emotions–communicates with the social environment. It is a major means by which the individual takes advantage of enriched environments.

Motivation

Children entering school often encounter the challenge of performing based on external rather than internal desire to learn. Reflecting on how easy it is for teachers to usurp the locus of control for individual learning, Healy (1990) comments, "Children need stimulation and intellectual challenges, but they must be actively involved in their learning, not responding passively while another brain—their teacher's or parent's—laboriously develops new synapses in their behalf" (p. 72)!

Marian Diamond (1998) discusses challenges that come to teachers and parents when a child's desire to learn is at odds with what adults think they need to learn. In such situations motivation and attention take center stage. The parent or teacher's challenge is to find ways to make learning fun. Making learning fun is not just a nice thing to do. It plays a critical role in promoting intrinsic motivation to learn.

According to Reed Larson, at the University of Illinois, Urbana/Champaign, by involving children in activities that promote high interest, like music, sports, hobbies, crafts, etc., at least two objectives are accomplished: (1) mental development is stimulated while, at the same time, (2) the child is benefited by an inner drive to transition from uncontrolled randomness to controlled focus (Larson, Ham, & Raffaelli, 1989).

Reflecting on Larson's research, Diamond (1998) indicates that he and other researchers "have identified various states of motivation and attention in children" (p.

226). Diamond continues. "A typical play session, for example, represents *high intrinsic motivation*, since the child wants to do the activity and does it freely, but *low attention,* since playing with toys or playmates usually presents little or no challenge" (p. 226). In contrast, a child sitting at a desk at school and working on math problems would be involved in *high attention* focus and *low intrinsic motivation,* because the seat work is what the teacher requires of students.

Writing about externally motivating children inappropriately, Healy (1990) says, "I often wonder how many children decide they are dumb because someone simply laid on the learning too soon in a form other than the one they needed to receive it in at the time." Continuing, she states, "I would contend that much of today's school failure results from academic expectations for which students' brains were not prepared—but which were bulldozed into them anyway" (p. 69).

Most students at school indicate at least some degree of motivation to learn, Jensen (1998) suggests. "After all, they've made it to class while the truly unmotivated students are still in bed or anyplace else but school" (p. 63). He suggests that students who show a lack luster spirit for learning may be just "temporarily unmotivated," possibly for three primary reasons:

1. "Associations from the past, which can provoke a negative or apathetic state" (p. 63). Unpleasant memories of such associations may be stored in the amygdala where it can be triggered easily and can set stressors into operation.

2. "Present-time and environmental" (p. 64) influences [such as] "unsuitable learning styles, a lack of resources, language barriers, a lack of choice, cultural taboos, fear of embarrassment, a lack of feedback, poor nutrition, prejudice, poor lighting, bad

seating, the wrong temperature, fear of failure, a lack of respect, irrelevant content, and a host of other possibilities" (p. 64).

3. "Relationship with the future." Students who do not have clearly defined goals or belief in their ability or resources to learn are at a disadvantage (p. 64).

These temporary states of being unmotivated can be highly subject to change depending on many factors, such as "chemical balance, body temperature, posture, eye pattern, heartbeat, EEG, and a host of other measures" (p. 64), according to Jensen. The *apathetic* attitude of being unmotivated is highly subject to change for most people. "Our states change with what we eat, humidity, fatigue, special events, good or bad news, success, and failure. . . . [In the classroom] apathy often disappears with a simple engaging activity, listening or sharing, or the use of music or group activities" (p. 64).

Punishment, Reward and Motivation

Teachers and parents often try to motivate children with rewards or punishments, but Larson (1989) indicates that that practice tends to be counterproductive in the long run. It tends to "erode whatever self-generated interest the child can muster," Diamond (1998) adds. Such "rewards lead to interest only in the reward itself, not the activity, and punishment leads to frustration, dependence, and hopelessness" (p. 226).

The behaviorists in the 1950s and 1960s popularized "rewards as a teaching strategy," says Jensen (1998, p. 63). Now, however, from a perspective of better understanding of how the brain functions, there is reason to believe that rewards are counterproductive to motivation and memory. Jensen explains this rationale:

> Dean Wittrick, head of the Division of Educational Psychology at the University of California at Los Angeles (UCLA), says that today's classroom instruction is based on a flawed theory. . . .The old paradigm of behaviorism told us that to increase a behavior, we simply need to reinforce the positive. If there's a negative behavior

> exhibited, we ought to punish it. This is the "outside-in" point of view. It's as if we are looking at the student as the subject of an experiment. This approach says that if demotivation is an established condition, then there are causes and symptoms. This way of understanding classroom behavior seemed to make sense for many. But our understanding of motivation and behavior has changed. Tokens, gimmicks, and coupons no longer make sense when compared with more attractive alternatives. (pp. 64-65)

Learning should be fun, Diamond says, and it happens best when children want to learn and their attention is engaged as a result of a natural interest to know more.

Flow and Motivation to Learn

Mihaly Csikszentmihalyi (1991) speaks of "optimal experience" (p. 3), where attention is aligned with the motivation of the heart. "Creating meaning," he says, "involves bringing order to the contents of the mind by integrating one's actions into a unified flow experience" (p. 216).

Aligning with Csikszentmihalyi's concept of *flow*, Diamond asserts that there exists a relationship between motivation and attention that is conducive to creating this *flow* experience. When *flow* occurs, both intrinsic motivation and attention levels are simultaneously high. Diamond (1998) explains:

> Only when a child is engaging in an activity that elicits intrinsic motivation *and* high levels of attention does he or she reach the state of self-absorbed enjoyment psychologists refer to as "flow." When in this state, the child's own internal drive to work at the activity is balanced with his or her skill level and the challenge the task represents. And the best way for a grade school child to move toward the motivated, directed, energetic attention of the teenager or adult is through the "flow" that comes with structured leisure activities—cooking, building models, working puzzles, sewing clothes or toys, playing basketball, practicing the flute, or doing any of the thousands of hobbies and activities available to youngsters. While "wrapped up" in a favorite pastime, children report feeling excited and forgetting their problems. The high internal motivation accompanying those feelings linked with concentrated attention is a form of reinforcement for directed effort, learning, and accomplishment that can't be achieved in any other way quite as successfully. (pp. 226-227)

Jensen (1998) concurs with Diamond when he says, "the brain makes its own rewards" (p. 65). And Reed Larson's research (1989) seems to indicate that over time rewards are counterproductive to stimulating intrinsic motivation, or inner flow of interest. They lead children to focus on the reward and not on self-generated drive.

Caine and Caine (1991) add another dimension to the consideration of flow, motivation, and attention. They refer to a similar state of *flow* when they discuss *creativity* and its relationship to intrinsic and extrinsic motivation.

> Without seeking to define creativity in detail, we know that it includes boundary breaking or the ability to go beyond standard frames of reference. It therefore includes both the perception and generation of new patterns (Jelen, 1988; Rogers, 1962). Creativity is facilitated by "autonomy, greater interest, less pressure and tension, more positive emotional tone, higher self-esteem, more trust, greater persistsence of behavior change, and better physical and psychological health" (Deci, 1987). In other words, as Amabile (1985; 1986) states, *"Intrinsic motivation is conducive to creativity and extrinsic motivation is detrimental."* Deci (1980) also shows us that intrinsic motivation plays a critical role in reflective creative learning and that extrinsic motivation, on the other hand, is closely related to work involving noncreative, memorized skills and tasks. This difference apparently holds across different research methods, subject populations, and assessment procedures. (p. 71, italics supplied)

Play and Motivation to Learn

Jane Healy (1990) speaks of "the importance of words without pictures" in helping children invest themselves in abstract thinking or "disembedded" contexts (pp. 91-92). According to research done by Wells (1985) and his associates, Healy states, "The most powerful predictor of [children's] school achievement was the amount of time spent listening to interesting stories" (p. 92), a form of play to the mind.

"The development of language and symbolic play," says Healy (1994), represent the beginning of abstract thought. . . . Until sometime around age six or seven, children's 'work' is to develop the basis for abstract thought, mastering their physical environments and learning to use language" (p. 48).

"Patterns are the key to intelligence" (p. 49), Healy is convinced. Autistic children "cannot play as other children do." They seem to have an inability to "make meaningful connections out of experience, so that the world seems to be a terrifying jumble of sights, sounds, and feelings" (p. 49).

For children with these difficulties, Healy (1994) further explains,

> We are not sure how much can be done to change things at these fundamental neural levels, but while the brain is still developing rapidly before age four or five, it is wise to focus on helping the child make physical and mental connections through lots of self-organizing play activities rather than emphasizing specific bits of information. (p. 49)

Healy provides some neurological explanation to support this concept that formal school emphasis is inappropriate for preschool age children:

> Because of immaturity in parietal lobe areas that connect sight, sound, touch, and body awareness, it is still difficult to combine processes from more than one modality, such as in looking at a letter form and saying a sound to go with it, or hearing a numeral and writing it. (p. 49)

Diamond (1998) cites research (Rescorla, Hyson, & Hirsh-Pasek, 1991; Sigel, 1987) which supports the concept of allowing children to be free to play up until kindergarten age; however, she also cautions that free play without parental nurture to prepare children for school can be disadvantageous for the child. She writes,

> We think there is a balance to be achieved between too much unguided play, leaving a child unprepared to learn academic skills, and too much book-learning too early, leaving them potentially less creative and less comfortable in school. And we think it is up to parents to find the right balance for their children. (p. 168)

Once a child enters school, play is still an important part of learning. Vivian Gussin Paley (1981), author of *Wally's Stories*, documents experiences with her kindergarten children and how she became aware of the importance of play as children process new information. Paley explains how lessons she thought she had taught superbly actually registered in distorted ways in the children's thinking. By allowing them to act out their perceptions, she was able to understand better how they were conceptualizing new ideas presented in the classroom. These dramatizations became a useful tool for the teacher and a vehicle for developing the children's own metacognition—their ability to reflect on their own thought processes. In this way, Paley was able to create dialog in the learning environment. She offered students opportunity to function from a position of being intrinsically motivated. Paley comments:

> A wide variety of thinking emerges [during conversations, stories, and playacting], as morality, science, and society share the stage with fantasy. If magical thinking seems most conspicuous, it is because it is the common footpath from which new trails are explored. I have learned not to resist this magic but to seek it out as a legitimate part of "real" school.
>
> *Wally's Stories* follows a group of five-year-olds through their kindergarten year. The scene is the classroom, and the teacher is the stage manager. . . . The children are scriptwriters and actors who know what kindergartners want to say. (pp. 4-5)

Hannaford (1995) expresses similar thoughts regarding the advantages of allowing children to mentally manipulate elements of their own cognition:

> The value of make-believe cannot be stressed enough. The child can take its world, and through play and familiarity organize it into more and more complex mental and emotional patterns. The time from ages two to five is a crucial stage for children's cognitive development as they learn to process information and expand it into creativity. Interactive communication and play, when children are learning from each other's imagination, accelerates the process. (p. 64)

Referring to Dr. Paul MacLean's (Chief of the Laboratory of Brain Evolution and Behavior at the National Institute of Mental Health in Washington, DC) studies in which he "ties the process of imaginative development to the development of play" (p. 65), Hannaford (1995) suggests that play becomes the essence of creativity and high-level reasoning. She stresses the value of intrinsic motivation in the play environment and cautions that even on the playground, extrinsic motivation (teacher direction) often threatens to take over.

> The marvelous changes unfold naturally [in playtime], and happily do not require adult supervision and meddling. Unfortunately, however, these days there seems to be less time and opportunity for children to simply play. Even playgroups seem to be organized and structured. There appears to be an assumption that children need to be entertained and their play orchestrated. I see it a lot in organized sports for children. Adults are in charge and competition is the goal. Rarely do you just see children initiate "pick up" games that were routine when I was a child. (p. 64)

Hannaford (1995) describes play as an opportunity for learning to take place in a holistic way—involving all learning systems. Playtime allows the individual to take ownership in creatively constructing his/her own meaning outside of the constraints of external controls. She explains:

> Play at the simplest physical level as well as the furthest reaches of the intellect, depends on a balance of all the elements of our humanity [mental, physical, emotional/social]. . . . When the emotions are brought into dynamic equilibrium with reason, insight, action and even survival; learning becomes a rational, creative process. If any part of the brain processing is left out of the learning process, integration of patterning and appropriate action are limited. When dynamic equilibrium is lost, learning and creativity suffer. (p. 66)

Educators often comment about the drop in creativity they observe between the time children enter kindergarten and the third grade year. Is this a developmental normality that happens to all children? Or does school culture's typical emphasis on early skills development and extrinsic motivation act to diminish creativity at a time when children are passing through critical periods of neural patterning and networking? Unknowingly, are educators squandering human potential during prime-time development?

Both extrinsic and extrinsic motivation appear to belong in curricular settings. To function well in society, children need the skills that seem to grow under extrinsic motivation. They also need creativity that blooms when intrinsic motivation is nurtured.

How do motivation—intrinsic and extrinsic—and attention affect memory retrieval and storage? That is the focus in the next section.

Memory

Though memory storage and retrieval is a major function in brain processing, not all of the brain educators in the literature reviewed were explicit about how the brain remembers. Caine and Caine, Jensen, and Sylwester do provide focused emphasis on memory. However, throughout the writings of Diamond, Hannaford, and Healy, memory is referenced widely although it is not a major, specific focus in their presentations.

Memory was a significant part of Caine and Caine's 1991 publication, *Making Connections*. They provide broad strokes in describing how the brain remembers. Since the writing of this book, additional information has emerged from neuroscience and seems to add more definition to what the Caines documented for educators.

Robert Sylwester's *A Celebration of Neurons* expands on the Caines' explanation of memory. Even more currently, Eric Jensen's *Teaching With the Brain in Mind*, published in 1998, adds to this database.

A study of learning theory shows a progressive development toward a stronger emphasis on the biological aspects of learning. In the 1800s the process of learning was established as a "legitimate research pursuit" (p. 12), according to Driscoll (1999). However, for centuries it has been a matter of concern among philosophers. Two major issues are often discussed regarding learning theory. The nature of knowledge and how we come to know (epistemology) is one of these two considerations. Much differing thought exists among learning theorists on this issue. "Some believe that knowledge is a matter of internally representing the external world and that it is primarily acquired through experience. Others argue that knowledge is a matter of interpretations that learners actively construct by imposing organization on the world about them" (p. 12), Driscoll asserts.

The second major consideration often discussed in learning theory "concerns the nature and representation of mental life" (p. 13), Driscoll continues. Theorists focused on this aspect of learning ask questions like: "When we learn something, how is it represented in the mind?" And "What are the operations or rules that govern mental phenomena?" (p. 13).

Behaviorism for decades was the reigning paradigm in educational practice, but gradually it has given way to constructivist thought. And constructivist thinking is now influenced by the biological findings in brain research. Numerous other theories have emerged as well. Though the focus of this paper is not to address the history or epistemology of learning, it is important to recognize that prevailing influences have impacted the attitudes and understanding of how learning and memory are acquired and utilized.

The literature review for this document covers a period of about 10 years, 1990-2000. During that time, because of rapidly accumulating data emerging from neuroscience, the understanding of how the brain learns and remembers has changed to some extent, though the changes appear to be supplementary rather than refutational. Because of this gradual change, I have chosen to address this section by looking at the contributors with a time-referenced perspective.

This section on memory begins with the ' broad strokes and subsequently moves toward incorporating Sylwester's and Jensen's data. The progression is chronological according to the time of writing.

Caine and Caine

Renate and Geoffrey Caine (1991) give primary emphasis to two major memory systems which affect learning: taxon and locale memories. A major concern throughout their writings centers on the need for educators to recognize that taxon memory learning has had a pervasive influence on education for decades and that students deserve instruction that honors more global brain function. The Caines align behavioristic thought with emphasis on taxon learning.

Taxon and locale memories

Most people equate memory with the ability to recall "dates or facts or lists of information and sets of instructions, requiring memorization and effort" (p. 37), Caine and Caine (1991) purport. However, memory involves much more complex functions that are critical to brain processes. At least two major types of memory function to our advantage, and their properties differ quite significantly, according to the Caines.

Taxon memory—a term derived from the word *taxonomy*, indicating lists—represents memories that "consist of items that do not depend on a specific physical context," the Caines explain. This type of memory includes "prototypes or categories that represent a generic item, such as bird or house or dog; the contents of categories, such as types of trees and cars; and routines and procedures, such as driving" (p. 38).

Taxon memory, if rehearsed long and well enough, can be stored in long-term memory, but while it is functional in short-term memory, it requires "continual rehearsal" in order to be maintained. Though long-term memory storage capacity is "virtually unlimited—loss of accessibility [does occur] over time" (p. 39).

The Caines list five specific features of taxon memory:

> 1. Information in taxon memories is placed there through practice and rehearsal.
> 2. Taxon learning is linked to extrinsic motivation and is powerfully motivated by external reward and punishment.
> 3. Our taxon memories are set in a way that makes them quite resistant to change. . . . Transfer of knowledge stored in taxon systems does not occur easily.
> 4. Items in our taxon systems are relatively isolated. This is they exist in stable entities, such as driving a car and memorization of phone numbers, that can be called on and used in a fairly predictable manner. . . .
> 5. Much of what we store in taxon systems is not initially meaningful. Such learning forms the basis of operant and classical conditioning and has greatly influenced our schools. (pp. 39-40)

The second type of memory the Caines describe is *locale* memory. It "differs substantially" from our taxon memory. Locale memory refers to locations and interconnected events. In contrast to remembering lists of discrete units, an example of locale memory would be recalling details of a dining-out experience. Even though emphasis was not given to memorizing the foods eaten, locale memory makes it possible to remember through experience and context.

"Maps are constructed within . . . the *locale memory system*" (p. 40), the Caines explain, describing how the brain relates to its physical context. The hippocampus is especially involved in this process. It is located in the limbic system near the brain's center.

Caine and Caine suggest that spatial maps—interconnecting places in the external world—"guide our movements and interactions within our surroundings" (p. 41)

Cognitive science uses a similar term—*schema*, say the Caines. Marcy Driscoll (1999) defines *schema* as an "organizing and orienting attitude that involves active organization of past experiences" (p. 127).

"We continuously monitor a great deal of sensory information, much more than can be specifically attended to," the Caines express. "We automatically form long-term memories of events and places without deliberately attempting to memorize them" (p. 41). This is locale memory.

Seven descriptors are among the basic features of locale memory the Caines use to define locale memory.

> 1. Every human being has a spatial memory system. It is survival oriented, and its capacity is virtually unlimited.
> 2. Locale memories are never limited to static, context-free facts. They are memories that exist in relationship to where we are in space, as well as what we are doing. Thus they are records of ongoing life events. . . . There is always a complex set of relationships among all these items.
> 3. Initial maps tend to form very quickly. . . .
> 4. We update our maps on a continuous basis. . . .
> 5. Map formation is motivated by novelty, curiosity, and expectation. . . . The dominant motivation is . . . intrinsic.
> 6. Locale or spatial memory is enhanced through sensory acuity, or enhanced awareness of smell, taste, touch, sound, and so on.
> 7. Although maps for specific places are relatively instant, some large, intricate maps may take a considerable amount of time to be formed. They are the consequences of many experiences that only gradually come together. (pp. 42-42)

The maps we construct mentally are not just "maps in physical space," the Caines contend. We also construct maps of "mental space," and the Caines refer to these as *thematic maps.*

> Thematic maps are critical for establishing more sophisticated links that aid in the transfer of knowledge. Thus there may be significant themes in our life, such as the need for a personal relationship or a political ideology, that operate to organize and shape much of our behavior. According to O'Keefe and Nadel (1978), these themes serve as mental representations of the type of fluid complex, and interactive relationships found in maps representing physical space. Our natural maps, therefore,

> seem to be at the heart of *thematic teaching*. That same memory system is engaged when we use stories, metaphors, celebrations, imagery, and music, all of which are powerful tools for brain-based learning. (p. 42)

Locale and taxon memories work in tandem say the Caines. "The locale system registers a continuous 'story' of life experience. The taxon systems house the 'parts' out of which the story is constructed" (p. 43). Meaning is constructed as these two systems work together. The locale memory system quickly shifts and registers broad contexts at a glance. It indexes and can rapidly "'call up' relevant items stored in the taxon systems, such as faces, trees, cars, and behaviors that were once new and meaningless. In fact, indexing is essential to the formation of our spatial maps" (p. 43).

When strong connections among neural pathways are available, information can be called up much more easily and flexibly and can be "accessed appropriately in unexpected contexts." In the normal course of life experiences, we develop these strong connections by "learning from significant experience" –both unconsciously and through "deliberately analyzed and explored" situations. "Either way, they become meaningful quickly, by virtue of their being packaged in relevant, complex, and highly socially interactive experiences" (p. 43).

"It is in the recognition and use of the power of our locale memory that we begin to give credibility to the complex forms of instruction that are needed to upgrade education" (p. 41), the Caines postulate. With more emphasis on locale memory, "real-life experience . . . becomes the organizer for education" (p. 50). Traditional education typically has honored taxon memory learning. "The behavioral approach to learning and, in fact, all rewards such as grades or privileges, tend to invoke and support learning via [taxon memories]. This is evident when students memorize for tests instead of seeking to understand ideas" (p. 39), the Caines argue.

Summarizing their position regarding the importance of honoring the global operations of the brain, the Caines state that "educators need to pay attention to all the dimensions and layers of stimuli that go into the makeup of experience" (p. 50):

> The peripheral sensory environment must be addressed.
>
> The ongoing social relationships must be appreciated and enhanced.
>
> The inner concerns and personal objectives of learners must be engaged because that is the key to invoking their curiosity and sense of novelty. (p. 50)

Learners are biologically driven to make sense of their world. Because much processing is done beneath the level of awareness and after a lesson is over, an effective atmosphere must be maintained throughout a school on an ongoing basis" (p. 50), the Caines stress. Continuing, they urge:

> And while specific strategies to aid in the memorization of some routes and procedures are important, *the focus of education must be on the generation by the learner, of more and more useful, sophisticated, and personally meaningful interconnections characteristic of flexible maps.* (p. 50, italics supplied)

The Caines also describe memory acquisition and retrieval in terms of the functions of the triune brain. This is a significant part of their belief that the brain functions with dynamic and distributed processing that involves the mind, the body, and the emotions and social aspects of learning. The next two contributors agree with the Caines; however, their comments are framed in more complex biological descriptions of learning and memory.

Sylwester

Sylwester's (1995) explanation of how memory is stored and accessed focuses on three elements of memory:

1. The physical changes that occur in neural networks when a memory is formed or erased
2. The functional organization and operation of the several memory systems our brain uses
3. The procedures we use to maintain selected important memories. (p. 88)

Physical changes that occur in neural networks

Any incoming information into the brain is communicated within the brain's vast networked systems. This happens by way of "chemical connections at the synapse, the narrow gap that neurotransmitters cross when they move from the axon terminal of a presynaptic neuron to attach to receptors on the dendrites or cell body of a postsynaptic neuron" (p. 88). In synchronized response patterns, these messages are transmitted within a "coalition of activated neural networks—principally in their firing rates and in the amounts of neurotransmitters their neurons release." Somehow these networks process the various elements of the "object or event, and we get a mental impression of spatial integration—for instance, we perceive a face as a unit—even though the various brain areas are operating independently, and no single brain site contains the total face" (p. 89). Though researchers "don't completely understand the process, . . . they believe that attention, thought, and memory emerge out of such synchronized patterns of neural network activity" (p. 89).

The dynamic nature of the brain is represented even in each neuron's function. "An individual neuron can be part of many memories, much as a light bulb in an advertising reader board can light up as a part of many different letters, digits, and words" (p. 90). This contributes to the brain's ability to process "a vast number of related memories" in spite of the relatively small size of the brain. "Further, our emotions connect memory networks to other related networks. When one network fires, it can activate other related networks." Unlike the memories of technology that are "localized and static," biological memories are distributed and dynamic, Sylwester suggests. "Memory is a function of the entire system, not just the synaptic changes" (p. 91)

Drawing these considerations toward classroom application, Sylwester comments, "Unfortunately much of our school testing program requires our students' very inventive biological memory system to exhibit high-level technological precision" (p. 90).

The functional organization and operation of our memory systems

The brain is continually bombarded with new information. A major function of this organ is to determine what is important and what is not. Short-term memory "is an initial memory buffer that allows us to hold a few units of information that we're attending to for a short period of time while we determine their importance" (p. 92).

Short-term memory appears to operate "through temporary synchronized firing patterns that emerge between related networks in the thalamus (the current situation) and the cortex (related memories), Sylwester explains. "The more rapidly firing, synchronized thalamus-cortex networks become foreground (attentional) information, and the less active neural networks become background (or context)" (p. 92).

Only a limited number of units of foreground information can be processed in short-term memory at one time. The brain accommodates itself by "chunking" "related bits of foreground information into larger units by identifying similarities, differences, and patterns that can simplify and consolidate an otherwise confusing sensory field" (p. 93). Typically, the brain can remember 7, plus or minus 2, bits of information at a time. Chunking allows the brain to increase its potential short-term memory capacity, Sylwester maintains. Telephone numbers are chunked into units of three or four numbers to accommodate short-term memory limitations. Social security numbers are grouped similarly. Though this may not have been the intent to those who established these number systems, this principle seems to have influenced their patterns.

Sylwester advises that "the curriculum enhances this remarkable brain capability when it focuses on the development of classification and language skills that force students to quickly identify the most important elements in a large unit of information" (p. 93). And when teachers provide opportunities for students to debate and play "games that require them to rapidly analyze complex information and briefly hold key points in their memory," they are helping students to develop their short-term memories. "Flowing games, such as soccer and basketball, also have this continuous challenge" (p. 93). Activities which allow students to be challenged with separating out foreground from background stimulate efficiency in short-term memory use.

Sylwester explains how he believes long-term memory develops:

> The development of a long-term memory emerges out of an ill-understood, often conscious decision that elements of the current situation are emotionally significant and will probably reoccur. If the situation does indeed reoccur after the memory is formed, sensory and perceptual processes will represent it in the thalamus. The cortical memory of the previous experience, resonating with the current thalamic perception, will then create an attentional state, and help to determine the response—current behavior influenced by past experience. Short-term memory allows us to experience the present, but we would become a prisoner of the present without our two interrelated forms of long-term memory, declarative (or explicit) and procedural (or implicit). (pp. 93-94)

As mentioned here, Sylwester suggests that long-term memory involves two different but related functions and are classified as *declarative* and *procedural.*

Declarative long-term memories are "factual label-and-location memories" that involve naming and identifying locations for objects. This type of memory defines "named categories. [It is] verbal and conscious" (p. 94). The hippocampus, located in the limbic area, and the cortex in the temporal lobe area are especially involved in processing these declarative long-term memories.

Sylwester separates declarative memories into two categories of processing: *episodic* (personal, intimate experiences) and *semantic* (abstract, context-free symbols like those used in language and mathematics). Memory established in one way may transfer to another memory system's function in time and as a result of how it is used or experienced. Sylwester explains how this happens by using the skill of typing or keyboarding as an example:

> Initial skill learning, such as learning to type, is often episodic—the memories contain both foreground and background elements of the experience. When I learned to type, my teacher, classroom, and typewriter provided an important, easily remembered emotional context during the initial learning period. It would have been inefficient for me to continue to recall all these background elements whenever I typed, however, and so my teacher used class and home drills and different typewriters to help me eliminate the context of the learning (background) from the execution of the skill (foreground).
>
> My typing knowledge and skill had thus become more semantic—more abstract, but also more useful in a wide variety of keyboard settings and tasks (background). In effect, my brain erased the background information from my memory by reducing its frequency and significance, and strengthened the foreground information (actual typing) by focusing on it.
>
> My typing speed was limited, however, by my simultaneous conscious spelling of words and activation of keys, and so I also had to eliminate this conscious behavior through a transfer of skills from semantic declarative memory to procedural memory—to master automatic touch typing. (pp. 94-95)

Procedural long-term memories are processed mainly in the amygdala "(our brain's emotional center, located in the limbic system), the cerebellum (located in the lower back of our brain), and the autonomic nervous system (which regulates circulation and respiration)—but procedural memories also involve altered muscle systems" (p. 95).

As exemplified in the case of having learned to type or keyboard, procedural memories do not require conscious effort to function, "except to initiate, monitor, and stop the extended movement sequence. However, it is possible to move between conscious and unconscious activation of procedural functions. " These memories are fast, efficient, "difficult to master and to forget . . . and are best developed through the observation of experts, frequent practice, and continual feedback" (p. 95).

Episodic memories are easily recalled, especially when they have personal meaning. In contrast, recall is not as easy for context-free semantic memories. "That's why schools have to spend so much time and energy on worksheet-type facts and skills that are isolated from specific contexts (but that generally have the important value of being useful in a wide variety of contexts)" (p. 96).

As previously mentioned, emotion and sensory input have a powerful influence on memory storage and retrieval.

> A memory is a neural representation of an object or event that occurs in a specific context, and emotionally important contexts can create powerful memories. When objects and events are registered by several senses (e.g., seeing, hearing, touching tasting), they can be stored in several interrelated memory networks. A memory stored in this way becomes more accessible and powerful than a memory stored in just one sensory area, because each sensory memory checks and extends the others. (p. 96)

Because of the strong influences of emotion and sensory input on memory, school programming that includes activities such as "games, role playing, simulations, and arts experiences" make learning easier. When school activities use both systems (procedural and declarative) to facilitate learning, they are encouraging both action and thought. "The combination of the two types of memory creates a powerful, integrated human memory system: thoughtful action" (p. 97).

Maintaining our memories

Sylwester contends that "memory networks must be constantly stimulated or else the neural synapses that were rebuilt to create an easily activated network will revert to the original state, and the memory network will disintegrate" (p. 98). Forgetting is another word for this disintegration. He suggests that our memories are maintained in at least four different ways: though dreaming, through experiences with mass media, through conversation, and through educational experiences.

Citing the research of Hobson (1989), Crick and Mitchison (1983), and Hobson (1994), Sylwester suggests that dreaming maintains memories—survival memories, in particular, that do not get "sufficiently activated during normal daytime activities" (p. 99). In addition, there is some reason to believe that obsolete memories are erased during sleep time. Sylwester explains this rationale:

> Hobson (1989) discovered that every 90 minutes during a sleep period called REM sleep (rapid eye movement), certain brainstem structures begin to fire randomly into the cortex, where declarative memories are stored; it's as if sensory information is entering our brain when it isn't. [3] . . . During these four to five nightly dream periods (which range from 10 to 40 minutes in length), our brainstem constantly and randomly activates memory networks. It's somewhat like a circuit-testing and updating process for maintaining key survival programs so that they'll be functional when we need to use them. (p. 99)

Individuals often speak of dreams in which they felt they were moving in slow motion when they felt a need to move quickly, in the case of survival-related dreams. This may occur because "during REM sleep, our motor system is inhibited so that we don't act out our dreams. . . .The cortex has sent a message to the motor system to run, but the motor inhibition stops the message prior to action" (p. 99).

Storytelling "formats that efficiently string together related factual events of an experience" (p. 100) help to maintain our memories. A broad range of experiences in the

American culture represent ways we "consciously stimulate the memories we want to maintain." We read novels, watch TV programs, sing songs, play games, and watch pageants, and in doing so, we strengthen our memories "of broad cultural issues that we consider important" (p. 100).

Metaphor plays a strong role in reinforcing memory, as well. When we consciously concentrate on aligning the characteristics of one situation with those of another, this seems to strengthen memory. Christ used parables to help many people more "easily identify with . . . issues" (p. 101) that could have been narrowly interpreted. Through the use of metaphor (parables), He increased the likelihood of broader application. Because parables are stories, they were easy to remember and could be aligned more easily, perhaps, with future experiences.

Songs often help to maintain memories. "The song slows the simple message so that we can savor all the emotions of the experience" (p. 101).

Though mass media maintains our memories of "broad social concerns," more informal personal memories are maintained through conversations with those near us. During celebratory occasions or family get-togethers, conversations often move toward recollecting former memorable experiences. And in everyday relationships with others, we discuss topics of mutual interest, often sharing our own stories and experiences. Sylwester describes how our personal drive to save our own memories influences how we listen to others:

> When we listen to another person's story and a related experience suddently pops into our mind, we tend to quit listening to the other person's story and focus our thoughts on ours—and then we insert our story into the conversation at the first opportunity. Schank (1991) argues that we don't listen to the stories of others to learn about their experiences, but rather in the expectation that the interaction will enhance the maintenance of our own related memories. (p. 101)

"Conversely," Sylwester says, "we may opt out of an event, such as a class reunion, because of the high probability that it will spark painful memories." In an effort to avoid maintaining unpleasant memories, we may shy away from conversing about those memories.

Long-term relationships develop and are maintained when we share mutual stories or "help each other recall mutually important events" (p. 102). When relationship partners no longer desire to share each other's stories and memories, the relationship may dissolve because conversations cease.

Some of the important information we must know "doesn't come to us in dreams, in mass media, or during meal conversations—for example, the multiplication tables, how to spell accommodate, the names of countries and their capitals, how to compute the area of a circle" (p. 102). Schools have developed for purposes such as these.

As mentioned previously, context-free bits of information are not easily remembered. "Unfortunately, our culture seems to value random facts, and schools tend to reinforce this bias" (p. 102). This necessitates that educators find ways to help students create and maintain memories for this necessary but hard-to-remember information.

> Our task as educators . . . is to help students begin to find *relationships* between the somewhat random, often trivial fact-filled experiences of everyday life and the fewer enduring principles that define life—and then to help them create and constantly test the memory networks that solidify those relationships. (p. 103)

Sylwester suggests that the "best school vehicle for this search for relationships is storytelling as a broad concept that includes such elements as conversations, debates, role playing, simulations, songs, games, films, and novels" (p. 103). As responsible facilitators of learning, we cannot just "forcefully forge new memory networks in our students. We must constantly help students test their memories in real and metaphoric life settings that encourage stimulating interaction, or else all our efforts to create the memories are for naught" (p. 103). By helping students seat knowledge through meaningful, emotion-related experiences, we increase the likelihood that memories will be maintained. Encouraging students "to tell their stories to each other and to themselves" in connection with curricular issues, makes memory storage and retrieval more likely.

Jensen

There are strong similarities between what Robert Sylwester offers educators regarding memory storage and retrieval and what Eric Jensen says about the same. Jensen (1998) observes that not all neuroscientists agree on how memory functions, but that key recent discoveries may provide helpful classroom information.

Fluidity is a major descriptor for the brain's memory functions. The memory process, says Jensen, is the "creation of a persistent change in the brain by a transient stimulus" (p. 100). As a process, memory is "not a fixed thing or singular skill." With certain memories, "many distinct locations of the brain are implicated" (p. 212). According to Jensen, areas of the brain especially involved in memory are:

1. Auditory cortex for sound

2. Parietal for lateral for working memory

3. Prefrontal cortex for working memory

4. Hippocampus for "spatial and other explicit memories, such as memory for speaking, reading, and even recall about an emotional event" (mediates semantic and episodic memory). (Jensen, 1998, p. 100)

5. Temporal lobe for "memories of names, nouns, and pronouns" (semantic retrieval) (Jensen, 1998, p. 100)

6. Amygdala for "implicit, usually negative emotional events (LeDoux, 1996)" (Jensen, 1998, p. 100)

7. Basal Ganglia for learned skills

8. Cerebellum for associative memory formation, particularly when precise timing is involved as in the learning of motor skills (Greenfield, 1995) (Jensen, 1998, pp. 100-101)

In addition to all these specific areas of the brain, "we also know that peptide molecules, which circulate throughout the body, also store and transfer information. This awareness helps us understand why 'our body' seems to recall things at times" (p. 100).

Having mentioned these specific areas known to be involved in memory, Jensen strongly suggests that rather than thinking of the brain as processing certain functions in given areas, it would be more appropriate to think of memory as a process. "Multiple memory locations and systems are responsible for our best learning and recall (Schacter, 1992)" (p. 100).

How are memories formed? Jensen suggests that "formation of explicit memories is long-term potentiation (LTP)"—a "rapid alternation in the strength of the synaptic connections" (p. 100). Citing a number of scientific reports to substantiate this position, Jensen (1998) says, "Most researchers believe the physical evidence of memory is stored as changes in neurons along specific pathways" (p. 101).

> Randy Gallistel, Endel Tulving, William Calvin, and others emphasize that it's the retrieval *process* that activates dormant neurons to trigger our memories (Calvin, 1996; Gazzaniga, 1997). They argue that you cannot spearate memory and retrieval: Memory is determined by what kind of retrieval process is activated. Each type of learning requires its own type of triggering. When enough of the right type of neurons firing in the right way are stimulated, you get a successful retrieval. In larger patterns, whole neuronal fields can be activated (Calvin, 1996). For example, certain words, like "school," might activate hundreds of neuronal circuits, triggering a

> cerebral thunderstorm. The number one way to elicit or trigger recall is by association. (pp. 101-102)

The body's *chemistry* is known to affect memory, Jensen (1998) proffers. "Hormones, foods, or neurotransmitters" are examples of the "many modulatory compounds [that] can enhance or depress recall if given at the time of learning" (p. 102). Some of the chemical substances Jensen (1998) suggests are important influences on memory are:

1. Calpain, a derivative of calcium, "helps digest protein and unblock receptors. Researchers suspect that calcium deficiencies are linked to the memory loss of the elderly" (p. 102).

2. Phenylalanine, "found in dairy products, helps manufacture norepinephrine, also involved in alertness and attention (Mark, 1989)" (p. 102).

3. Adrenalin, a memory fixative, locks up "memories of exciting or traumatic events (Cahill, 1994)" (p. 102).

4. Acetylcholine is important for long-term memory formation. "Increased levels . . . are linked to improved recall" (p. 102).

5. Lecithin, "found in eggs, salmon, and lean beef, is a dietary source that raises the choline levels and has boosted recall in many studies (Ostrander, 1991)" (p. 102).

6. Choline "is a key ingredient in the production of acetylcholine" (p. 102).

7. Sugar, even household, "can enhance memory if given after a learning event (Thompson, 1993)" (p. 102).

The body's chemistry has a great deal to do with the physiological states and the "triggering of recall. Learning acquired under a particular state (happy, sad, stressed, or relaxed) is most easily recalled when the person is in that same state" (p. 102).

Rather than thinking of memories as "retrieved like chapter notes from a file cabinet," Jensen suggests that they are *reconstructed*. There two theories on how this "miraculous process" happens:

> One is that we have "indexes" that contain instructions for the brain on how to rekindle content; they don't index the content itself. University of Iowa researchers Hanna Damasio and Antonio Damasio call these "convergence zones," which help tie together the pieces so that you have appropriate retrieval. . . .
>
> The other theory is that memories are frozen patterns waiting for a resonating signal to awaken them. They're like ripples on a bumpy road that make no sound until a car drives over them. Neurobiologist William Calvin says the content may be embedded in "spatiotemporal themes," which will resonate and create a critical mass needed for retrieval. Enough of that thought's identical copies have been made for the cerebral code to trip and "action switch" for you to recall (Calvin, 1996). (pp. 102-103)

Variety describes the types of memories that exist, says Jensen. "Our separate memory pathways are used for different types of memories." Jensen's description of these memory pathways matches the descriptions Sylwester provides, except Jensen includes two major differentiations: (1) Short-term memory functions are incorporated into *explicit (or declarative)* memories—specifically the *semantic* memory functions; and (2) *Reflexive* memories are included to incorporate conditioned responses and emotional function. Figure 3 shows Jensen's graphic representation of these memory pathways. For the most part, this figure also represents Sylwester's descriptions of these same memory pathways.

Jensen's description of *reflexive* memories suggests that these automatic functions depend "on a number of cortical pathways. They include the amygdala for emotional responses, muscle conditioning, and the cerebellum. Often referred to as 'the hot stove effect,' our reflexive retrieval system is full of instant associations" (p. 108). When teachers use "flashcard repetitions or other forms of content-laden raps," they are stimulating reflexive memory formations. "Raps trigger the implicit memories of stored material and engage a different part of the brain than an essay would," and some children learn well with this memory strategy (p. 108).

Jensen recognizes that *emotions* have a strong effect on memory. "Several scientists at the Center for the Neurobiology of Learning and Memory at the University of California at Irvine have tested the effects of emotions on memory. Their studies (Cahill, Prins, Weber, & McGaugh, 1994) suggest enhanced memory for events associated with emotional arousal" (p. 108). Emotions are associated with the release of "chemicals such as adrenaline, cortisol, or ACTH." They can act as "memory fixatives and strengthen the neural pathways" (p. 108).

Often music and other auditory experiences strongly register in memory. This is because "auditory memories are potent emotional triggers" (p. 109), Jensen says. "Researchers speculate that this stimulation takes separate pathways, distinct from the more mundane content-laden ones. This may be why traumatic events have such a lasting impact. They have their own 'automatic' retrieval triggers" (p. 109).

Marcy Driscoll provides a graphic representation of memory pathways similar to the body of information Jensen offers (see Figure 4). The terms and associations in this figure are conceptually similar to those referred to by Sylwester and Jensen. Driscoll's depiction of the "Taxonomy of Memory and Associated Brain Structures includes more of the networking details that both Sylwester and Jensen described, although she was referencing research by Squire and Knowlton in Gazzaniga (1995).

Practical Suggestions for Enhancing Memory in Classrooms

Jensen (1998) offers a number of practical strategies for educators who want to provide students with various opportunities to develop memory.

Explicit declarative strategies

1. Provide "strong activation of this type of learning with rhymes, visualization, mnemonics, peg words, music, and discussion" (p. 109).

2. "Remind students to stop often [when reading a chapter] every quarter to half page and take notes. Discuss what was read, or reflect" (p. 109).

3. "Conduct oral or written review, both daily and weekly" (p. 109). (Students can pair to do this.)

4. "Repeat key ideas within 10 minutes of the original learning, then 48 hours later, and then tie it all in 7 days later. Spaced learning . . . is valuable" (p. 109). Quiet processing time is needed for transference to long-term memory.

5. Keep *chunks* to a minimum. "When giving directions and instructions to 6- to 9-year-olds, use small chunks, 1-3 items at a time. To older students, ages 10-17, use up to 7 chunks" (p. 109).

6. Use acrostics (p. 109).

7. "Create action pictures that tie words together." (*Semantic* = "'sea man with ticks on his face' holding up a long list of words to memorize") (p. 109)

8. Use "mind-maps or other graphic organizers" (p. 109).

9. "Put the most important material first and last, so it's recalled better" (p. 110).

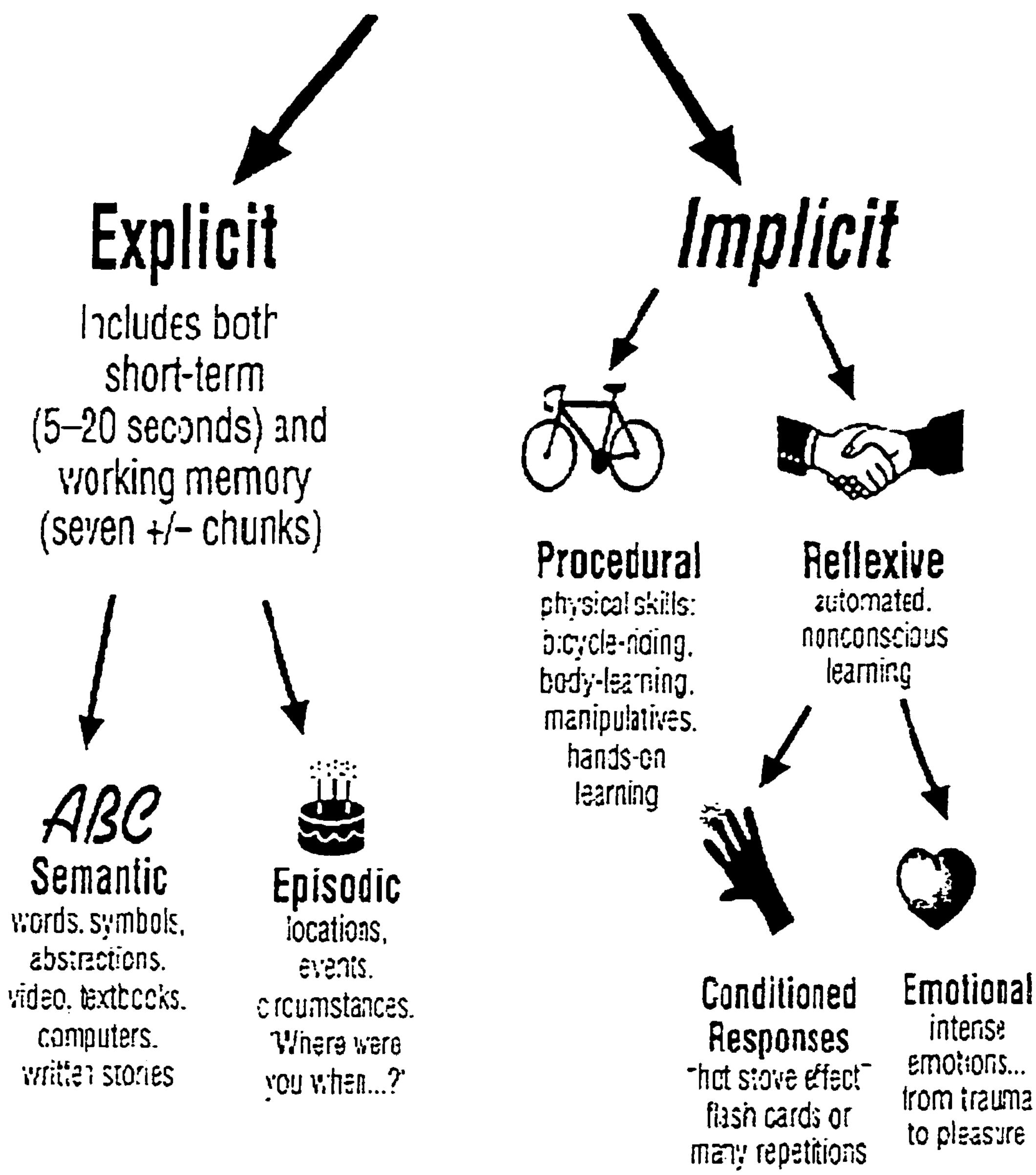

Figure 3. Memory pathways. From *Teaching With the Brain in Mind* (p. 103), by E. Jensen, 1998, Arlington, VA: Association for Supervision and Curriculum Development. Copyright 1998 by Eric Jensen. Reprinted with permission.

10. Teach wholes first, then parts (p. 110).

11. Use “poster-type peripherals to create more visually effective contexts” (p. 110).

12. “Make and use storyboards” (p. 110).

13. Encourage “peer teaching and sharing” (p. 110).

14. Use “cliffhangers” when it is appropriate. “Introduce a pressing, relevant problem to solve, and leave brainstorming for solutions until the next day” (p. 110)

15. Promote a positive “Yes, you can” attitude toward learning (p. 110).

Episodic strategies

1. Change learning locations by planning field trips (p. 110).

2. Use emotion to enhance learning by including music in the curriculum, incorporating drama into class activities, allowing students to do formal discussion and debate sessions, inviting a guest speaker, etc. (p. 111)

3. Use movement in the classroom by allowing students to become physically involved in curricular activities (p. 111).

4. Create novel classroom positions—seating arrangements, centers for learning, thematic unit designs that revamp classroom setup, position from where teaching is done, etc. (p. 111).

5. “Codify or ‘mark’ the learning” by learning “concepts in different places so each location is a key clue to the content. Take the class outside for an introduction to something new” (p. 111).

6. “Help students match learning and testing states” by avoiding “neutral moods,” teaching them to “manage their own states at test time,” and rehearsing “the learning in a variety of states to promote ‘recall resiliency’” (p. 111).

7. “Remember to test in the same room in which students learned the material” (p. 111).

8. “Create theme days (skeptical day, repeat day, brain day, opposite day) or theme weeks . . . to add color to learning.” Teach a related unit during a theme week. For example, “if the class is studying anatomy during ‘sports week,’ the extra connections of sports and the human body bring the topic to life” (p. 111).

Procedural strategies

1. Think of clever ways to incorporate movement in learning. For example: “If you have three points to make, ask students to rise . . . take three steps in any direction. . . . [You] introduce the first of the three points briefly . . . include an action to link it with the topic . . . ask students to walk three more steps . . . repeat this step” to introduce all three points. “Dance, sculpture, industrial arts, and total physical response” are other movement tactics to embed learning (p. 111).

2. “Embed emotions in learning” by: (a) using celebrations, (b) investing “more time on affecting emotions in the middle of class,” (c) creating “role plays, improv theater, or reenactments,” (d) having students make presentations in class, (e) teaming for debate or discussion, (f) creating or redoing a song, rewriting the lyrics of an old favorite or “making a rap out of the key terms or ideas,” (g) using dramatic concert readings, and (h) reading the “key points you want to recall with dramatic instrumental music as a backdrop” (pp. 111-112.

Reflexive strategies

1. Use fill-in-the-blank on written tests if enough review and rehearsal was done (p. 112).

2. Use "flash cards, games like hopscotch, and other quick-reaction activities [that] can help store and retrieve memories" (p. 112).

3. Use rap to "trigger implicit memories through both the physical motions and the auditory cues" (p. 112).

Summary of Body/Mind/Emotion/Social Connections

This section added social issues to the mind/body/emotion construct. Multiple factors contribute to the sociological influences that nurture learning and cognition. The *nature versus nurture debate* seems to have assumed a lesser position of importance in the wake of the studies on plasticity and enrichment. Most brain educators now agree that heredity and environment both play significant roles in brain development.

Naturalism's preponderant influence is apparent in research involving the brain and models defining neural functions. Leading voices on this topic proffer that the mind is no more than a product of brain chemistry and is not dependent on an outside force. A jungle metaphor may be appropriate to depict brain function rather than the model of a computer, which typically has been used in the past to illustrate how the brain operates. A computer is dependent on an outside force, says Edelman, but that is not an accurate model, in his opinion.

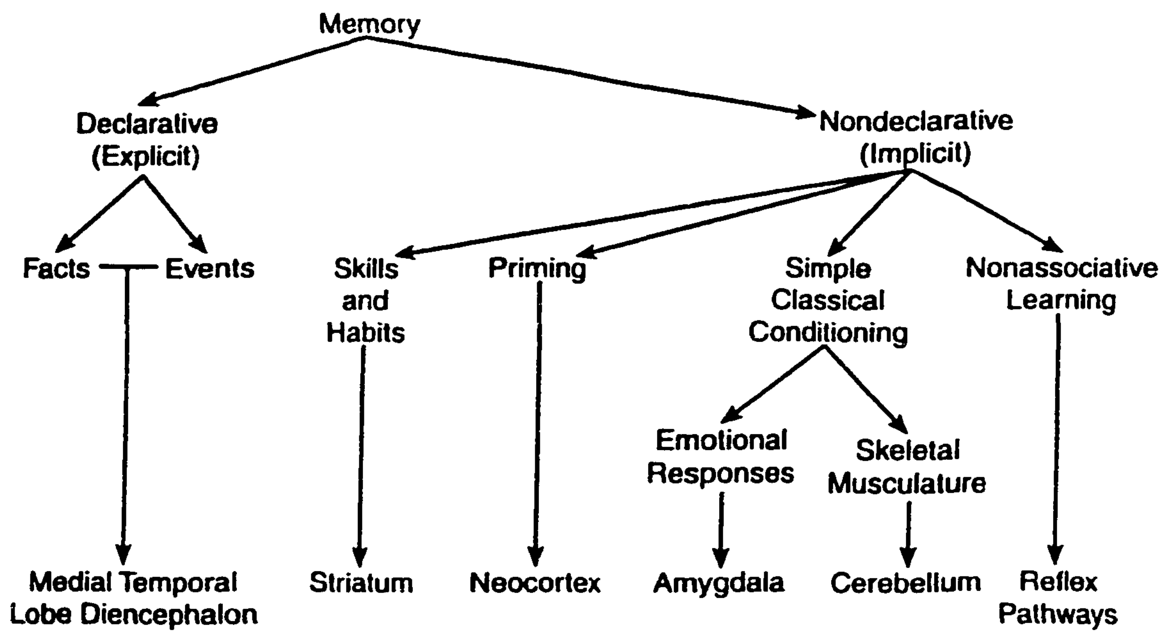

Figure 4. Taxonomy of memory and associated brain structure. From *Psychology of Learning for Instruction* (2nd ed.), (p. 285), by M. Driscoll, Needham, MA: Allyn & Bacon. In "Memory, Hippocampus, and Brain Systems" by L. R. Squire and B. J. Knowlton. In M. S. Gazzaniga (ed.), *The Cognitive Neurosciences 1995,* Cambridge, MA: MIT Press, 1994. Reprinted with permission.

Along with Edelman, each of the brain educators cited in this document seem to agree that "our brain is powerfully shaped by genetics, development, and experience" (Sylwester, 1995, p. 21).

Plasticity, the brain's ability to grow dendritically as a result of environmental influences, is now accepted as a property of brain development. Enriched and natural environments provide the greatest benefit for brain nurture, while impoverished environments that deprive the child of interaction with others and with stimulating surroundings can rob a child of needed nurture during critical periods of development—especially in the case of sight and hearing sensory abilities.

The social environment plays a significant role in shaping the ways an individual constructs meaning. Individuality is impressed upon by local and cultural forces. Relationships with animate and inanimate elements in the environment influence mental representations.

Language learning is significantly dependent on social influences, as well. Acquiring this multifaceted communication skill takes years to accomplish and is nurtured best when it happens in interactive environments where purposeful activities are involved.

Care-givers who teach language skills also teach ways of thinking, according to Healy (1990). For this reason great consideration should be given to the language coaches available to young children.

Learner differences play an important role in how the student will acculturate to the classroom environment. Healy places much emphasis on the issues of language, thinking styles, and hemisphericity. When dyslexia manifests itself, the classroom teacher must work to prevent this condition from scarring the student as she learns to cope among students who function differently. The teacher must strive to incorporate abundant opportunities for students to participate in alternate ways with language, body, and emotion. In the past, major emphasis has been given to language development.

Social influences have much to do with the student's motivation to learn. Teachers typically have provided much more extrinsic motivation than encouraged intrinsic motivation. Some research indicates that extrinsic motivation stimulates skill and drill learning; however, it tends to be a deterrent to intrinsic motivation, which promotes creativity. States of being strongly determine the level of motivation for a student. Levels of hunger, fatigue, humidity, interest in special events, success, and failure strongly influence motivation type and levels.

Rewards are now questioned in regard to their ability to motivate students. Some research suggests that the brain makes its own rewards when the learner is intrinsically motivated. The importance of flow and play provide additional dimensions to the value of intrinsic motivation.

Memory and recall play important roles in the learning process. Contrary to previous belief, neuroscience now suggests that memory is a fluid process more than a fixed skill located in a specific area of the brain. Current thought regarding memory is that memory systems exist throughout the body/brain. Body/brain chemistry can modulate recall by enhancing or depressing memories.

Various memory pathways seem to exist for different types of memories. This may lend credence to the importance of providing multiple ways for students to internalize knowledge. Multiple intelligence instruction and learning represent one set of strategies for addressing this new concept of memory storage.

CHAPTER THREE

REVIEW OF ELLEN G. WHITE'S WRITINGS ON PRINCIPLES OF EDUCATION

Introduction

The writings of Ellen Gould White contain volumes of information on the topic of education. Though she died in 1915, additional publications have been and continue to appear under her name. This is according to her last wishes, Herbert Douglass (1998) explains in his book *Messenger of the Lord: The Prophetic Ministry of Ellen G. White.* In her will, dated February 9, 1912, about 3 years before her death, White "in essence" created an organization which would perpetuate the distribution of her writings—both published and unpublished. Douglass describes the function of the organization that assumed this responsibility—the Ellen G. White Estate—as a "self-perpetuating board of five members."

> Its four-point task included disposition of her real property (such as personal goods and land, preservation of her manuscript files, printing of future compilations drawn from her writings, and supervision of the translation and publication of her books into other languages. (p. 528)

Ellen White's literary properties were moved from St. Helena, California, around 1938 to "vaults and offices at the world headquarters of the Seventh-day Adventist Church in Washington, D. C." (p. 528), Douglass writes.

> The Ellen G. White Board in cooperation with the General Conference set up eleven research centers in various world divisions of the church, plus branch offices at Andrews University in Berrien Springs, Michigan, and Loma Linda University, in

> California. These centers contain copies of Mrs. White's letters and manuscripts, historical material relating to the church, and significant books and pamphlets not easily available elsewhere. (p. 528)

Though she wrote only 40 books before she died, more than 100 titles in English are attributed to her. Compilations of her writings have been created from the 50,000 pages of manuscripts she completed before her death.

Much of what Ellen White wrote is education-relevant. Her counsels to educators are found in entire books devoted to this topic as well as throughout her other writings. Four individuals considered to be specialists on Ellen White's writings provided lists of what they considered to be the major themes and issues in her counsels on education. These individuals also are closely affiliated with the Seventh-day Adventist educational system. They concur that the following themes are seminal in her education-relevant manuscripts:

1. *Biblical Foundation.* God is revealed in Holy Scripture.

2. *Knowledge of God.* To know God is to know the source of all true wisdom.

3. *Redemption and Restoration of Image of God in Humanity.* The purpose of education is to aid humanity in accepting Christ's redemption, and to restore the image of God in man.

4. *Power of Choice and Human Will.* God will not violate the human will and freedom to choose.

5. *Character Development.* Character development is a major objective in education.

6. *Service.* Service to others is foundational to Christian education.

7. Harmonious Development. Education involves the harmonious development of mental, physical, and spiritual powers.

8. Amusement and Recreation. Amusement tends to be counterproductive to the goals of education when it is based on sensual gratification, and recreation tends to benefit the whole person when it provides variety of function and physical activity.

9. Work and Practical Functions. Work and practical experience are integral to a balanced educational program.

10. Health Habits. Health habits are critically important in the learning process.

11 Parental Influence. Parents are powerful influences in a child's education.

12. Teacher Influence and Characteristics. Teachers, like parents but to a lesser degree, profoundly influence a child's education; and certain teacher characteristics are more beneficial than others.

Each of the following 12 subsections addresses one of these 12 principles. However, related subtitles have been added for organizational purposes and to provide a comprehensive coverage of these 12 principles. For example, the *Knowledge of God* principle is a multifaceted concept that incorporates a significant number of subtopics that are intimately related.

Because Ellen White was a strong proponent of the idea that human growth and development involve an intimate integration of the physical, mental, and spiritual powers, it is difficult to discuss one principle without overlapping into the area of other principles. There is a strong relatedness among all parts of her counsels to parents, teachers, and other care-givers. For this reason, there is some duplication of references; however, much effort has been given to reducing this occurrence.

Biblical Foundation

Ellen White (1905) believed that it is man's privilege to know God (Father, Son, and Holy Spirit) intimately through Holy Scriptures. "We must seek to become acquainted with God; we must study to understand the Scriptures" (paragraph 19), White (1878c) counsels.

Quoting Scripture (John 5:39) as her source for this position, White (1886b) posits,

> Said Christ: "Search the Scriptures; for in them ye think ye have eternal life; and they are they which testify of me." No one can neglect the word of God, and yet attain to Christian perfection. But by carefully searching that word, we become acquainted with the divine Model; and in order to imitate the Pattern, it must be frequently and closely inspected. (paragraph 1)

White (1883) cautions, "There is no safety in depending upon human wisdom and judgment" (paragraph 13). However, "the Word is able to make men and women and youth wise unto salvation" (White, 1909b, paragraph 6). Continuing, she says, "If God's word were studied as it should be, men would have a breadth of mind, a nobility of character, and a stability of purpose that is rarely seen in these times" (paragraph 6).

White indicates that all three of the Godhead are involved when humanity turns its thoughts to Holy Scripture. "It is the efficiency of the Holy Spirit that makes the ministry of the word effective" (White, 1915a, p. 155). "The Scriptures clearly indicate the relation between God and Christ, and they bring to view as clearly the personality and individuality of each" (White, 1905, p. 421). Focusing on Christ's relationship to Scripture, White (1906a) says,

> The whole Bible tells of Christ. From the first record of Creation—"for without Him was not anything made that was made"—to the closing promise, "Behold, I come quickly," we are reading of His works, and listening to His voice. If you would become better acquainted with the Savior, study the Scriptures. (paragraph 3)

Christ alone can give "light and life" White (1855/1909a, p. 388) insists. Describing the Holy Spirit as an aid to Bible study, White (1909b) states, "The gift of Christ and the illumination of the Holy Spirit reveal to us the Father" (paragraph 6). "The office of the Holy Spirit is to bring all things to our remembrance and to guide us into all truth" (p. 202), White (1964) advises. "Ask God to reveal light and truth to you by His Holy Spirit, that you may understand what you read in His Word" (p. 202).

Themes of the Bible are accessible now, but they will also be the subject of study throughout eternity, according to White (1906a). "The theme of redemption is one that angels desire to look into; it will be the science and the song of the redeemed throughout the ceaseless ages of eternity. Is it not worthy of careful thought and study now?" (paragraph 4) she asks.

Describing Scripture as not limited to spiritual concepts, White (1900c) proposes that the Bible is supportive of all quests for knowledge, including science:

> The Bible is God's great lesson book, His great educator. The foundation of all true science is contained in the Bible. Every branch of knowledge may be found by searching the word of God. And above all else it contains the science of all sciences, the science of salvation. (p. 107)

The relationship White establishes between the Bible's store of knowledge and that of science is discussed further in the next section—*Knowledge of God.*

White clearly indicates that the Bible is the medium through which humanity has access to knowledge and wisdom. It is the means through which Christ is revealed to the world (White, 1870/1877/1878/1884, p. 211). Biblical Scripture is the vital link to the mind of the One who created and sustains earth and life on earth, White counsels. The Creator God is the source of all knowledge, power, and wisdom (White, 1903b). It is humanity's privilege to know its Creator.

Knowledge of God

Knowledge of God, as indicated by the Ellen G. White authorities referenced in this document, seems to include several different, but related, concepts, among which are: knowledge *of* God, knowledge *about* God, knowledge as an acquaintance with God, and knowledge about creation that God Himself called into existence. Perhaps this multifaceted nature of the *knowledge of God* is reflective of White's description of the multifaceted nature of God Himself. White describes Him as omnipotent—all-powerful (White, 1952, p. 340; 1953/57, pp. 921, 946); omnipresent—capable of being present anywhere at any time (White, 1958/1980, p. 311); and omniscient—all-knowing (White, 1903b; 1917; 1958; 1967; 1973). This section addresses these different aspects of the *knowledge of God* in the context of these characteristics, but not necessarily in the sequence ordered above.

In humanity's original condition after creation, Adam and Eve were capable of becoming increasingly more knowledgeable as a result of becoming better and better acquainted with the Creator Himself, White (1903b, pp. 14, 15) indicates. "In Him 'are hid all the treasures of wisdom. ' Colossians 2:3" (White, 1903b, pp. 13, 14). Adam and Eve walked and talked with God, White (1903b, pp. 14, 15) explains, citing Old Testament accounts of this occurrence. As long as humanity maintained this pure relationship with the Creator, human development and function would be maintained in a harmonious, beneficial state. However, if humanity chose to embrace life's antithesis (Satan and evil), a cacophonous, detrimental state would be the result (White, 1903b, pp. 23-27).

Honoring humanity's freedom of choice, God gave mankind opportunity to exercise will power. The tree of the knowledge of good and evil was placed in the Garden of Eden, but God lovingly cautioned Adam and Eve to avoid eating the fruit from that source because it would initiate physical, mental, and spiritual decline (White, 1903b, pp. 23-27). White (1903b) discusses the rationale behind this test for humanity:

> There was nothing poisonous in the fruit itself, and the sin was not merely in yielding to appetite. It was distrust of God's goodness, disbelief of His word, and rejection of His authority, that made our first parents transgressors, and that brought into the world a knowledge of evil. It was this that opened the door to every species of falsehood and error.
>
> Man lost all because he chose to listen to the deceiver rather than to Him who is Truth, who alone has understanding. By the mingling of evil with good, his mind had become confused, his mental and spiritual powers benumbed. (p. 25)

Throughout her writings Ellen White ardently promotes the idea that through Christ's sacrifice for humanity and the willful choice of man to believe in God's love, power, and wisdom, humankind can be restored to oneness with God and to eternal life (White, 1903b, pp. 23-32). Consequently, the *knowledge of God* is a significant theme, not only in her counsels to educators but throughout her manuscripts.

God's Plan for Disseminating Knowledge of Himself and About Himself

Ellen White (1903b) promoted the idea that "The system of education established in Eden centered in the family. Adam was 'the son of God' (Luke 3:38), and it was from their Father that the children of the Highest received instruction" (p. 33). The family unit was the God-ordained vehicle for educating young minds. This reverence for organizational structure in education underlies all of Ellen White's counsels to parents, teachers, and students. By connecting with the mind of God, the author of life, energy, and wisdom, the powers of the mind are best developed, she reiterates often in her counsels. Citing Holy Scripture, she explains, "The source of such education is brought to view in these words of Holy Writ, pointing to the Infinite One: In Him 'are hid all the treasures of wisdom.' Colossians 2:3. 'He hath counsel and understanding.' Job 12:13" (p. 13).

Though there have been great minds in Earth's history, no source of wisdom compares with that of the Creator God, the Father of all humanity, White (1903b) suggests. "Every gleam of thought, every flash of the intellect, is from the Light of the World" (p. 14). Continuing, White states that "in a knowledge of God all true knowledge and real development have their source."

> Wherever we turn, in the physical, the mental, or the spiritual realm; in whatever we behold, apart from the blight of sin, this knowledge is revealed. Whatever line of investigation we pursue, with a sincere purpose to arrive at truth, we are brought in touch with the unseen, mighty Intelligence that is working in and through all. The mind of man is brought into communion with the mind of God, the finite with the Infinite. The effect of such communion on body and mind and soul is beyond estimate. (p. 14)

White often speaks of the importance of getting to know God as the source of life, love, power, etc. In addition, she encourages her readers to consider that in God is all knowledge and wisdom (White, 1903b, p. 13). Knowing God provides access to the secrets of knowledge, she suggests (p. 13). This knowledge access is not confined to spiritual and philosophical matters. She states that there is "science in religion."

White's use of the word *omniscience* to indicate God's attribute of being all-knowing seems appropriate for wedding White's concepts of science and religion. According to *Webster's Dictionary* (Braham et al., 1999), *omni* means "all" (p. 922), and *science* means "a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws" (p. 1175). Today's meaning of this word still maintains much of the meaning described in dictionaries of Ellen White's time.

It is interesting to note that *Webster's Dictionary* (1828) 170 years ago made alignments between science and religion. Perhaps this contributed to White's alignment of science and religion. Following is the entire entry for the word *science* in the 1828 version of Webster's dictionary. (Pages are not numbered in this dictionary, and the bracketed note at the end of the entry is part of the entry as it appears in the 1828 dictionary.)

> SCI'ENCE, n. [Fr. From L. scientia, from scio, to know; Sp. Ciencia; It. Scienza. Scio is probably a contracted word.]
>
> 1. In a *general sense*, knowledge, or certain knowledge; the comprehension or understanding of truth or facts by the mind. The *science* of God must be perfect.
>
> 2. In *philosophy*, a collection of the general principles or leading truths relating to any subject. *Pure* science, as the mathematics, is built on self-evident truths; but the term science is also applied to other subjects founded on generally acknowledged truths, as *metaphysics*; or on experiment and observation, as *chimistry* and *natural philosophy*; or even to an assemblage of the general principles of an art, as the science of *agriculture*; the science of *navigation. Arts* relate to practice, as painting and sculpture.
> A principle in *science* is a rule in art.
> *Playfair.*
>
> 3. Art derived from precepts or built on principles.
> *Science* perfects genius.
> *Dryden*
>
> 4. Any art or species of knowledge.
> No *science* doth make known the first principles on which it buildeth
> *Hooker*
>
> 5. One of the seven liberal branches of knowledge, viz. Grammar, logic, rhetoric, arithmetic, geometry, astronomy and music.
> *Bailey. Johnson.*
>
> [*Note.*—Authors have not always been careful to use the terms *art* and *science* with due discrimination and precision. Music is an *art* as well as a *science*. In general, an *art* is that which depends on practice or performance, and *science* that which

> depends on abstract or speculative principles. The *theory* of music is a *science*; the *practice* of it an *art*.]

Perhaps Ellen White thought of the *theory* of religion, salvation, and eternity (of which she says there is science) as the scientific element and the *practice* of this theory as the aesthetic or affective element that contributes to the triad function of mental, physical, and spiritual powers. At this point only speculation can be made. Further research might determine more specifically what her position was on this matter.

White often related the study of the knowledge of God with the concept of science. The terms *science* and *knowledge* appear to be somewhat synonymous today, as they were in the 1800s and early 1900s.

The Science of Religion as Knowledge of God

Ellen White speaks of the "science of religion," and sometimes she uses the term the "science of salvation" or "science of eternity" (White, 1952b). As an example of her use of this term, referring to Jesus' conversation with Nicodemus regarding how an individual could be "born of the Spirit," White (1946b) makes an exclamatory remark regarding Nicodemus's incomplete understanding of this concept. "A teacher in Israel, a man among wise men, a man who supposed that he was able to comprehend the science of religion, and yet stumbling at the doctrine of conversion!" (p. 289). Judging by her implication here, White believed the *science* to which she refers to be knowledge that a student of Scripture would surely understand.

More specifically linking science with religion, White (1900c) proffers that all true science has its source in the spiritual world:

> This is the treasure that is found in the Scriptures. The Bible is God's great lesson book, His great educator. The foundation of all true science is contained in the Bible. Every branch of knowledge may be found by searching the word of God. And above

> all else it contains the science of all sciences, the science of salvation. The Bible is the mine of the unsearchable riches of Christ. (p. 107)

White (1958) explains that a "knowledge of science is power," but that the "knowledge that Jesus came in person to impart is still greater power" (p. 321). She defines a "more essential" element than just physical science—"The science of salvation is the most important science to be learned in the preparatory school of earth. The wisdom of Solomon is desirable, but the wisdom of Christ is far more desirable and more essential" (p. 321).

This parallel construct seems to imply an equality between the "science of salvation" and the "wisdom of Christ."

A strong supporter of both science as curriculum and science linked with the spiritual element, White (1977b) states,

> A knowledge of science of all kinds is power, and it is in the purpose of God that advanced science shall be taught in our schools as a preparation for the work that is to precede the closing scenes of earth's history. (p. 360)

Explaining that during His time on earth, Christ placed the *science of salvation* in higher rank over other sciences, Ellen White (1977b) posits,

> Jesus could have flashed bright beams of light on the darkest mysteries of science, but He would not spare a moment from teaching the knowledge of the science of salvation. His time, His knowledge, His faculties, His life itself, were appreciated only as the means of working out the salvation of the souls of men. (p. 245)

Christ's emphasis on the science of religion has an antithesis, White (1946a) suggests. Contrasting Christ's example of selfless love for humanity with another influential spirit on earth, Ellen White states that the spirit of evil is the antithesis of Christ's spirit of love. In 1905, she spoke of this spiritual influence that deludes and is counterproductive to benefiting the whole being. She counseled against "giving heed to seducing spirits and doctrines of devils. They talk science, and the enemy comes in and gives them an abundance of science; but it is not the science of salvation" (p. 29).

Continuing, she defines the *science of salvation* as "the science of humility, of consecration, or of the sanctification of the Spirit" (p. 29). At another time she added (White, 1973), "Christ crucified for our sins; Christ risen from the dead; Christ ascended on high as our intercessor—this is the science of salvation that we need to learn and to teach" (p. 208).

Why did Ellen White choose a term such as *science* to discuss the knowledge of God and the nature of spiritual function? Was she suggesting a metaphysical concept—an integration between the physical and the spiritual? The answer to this question can only be inferred from a review of her references to this topic. Her uses of the term *science of religion* or *science of salvation* seem to indicate that she does link physical and spiritual elements in this concept.

Because White states "this is the science of salvation that we need to learn and to teach," it seems appropriate to assume that she places a high value on the relationship between science and religion. She deems it worthy of learning *and* teaching (White, 1973, p. 208). It also seems likely that her strong emphasis on this matter is related to its connection with the survival of humanity; hence, she uses the term *science of salvation*.

Clearly, Ellen White believed that there are two supernatural powers existing on earth and that they are diametrically opposed to each other. She counsels God's followers to understand that these two warring elements exist and to align with Christian power in order to avoid Satanic destruction. Without this alignment, death is certain, she counsels; and with the alignment, eternal life becomes reality (White, 1888c).

Citing the life and death of Christ as an example of this dichotomous tension, White stresses the need to access the knowledge God provides to help humanity understand the *science of salvation.* She defines the conditions that surrounded Christ prior to his execution at the hand of satanic forces—the same forces that all humanity must learn to resist in order to survive. Describing the individuals in power during Christ's time on earth, White (1905) explains how evident were Satan's subtle attempts to supernaturally control physical elements.

> Satanic agencies took possession of men. The bodies of human beings, made for the dwelling place of God, became the habitation of demons. The senses, the nerves, the organs of men were worked by supernatural agencies in the indulgence of the vilest lust. The very stamp of demons was impressed upon the countenances of men. Human faces reflected the expression of the legions of evil with which men were possessed. (p. 142)

Here White alludes to supernatural influence over brain and body functions to the extent that the whole being—mind, body, and soul—was possessed by an evil, spiritual influence. This influence of evil is present on the earth now, she suggests, and it wars constantly against the Spirit of love. In 1888, White devoted an entire book to this topic—*The Great Controversy Between Christ and Satan.*

On another occasion, Ellen White (1890b) further describes the same opposing supernatural power as highly deceptive and capable of falsely representing truth. Referring to the biblical account of King Saul's visit with the Witch of Endor, recorded in I Sam 28, White posits,

> It was not God's holy prophet that came forth at the spell of a sorcerer's incantation. Samuel was not present in that haunt of evil spirits. That supernatural appearance was produced solely by the power of Satan. He could as easily assume the form of Samuel as he could assume that of an angel of light, when he tempted Christ in the wilderness. (p. 679)

White (1890b) counsels Christians to guard against the subtlety of this opposing power—this metaphysical science of delusion. She urges her readers to recognize the existence of such deceptive power, and she explains that, by discrediting the possibility that supernatural powers exist, we can become vulnerable to satanic deception:

> There are many, however, who regard spiritualism as a mere imposture. The manifestations by which it supports its claims to a supernatural character are attributed to fraud on the part of the medium. But while it is true that the results of trickery have often been palmed off as genuine manifestations, there have also been marked evidences of supernatural power. And many who reject spiritualism as the result of human skill or cunning will, when confronted with manifestations which they cannot account for upon this ground, be led to acknowledge its claims. (p. 685)

The forces of evil are "both many in number and unceasing in activity," White (1953/1957) writes. And though the "Christian should never feel hopeless or discouraged," it is important to recognize the strength of the power against which you war. The Christian "may not hope to escape" as a result of "satanic inefficiency." Human power and wisdom alone are not sufficient to withstand this power (p. 1119).

Ellen White espoused the thought that just as real as demonic spirits are the spiritual powers of goodness. She (White, 1952b) proffers that in Eden man was provided with a supply of supernatural food—the tree of life—that endowed him with supernatural virtues and the ability to live forever. "Its fruit was the antidote of death. Its leaves were for the sustaining of life and immortality. . . . After the entrance of sin the heavenly Husbandman transplanted the tree of life to the Paradise above" (p. 355). White explains that if humanity had eaten of the tree of life after sinning, the tree's properties would have perpetuated mortality, eternally, so powerful were its properties (White, 1903b, p. 302; 1952b, p. 355; 1973, p. 360; 1976, p. 325).

However, when God took away the tree of life, He did not leave humanity without a source of supernatural support, White states (1985c). To assist humankind in resisting the supernatural powers of Satan, Jesus Christ commissioned the Holy Spirit to empower those who desire supernatural help. Referencing this occurrence that is chronicled in the biblical New Testament, White (1985c) explains Christ's commitment to aid humanity:

> The Holy Spirit was promised to be with those who were wrestling for victory, in demonstration of all mightiness, endowing the human agent with supernatural powers, and instructing the ignorant in the mysteries of the kingdom of God. That the Holy Spirit is to be the grand helper is a wonderful promise. (p. 132)

White (1955) describes the process of connecting with this supernatural support:

> When the soul surrenders itself to Christ, a new power takes possession of the new heart. A change is wrought which man can never accomplish for himself. It is a supernatural work, bringing a supernatural element into human nature. The soul that is yielded to Christ becomes His own fortress, which He holds in a revolted world, and He intends that no authority shall be known in it but His own. A soul thus kept in possession by the heavenly agencies is impregnable to the assaults of Satan. (p. 23)

Christ Himself experienced the horrors of man's dilemma in having to face Satan's supernatural forces, White (1888c) explains. Refusing to use His own supernatural powers for self-advantage, Christ endured the agonizing tortures of Satan's wickedness, she notes. Depicting the tension between the physical and the spiritual world, White describes Christ's last agonizing hours on earth as the "son of man." She (White, 1888c) writes,

> And now before the swaying multitude are revealed the final scenes,—the patient Sufferer treading the path to Calvary; the Prince of Heaven hanging upon the cross; the haughty priests and the jeering rabble deriding his expiring agony; the supernatural darkness; the heaving earth, the rent rocks, the open graves, marking the moment when the world's Redeemer yielded up his life. (p. 667)

Depicting nature's sympathy with Christ's death, White (1896c) indicates that God responded to the evils of this scene with drastic measures in the physical world. "The sun shone clearly until midday, when suddenly it seemed to be blotted out. All about the cross was darkness as deep as the blackest midnight. This supernatural darkness lasted fully three hours" (p. 145).

For parts of 3 days Christ rested in the grave, a slain prey of Satan and his forces. But on the third day, as He had predicted, angels from Heaven called Him forth from the grave, Ellen White (1947) explains. "Thou Son of God, Thy Father calls Thee! Come forth" (p. 231). The supernatural powers of the Father dominated Satan's abilities, and Jesus, both the Son of Man and the Son of God, superceded the powers of darkness (pp. 230-232) as He rose from death to life.

In the context of these supernatural considerations, White's use of the term *science of salvation* takes on additional meaning. When she counsels humanity to prepare for Christ's second coming, she does so with concern over supernatural issues that involve the philosophical, physical, and spiritual powers (White, 1923b, p. 99; 1955, p. 231; 1977a, p. 744). "We must contend with invisible, supernatural foes," she says. "We are to put on the whole armor of God, that we may be prepared for the battles we have daily to fight" (White, 1981/1993g, p. 395). Here White is referring to Eph 6:11.

In the biblical book of Ephesians, the sixth chapter, vss. 13 to 19, the term "whole armor of God" is defined as including the following items, along with their metaphoric analogies:

Loin cloths	Truth
Breast plate	Righteousness
Shoes	Gospel of peace
Shield	Faith
Helmet	Salvation

Sword of the Spirit Word of God

"Christ can do nothing for those who are yoked up with the enemy," White (1932, p. 117) advises. He will not violate the right to choose another God other than Himself. However, He entreats humanity to invite Him into their hearts and to receive His power, His life, and His protection by putting on His armour.

It is impossible to access the supernatural power to overcome satanic forces on our own, White proffers. We must embrace His Spirit and allow it to sanctify us thoroughly. The Spirit is accessed through study of God's Word, and the Word contains the *science of salvation,* White (1906b) indicates. As referenced previously, "The foundation of all true science is contained in the Bible. Every branch of knowledge may be found by searching the Word of God. And above all else, it contains the science of all sciences, the science of salvation" (paragraph 5).

Amplifying this thought even further, White (1981/1993e) adds:

> By those who make the Scriptures their constant study, true natural science is far better understood than it is by many so-called learned men. Science, as revealed in Holy Writ, flashes light upon many hidden things in God's Word. The science of the Bible is pure, undefiled religion; it is the science of true godliness. And obedience to God, in all schemes of human benevolence—practical activity—is the science of salvation. The gospel is "the power of God unto salvation to every one that believeth."—Ms 24, 1891, p. 19. (p. 434)

Knowledge of God is found in Scripture. "All Scripture is given by inspiration of God, and is profitable for doctrine, for reproof, for correction, for instruction in righteousness; that the man of God may be perfect, thoroughly furnished unto all good works" (paragraph 1), White (1900a) explains, quoting Scripture. As such, White suggests, it is the most appropriate resource for power, instruction, and survival. Scriptural study is the means by which humanity comes to know the science of salvation—the processes of integrating spiritual powers into the mental and physical powers (White, 1900a, paragraph 1; 1906b, paragraph 5; 1913, p. 189; 1923b, p. 99; 1977a, p. 744).

The study of nature is another means through which humanity accesses the knowledge of God and the science of religion/salvation, White (1915b) indicates.

> Nature is full of lessons of the love of God. Rightly understood, these lessons lead to the Creator. They point from nature to nature's God, teaching these simple, holy truths which cleanse the mind, bringing it into close touch with God. These lessons emphasize the truth that science and religion can not be divorced. (p. 186)

"Man's wisdom cannot originate the science which is divine" (p. 186), White counsels. That is why Christ came to this earth—"to teach men the mysteries of the kingdom of God" (p. 186). Through Scripture and lessons in nature, God leads the mind that is yielded to Him to understand physical and eternal truths:

> When man is reconciled to God, nature speaks to him in words of heavenly wisdom, bearing testimony to the eternal truth of God's Word. As Christ tells us the meaning of the things in nature, the science of true religion flashes forth, explaining the relation of the law of God to the natural and spiritual worlds. (p. 186)

By becoming acquainted with the knowledge of God, humanity gains access to an understanding of the connections between science and religion and/or salvation (White, 1903b, p. 134).

Heart/Mind Relationship to the Knowledge of God

Ellen White (1903b) proposes that humanity cannot access ultimate truth and the knowledge of God without the assistance of the Holy Spirit (p. 134). "Ask God to reveal light and truth to you by His Holy Spirit, that you may understand what you read in His Word," she (1964) counsels. "The office of the Holy Spirit is to bring all things to our remembrance and to guide us into all truth" (p. 202).

The Holy Spirit establishes itself in a receptive individual by residing in the heart, White (1977, p. 656; 1961, p. 155) explains. "His [the Holy Spirit's] work is to define and maintain the truth. He dwells in the heart as the Spirit of truth. . . . Through the Scriptures the Holy Spirit speaks to the mind, and impresses truth upon the heart" (White, 1958, p. 56).

Does White use the term *heart* literally or figuratively in these references? This is not always distinguishable; however, there is some reason to believe that she may have considered the cardial heart to be involved in the act of knowing.

In four different references Ellen White uses the term *moral organs*. Each reference is in a similar context as this one—"They have contracted wrong habits which injure the constitution and the brain, causing the *moral organs* to become diseased and making it impossible for them to think and act rationally upon all points" (White, 1977b, p. 292).

No more specific definition is provided for this term *moral organs* than is seen here. In each of the four references White specifically refers to a plural concept—more than one moral organ. Is it possible that she included the brain and the heart in her use of this term? She speaks often of the mind and the heart in connection with moral issues. Whether or not she was implying inclusion of other organs is not indicated.

Heart and brain and *heart and mind* are terms commonly used in Ellen White's writings (White, 1897, pp. 180, 185, 186, 196, 202; 1955, p. 171; 1961, p. 162; 1973, p. 181; 1985c, pp. 121, 286). At times she seems to speak of the heart, the brain, and the mind as three different entities—"A diseased body," she says, "causes a disordered brain, and hinders the work of sanctifying grace upon the mind and heart" (White, 1897, p. 42).

"Vital energy is imparted to the mind through the brain; therefore the brain should never be dulled by the use of narcotics or excited by the use of stimulants" (White, 1977a, p. 407), she wrote in counsels on health. And in an 1890 letter to encourage Christians around the world, she penned, "What we want most is . . . heart power, prayer to God in faith for His converting power. . . . It is not brain power or purse power, but heart power, that the people need now" (White, 1985c, p. 121).

Elaborating on the connection between the brain and all other parts of the body, White (1977b) says, "The brain nerves which communicate with the entire system are the only medium through which Heaven can communicate to man and affect his inmost life" (p. 230). When "Heaven" uses this electrical communication pathway, White (1977b) claims vitalizing, healing energy results:

> The love which Christ diffuses through the whole being is a vitalizing power. Every vital part—the brain, the heart, the nerves—it touches with healing. By it the highest energies of the being are roused to activity. It frees the soul from the guilt and sorrow, the anxiety and care, that crush the life-forces. With it come serenity and composure. It implants in the soul joy that nothing earthly can destroy—joy in the Holy Spirit—health-giving, life-giving joy.—MH 115 (1905). (p. 250)

White indicates that enlightenment from Scripture empowers the heart and mind. "Such study [of the Bible] has vivifying power. The mind and heart acquire new strength, new life" (White, 1903b, p. 171). "Through the Scriptures the Holy Spirit speaks to the mind, and impresses truth upon the heart," White (1958, p. 56) adds. Recognizing that humanity has a choice in aligning with the Holy Spirit, she states, "The heart of man may be the abode of the Holy Spirit" (White, 1961, p. 155).

Providing further explanation of this phenomenon of mental and spiritual empowerment of mind and heart through Holy Scripture and the Holy Spirit, White (1967) explains,

> It is not enough to study the Bible as other books are studied. In order for it to be understood savingly, the Holy Spirit must move on the heart of the searcher. The same Spirit that inspired the Word must inspire the reader of the Word. Then will be heard the voice of heaven. (p. 138)

White (1967) offers even further clarification of this process,

> It is not the mere letter of the words which gives the light and the understanding, but the Word is in a special manner written upon the heart, applied by the Holy Spirit. To the mind and heart consecrated to God, an increased measure of understanding is given as the light is communicated to others. (p. 139)

White (1988a) describes the effect of one person's heart activity upon other individuals. Citing Scripture, she says, "When the Holy Spirit was poured out upon the early church, 'the multitude of them that believed were of one heart and of one soul' (Acts 4:32). The Spirit of Christ made them one" (p. 296). In another reference White (1982) writes about a magnetic power between hearts of individuals. When the sunshine of heaven fills hearts, she says, "hearts are drawn together. . . . The Holy Spirit binds heart to heart" (p. 106).

Adding a word of caution regarding the effect of the Holy Spirit and Holy Scriptures on the heart, White (1888b) again quotes Scripture, and says,

> "To the law and to the testimony; if they speak not according to this word, it is because there is no light in them." Even the work of the Holy Spirit upon the heart is to be tested by the word of God. The spirit which inspired the Scriptures, always leads to the Scriptures. (p. 901)

The scriptural use of the term *light* is significant in White's manuscripts. This will be addressed in a subsequent subsection.

As mentioned previously, White sometimes refers to heart and mind as if they were the same. She also refers to these two entities as separate units. She says, "The whole mind, the whole soul, the whole heart, and the whole strength are purchased by the blood of the Son of God" (White, 1973, p. 155). "The intellect, as well as the heart, must be consecrated to the service of God" (White, 1961, p. 111). "It is not brain power or purse power, but heart power, that the people need now" (White, 1985c, p. 121). And when providing counsel to those who wore heavy wigs that covered the area at the base of the skull, White (1897) said,

> The heat caused by these artificial coverings induces the blood to the brain. The action of the blood upon the lower or animal organs of the brain, causes unnatural activity, tends to recklessness in morals, and the mind and heart are in danger of being corrupted. (p. 185)

White's use of the term "lower or animal organs of the brain," probably refers to the brain stem, which now is sometimes referred to as the *reptilian brain*. This portion of the brain is believed to be the area where functions of survival are centered.

White tends to use the term *brain* when referring to the physical cranial organ. Multiple times she seems to use two parallel structures of three units—*brain, bone, and muscle*; and *mind, body, and heart*. In such cases, *heart* may be used as a figurative term, rather than to distinguish the physical cardiac organ. However, she does speak of the heart and other organs of the body in a physiological sense, as well. "The liver, heart, and brain are frequently affected by drugs, and often all these organs are burdened with disease" (White, 1897, p. 202).

This duplistic use of terms is not atypical of White's writing style. On one occasion she commented on her use of metaphor (White, 1977b):

> These words have a first and second sense, a literal and a figurative meaning. They are full of truth in regard to the bodily eye, with which we see external objects. And they are true also in regard to the spiritual eye, the conscience, with which we estimate good and evil. If the eye of the soul, the conscience, is perfectly healthy, the soul will be taught aright. (p. 323)

It seems clear that White recognized a holistic relationship between heart, mind, and brain. In addition, it also seems clear that White at times speaks figuratively and at other times literally about these entities.

Describing the oneness of heart and mind, White (1973) uses Christ's words and says, "When Jesus speaks of the new heart, He means the mind, the life, the whole being" (p. 100). "Humble your heart before the Lord. Keep heart and mind pure and clean, and free from worldly entanglements" (White, 1985c, p. 248), she counsels on another occasion.

White (1913) speaks of the mind as "the capital of the body" (p. 78). "Every organ of the body was made to be servant to the mind," she says. Yet, she also speaks of the heart's influence on the mind (White, 1894b, paragraph 3; White, 1908, paragraph 4). In 1891, she wrote (White, 1977a),

> Real religion has its seat in the heart; and as it is an abiding principle there, it works outwardly, molding the external conduct, until the entire being is conformed to the image of Christ; even the thoughts are brought into subjection to the mind of Christ. If the abiding principle is not in the heart, the mind will be molded after the deceiving similitude of Satan's mind, working his will to the ruin of the soul. The atmosphere which surrounds such souls is deleterious to all around them, whether believers or unbelievers. (p. 802)

As mentioned previously, White uses the word *heart* to refer to the physical organ which pumps blood throughout the body and as a metaphoric inference for the center of the being and spirituality. Only in context does she differentiate between these two functions. She describes the heart as functional in physical, emotional/spiritual, and even mental capacities when she aligns it with the mind.

When she speaks of the *brain*, she tends to be consistent in using this term to refer to the physical organ. However, she sometimes uses the term *mind* to indicate a more holistic function of the brain—especially when referring to reason and intellect.

In the following quotation, White (1981/1993a) provides counsel to an individual regarding the dangers of developing a callused heart. She also seems to tie the figurative heart as it relates to morality with the literal heart that pumps blood.

> You are living in hourly contact and conscious communion with the principles of truth and righteousness, and if there is not a corresponding rising in moral and intellectual power, if you do not cooperate with the divine influences, you will become hard and unimpressible. The light will become darkness to you. Your heart must be changed, its principles elevated, and your heart beat and your eye flash in response to the deep, holy principles which your own strenuous efforts may combine with the grace of God implanted in your nature. Your morals then will be sound, your principles firm. In this aim you may be ambitious, for you are drinking from the true source of wisdom and virtue. (p. 258)

Throughout her writings White emphasizes the importance of the harmonious relationship between the physical, mental, and spiritual powers in the process of knowing God and learning of His creation. The heart's role of importance in Ellen White's counsels will be further discussed in the section *Harmonious Development.*

Along with her discussions regarding the role of the heart in accessing the *Knowledge of God,* White speaks of God's knowledge coming to humanity as light. The next section addresses this concept.

Light From God Charges the Mind

A commonly referenced term in Ellen White's writings is her referral to *the light of God*. She seems to use this to indicate power that comes to the individual when he knows or connects with God. Often in these references she also discusses involvement of the heart and the Holy Spirit.

Clearly it was Ellen White's belief that the heart is at the center of the dynamic connection that can be established between God and humanity. She emphasizes that the Holy Spirit impresses the heart, which in turn molds the mind. Ocassionally, she also describes the Spirit's entry into this dynamic process as a result of "light" from God—the source of all knowledge, light, and life. This light flashes into the mind, she says. "If you will study the word of God, light will flash into your mind" (White, 1913, p. 455). "Every gleam of thought, every flash of the intellect, is from the Light of the world" (White, 1903b, p. 14), she explains. White describes the light that comes from God as energy that empowers the mind and the heart. Adding further, she says,

> Christ is the "Light, which lighteth every man that cometh into the world." John 1:9. As through Christ every human being has life, so also through Him every soul receives some ray of divine light. Not only intellectual but spiritual power, a perception of right, a desire for goodness, exists in every heart. (p. 29)

Again, in this discussion of light and its life-giving power, White (1903b) provides a warning regarding the opposing forces which aim to obliterate the intended influence of Christ's light and the necessary power it yields:

> But against these principles there is struggling an antagonistic power. The result of the eating of the tree of knowledge of good and evil is manifest in every man's experience. There is in his nature a bent to evil, a force which, unaided, he cannot resist. To withstand this force, to attain that ideal which in his inmost soul he accepts as alone worthy, he can find help in but one power. That power is Christ. Co-operation with that power is man's greatest need. In all educational effort should not this co-operation be the highest aim? (p. 29)

Many times White refers to "light" from God flashing into the minds of individuals, vitalizing their spirit, and empowering mind and body (White, 1893b, paragraph 7; 1902a, paragraph 8; 1903b, p. 13; 1915a, p. 50; 1946b, pp. 116, 438; 1967, p. 27; 1982, p. 374). This light proceeds from God the Creator, she says, in loving ministrations to his created beings. White describes this light energy in four different categories:

1. Light from God as energy that empowers the mind and heart
2. Light from God that stimulates memory
3. Light from God that is stored within an individual to be shared with others
4. Light from God that becomes accessible through prayer, study of Holy Scriptures and study of nature.

Following are kernel statements from a number of the writings that support these four positions:

Light as Energy to Empower Mind and Heart

"Every gleam of thought, every flash of the intellect, is from the Light of the world," White (1903b, p. 13) proffers. However, not having established a positive relationship with God interferes with the divine energy source. "If the sinner or the backslider settles himself in disobedience and sin, the light may flash from heaven all about him, . . . without breaking the bewitching power of falsehood and the spell of the world's deception," she warns (White, 1967, p. 27).

Describing the biblically predicted time of judgment when the wicked will be judged, White (1902a) speaks of a "flash of light [that] will come to all lost souls . . . [as they] see the power of the mystery of godliness" (paragraph 8). This same power she describes another time as a "bright flash of light from the angels of God"—a sight humanity could not endure, a power so strong it caused men to fall prostrate on the ground (White, 1990/1994, p. 264).

Ellen White (1913) challenges youth to experiment to determine the power of God, and again she refers to energy released as a *flash of light.*

> Take the Bible as a study book, and see if you are not filled with the love of God. Your heart may be barren, your intellect feeble; but if you will prayerfully study the word of God, light will flash into your mind. God works with every diligent student. Teachers who will learn from the Great Teacher will realize the help of God. (p. 455)

Writing in 1891 regarding the importance of establishing Christian schools, Ellen White (1977b) used the *flash of light* term in conjunction with discussion of science and power. "But while the knowledge of science is power, the knowledge which Jesus in person comes to impart to the world was the knowledge of the gospel. The *light of truth was to flash its bright rays* into the uttermost parts of the earth" (p. 360).

Counseling ministers regarding their attempts to enlighten those interested, White (1892b) alludes to the effect of light energy on the mind.

> The light of God is to be brought before their vision. How often when this has been done, and the minister has been able to answer their inquiries, has a flood of light broken into some darkened mind, and hearts have been comforted together in the faith of the gospel. This is the way we are to work in order to flash the light into the minds of those who are seeking a knowledge of the way of salvation. (paragraph 6)

Often as Ellen White speaks of the power Christ exhibited during His ministry on earth, she refers to this concept of light and energy. "He spoke with no hesitation, but with authority, as one who would *flash light upon all around him,*" she says. And "the cavilers were seeking to destroy Christ's influence over the people, but He *flashed forth such divine truth* that they dared not ask him further questions" (White, 1898d, paragraph 4).

White (1888d) speaks of truths that "*flash upon the mind*," and the "*light reflected from the cross*" revealing the Savior to men's souls. Referring to Christ as a 12-year-old child, she states, "He asked such questions as would *flash light* into the minds of those with whom he was talking" (White, 1895a, paragraph 4).

Light That Stimulates Memory

Speaking from personal experience regarding the *flashes of light* she experienced from time to time, Ellen White (1958/1980) explains,

> The question is asked, How does Sister White know in regard to the matters of which she speaks so decidedly, as if she had authority to say these things? I speak thus because they flash upon my mind when in perplexity like lightning out of a dark cloud in the fury of a storm. Some scenes presented before me years ago have not been retained in my memory, but when the instruction then given is needed, sometimes even when I am standing before the people, the remembrance comes sharp and clear, like a flash of lightning, bringing to mind distinctly that particular instruction. At such times I cannot refrain from saying the things that *flash into my mind*, not because I have had a new vision, but because that which was presented to me, perhaps years in the past, has been recalled to my mind forcibly.—Manuscript 33, 1911. (p. 43)

White (1896d) suggests that anyone connected with the mind of God through the Holy Spirit can access this same divine energy supply.

> The words of God are the wellsprings of life. As you seek unto those living springs you will, through the Holy Spirit, be brought into communion with Christ. Familiar truths will present themselves to your mind in a new aspect, texts of Scripture will burst upon you with a new meaning as a flash of light, you will see the relation of other truths to the work of redemption, and you will know that Christ is leading you, a *divine Teacher is at your side*. (p. 20)

Writing about Peter's experience in the betrayal of Christ, Ellen White (1891) again links the *flash of light* with memory and recall. "All came to him like a *flash of lightning*," she describes. "Memory was alive, and his sins were pictured before him in all their heinous light" (paragraph 8).

Light Stored Within an Individual to Be Shared With Others

Ellen White not only speaks of afferent light coming to the individual, she refers as well to efferent light passing from those inspired by God to others. "Additional *light will flash forth* from the men who are sent of God" (White, 1946b, p. 116).

> The whole earth is to be illuminated with the glory of God's truth. The light is to shine to all lands and all peoples. And it is from those who have received the light that it is to shine forth. The daystar has risen upon us, and we are to flash its light upon the pathway of those in darkness. (White, 1976, p. 261)

"Flash upon your friends in the world the bright gems of light and truth imparted to you abundantly from the throne of God" (White, 1961, p. 297), she says. "Let your shining not be as a meteor flash, to go out in darkness. Let your light be the reflected light of the Sun of Righteousness" (White, 1981/1993b, p. 298).

In numerous passages White continues to reiterate this concept that light from God passes from receptive individuals on to others. Repeatedly, she implies that this energy transmission is associated with light and that that light is from the throne of God—the source of all light and life (White, 1903, p. 13; 1946, pp. 116; 438; 1977, p. 360).

Light Becomes Accessible Through Prayer, Scriptural Study, and Nature Study

The *light* Ellen White so often talks about becomes available to humanity through a conscious choice to connect with the mind of God via prayer, Bible study, and the study of nature. When this connection is established, the work of the Holy Spirit in the heart begins. In the following reference, White (1892a) explains this process relative to prayer and Bible study:

> While you are putting up your *petition to God* [prayer], the Holy Spirit applies the faithful promises of God to your heart. In moments of perplexity, when Satan suggests doubt and discouragement, the Spirit of the Lord will lift up as a standard against him the faithful sayings of Christ [Scripture], and the bright beams of the Sun of Righteousness will flash into your mind and soul. When Satan would overwhelm you with despair, the Holy Spirit will point you to the intercession made for you by a living Saviour. Christ is the fragrance, the holy incense, which makes your petitions acceptable to the Father. When the light of Christ's righteousness is fully understood and accepted, love, joy, peace, and inexpressible gratitude will pervade the soul, and the language of him who is blessed will be, "Thy gentleness hath made me great." (paragraph 5)

"Take the Bible as a study book, Ellen White (1981/1993g) counsels, "and see if you are not filled with the love of God. Your heart may be barren, your intellect feeble, but *if you will prayerfully study the Word of God, light will flash into your mind*" (p. 263).

Light also comes to humanity through the study of nature. In the following reference White (1892c) depicts a relationship between the natural and the spiritual.

> The Lord Jesus was the maker of the things in heaven and earth, and the expositor of his own truth, and he called upon nature to reflect the light of the glory of God. . . . He connected the visible works of the Creator with the words of life, and led the mind up from nature to nature's God. Every humble shrub and delicate flower bears testimony to the heart of the love of God. If the eye is not closed, if the ear is not heavy, if the heart is open to receive the impressions of the divine Spirit, nature will speak of the harmony of the natural with the spiritual. Through illustrations drawn from the natural world, Christ has taught lessons of vast importance to the soul; and in thinking of his words while contemplating the object with which he associated his lessons, the divine significance becomes clearer to the mind, and the truth of God enlightens the understanding like a flash of light. Mysteries grow clear, and that which was hard to grasp becomes evident. (paragraph 9)

Ellen White describes brain function as the electrical flow of energy (White, 1903b, p. 209). *Light* also is commonly known as an electrical flow of energy. One definition that Webster's dictionary ascribes to *light* is "An electromagnetic radiation just beyond either end of the visible spectrum" (Braham et al., 1999, p. 766).

Ellen White refers to the source of this external energy—*light*—as God Himself. Referring to the book of John in the Bible, she recognizes Jesus Christ as the "Light of the World" and the source of all energy. God the Father is referred to as the "Father of Lights." Following are references that further support these thoughts.

Citing biblical Scripture (John 8:12), White (1898a) references Christ's claim to be the light that sustains life. "Then spake Jesus again unto them, saying, *I am the light of the world:* he that followeth Me shall not walk in darkness, but shall have the *light of life*" (p. 463).

Elaborating on the physical aspects of Christ's identification as the *light of the world*, White (1979b) comments,

> Through Him light is shining amid the moral darkness. If He were not light, the darkness would not be apparent, because light reveals darkness. The clearer the light, the more manifest the contrast between light and darkness. Let the light be removed, and there is nought but darkness. (p. 357)

White (1902b) expresses that the Christ who claims to be the light of the world—the same authority that established light at the world's beginning—is also the One who is the author of life.

> Those who do not receive Him as a personal Saviour can never, never come to the light. They can never have eternal life. But those who follow Him have the light of life. He who commanded the light to shine out of darkness shines into their hearts, revealing through their lives the light of the knowledge of Christ. In His light they see light. (paragraph 6)

Still another *light-related* term White uses multiple times is *Father of Lights*. Citing Jas 1:17, she uses this term to indicate that when divine light is present, there are no shadows. "Every good gift and every perfect gift is from above, and cometh down from the *Father of lights,* with whom is no variableness, neither shadow of turning" (White, 1958, p. 88).

Writing about how physical activity can benefit the mind and the heart, White (1903b) describes electrical connectivity that takes place when the human mind connects with the mind of God.

> Physical inaction lessens not only mental but moral power. The brain nerves that connect with the whole system are the medium through which heaven communicates with man and affects the inmost life. Whatever hinders the circulation of the electric current in the nervous system, thus weakening the vital powers and lessening mental susceptibility, makes it more difficult to rouse the moral nature. (p. 209)

The relationship established with God brings to the individual the spiritual spark that initiates reciprocal functions that empower body, mind, and spirit (White, 1977b, pp. 11-12). As is indicated in the numerous references cited previously, when this relationship is present, human potential is maximized. Ellen White (1903b) links these thoughts specifically to unbounded educational potential.

> In a knowledge of God all true knowledge and real development have their source. Wherever we turn, in the physical, the mental, or the spiritual realm; in whatever we behold, apart from the blight of sin, this knowledge is revealed. Whatever line of investigation we pursue, with a sincere purpose to arrive at truth, we are brought in touch with the unseen, mighty Intelligence that is working in and through all. The mind of man is brought into communion with the mind of God, the finite with the Infinite. The effect of such communion on body and mind and soul is beyond estimate. (p. 14)

Citing many reasons for proffering the importance of accessing the *light* of God, Ellen White maintains that this empowerment is vital to optimizing learning potential.

In summary of this section on the heart, mind, and brain connections, though Ellen White often uses the terms *heart* and *mind* synonymously, there are many references which indicate that she must have conceptualized them as having distinctive differences. She seems to align the *heart* with feeling, emotion, and the site where the Holy Spirit resides in the individual who is open to it. On the other hand, White seems to relate the *mind* to reason, intellect, and the receptor site for the incoming electrical energy (light) received when the mind of humanity connects with the mind of God.

No data surfaced to suggest that the figurative use of *heart* and *mind* was not indicative of the site locations of the heart organ and the brain organ respectively. In other words, White implies that the figurative heart and the literal heart are closely tied and that the mind and the brain also are bound together in a similar relationship. In addition, she strongly suggests that what happens in the mind/brain significantly influences what happens in the heart/heart and vice versa.

White refers to the *science of salvation* and *the science of religion.* She often connects physical science terms such as *light, electrical current, atmosphere*, and *supernatural influences* with her explanations of how the human organism operates and how the individual learns and comes to know God. These factors majorly involve the heart/heart and the mind/brain in these functions. White maintains that in a reciprocal fashion the body, heart, mind, and brain communicate, influence, and relate to each other.

Redemption and Restoration of the Image of God in Humanity

In Eden Adam and Eve, the first human beings God created, chose to violate the laws of life He had established to sustain humanity, White (1903b) explains. Knowing that the eventual results of this choice would be death, God determined to provide a means to save humanity from this ultimate end.

Ellen White (1903b) describes the radical results of evil in the divine plan for man's perfect development, and she explains the rationale behind an alternate plan, developed by God, to rescue humankind from the devastating consequences of the decision made in Eden.

> By infinite love and mercy the plan of salvation had been devised, and a life of probation was granted. To restore in man the image of his Maker, to bring him back to the perfection in which he was created, to promote the development of body, mind, and soul, that the divine purpose in his creation might be realized—this was to be the work of redemption. This is the object of education, the great object of life. (pp. 15-16)

"Love," White stresses, is the "basis of creation and of redemption." It also is the "basis of education" (p. 16). Love to God, she says, referring to the Ten Commandments, is our first responsibility; and love to our fellow man is the next, she indicates. On these two concepts, all 10 of the laws of life hang. The first 4 refer to our relationship with God. The last 6 are prescriptive for maintaining positive relationships with humankind (White, 1903b, p. 16).

Adam and Eve failed their test of "love and loyalty" when they chose to distrust the *knowledge of God* and to violate His counsel, White (1903b, pp. 16, 23) explains. Selfishness became a part of their lives (p. 16). "Distrust of God's goodness, disbelief of His word, and rejection of His authority . . . made our first parents transgressors" (p. 25). It was these things that "brought into the world a knowledge of evil" (p. 25). Their sins hid God's face from them, but God devised a plan to restore that benefit to humankind, White posits.

> Sin not only shuts us away from God, but destroys in the human soul both the desire and the capacity for knowing Him. . . .The faculties of the soul, paralyzed by sin, the darkened mind, the perverted will, He has power to invigorate and to restore. . . . Christ is the 'Light, which lighteth every man that cometh into the world.' John 1:9. As through Christ every human being has life, so also through Him every soul receives some ray of divine light (p. 29)

White (1903b) often refers to the need to look into the face of Jesus. "We may not in person approach into His [God's] presence; in our sin we may not look upon His face; but we can behold Him and commune with Him in Jesus, the Savior" (p. 28), she states.

Is it vital for humanity to see the face of God? White seems to link this ability to the *knowledge of God*. She comments, quoting Scripture, "'The light of the knowledge of the glory of God' is revealed 'in the face of Jesus Christ.' God is 'in Christ, reconciling the world unto Himself.' 2 Corinthians 4:6; 5:19" (p. 28).

Though humanity was condemned to death after sinning and violating the laws of life, the Father had prepared a plan to restore eternal life to fallen humankind, White (1903b, p. 28) maintains. As a result of their own choice, humanity could no longer look into the face of its Creator for life and light. However, God disguised Himself in the form of a man in order to restore this privilege and access to power and knowledge. Christ, who was One with the Father and the Holy Spirit, chose to become one with humanity in a plan of rescue and redemption (pp. 28-30).

"In the highest sense the work of education and the work of redemption are one, for in education, as in redemption, 'other foundation can no man lay than that is laid, which is Jesus Christ,'" White (1903b, p. 30) proffers. "Adam and Eve received instruction through direct communion with God; we behold the light of the knowledge of His glory in the face of Christ" (p. 30).

Education focuses on the dissemination of knowledge, but White (1903b, pp. 13-19, 21, 34, 81) maintains that knowledge purged of the knowledge of God falls far short of truth. White (1903b) suggests a divine opportunity is available to every educator who chooses it:

> To aid the student in comprehending these principles [of education], and in entering into that relation with Christ which will make them a controlling power in the life, should be the teacher's first effort and his constant aim. The teacher who accepts this aim is in truth a co-worker with Christ, a laborer together with God. (p. 30)

The true object of education is to restore the image of God in man, White (1890b, p. 595; 1893a, p. 63; 1977b, p. 359) proffers. She explains God's plan to accomplish this objective:

> In the beginning, God created man in his own likeness. He endowed him with noble qualities. His mind was well-balanced, and all the powers of his being were harmonious. But the fall and its effects have perverted these gifts. Sin has marred and well-nigh obliterated the image of God in man. It was to restore this that the plan of salvation was devised, and a life of probation was granted to man. To bring him back to the perfection in which he was first created, is the great object of life,—the object that underlies every other. It is the work of parents and teachers, in the education of the youth, to co-operate with the divine purpose; and in so doing they are "laborers together with God."[1 COR. 3:9.] (White, 1893a, pp. 63-64)

"As the perfection of His character is dwelt upon, the mind is renewed, and the soul is re-created in the image of God," White (1903b, p. 18) counsels. "Higher than the highest human thought can reach is God's ideal for His children. Godliness—godlikeness is the goal to be reached" (p. 18).

"True education," White posits, "is the harmonious development of the physical, the mental, and the spiritual powers" (p. 13). However, this development does not reach its potential until the mind of humanity intimately connects with the mind and knowledge of God—the source of all life, energy, and power; the origin of love (White, 1903b, pp. 28-30).

As a loving Father, God created humankind in perfect form—in His own image. Out of a heart of love, He devised a perfect plan for nurturing His offspring—a model school. Ellen White (1903b) describes God's "glorious purpose in the education of the human race":

> When Adam came from the Creator's hand, he bore, in physical, mental, and spiritual nature, a likeness to his Maker. "God created man in His own image" (Genesis 1:27), and it was His purpose that the longer man lived the more fully he should reveal this image—the more fully reflect the glory of the Creator. All his

> faculties were capable of development; their capacity and vigor were continually to increase. Vast was the scope offered for their exercise, glorious the field opened to their research. The mysteries of the visible universe—the "wondrous works of Him which is perfect in knowledge" (Job 37:16)—invited man's study. Face-to-face, heart-to-heart communion with his Maker was his high privilege. (p. 15)

In a perfect environment, amid the "beautiful scenes of nature . . . our first parents were to receive their education," White (1903b) writes.

> The system of education instituted at the beginning of the world was to be a model for man throughout all aftertime. As an illustration of its principles a model school was established in Eden, the home of our first parents. The Garden of Eden was the schoolroom, nature was the lesson book, the Creator Himself was the instructor, and the parents of the human family were the students. (p. 20)

Describing in further detail the relationship between the instructor—God—and His first earthly students, White says,

> In His interest for His children, our heavenly Father personally directed their education. Often they were visited by His messengers, the holy angels, and from them received counsel and instruction. Often as they walked in the garden in the cool of the day they heard the voice of God, and face to face held communion with the Eternal. His thoughts toward them were "thoughts of peace, and not of evil." Jeremiah 29:11. His every purpose was their highest good. . . . Useful occupation was appointed them as a blessing, to strengthen the body, to expand the mind, and to develop the character. . . . The book of nature, which spread its living lessons before them, afforded an exhaustless source of instruction and delight. On every leaf of the forest and stone of the mountains, in every shining star, in earth and sea and sky, God's name was written. . . . The mysteries of light and sound, of day and night—all were objects of study by the pupils of earth's first school. (p. 21)

Focusing more on the curricular emphasis of the Eden school, White comments,

> The laws and operations of nature, and the great principles of truth that govern the spiritual universe, were opened to their minds by the infinite Author of all. In "the light of the knowledge of the glory of God" (2 Corinthians 4:6), their mental and spiritual powers developed, and they realized the highest pleasures of their holy existence. (p. 22)

In the idyllic setting of Eden, White (1903b, pp. 13-30) explains, humanity reflected the image of its Maker. But when Adam and Eve sinned, they mingled evil with good, and their minds became confused, their "mental and spiritual powers benumbed," and their physical bodies were deprived of the life-giving nurture of the tree of life (White, 1903b, pp. 20-21, 25). Though God could have prevented this fall from perfection, He chose to honor the freedom of choice He had established for humanity (White, 1903b, p. 23).

Power of Choice and Human Will

White believed that teachers and parents cannot truly understand and potentiate the educational process without first considering "the nature of man and the purpose of God in creating him" (White, 1903b, p. 14). Though God created man perfect in thought, body, and spirit, He also created man with the power to choose—"the power to yield or to withhold obedience" (p. 23). "God might have created them without the power to transgress His requirements, but in that case there could have been no development of character; their service would not have been voluntary, but forced" (p. 23).

"It was the will of God that Adam and Eve should not know evil." Yet, in love He chose to honor them as free-will agents, endowed with the right to choose. "Before they could receive in fullness the blessings He desired to impart, their love and loyalty must be tested" (p. 23). White describes the test they were required to take:

> In the Garden of Eden was the "tree of knowledge of good and evil. . . . And the Lord God commanded the man, saying, Of every tree of the garden thou mayest freely eat: but of the tree of the knowledge of good and evil, thou shalt not eat." Genesis 2:9-17. It was the will of God that Adam and Eve should not know evil. The knowledge of evil,—of sin and its results, of wearing toil, of anxious care, of disappointment and grief, of pain and death,—this was in love withheld. (p. 23)

Though God had arranged everything in Eden to benefit Adam and Eve, White explains, they failed the one test of their loyalty. "While God was seeking man's good, Satan was seeking his ruin" (pp. 23-24). Eve disregarded her Heavenly Father's counsel to stay away from the tree of the knowledge of good and evil. God had said, "Ye shall not eat of it, neither shall ye touch it, lest ye die" (Gen 3:3). But Satan tempted, "Ye shall not surely die: for God doth know that in the day ye eat thereof, then your eyes shall be opened, and ye shall be as gods, knowing good and evil" (Gen 3:4-5).

Cleverly, deceptively, Satan mixed truth with untruth in an attempt to convince Eve that "God was withholding great good." He sought to "prevent them from reaching a nobler development and finding greater happiness" (p. 24). White (1903b) describes the critical flaw in Eve's choice:

> While Satan claimed to have received great good by eating of the forbidden tree, he did not let it appear that by transgression he had become an outcast from heaven. Here was falsehood, so concealed under a covering of apparent truth that Eve, infatuated, flattered, beguiled, did not discern the deception. She coveted what God had forbidden; she distrusted His wisdom. She cast away faith, the key of knowledge. (p. 24)

The knowledge of evil, introduced in Eden, poses interference with the original divine model for education. When sin entered the world, humanity's central focus of attention shifted from the creator to the created. This shift initiated a humanistic philosophy that contradicts physical and spiritual laws the Creator established to ensure the well-being and happiness of His children. Fear, threat, and stress emerged out of this contradiction to God's natural laws of life. Distrust and dishonesty distanced Adam and Eve from the source of Goodness (White, 1903b, pp. 13-19).

At the center of this newly realized drama in Eden was an age-old controversy which began before man was created—the war between good and evil, between God and Satan. This war threatens the vital connection between Earth's inhabitants and the source of life and love and truth (White, (1903b, pp. 13-19, 23-27). Evil distorts the laws that sustain humankind. Satan attempts to usurp the power of God and to develop his own evil image in man, White explains.

Choices made in Eden disrupted the perfect plan for human potential. God had destined humankind to an unending life filled with opportunities to "gain new treasurers of knowledge, to discover fresh springs of happiness, and to obtain clearer and yet clearer conceptions of the wisdom, the power, and the love of God." This plan was thwarted in Eden. Man was created by a loving Father with a desire that His creation would "more and more fully [reflect] the Creator's glory" (White, 1903b, p. 15). Instead, through violation of the laws that perpetuated life, this plan was muddled. White explains:

> Through sin the divine likeness was marred, and well-nigh obliterated. Man's physical powers were weakened, his mental capacity was lessened, his spiritual vision dimmed. He had become subject to death. Yet the race was not left without hope. (p. 15)

Character Development

According to White (1903b), a major objective in education is character development. This objective is also a main purpose that Holy Scripture serves.

Providing definition for elements of educational success, White (1903b) states, "Since God is the source of all true knowledge, it is . . . the first object of education to direct our minds to His own revelation of Himself" (p. 16). That revelation is available to us through Holy Scriptures—"the perfect standard of truth." As such, they "should be given the highest place in education" (p. 17).

"Its [Holy Scripture's] teachings will give a strength of character and mental development that no other book can impart" (paragraph 8), White (1907) says, and explains further,

> Let the student make the Word of God the chief book of study, giving all other branches of learning a secondary place. And as the heart is opened to the entrance of the Word, light from the throne of God will shine into the soul. The Word, cherished in the heart, will yield to the student a treasure of knowledge that is priceless. Its

> ennobling principles will stamp the character with honesty and truthfulness, temperance and integrity. (paragraph 8)

"Natural powers are enlarged because of holy obedience" to God's Word, White (1905) proffers.

> From the study of the word of life, students may come forth with minds expanded, elevated, ennobled. . . . Being pure-minded, they will become strong-minded. Every intellectual faculty will be quickened. They may so educate and discipline themselves that all within the sphere of their influence shall see what man can be, and what he can do, when connected with the God of wisdom and power. (p. 466)

"The work of true education," says White (1903b), is to "develop [the power to think and to do], to train the youth to be thinkers, and not mere reflectors of other men's thoughts" (p. 17). More than just "mental discipline" or "physical training" is the goal of education. Much importance rests on strengthening "of character, so that truth and uprightness are not sacrificed to selfish desire or worldly ambition" (p. 18). Ultimately, education should aim to connect students with the mind of God, their Maker, through His Word. "As the perfection of His character is dwelt upon, the mind is renewed, and the soul is re-created in the image of God" (p. 18).

Ranking moral considerations as primary in educational values, White (1903b) emphasizes building character as a critical spiritual component. She posits,

> True education does not ignore the value of scientific knowledge or literary acquirements; but above information it values power; above power, goodness; above intellectual acquirements, character. The world does not so much need men of great intellect as of noble character. It needs men in whom ability is controlled by steadfast principle. . . . Character building is the most important work ever entrusted to human beings. (p. 225)

"Higher than the highest human thought can reach is God's ideal for His children. Godliness—godlikeness—is the goal to be reached" (p. 18), White (1903b) counsels.

> [The educator] who co-operates with the divine purpose in imparting to the youth a knowledge of God, and molding the character into harmony with His, does a high and noble work. As he awakens a desire to reach God's ideal, he presents an

> education that is as high as heaven and as broad as the universe; an education that cannot be completed in this life, but that will be continued in the life to come; and education that secures to the successful student his passport from the preparatory school of earth to the higher grade, the school above. (p. 18)

White's philosophy of education is established on the premise that education involves both process and product (White, 1903b, pp. 13-19):

1. The process: The harmonious development of the physical, mental, and spiritual powers (This three-part formula for learning reaches its optimum potential when the individual chooses to establish a vibrant connection with God—the Creator—through prayer, study of biblical Scriptures, and the study of nature.)

2. The product: The image of God restored in humanity. (Love for God and love for humankind is evidenced in service to God and others.)

Service to Humankind

Seminal to White's philosophy of education is the role of service to humankind. The balance she promotes between mental and physical development, the emphasis she places on including significant periods of time for practicum involvement (not just theoretical study), the importance given to maintaining a vibrant relationship with God—all are predicated on the ultimate goal of fully developing self-potential for the purpose of greater service to humankind.

"Unselfishness underlies all true development. Through unselfish service we receive the highest culture of every faculty. More and more fully do we become partakers of the divine nature," White (1903b) counsels. By developing a spirit of loving service to others, "We are fitted for heaven, for we receive heaven into our hearts" (p. 16).

The aim of true education is service, Ellen White (1903b) posits.

> True education means more than the pursual of a certain course of study. It means more than a preparation for the life that now is. It has to do with the whole being, and with the whole period of existence possible to man. It is the harmonious development of the physical, the mental, and the spiritual powers. It prepares the student for the joy of service in this world and for the higher joy of wider service in the world to come. (p. 13)

Ellen White (1900c) strongly advocated the development of self-potential, and she did so on the premise that optimum self-development increases our usefulness for self-less service to others. This concept is foundational in her model for education.

> The development of all our powers is the first duty we owe to God and to our fellow men. No one who is not growing daily in capability and usefulness is fulfilling the purpose of life. In making a profession of faith in Christ we pledge ourselves to become all that it is possible for us to be as workers for the Master, and we should cultivate every faculty to the highest degree of perfection, that we may do the greatest amount of good of which we are capable. (pp. 329-330)

Selfish ambition is contrary to God's plan for humanity, White (1903b) indicates. The Word of God is "robbed of its power by the interpretations and traditions of . . . self-aggrandizement, love of domination, jealous exclusiveness, bigotry and contemptuous pride" (pp. 64-65). The attitude of Christian service, on the other hand, is empty of such "prejudices and traditions." It is "inspired by the one principle of self-sacrifice, the ministry of love" (p. 65). "The right use of one's self includes the whole circle of human obligations to one's self, to the world, and to God" (White, 1981/1993d, p. 220).

Service is humanity's responsibility to itself, White (1903b) proffers. It is not merely a *thoughtful* act in a worthy cause. It is a critical component in the dynamic process of educating, learning, and sustaining life.

> All things both in heaven and in earth declare that the great law of life is a law of service. The infinite Father ministers to the life of every living thing. Christ came to the earth [as a servant]. . . . The angels are "ministering spirits." . . . The same law of service is written upon all things in nature. The birds of the air, the beasts of the field, the trees of the forest, the leaves, the grass, and the flowers, the sun in the heavens and the stars of light—all have their ministry. Lake and ocean, river and water spring—each takes to give.

> As each thing in nature ministers thus to the world's life, it also secures its own. "Give, and it shall be given unto you" (Luke 6:38), is the lesson written no less surely in nature than in the pages of Holy Writ. (p. 103)

White (1903b) attaches the importance of emotion to the act of service. A positive affective response to the felt needs of others is inspired by a Higher Power, and it should be viewed as an opportunity, not an obligation.

> Love and loyalty to Christ are the spring of all true service. In the heart touched by His love, there is begotten a desire to work for Him. Let this desire be encouraged and rightly guided. Whether in the home, the neighborhood, or the school, the presence of the poor, the afflicted, the ignorant, or the unfortunate should be regarded, not as a misfortune, but as affording precious opportunity for service. (p. 268)

Even in informal learning situations White applies this principle—the law of service. "No recreation helpful only to themselves will prove so great a blessing to the children and youth as that which makes them helpful to others" (1903b, p. 212).

In summary, Ellen White's philosophy of education is laced with her strong creationist theology that embraces God (Father, Son, and Holy Spirit) as the author and sustainer of life on earth. Humanity is at extreme risk in the ongoing struggle between good and evil that is being played out on Earth. It is God's plan to restore His image in humankind, to empower humanity to resist the destructive influences of evil, and to equip His created ones for loving service to others. However, God will not violate humanity's will and freedom to choose. For those who choose to align with God's plan of restoration and redemption through Jesus Christ, He provides a supernatural assist through His Holy Spirit.

The next main section focuses on the "harmonious development" of three specific powers common to humanity. Ellen White proposes that these three factors are critical parts of the educational process. Included in this section's discussions are related topics, such as: mind and body, the senses, physical activity, amusement, recreation, work and practical experience, and health habits.

Harmonious Development

Defining education, Ellen White (1903b) writes, "True education . . . has to do with the whole being, and with the whole period of existence possible to man. It is the harmonious development of the physical, the mental, and the spiritual powers" (p. 13). Allusion to, as well as specific reference to, this three-phased relationship (physical, mental and spiritual) in the learning process recurs many times throughout her counsels. In fact, it seems to be the substantive framework for all of her counsels on education.

White (1903b) suggests that these three powers apply to life in universal ways—more than just educationally. She proffers that a balance exists within this triad that cannot be ignored. "To transgress His law, physical, mental, or moral, is to place one's self out of harmony with the universe, to introduce discord, anarchy, ruin" (p. 100).

In the numerous references where White mentions the harmonious relationship between *mental, physical, and spiritual powers,* she often uses other terms that seem to imply the same three concepts. Examples of this are: *mind, body, and soul; head, hand, and heart; mental, physical, and moral; law, power, and love; etc.*

Mind, Body, and Spirit Are One

Mind and body commonly were viewed as separate entities during the time Ellen White wrote. This is evidenced in comments she directed toward mothers as caregivers (White, 1913).

> To become acquainted with the wonderful human organism, the bones, muscles, stomach, liver, bowels, heart, and pores of the skin, and to understand the dependence of one organ upon another for the healthful action of all, is a study in

> which most mothers take no interest. They know nothing of the influence of the body upon the mind, or of the mind upon the body. The mind, which allies the finite to the Infinite, they do not seem to understand. Every organ of the body was made to be servant to the mind. The mind is the capital of the body. (p. 78)

Numerous times throughout her writings White refers to mind and body connections. Though the quotation above may lead the reader to believe that she might have considered the mind as the greater entity in the three-part harmony she emphasizes, a broad review of her works seems to suggest otherwise. There are numerous comments regarding the importance of the physical and of the moral elements. Though she refers to the mind as the "capital of the body," in another reference she indicates that especially during the early years of schooling, physical activity should take preeminence over academic function (White, 1870, p. 133). In 1903, she provided the following counsel to educators as she discussed physical culture and the study of physiology (White, 1903b):

> The influence of the mind on the body, as well as of the body on the mind, should be emphasized. The electric power of the brain, promoted by mental activity, vitalizes the whole system, and is thus an invaluable aid in resisting disease. This should be made plain. The power of the will and the importance of self-control, both in the preservation and in the recovery of health, the depressing and even ruinous effect of anger, discontent, selfishness, or impurity, and, on the other hand, the marvelous life-giving power to be found in cheerfulness, unselfishness, gratitude, should also be shown. (p. 197)

White (1903b) explains that too little emphasis on physical movement is counterproductive in promoting mental and moral health.

> Physical inaction lessens not only mental but moral power. The brain nerves that connect with the whole system are the medium through which heaven communicates with man and affects the inmost life. Whatever hinders the circulation of the electric current in the nervous system, thus weakening the vital powers and lessening mental susceptibility, makes it more difficult to rouse the moral nature. (p. 209)

Further, White (1903b) stresses that too much mental activity is detrimental to moral function.

> Again, excessive study, by increasing the flow of blood to the brain, creates morbid excitability that tends to lessen the power of self-control, and too often gives sway to impulse or caprice. Thus the door is opened to impurity. The misuse or nonuse of the physical powers is largely responsible for the tide of corruption that is overspreading the world. "Pride, fullness of bread, and abundance of idleness," are as deadly foes to human progress in this generation as when they led to the destruction of Sodom. (p. 209)

Clearly, Ellen White believed that the mind, body, and spirit are intimately related in function. One significantly influences the other. In addition, White promoted the idea that balance must be maintained between mind, body, and morality in order for the whole system to operate effectively.

Physical inputs, received by the brain as sensory messages, travel through the network of brain nerve connections. White addresses this means of neural stimulation as she discusses the connections between the body and the mind.

Spriritual Emphasis

Ellen White (1903b) invites parents and teachers to consider the powerful effect of the spiritual element on human existence. Understanding this, she suggests, is critical to helping children relate to life and their potential development. She writes:

> The youth need to understand the deep truth underlying the Bible statement that with God "is the fountain of life." Psalm 36:9. Not only is He the originator of all, but He is the life of everything that lives. It is His life that we receive in the sunshine, in the pure, sweet air, in the food that builds up our bodies and sustains our strength. It is by His life that we exist, hour by hour, moment by moment. Except as perverted by sin, all His gifts tend to life, to health and joy. (p. 197)

White recognizes that the harmonious development of mind, body, and soul is a critical part of the education process, but she also insists that that balanced function has to be empowered by energy outside of humanity itself. Though she includes the term *spirit* in the harmonious triad of "physical, mental, and spiritual," she seems to indicate that there are two forms of spirit—man's spirit and the Holy Spirit.

Referring to the divine Spirit, White (1911) explains,

> When the mind of man is brought into communion with the mind of God, the finite with the Infinite, the effect on body and mind and soul is beyond estimate. In such communion is found the highest education. It is God's own method of development. "Acquaint now thyself with Him" (Job 22:21), is His message to mankind. (p. 126)

Further emphasizing this point, White (1903b) cites biblical Scripture as she aligns this concept with Christ's mission on earth. Here she depicts Christ's personification of spiritual empowerment for physical, mental and spiritual powers. She comments,

> The people "were astonished at His teaching (R.V.), for His word was with power." Luke 4:32. Never before spoke one who had such power to awaken thought, to kindle aspiration, to arouse every capability of body, mind, and soul. (p. 81)

Speaking of individuals who feel no need of God's power to learn, she says, "In their view, man needs only to develop that which is within him. Such education leads the student to self-sufficiency, thus cutting him off from the source of true knowledge and power" (White, 1903b, p. 230).

White (1885a) also teaches that another scenario is capable of prohibiting the power of God from releasing human potential. Speaking to ministers, she refers to individuals who zealously advocate *the truth*, "while the every-day life and character do not testify to its sanctifying power." This will avail nothing, she says. "Such a course hardens the heart and narrows the mind to a form of godliness without the power" (paragraph 14) Instead of being transformed into God's image by His love, these individuals, though they profess to know the truth, "become egotistical, critical, harsh, and repulsive. Others become plastic and yielding, and bend this way and that to please everyone" (paragraph 14).

The vital connection humanity can establish between itself and God in order to realize human potential must be a connection based on an intimate relationship with the God of Love. The connection does not take place without the Spirit of love (White, 1952b, p. 26). White (1903b) comments:

> Love, the basis of creation and of redemption, is the basis of true education. This is made plain in the law that God has given as the guide of life. . . . To love Him, the infinite, the omniscient one, with the whole strength and mind and heart, means the highest development of every power. It means that in the whole being—the body, the mind, as well as the soul—the image of God is to be restored. (p. 16)

God created humanity with the equipment necessary to function, White (White, 1981/1993e) teaches; however, those created cannot function independent of its Creator. She states,

> The Lord made the brain, that the mind may be able to think to a purpose. There is action and reaction in thinking. God designs that man shall use the brain with a vital earnestness. The whole human machinery is to be under the control of the One who made man. Mind, heart, soul, strength, are required in the service of God.—Letter 100, 1898. (p. 364, paragraph 1)

Ellen White strongly advocates *harmonious development* of all human powers, but a dynamic love relationship with God, the source of all knowledge and power, is essential for optimum function (White, 1903b, pp. 13-19).

Ellen White makes repeated remarks that tie spiritual development with physical aspects, as well—particularly physical science.

The following subsection emphasizes the intimate relationship White ascribes to the physical, emotional, and mental capacities. She defines heart function as an integral part of this dynamic relationship that is vital to life itself.

Heart, Mind, and Spirit

The synonymous relationship White refers to when she speaks of *mind and heart* is similar to her use of *mind and body*. While she seems to connect heart with body, White (1888a) also seems to conceptualize *heart* as more than just a physical-body influence on cognition. She even more strongly ties the heart to spiritual issues. Writing about the importance of spiritual health, she says, "Here is represented the need of spiritual exercise, the training of mind and heart. This is even more essential than physical training. It is by the training of heart and mind that spiritual strength is gained, that weak points of character are made strong" (p. 583).

Though White is not explicit about aligning the heart *exclusively* with either physical or emotional functions, both of these attributes are discussed as properties of heart function. She speaks of the heart's function as an organ to pump blood throughout the body, and she is specific about the heart being the seat of spiritual function (White, 1977a, p. 802).

In the following statement, the *heart* may be equated with the *physical* component in the triad relationship between mental, physical, and spiritual powers: "The reward of whole-souled liberality is the leading of mind and heart to a closer fellowship with the Spirit" (White, 1855/1909c, p. 390). Though she may use the term *heart* synonymously with *body*, White also uses the term to represent the spirit, as will be seen in numerous instances in subsequent subsections that follow.

Overall, White seems to imply a reciprocal relationship both between the heart and the mind (spiritually and physically) and between the heart and the body (physically and spiritually). The heart plays a major role in both these dynamic relationships. The following subsections bear this out.

Moral organs

Ellen White spoke of *moral organs* on several occasions as she discussed the balance between mind and body. The following quotation is one sample of this usage (White, 1977b).

> Through disease transmitted to them from their parents and an erroneous education in youth, they have contracted wrong habits which injure the constitution and the brain, causing the *moral organs* to become diseased and making it impossible for them to think and act rationally upon all points. They have not well-balanced minds. Godliness and righteousness are not destructive to health, but are health to the body and strength to the soul.—1T 501, 502 (1867). [emphasis supplied.] (p. 292)

Though it is not at all clear whether or not she included the heart as a *moral organ*, that possibility may exist. At least one neuroanatomy-related, medical school textbook of her day strongly discusses neural, brain-like function at locations in the body other than in the cranial cavity.

A cursory review of medical school textbooks from the 1800s reveals that the limbic center of the brain and its emotion-relevant organs were little understood. The thalamus is mentioned, but not with great definition.

Poor health confounds mind and heart function

Poor health is counterproductive to mind health and heart health, White (1897) suggests. "A diseased body causes a disordered brain, and hinders the work of sanctifying grace upon the mind and heart" (p. 42), she says. In other statements she makes additional reference to the *afferent*—"affected by"—influences of body on heart and mind function: "Those things which fret and derange the stomach will have a benumbing influence upon the finer feelings of the heart" (p. 40); and "Overeating prevents the free flow of thought and words, and that intensity of feeling which is so necessary in order to impress the truth upon the heart of the hearer" (p. 41).

In counsels to physicians, White (1923a) describes the healthful benefits (efferent influence) of a "merry" heart on the body. She writes, "Courage, hope, faith, sympathy, love, promote health and prolong life. A contented mind, a cheerful spirit, is health to the body and strength to the soul. 'A merry [rejoicing] heart doeth good like a medicine.' Proverbs 17:22" (p. 344).

Occasionally, White seems to align the heart with feelings and emotion, as in the reference above from p. 40 of the book *Healthful Living*—"the finer feelings of the heart." The mind, on the other hand, is sometimes described as capable of functioning with less influence from emotion—as when White (1900b) wrote to church members in Australia: "When the mind is occupied with matters of business, there must necessarily be a dearth of spiritual power. Personal piety, true faith, and heart holiness must be kept before the mind until the people realize their importance" (p. 16).

On another occasion, White (1923a) made specific reference to the heart as a center of feeling and emotion. She wrote, "It is heart work that the Lord requires, good works springing from a heart filled with love" (p. 377). Even earlier, in 1891, she wrote (White, 1977a),

> Real religion has its seat in the heart; and as it is an abiding principle there, it works outwardly, molding the external conduct, until the entire being is conformed to the image of Christ; even the thoughts are brought into subjection to the mind of Christ. If the abiding principle is not in the heart, the mind will be molded after the deceiving similitude of Satan's mind, working his will to the ruin of the soul. The atmosphere which surrounds such souls is deleterious to all around them, whether believers or unbelievers. (p. 802)

White's inference here to the heart's ability to mold the mind is suggested in other statements also. One example occurs in a church periodical. She (1898b) states:

> The religion of Christ can bless only where it works and influences, as the leaven the meal. When the leaven of truth is hidden in the heart, it becomes a vital working power, to bring into conformity to itself all the capabilities of the being. The mind, the affections, the motives, all the powers become converted through the truth. All are worked by the same spirit. God is not the author of confusion, but of peace. (paragraph 1)

An additional indication that White (1985b) believed that the heart influences mind function appears in an article, "How to Be Preserved From Deceptive Influences."

> It is not by force that Satan takes possession of the human mind. While men sleep, the enemy sows tares in the church. While men are spiritually sleeping, the enemy accomplishes his work of iniquity. It is when his subject "understandeth it not" that he catcheth away the good seed sown in the heart. When men and women are in this condition, when their spiritual life is not being constantly fed by the Spirit of God, Satan can imbue them with his spirit, and lead them to work his works. (p. 17)

At another time White (1886a) counseled Sabbath-school teachers to be aware of the Holy Spirit's influence in the heart.

> All spiritual culture Christ has provided for his children. If Jesus is abiding in the soul, the heart is filled with the holy graces of his spirit, which makes itself manifest in the transforming of the features. If you would have beauty and loveliness of character, the divine law must be written upon the heart and carried out in the life. (paragraph 4)

The impressions made upon the heart by the Holy Spirit also mold the mind, White (1908) says as she describes the role of a true teacher:

> Every teacher needs to receive the truth in the love of its sacred principles; then he can not fail of exerting an influence that is purifying and uplifting. The teacher whose soul the truth cleanses, refines, and ennobles, whose heart is stayed upon Christ, will speak and act like a Christian. Such an one will not be satisfied until the truth cleanses his life from every unessential thing. He will not be satisfied unless his mind is day by day being molded by the holy influences of the Spirit of God. Then Christ can speak to the heart, and his voice, saying, "This is the way, walk ye in it," will be heard and obeyed. (paragraph 4)

Further, White (1955) adds additional confirmation to the concept that the heart molds the brain:

> Every heart that has been visited by the bright beams of the Sun of Righteousness will reveal the working of the Spirit of God in voice, mind, and character. . . . The holy influences will be imparted to others in words of kindness, tenderness, love, and encouragement.

Plainly, White promotes the idea that there is a significant, influential relationship between the heart and the brain, and the heart and the mind.

The heart creates an atmosphere around the body.

What goes on in an individual's heart may be communicated to others, according to White. The influence of one person's heart condition on another individual is not a foreign thought in her writings, as mentioned previously.

On numerous occasions White wrote in support of this concept. In the following reference, White (1985c) indicates that the atmosphere surrounding an individual can be either positively or negatively charged and capable of influencing others:

> Every soul is surrounded by an atmosphere of its own—an atmosphere, it may be, charged with the life-giving power of faith, courage, and hope, and sweet with the fragrance of love. Or it may be heavy and chill with the gloom of discontent and selfishness, or poisonous with the deadly taint of cherished sin. By the atmosphere surrounding us, every person with whom we come in contact is consciously or unconsciously affected. (p. 262)

Through willful choice, individuals determine the nature of influence that surrounds their being. White (1979a) is explicit as to how the atmosphere becomes charged for good or evil.

> There are the impressions that are going forth all the time. There is an atmosphere that surrounds the human soul and that atmosphere is a heavenly atmosphere or a hellish atmosphere. There are but two distinct lines. Either we are on Christ's side of the question or on the enemy's side. And if we are continually drawing rays of divine light from glory, angels of God are around about us and there is an atmosphere that

> surrounds the human soul. Our very attitude, our very words, witness genuine conversion to all who come within the sphere of our influence. (p. 65)

Ellen White (1973) emphasizes the thought that God's Spirit provides a positive atmosphere that is capable of engendering life-giving influence for others. "It is the atmosphere of grace which surrounds the soul of the believer, the Holy Spirit working upon mind and heart, that makes him a savor of life unto life, and enables God to bless his work" (p. 238), she says. "If you seek the help and grace of God, the Holy Spirit will take possession of mind and character and work in you that [which will benefit you and others]. . . . The atmosphere that surrounds your soul will be of a pure, healthful character" (White, 1964, p. 236).

As a natural effect of sincerely studying God's Word, a heavenly atmosphere forms around the student of Scripture, White (1973) indicates.

> Those who study the Word of God and day by day receive instruction from Christ bear the stamp of heaven's principles. A high, holy influence goes forth from them. A helpful atmosphere surrounds their souls. The pure, holy, elevated principles that they follow enable them to bear a living testimony to the power of divine grace. (p. 274)

Through purposeful effort, humanity can establish a supportive surrounding atmosphere that not only works to secure eternal destiny, it is capable of benefiting others as well, according to Ellen White (1977a).

> It is of the greatest importance to us that we surround the soul with the atmosphere of faith. Every day we are deciding our own eternal destiny in harmony with the atmosphere that surrounds the soul. We are individually accountable for the influence that we exert, and consequences that we do not see will result from our words and actions. (p. 433)

"Whatever we are at heart will be revealed in character and will have an influence on those with whom we associate. Our words, our actions, are a savor of life or of death unto death" (1977a, p. 801), White posits. "As is the health of the heart, so is the religious experience and the fruit seen in the life" (1981/1993f, p. 124), she stresses. Again, referencing the heart as the seat of spirituality and potential empowerment, she cautions (White, 1981/1993f),

> Standing as you do, my brother and sister, God's plan with you is to begin at the very seat of all difficulties, the heart, and then from out of the heart will issue the principles of righteousness; the reformation will be outward as well as inward. (p. 112)

The Senses

Ellen White (1897) metaphorically describes the senses as the "avenues to the soul" (p. 54). Because in other references she often replaces the term *physical, mental, and spiritual* with *body, mind, and soul*, it seems reasonable to assume that her use of the term *avenues to the soul* implies that the senses have a direct input into the moral center of the brain.

White alludes to this relationship of sensory input with the brain's moral center when she speaks of the need not only to "benefit the growth of the mental capacity of man, but, also, to instruct how *the moral senses* may be quickened" (White, 1923b, p. 339, emphasis supplied).

Often White speaks of both moral and immoral inputs that channel into the brain via the senses. In a list of practices to be avoided, White (1894a) refers to undesirable input from the senses. Addressing the students of Battle Creek College, she says, "Give no encouragement to indulgence in appetite, in selfish gratification of the senses, in pride, ambition, love of dress and display, love of praise and flattery, and strife for high rewards and honors as a recompense for good scholarship" (paragraph 3).

In 1892, while describing a condition of the Jewish nation during Bible times, White suggested that attitudes can interfere with sensual reception and cognition. She posits, "The blindness of Israel in discerning spiritual things closed their senses to the mission and work of Christ. . . . Their whole conception had been perverted. . . . In proportion as the spirit and life of Christ are in us, in that proportion is man enlightened and can discern spiritual things" (paragraph 2).

Environmental influences that negatively affect sensual input are situations to avoid, according to White's counsels in unpublished manuscripts (White, 1915b).

> It seems cruel to establish our schools in the cities, where the students are prevented from learning the precious lessons taught by nature. It is a mistake to call families into the city, where children and youth breathe an atmosphere of corruption and crime, sin and violence, intemperance and ungodliness. . . . It is a terrible mistake to allow children to come in contact with that which makes such a fearful impression on their senses. (p. 186).

White counsels parents and teachers to protect children from unwholesome sensual input. She suggests some parameters for guarding the "senses." "Guard well the avenues of the soul; . . . avoid reading, seeing, or hearing that which will suggest impure thoughts" (White, 1952a, p. 403); and "Sanctification does not close the avenues of the soul to knowledge, but expands the mind and inspires it to search for truth as for hidden treasure" (White, 1913, p. 449).

In 1882, Ellen White (1977a) counseled against allowing sensual pleasures to override good judgment.

> Yet, how many who call themselves Christians are unwilling to exercise self-denial, even for Christ's sake. How often the love for some pernicious indulgence is stronger than the desire for a sound mind in a sound body. Precious hours of probation are spent, God-given means squandered, to please the eye or to gratify the appetite. Custom holds thousands in bondage to the earthly and sensual. Many are willing captives; they desire no better portion. (p. 381)

Clearly, Ellen White recognized the important function the senses play in linking body to mind function. Further, she also recognized that sensual input could be both positive and negative. Her recommendations suggest that high standards of morality be operationalized in order to promote spiritual health and mental function.

Physical Activity to Promote Learning

Exercise of the body is a critical part of brain function, according to Ellen White. She wrote much about this important factor in the learning process. Classroom expectations in schools of Ellen White's time often required that students sit for long periods of time with little activity, she explains. White (1903b) advised against this practice, cautioning that such regimen was counterproductive to mental function. She cautioned that this confinement potentially could be harmful because of the negative effects that lack of physical activity has on the brain.

> The whole body is designed for action; and unless the physical powers are kept in health by active exercise, the mental powers cannot long be used to their highest capacity. The physical inaction which seems almost inevitable in the schoolroom—together with other unhealthful conditions—makes it a trying place for children, especially for those of feeble constitution. (p. 207)

Not only was White (1903b) concerned about the lack of physical movement, she also criticized other environmental aspects within the classroom that were detrimental to mind and body function. She asserts,

> Often the ventilation is insufficient. Ill-formed seats encourage unnatural positions, thus cramping the action of the lungs and the heart. Here little children have to spend from three to five hours a day, breathing air that is laden with impurity and perhaps infected with germs of disease. No wonder that in the schoolroom the foundation of lifelong illness is so often laid. The brain, the most delicate of all the physical organs, and that from which the nervous energy of the whole system is derived, suffers the greatest injury. (pp. 207-208)

In addition to the poor environmental conditions White (1903b) cites as prevalent in her day, she draws attention to the problem of expecting children to perform tasks before the body and brain are adequately matured for those functions.

> The brain, the most delicate of all the physical organs, and that from which the nervous energy of the whole system is derived suffers the greatest injury. By being forced into premature or excessive activity, and this under unhealthful conditions, it is enfeebled, and often the evil results are permanent. (pp. 207-208)

White provides some definition for developmental readiness in terms of age approximations, and she indicates a rank order in physical and academic development importance.

> Children should not be long confined within doors, nor should they be required to apply themselves closely to study until a good foundation has been laid for physical development. For the first eight or ten years of a child's life the field or the garden is the best schoolroom, the mother the best teacher, nature the best lesson book. Even when the child is old enough to attend school, his health should be regarded as of greater importance than a knowledge of books. He should be surrounded with the conditions most favorable to both physical and mental growth. (pp. 207-208)

Further, Ellen White suggests that without adequate physical activity, academics will suffer. "Those who give proper attention to physical development will make greater advancement in literary lines than they would if their entire time were devoted to study" (p. 209). As much as one-third of school time should be devoted to physical activity, White (1981/1993d, p. 220) suggests. This thought will be addressed further in the following subsection which considers necessary balance between mental and physical function.

Balance Between Mental and Physical Functions

Throughout her writings, White speaks of an integrated relationship between mind and body, and she strongly advocates balance between mental and physical activity. White (1923b) counseled, "We are to educate the youth to exercise equally the mental and physical powers. The healthful exercise of the whole being will give an education that is broad and comprehensive" (p. 538). Using the term "balanced," she suggests that as much as one-third of *learning time* should be spent in physical activity.

> If one third of the time now occupied in the study of books, using the mental machinery, were occupied in learning lessons in regard to the right use of one's own physical powers, it would be much more after the Lord's order, and would elevate the labor question, placing it where idleness would be regarded as a departure from

> the word and plans of God. The right use of one's self includes the whole circle of human obligations to one's self, to the world, and to God. Then use the physical power proportionately with the mental powers. (White, 1981/1993d, p. 220)

In a context of cautioning students against intensive mental function, to the exclusion of ample physical activity, White says,

> From the light given me from the Lord, I know that four or five successive years of application to book study is a mistake. Those who encourage close application to books, working the brain, and neglecting the education they should gain by using the muscles proportionately with the brain, are simply incapable of retaining the lessons they endeavor to learn. (1981/1993d, p. 220)

Providing a physiological rationale for the importance of balance between mental and physical function, White (1897) explains that "the exercise of the brain in study, without corresponding physical exercise, has a tendency to attract the blood to the brain, and the circulation of the blood through the system becomes unbalanced" (p. 184). "The harmonious action of all the parts—brain, bone, and muscle—is necessary to the full and healthful development of the entire human organism" (White, n.d., p. 13).

Referring to attitudes of her day regarding the value of balance between mental and physical functions, White (1932) says, "The most astonishing ignorance prevails in regard to putting brain, bone, and muscle into active service. Every part of the human organism should be equally taxed. This is necessary for the harmonious development and action of every part" (p. 296). In another publication, White (1855/1909c) reiterates this thought. "If students will develop brain, bone, and muscle harmoniously, they will be better able to study and better qualified to cope with the realities of life" (p. 218).

Implying a possible link between mind/body and memory function, White (1913) says, "Exercise the mental powers, and in no case neglect the physical. Let not intellectual slothfulness close up your path to greater knowledge. Learn to reflect as well as to study, that your minds may expand, strengthen, and develop" (p. 475).

Overtaxing the mind places unwise stress on mind and body, White (1977b, pp. 91, 112), suggested as early as 1913. Speaking to those who choose to overload the mind in an attempt to get ahead, White cautioned:

> The student who desires to put the work of two years into one should not be permitted to have his own way. To undertake to do double work means, with many, overtaxation of the mind and neglect of physical exercise. It is not reasonable to suppose that the mind can assimilate an oversupply of mental food; and it is as great a sin to overload the mind as it is to overload the digestive organs. *Medical Missionary*, Nov-Dec, 1892. (CH 505). (1977b, p. 444)

Ellen White's writings on balance between mind and body reveal a definitive position: This relationship is essential for optimal cognitive function and for physical health, as well. "Exercise is important to digestion, and to a healthy condition of body and mind" (1897, p. 133), White counsels. She maintains this stand consistently throughout her writings. "The whole body is designed for action; and unless the physical powers are kept in health by active exercise, the mental powers cannot long be used to their highest capacity" (p. 207).

Physical Development With Worthy Purpose

White's emphasis (1923b) on the importance of physical activity entails more than just physical exercise. She specifies that activity should provide for physical movement *and* productive purpose as well.

> Then when I look upon the scenes presented before me; when I consider the schools established in different places, and see them falling so far below anything like the schools of the prophets, I am distressed beyond measure. The physical exercise was marked out by the God of wisdom. Some hours each day should be devoted to useful education in lines of work that will help students in learning the duties of practical life, which are essential for all our youth. But this has been dropped out, and amusements introduced, which simply give exercise, without being any special blessing in doing good and righteous actions, which is the education and training essential. (p. 228)

Summary of Harmonious Development

Summarizing Ellen White's thoughts on the harmonious development of the physical, mental, and spiritual powers, it is clear she recognized that education is a dynamic process involving all three of these factors in significant ways. Elimination of even one of these entities disequilibrates the interdependence of this dynamic triad.

It is also clear that White believed this triad reaches its fullest potential when the human mind is connected with the mind of God in an intimately personal relationship. "When Christ abides in the heart," she writes (White, 1979b), "the powers of the whole being work in unity and harmony. The whole individual person's reason, and the affections, knowing how to act their parts, labor together unitedly" (p. 23).

In this state of orchestrated unity, the mind is potentiated to reach its highest capabilities. When "the mind of man is brought into communion with the mind of God, the finite with the Infinite . . . the effect of such communion on body and mind and soul is beyond estimate" (p. 14), White (1903b) reiterates.

The potential of this vital connection, she suggests, is magnified by the Holy Spirit who uses Holy Scripture, prayer, and the book of nature to accomplish potentiation (White, 1903b, pp. 13-19). Education's true potential cannot be established without the dynamic integration of body, mind, and spirit and the power of the divine Spirit initiated by enlightenment from Heaven.

White integrates science with her teachings regarding the spiritual nature of the learning process. She implies that the laws of physical science work together with spiritual power to connect the mind of man with the mind of God. Light flashing into the brain and mind often is mentioned. And she speaks of an atmosphere that physically surrounds an individual with either a positive or negative charge capable of transmitting the same to others. White stresses that an individual is accountable for the effect the atmosphere that surrounds them has upon others—whether for good or evil (White, 1964, p. 90).

A critical element determines whether or not this dynamic, harmonious model for education is activated. Human will power, the act of choosing or not choosing to establish a connection with the God of Love, is required to activate this process. The triad relationship of mind, body, and spirit can function without the dynamic connection with God's Spirit, but this level of function does not reach maximum potential. According to White, the fact that this triad function can operate minimally is merely a result of the presence of the God of love on earth. Humanity, even in its rebellion to the love of God, continues to receive the benefits of His love.

White speaks of supernatural powers that exist on earth—God and Satan, good and evil. She indicates that "there is in [man's] nature a bent to evil, a force which, unaided, he cannot resist" (White, 1903b, p. 29). Only one power can pull humanity out of the grasp of this negative power that truncates man's potential. "That power is Christ. Co-operation with that power is man's greatest need. In all educational effort should not this co-operation be the highest aim?" (p. 29), she asks.

"The love of Christ is the bond that is to unite believers heart to heart and mind to mind," White (1903c) asserts.

Finally, "the harmonious development of the physical, mental, and spiritual powers" is a concept that thoroughly permeates Ellen White's counsels to educators. She supports this triangulated relationship with the tenets of her biblical philosophy.

Throughout her writings she advises educators to recognize the balance necessary in relating to these three components of learning.

The next section addresses the influence of parents and teachers on the learner–the last of the commonly agreed-upon principles of education White's reviewers suggested. In addition, other topics are included which may not have been listed by the experts on Ellen White's writings. These additional discussions are topics that Ellen White addresses in relation to brain function.

Amusement and Recreation

Compared to the major emphasis on entertainment in today's world, White assumed an ultra-conservative position. She openly denounces amusement on the basis that it tends to nurture non-productive activity that is likely to evolve toward self-aggrandizement. However, amusement and recreation were not the same in White's thinking. Her writings clearly indicate a distinctive difference (White, 1903b).

> There is a distinction between recreation and amusement. Recreation, when true to its name, re-creation, tends to strengthen and build up. Calling us aside from our ordinary cares and occupations, it affords refreshment for mind and body, and thus enables us to return with new vigor to the earnest work of life. Amusement, on the other hand, is sought for the sake of pleasure and is often carried to excess; it absorbs the energies that are required for useful work and thus proves a hindrance to life's true success. (p. 207)

Recreation is a valuable part of the education process, according to White (White, 1855/1909b), if it promotes mental and physical health. "There are modes of recreation which are highly beneficial to both mind and body," she says. "An enlightened, discriminating mind will find abundant means for the entertainment and diversion, from sources not only innocent, but instructive. Recreation in the open air, the contemplation of the works of God in nature, will be of highest benefit" (p. 653).

Recreational activities White considered to be counter-productive to balanced physical and mental development were activities that distract the mind from high standards of respect for God and service to mankind. Amusement that promotes selfish gratification neutralizes the values and high standards of education and moral development, she suggests. "Amusements coming from such a source will unbalance the mind, disqualify the body for the performance of daily responsibilities, and create a positive dislike for practical domestic duties," White (1893c, paragraph 6) instructed. "Amusements excite the mind, but depression is sure to follow" (White, 1977a, p. 444).

Ellen White (1952a) so endorsed the importance of physical activity in mental development, she prescribed a course of purposeful daily activity even for the very young. Counseling mothers of young children, she advised that they should help their children learn to perform daily "duties." This routine, she says, will help promote memory and will help children establish a pattern in life that will honor character development and physical activity as they continue to mature.

> In the fulfillment of their apportioned tasks strength of memory and a right balance of mind may be gained, as well as stability of character and dispatch. The day, with its round of little duties, calls for thought, calculation, and a plan of action. As the children become older, still more can be required of them. It should not be exhaustive labor, nor should their work be so protracted as to fatigue and discourage them; but it should be judiciously selected with reference to the physical development most desirable and the proper cultivation of the mind and character. (p. 286)

Work and Practical Functions

Ellen White was a strong proponent of education that provided practical experience. In some of her earliest periodical publications (White, 1877) she wrote about the value of emphasizing physical development aligned with purposeful and productive activity. Even "children can be educated to be helpful," she says. "They are naturally active and inclined to be busy; and this activity is susceptible of being trained and directed in the right channel" (paragraph 2). Continuing, she clarifies her point:

> Children may be taught, when young, to lift daily their light burdens, each child having some particular task for the accomplishment of which he is responsible to his parents or guardian. They will thus learn to bear the yoke of duty while young; and the performance of their little tasks will become a pleasure, bringing them a happiness that is only gained by well-doing. They will become accustomed to work and responsibility, and will relish employment, perceiving that life holds for them more important business than that of amusing themselves. (paragraph 2)

"In order to have an education that [is] complete, the time of study must be divided between the gaining of book knowledge and the securing of a knowledge of practical work" (paragraph 19), White (1909a) advises.

Work-related physical activity throughout a child's formative years is strongly encouraged in White's writings. "Outdoor exercise, especially in useful labor, is one of the best means of recreation for body and mind; and the teacher's example will inspire his pupils with interest in, and respect for manual labor" (p. 278), White (1903b) urged. "Physical labor, a diversion from mental, will draw the blood from the brain. . . . The circulation of the blood will be better equalized" (paragraph 4), she counseled (White, 1897). Earlier writings—in 1872—suggest additional benefits of physical labor: "Useful labor and physical exercise will have a more healthful influence upon the mind and will strengthen the muscles, improve the circulation, and will prove a powerful agent in the recovery of health" (1977a, p. 646).

On one particular occasion, White (1855/1909d) reprimanded parents for having deprived their daughter of the privilege of work. Your daughter's "physical powers have so long lain dormant that her life is nearly useless," White scolded.

> Know you not that in giving your daughter so many privileges of learning the sciences, and not educating her to usefulness and household labor, you do her a great

> injury? This exercise would have hardened, or confirmed, her constitution and improved her health. Instead of this tenderness proving a blessing, it will prove a terrible curse. Had the family burdens been shared with the daughter, the mother would not have overdone, and might have saved herself much suffering and benefited the daughter all the time. (p. 700)

White (n. d.) valued the learning of practical arts more highly than academic regimen. "If the youth can have but a one-sided education, which is of the greater consequence, a knowledge of the sciences . . . or a knowledge of labor for practical life? We unhesitatingly answer, The latter. If one must be neglected, let it be the study of books" (paragraph 4).

In another writing, White (1977b) again speaks of the dependence of mind function on physical activity:

> Physical labor will not prevent the cultivation of the intellect. Far from it. The advantages gained by physical labor will balance a person and prevent the mind from being overworked. The toil will come upon the muscles and relieve the wearied brain. (p. 117)

In 1896, White (1977a) advised,"The whole system needs the invigorating influence of exercise in the open air. A few hours of manual labor each day would tend to renew the bodily vigor and rest and relax the mind" (p. 383). On another occasion she (White, 1913) reiterated, "Physical exercise was marked out by the God of wisdom. Some hours each day should be devoted to useful education in lines of work that will help students in learning the duties of practical life, which are essential for all our youth" (p. 283).

A balanced life of mental and physical productivity also promotes high moral standards, Ellen White (1890a) insists. "There is nothing which more surely leads to evil than to lift all burdens from children, leaving them to an idle, aimless life, to do nothing, or to occupy themselves as they please" (p. 134). White further explains her position on this matter:

> The minds of children are active, and if not occupied with that which is good and useful, they will inevitably turn to what is bad. While it is right and necessary for them to have recreation, they should be taught to work, to have regular hours for physical labor, and also for reading and study. See that they have employment suited to their years, and are supplied with useful and interesting books. Satan improves the opportunity to educate idle minds. . . . Children need more frequent change of employment and intervals of rest than grown persons do; but even when quite young, they may begin learning to work, and they will be happy in the thought that they are making themselves useful. Their sleep will be sweet after healthful labor, and they will be refreshed for the next day's work. (p. 134)

Speaking to an audience well acquainted with the use of farm implements, which White (White, 1981/1993g) uses metaphorically in her writings to represent physical labor, she wed the importance of physical activity with social morality. White lifted physical labor to a high level of respect and value in learning and living.

> There are practical lessons in the Word of God, lessons that Christ would have teachers and parents present to their children in the home and in the school. That Word teaches living, holy principles, which prompt men to do unto others as they would have others do unto them, principles which they are to bring into the daily life here, and carry with them into the school above. This is the higher education. No learning of human origin can reach these heights, for they reach into eternity, and are immortalized. The altar and the plough are the experiences for all who seek eternal life. (p. 262)

White often comments regarding the interrelationships and health benefits between mind, body, and spirit. In the following excerpt (White, 1903b) she highlights the importance of physical activity for integrating mental and spiritual function.

> Since the mind and the soul find expression through the body, both mental and spiritual vigor are in great degree dependent upon physical strength and activity; whatever promotes physical health, promotes the development of a strong mind and a well-balanced character. Without health no one can as distinctly understand or as completely fulfill his obligations to himself, to his fellow beings, or to his Creator. Therefore the health should be as faithfully guarded as the character. A knowledge of physiology and hygiene should be the basis of all educational effort. (p. 195)

Health Habits

One of the great missions in Ellen White's lifetime was "health reform." As mentioned above, she believed that an individual could not be healthy mentally or spiritually if the physical body was not benefiting from proper care. Implied throughout her writings is her belief that overall health is dependent on an intimate relationship between mind, body, and spirit. "In teaching health principles keep before the mind the great object of reform, that its purpose is to secure the highest development of body and mind and soul" (White, 1933, p. 33), she advises. "Obey the principles of health reform and educate others to do this," she counsels further. "The health of the mind is to a large degree dependent upon the health of the body, and the health of the body is dependent upon the way in which the living machinery is treated" (White, 1977a, p. 387).

To the important relationship between mind and body, White adds emphasis to spiritual matters, as well. "A diseased body causes a disordered brain, and hinders the work of sanctifying grace upon the mind and heart.—H. R." (White, 1897, p. 42). "A person whose mind is quiet and satisfied in God is in the pathway of health.—RH, Mar 11, 1880. (ML 150.)" (White, 1977a, p. 648). "In order to have perfect health our hearts must be filled with hope and love and joy.—SpT Series A, No. 15, p 18, Apr 3, 1900. (CH 587.)" (White, 1977a, p. 403), she adds. "Courage, hope, faith, sympathy, love, promote health and prolong life. A contented mind, a cheerful spirit, is health to the body and strength to the soul. "A merry [rejoicing] heart doeth good like a medicine" (Proverbs 17:22).—MH 241 (1905)" (White, 1977a, p. 647). Continuing to stress the dynamic relationship between spirit and body, White (1977a) says,

> The principles of health reform should be brought into the life of every Christian. Men and women who disregard these principles cannot offer to God a pure, vigorous

> devotion; for a dyspeptic stomach or a torpid liver makes the religious life an uncertainty. (p. 407)

Health reform appears to be more than just a wise pursuit to Ellen White (1898a). She seems to view it as a sacred trust.

> There are conditions to be observed by all who would preserve health. All should learn what these conditions are. The Lord is not pleased with ignorance in regard to His laws, either natural or spiritual. We are to be workers together with God for the restoration of health to the body as well as to the soul. (p. 824)

In 1890, White (1938a) provided rationale for her position on health reform. One of the points she stresses is:

> Health is a treasure. Of all temporal possessions it is the most precious. Wealth, learning, and honor are dearly purchased at the loss of the vigor of health. None of these can secure happiness, if health is lacking. It is a terrible sin to abuse the health that God has given us; such abuses enfeeble us for life, and make us losers, even if we gain by such means any amount of education. (p. 20)

Ellen White wrote much about health practices. Entire volumes focus on topics such as diet, health, and temperance—*Counsels on Diet and Foods, Ministry of Healing, A Call to Medical Evangelism and Health Education, Counsels on Health, The Health Food Ministry, Healthful Living, Medical Ministry,* and *Temperance.* Though these books are totally devoted to health topics, she includes health counsels in many other books, articles, and pamphlets on spiritual, health, and educational issues. This fact seems to indicate her deep conviction that physical health is a major factor in maintaining the health of the whole being—body, mind, and spirit. Woven throughout her writings on health-relevant topics is her prescription for health preservation:

> Pure air, sunlight, abstemiousness, rest, exercise, proper diet, the use of water, trust in divine power—these are the true remedies. . . . Nature, untrammeled, does her work wisely and well. Those who persevere in obedience to her laws will reap the reward in health of body and health of mind. (White, 1958, p. 233)

On these eight remedies, White elaborates extensively. Following are some of the major points she makes as she relates these factors to mind, body, and moral function. Because she often discusses more than one of these remedies at a time, some are grouped together below.

Pure Air, Good Water, and Sunshine

"Nature is God's physician" White (1923a, p. 170) asserts, speaking of the value of being outdoors. The "things of nature" are "God's blessings" to provide "health to body, mind, and soul" (p. 169).

> The pure air, the glad sunshine, the beautiful flowers and trees, the orchards and vineyards, and outdoor exercise amid these surroundings, are health-giving—the elixir of life. Outdoor life is the only medicine that many invalids need. Its influence is powerful to heal sickness caused by fashionable life, a life that weakens and destroys the physical, mental, and spiritual powers. (p. 170)

Speaking further of the value of natural remedies over medicinal treatments, she counsels,

> They are given to the well to keep them well, and to the sick to make them well. Connected with water treatment, they are more effective in restoring health than all the drug medication in the world. (p. 169)

Often in her book *Counsels on Health*, White speaks specifically of the importance of fresh air.

> Life in the open air is good for body and mind. It is God's medicine for the restoration of health. Pure air, good water, sunshine, beautiful surroundings—these are His means of restoring the sick to health in natural ways. To the sick it is worth more than silver or gold to lie in the sunshine or in the shade of the trees. (p. 166)

Linking fresh air intake to multiple health benefits, White (1890a) asserts that

> fresh air will purify the blood, refresh the body, and help to make it strong and healthy. The invigoration produced will be reflected upon the mind, imparting to it tone and clearness, as well as a degree of composure and serenity. It gives a healthful stimulus to the appetite, renders the digestion of food more perfect, and induces sound, sweet sleep. Living in close, ill-ventilated rooms, weakens the system, makes

> the mind gloomy, the skin sallow, and the circulation feeble; the blood moves sluggishly, digestion is retarded, and the system is rendered peculiarly sensitive to cold. One should so accustom himself to fresh, cool air that he will not be affected by slight changes of temperature. (p. 104)

White (1977a) suggests that additional benefits in good respiration and intake of fresh air can ward off symptoms of debilitating conditions. She urges,

> In order to have good blood, we must breathe well. Full, deep inspirations of pure air, which fill the lungs with oxygen, purify the blood. They impart to it a bright color and send it, a life-giving current, to every part of the body. A good respiration soothes the nerves; it stimulates the appetite and renders digestion more perfect; and it induces sound, refreshing sleep.—MH 272 (1905). (p. 484)

Further, explaining the negative effects on the entire system when there is a lack of fresh air, White (1905) comments,

> Thus an insufficient supply of oxygen is received. The blood moves sluggishly. The waste, poisonous matter, which should be thrown off in the exhalations from the lungs, is retained, and the blood becomes impure. Not only the lungs, but the stomach, liver, and brain are affected. The skin becomes sallow, digestion is retarded; the heart is depressed; the brain is clouded; thoughts are confused; gloom settles upon the spirits; the whole system becomes depressed and inactive, peculiarly susceptible to disease. (p. 273)

Counseling parents regarding the importance of appropriate dress, as well as time in the sun and fresh air, White (1903a) states,

> Dress your children neatly in simple clothing, and allow them to spend much time out-of-doors. You can furnish them with cart-loads of sand in which to play. By playing in the sunshine and the fresh air, children will gain health and strength of mind and body. They will be benefited both spiritually and physically. (paragraph 7)

Ellen White (1871b) strongly counseled that daily, weather permitting, everyone should do "a portion of their work in the open air and sunshine" because of the benefits to the entire body. For the same reasons, children should spend time in the air and sunshine (White, 1871a).

In 1863, in the context of addressing the need to be temperate in all matters regarding healthful practice, Ellen White (1958/1980) refers to the medicinal use of water. Describing water's value, she refers to "God's great medicine, water, pure soft water, for diseases, for health, for cleanliness, and for a luxury" (p. 280).

In a compilation of White's messages for medical students at what is now known as Loma Linda University Medical School, White (1926) comments on the use of water to treat illness.

> In health and in sickness, pure water is one of Heaven's choicest blessings. Its proper use promotes health. It is the beverage which God provided to quench the thirst of animals and man. Drank freely, it helps to supply the necessities of the system, and assists nature to resist disease. (p. 151)

In her book *Healthful Living*, White (1897) speaks often about the advantages of pure water. "Water is the best liquid possible to cleanse the tissues" (p. 226). "Pure water to drink and fresh air to breathe invigorate the vital organs, purify the blood, and help nature in her task of overcoming the bad conditions of the system" (p. 187). "If you feel that you must eat at night, take a drink of cold water, and in the morning you will feel much better for not having eaten" (p. 85), she states.

Abstemiousness and Temperance

According to Webster's Dictionary (Braham et al., 1999), *temperance* is "moderation or self-restraint," "habitual moderation in any indulgence, appetite, etc.," and "abstinence from alcoholic beverages" (p. 1343). *Abstemious* in the same lexical source is defined as "sparing in eating and drinking," and "temperate" (p. 6). The two terms are quite synonymous.

Overeating and gluttony were a major violation of health principles in Ellen White's writings. In 1880 (White, 1938a), she commented on the ill effects of self-indulgence and intemperance.

> Some do not exercise control over their appetites, but indulge taste at the expense of health. As the result, the brain is clouded, their thoughts are sluggish, and they fail to accomplish what they might if they were self-denying and abstemious. These rob God of the physical and mental strength which might be devoted to His service if temperance were observed in all things. (p. 132)

When commenting on temperance and abstinence, White often refers to the biblical account of Daniel and his three friends and their experience when the Jewish nation was taken captive by the Babylonian army. She explains that Daniel, Shadrach, Meshack, and Abednego, as young captives the King of Babylon wished to train for his own purposes, were expected to eat the food and fermented drink from the king's table. Because of its richness and poor quality of nutrition, these four young men asked to be served simpler fair instead—simply prepared fruits, vegetables, legumes, nuts, and grains (a vegetarian diet). They requested that they be given a 10-day trial period to determine the effects of their choice in diet.

After 10 days on this special, simple diet, these four young men were examined by the king's helper—Melzar—to determine whether or not their diet was inferior or superior and to compare their physical health with that of those who had chosen to eat from the king's table. White (1938a) comments on the results of this test:

> At the end of the ten days the result was found to be quite the opposite of Melzar's expectations. Not only in personal appearance, but in physical activity and mental vigor, those who had been temperate in their habits exhibited a marked superiority over their companions who had indulged appetite. (p. 31)

Ellen White (1952b) stresses the point that Daniel maintained a resolute position regarding abstinence and temperance. That choice put him at a distinct advantage over those who did not exhibit self-control.

> He purposed in his heart that he would not indulge in the luxuries of the King's table, but that he would keep his faculties in the best order, and his mind in a condition to appreciate eternal and spiritual truths. And when the king inquired of him, he found

> him ten times wiser than all the astrologers and wise men in his court; for God gave him understanding and wisdom. (p. 147)

Another biblical example White (1988a) uses to indicate the advantages of self-control and temperance is the case of John the Baptist during Christ's time on earth. According to Scripture, White explains, an angel of God appeared to John's parents to tell them to nurture John with only simple foods as he grew to adulthood. This was in stark contrast to the practices of that day. White describes the culture at that time as dominated by "greed for riches, and love of luxury and display." She states,

> Sensuous pleasures, feasting and drinking, were causing physical disease and degeneracy, benumbing the spiritual perceptions, and lessening the sensibility to sin. John was to stand as a reformer. By his abstemious life and plain dress he was to rebuke the excesses of his time. Hence the directions given to the parents of John,—a lesson of temperance by an angel from the throne of Heaven. (p. 100)

White used these examples of Daniel and John the Baptist to promote moderation and self-discipline. While she endorsed a conservative position in diet, drink, dress, and all other aspects of life, she also counseled against extremes in abstinence and temperance. Writing to a minister who was assuming an extreme position (White, 1938a), she said,

> I have been informed that you have taken but one meal a day for a period of time; but I know it to be wrong in your case, for I have been shown that you needed a nutritious diet, and that you were in danger of being too abstemious. Your strength would not admit of your severe discipline. (p. 191)

In further clarification for this same individual, White wrote:

> I beg of you to be cautious and eat freely good, wholesome food twice a day. You will surely decrease in strength and your mind become unbalanced unless you change your course of abstemious diet. (p. 191)

Temperance, according to Ellen White, also included abstinence from tobacco, alcohol, and other stimulants and narcotics. She included coffee and tea in this category.

"Tobacco weakens the brain and paralyzes its fine sensibilities," she writes in *Child Guidance* (White, 1954). "Its use excites a thirst for strong drink, and in very many cases lays the foundation for the liquor habit" (p. 404).

Referring to the biblical prescription for acquiring wisdom, Ellen White refers to 2 Pet 1:5-8. "And beside this, giving all diligence, add to your faith virtue; and to virtue knowledge; and to knowledge temperance; and to temperance patience; and to patience godliness; and to godliness brotherly kindness; and to brotherly kindness charity."

Focusing on the importance of temperance in this graduated accrual of virtues, she says (White, 1961), "Any habit or practice which will weaken the nerve and brain power or the physical strength disqualifies for the exercise of the next grace which comes in after temperance—patience" (p. 69).

At another time, White (1949) more explicitly speaks about the effect of intemperance on brain function. She writes,

> The brain nerves which communicate with the entire system are the only medium through which Heaven can communicate to man and affect his inmost life. Whatever disturbs the circulation of the electric currents in the nervous system lessens the strength of the vital powers, and the result is a deadening of the sensibilities of the mind.—*Testimonies*, vol. 2, p. 347. (p. 13)

White (1949) implicates individuals who carry responsibility for "safeguarding their fellow men from accident and harm" as guilty of being "untrue to their trust," when they indulge in using tobacco and liquor. "They do not keep the mind clear and composed. . . . They becloud the brain by using stimulating narcotics, and temporarily lose their reasoning faculties. Many a shipwreck upon the high seas can be traced to liquor drinking" (p. 35).

Further, White (1949) claims that individuals who compromise their mental clarity with the use of stimulants or narcotics are more likely to commit crimes "that would have been left undone had the mind been clear and free from [those influences] (p. 59). Even physicians were not exempt from her pointed comments on this topic. "While disordering his nerves and clouding his brain by the use of narcotic poisons, how can one be true to the trust reposed in him as a skillful physician? How impossible for him to discern quickly or to execute with precision" (p. 70)!

White (1949) relates to the negative effects of tobacco, alcohol, and stimulants as more than just a poor choice. She classifies such practice as a moral sin in that it defiles the temple of God—the human body. Speaking specifically about tobacco use, she says,

> The use of tobacco is an inconvenient, expensive, uncleanly habit. The teachings of Christ, pointing to purity, self-denial, and temperance, all rebuke this defiling practice. . . . Is it for the glory of God for men to enfeeble the physical powers, confuse the brain, and yield the will to this narcotic poison?—Christian Temperance and Bible Hygiene, pages 17, 18. (p. 62)

As early as 1897 in her book *Healthful Living*, Ellen White commented on the effect of tobacco smoke on infants and seemed to suggest a possible connection between second-hand smoke and sudden infant death. She states,

> While it [tobacco] acts upon some [infants who are compelled to inhale its fumes] as a slow poison, and affects the brain, heart, liver, and lungs, and they waste away and fade gradually, upon others it has a more direct influence, causing spasms, paralysis, and sudden death.—H. to L., Chap. 5, p. 68. (p. 201)

Honoring the body and its functions is a way of honoring God who created humankind, White (1949, pp. 60-63) says. "Brain, bone, and muscle, are to be brought into harmonious action, that all may work as well-regulated machines, each part acting in harmony, not one being overtaxed" as is the case when the brain is "dulled by the use of narcotics or excited by the use of stimulants" (p. 74). White (1933) calls for young people to "lift their voices in the cause of temperance and show its bearing upon Christianity." She invites them to "engage in the holy war against appetite and lust" (p. 38).

Coffee and tea also are substances against which White (1949) cautions. "Coffee is a hurtful indulgence," she says, and she explains why:

> It temporarily excites the mind to unwonted action, but the after-effect is exhaustion, prostration, paralysis of the mental, moral, and physical powers. The mind becomes enervated, and unless through determined effort the habit is overcome, the activity of the brain is permanently lessened. (p. 34)

Brain, heart, stomach, and other organs are compromised when stimulants are used, White (1897) says. "What the users of these stimulants call strength is only received by exciting the nerves of the stomach, which convey the irritation to the brain, and this in turn is aroused to impart increased action to the heart" (p. 196). At a later writing, White (1905) offered additional rationale regarding the negative effect of consuming tea, coffee, and other stimulating drinks:

> Tea acts as a stimulant and, to a certain extent, produces intoxication. The action of coffee and many other popular drinks is similar. The first effect is exhilarating. The nerves of the stomach are excited; these convey irritation to the brain, and this in turn is aroused to impart increased action to the heart and short-lived energy to the entire system. Fatigue is forgotten; the strength seems to be increased. The intellect is aroused, the imagination becomes more vivid. (p. 326)

"All should bear a clear testimony against tea and coffee, never using them. They are narcotics, injurious alike to the brain and to the other organs of the body" (1938a, p. 430). "Tea, coffee, and tobacco, as well as alcoholic drinks, are different degrees in the scale of artificial stimulants," White (1926, p. 145) wrote earlier. "The effect of tea and coffee, as heretofore shown, tends in the same direction as that of wine and cider [hardened], liquor and tobacco" (White, 1938a, p. 421). "By the use of tea and coffee an appetite is formed for tobacco," she writes (White, 1949, p. 57).

White's definition of *temperance* was inclusive of more than just alcohol, tobacco, stimulants, and narcotics abuse. To this list of questionable substances, White adds intemperance regarding food intake. Intemperance in eating, White says, is deleterious to the overall function of the body. She writes (White, 1949):

> Those who eat and work intemperately and irrationally, talk and act irrationally. It is not necessary to drink alcoholic liquors in order to be intemperate. The sin of intemperate eating—eating too frequently, too much, and of rich, unwholesome food—destroys the healthy action of the digestive organs, affects the brain, and perverts the judgment, preventing rational, calm, healthy thinking and acting.—Christian Temperance and Bible Hygiene, page 155. (p. 138)

Healthful food consumed in proper quantities is certainly not objectionable, she counsels, but when amounts are taken in excess of "the actual need of the system, [this] becomes a dangerous element. It decays in the stomach, and causes dyspepsia. Continual overeating uses up the vital forces, and deprives the brain of power to do its work.—Manuscript 155, 1899" (White, 1949, p. 162). "Intemperance in eating, even of food of the right quality, will have a prostrating influence upon the system, and will blunt the keener and holier emotions," White (1938a, p. 55) emphasizes. "Indulgence of appetite is the greatest cause of physical and mental debility and lies at the foundation of the feebleness which is apparent everywhere.—3T 487 (1875)" (White, 1977a, p. 386).

Exercise

Ellen White (1903b) firmly believed that "the whole body is designed for action; and unless the physical powers are kept in health by active exercise, the mental powers cannot long be used to their highest capacity" (pp. 207-208). "Physical inaction lessens not only mental but moral power" (p. 209), she says. "Recreation in the open air, the contemplation of the works of God in nature, will be of highest benefit" (White, 1855/1909b, p. 653).

Writing about the correlation between exercise and health, White (1977b) says,

> Inactivity is a fruitful cause of disease. Exercise quickens and equalizes the circulation of the blood, but in idleness the blood does not circulate freely, and the changes in it, so necessary to life and health, do not take place. The skin, too, becomes inactive. Impurities are not expelled as they would be if the circulation had been quickened by vigorous exercise, the skin kept in a healthy condition, and the lungs fed with plenty of pure, fresh air. This state of the system throws a double burden on the excretory organs, and disease is the result.—MH 238. (p. 116)

White (1977a) was a strong proponent of exercise with a practical purpose. She suggested that physical activity be combined with useful purpose. "Useful labor and physical exercise will have a more healthful influence upon the mind and will strengthen the muscles, improve the circulation, and will prove a powerful agent in the recovery of health" (p. 646). She advised that students arrange to alternate study time with purposeful labor and to "combine physical exercise with study" (White, n.d., p. 41).

Finally, White (1923b) often speaks of the importance of exercise in conjunction with the harmonious development of mental and physical properties.

> Exercise is an important aid to physical development. It quickens the circulation of the blood, and gives tone to the system. If the muscles are allowed to remain unused, it will soon be apparent that the blood does not sufficiently nourish them. Instead of increasing in size and strength, they will lose their firmness and elasticity, and become soft and weak. Inactivity is not the law the Lord has established in the human body. The harmonious action of all the parts,—brain, bone, and muscle,—is necessary to the full and healthful development of the entire human organism. (p. 426)

Rest

Just as important as physical activity is regular, adequate rest in maintaining health and function, White (1952b) maintains. "Since the work of building up the body takes place during the hours of rest, it is essential, especially in youth, that sleep should be regular and abundant" (p. 143). "Body and mind need rest, that the mind may not become unbalanced and excited from being subjected to a constant strain" (White, 1884, paragraph 10). Continuing, she states, "And good and regular sleep should be secured, that the mind may be clear, and in the best condition possible to weigh the arguments presented and to decide between truth and error" (paragraph 10).

White (1954) acknowledged the tendency of young people to want to sleep late in the morning, but she discouraged this practice. "How prevalent is the habit of turning day into night, and night into day. Many youth sleep soundly in the morning, when they should be up with the early singing birds and be stirring when all nature is awake" (p. 111). She provided rationale for this position in another writing (White, 1981/1993h)). "I know from the testimonies given me from time to time for brain workers, that sleep is worth far more before than after midnight. Two hours' good sleep before twelve o'clock is worth more than four hours after twelve o'clock" (p. 224).

Diet

"The human organism is a wonderful piece of machinery," Ellen White (1977a) counsels, "but it can be abused. . . . The transformation of food into good blood is a wonderful process, and all human beings should be intelligent upon this subject" (p. 385). So important did White consider this topic, she wrote entire books and sections of books on the matter of diet.

Though some consider her counsels regarding diet to be extreme, Ellen White offers rationale to support the concepts she recommends. Her prescription for providing the proper nutrition for body, mind, and soul is based on the biblical diet established in Eden—fruits, nuts, and grains—as instituted by the Creator. White (1903b) suggests, "Grains, fruits, nuts, and vegetables, in proper combination, contain all the elements of nutrition; and when properly prepared, they constitute the diet that best promotes both physical and mental strength" (p. 205).

In contrast to this recommended diet, White (1903b) defines an inferior nutritional regimen.

> The effect of a concentrated and stimulating diet, also of foods deficient in the elements of nutrition, should be made plain. Tea and coffee, fine-flour bread, pickles, coarse vegetables, candies, condiments, and pastries fail of supplying proper nutriment. Many a student has broken down as the result of using such foods. Many a puny child, incapable of vigorous effort of mind or body, is the victim of an impoverished diet. (pp. 204-205)

White advised that the choice of foods we eat has a significant effect on mental attitude. "Gross and stimulating food fevers the blood, excites the nervous system, and too often dulls the moral perceptions so that reason and conscience are overborne by the sensual impulses," she (1977b, p. 322) writes. White (1977a) states,

> I referred [in an address] to the blessings of health reform, and the advantages to be gained by the use of proper combinations of simple, nourishing foods. The close relationship that eating and drinking sustain to the state of one's mind and temper was dwelt upon. We cannot afford to develop a bad temper through wrong habits of living. (p. 386)

Ellen White (1977a) alludes to the balance between mind, body, and spirit as she addresses the importance of proper nutrition. "A dyspeptic stomach always leads to irritability," she says. "A sour stomach leads to a sour temper. Your body must be kept in subjection if you make it a meet temple for the indwelling of the Holy Spirit. . . . Eat sparingly of even wholesome food" (p. 394). "Under the influence of unhealthful food the conscience becomes stupefied, the mind is darkened, and its susceptibility to impressions is impaired" (p. 394). "Through appetite Satan controls the mind and the whole being. Thousands who might have lived have passed into the grave, physical, mental, and moral wrecks, because they sacrificed all their powers to the indulgence of appetite.—CTBH 37, 1890" (p. 387).

"Because it is wrong to eat merely to gratify a perverted taste, it does not follow that we should be indifferent in regard to our food," White (1890a) counsels in an effort to encourage balance in regard to nutrition.

> It is a matter of the highest importance. No one should adopt an impoverished diet. Many are debilitated from disease, and need nourishing, well-cooked food. Health reformers, above all others, should be careful to avoid extremes. The body must have sufficient nourishment. The God who gives his beloved sleep has furnished them also suitable food to sustain the physical system in a healthy condition. (p. 49)

Ellen White's position on meat consumption places her in an extreme position in popular American culture today and during her time. Yet, she was outspoken and convinced that the exclusion of meat from the diet provided many advantages for optimizing mental, physical, and spiritual health.

"We are composed of what we eat," says White (1977a), "and eating much flesh will diminish intellectual activity. Students would accomplish much more in their studies if they never tasted meat. When the animal part of the human agent is strengthened by meat eating, the intellectual powers diminish proportionately" (p. 390).

Flesh food White names as an inferior source of nutrition. She forwardly states, "Meat is not essential to the maintenance of health and strength" (White, 1890a, p. 47). "Those who use flesh-meats freely, do not always have an unclouded brain and an active intellect, because the use of the flesh of animals tends to cause a grossness of body, and to benumb the finer sensibilities of the mind. The liability to disease is increased by flesh-eating" (p. 47), she elaborates.

Meat was a regular part of Ellen White's diet for many years. Not until she became convinced of the deleterious effects of meat on the entire system was she determined to eliminate it from her diet. Citing the original diet provided for humanity by the Creator and the experiences of the Jewish nation as meat eaters and as non-meat eaters, a reference to the latter (White, 1977a) follows:

> As a general thing, the Lord did not provide His people with flesh meat in the desert because He knew that the use of this diet would create disease and insubordination. In order to modify the disposition and bring the higher powers of the mind into active exercise, He removed from them the flesh of dead animals.—MS 38, 1898. (p. 391)

White elaborates on this concept with an integral thought from Scripture.

> A religious life can be more successfully gained and maintained if meat is discarded, for this diet stimulates into intense activities, lustful propensities, and enfeebles the moral and spiritual nature. "the flesh . . . [warreth] against the spirit, and the spirit against the flesh" (Galatians 5:17). (p. 390)

"The intellectual, the moral, and the physical powers are depreciated by the habitual use of flesh meats," White (1977a) elaborates. Meat eating deranges the system, beclouds the intellect, and blunts the moral sensibilities.—2T 64 (1900)" (p. 390). Again, referring to Daniel's example in Scripture, White (1938a) substantiates her belief that meat is an inferior food for human consumption:

> He purposed in his heart that he would not defile himself with the portion of the king's meat, nor with the wine which he drank; for he knew that such a diet would not strengthen his physical powers or increase his mental capability. He would not use wine, nor any other unnatural stimulant; he would do nothing to becloud his mind; and God gave him "knowledge and skill in all learning and wisdom," and also "understanding in all visions and dreams." (p. 154)

Trust in Divine Power

Throughout her counsels to educators (1877; 1894a; 1900c; 1903a; 1903b; 1909a; 1913; 1923b), Ellen White builds a case for the controversy she believes is being played out on earth—a controversy between God and Satan, the forces of good and the forces of evil. Using supports from biblical Scripture, she establishes that Satan's plan is to "eclipse eternal interests" so that he can more easily attract the minds of youths through "worldly interests." By alluring youth to gratify their own selfish desires, White explains, he places them in contradiction to the ways and laws of God. Satan promotes trust in self; whereas, God promotes trust in Himself as humanity's Creator. He knows humankind is dependent on His sustaining power, White proffers. Separated from the power of God, the Creator, humanity perishes. On these premises, Ellen White entreats her readers to trust in divine power. White (1958) describes the tension between Satan and God in regard to the issue of trust:

> The Lord's hand has been reached out in tenderest compassion and love; but they do not care to trust Him. They want to feel fully able to devise and plan for themselves. . . . The Lord marks out a way in which He would have them walk. He has lent them talents to be used for His glory, to do a certain work for the Master; but Satan says, "I will countermand the order of Christ. I will find another line of work for active brain and busy hands, whereby they shall serve me. I will eclipse eternal interests before this youth, and attract his mind by worldly interests. . . . I will bind him about with worldly allurements like the finest threads, whose power to bind will become at last like ropes of steel, and he shall be bound in my service." (p. 323)

In this context of tension between good and evil, White encourages all to defer from trusting self in favor of trust in God. She writes (1970),

> It is impossible for us in our own strength to maintain the conflict; and whatever diverts the mind from God, whatever leads to self-exaltation or to self-dependence, is surely preparing the way for our overthrow. The tenor of the Bible is to inculcate distrust of human power and to encourage trust in divine power. (p. 177)

Ellen White (1970) indicates that the Bible "has little to say in praise of men," even the most virtuous ones; because "all good qualities that men possess are the gift of God" (p. 365). She continues,

> Since they owe all to God the glory of whatever they are or do belongs to Him alone; they are but instruments in His hands. More than this—as all the lessons of Bible

> history teach—it is a perilous thing to praise or exalt men; for if one comes to lose sight of his entire dependence on God, and to trust to his own strength, he is sure to fall. (p. 365)

The way to Christ is also the way to developing intellectual potential, White (1977a) suggests.

> We cannot reach Christ through a mere intellectual training, but through Him we can reach the highest round of the ladder of intellectual greatness. While the pursuit of knowledge in art, in literature, and in trades should not be discouraged, the student should first secure an experimental knowledge of God and His will.—CT 19 (1913). (p. 241)

Depicting God as a loving Father, constantly mindful of humanity's need of Him, White (1967) stresses the importance of connecting with Him, spiritually. "We can have a close connection with God and with our Saviour; and when we are connected with God, we shall be all light in the Lord, for in Him is no darkness at all" (p. 123).

White (1967) counsels that God is trustworthy because not even changing circumstances can "change God's relation to us. He is the same yesterday, today, and forever; and He asks us to have unquestioning confidence in His love" (p. 120). Citing Isa 26:4, White (1952b) says, "Trust ye in the Lord for ever: for in the Lord Jehovah is everlasting strength" (p. 10). "We must trust; we must educate and train our souls to believe the word of God implicitly" White (1967, p. 126) urges. "Remember that you need to be braced by constant watchfulness and prayer. So long as you look to Christ you are safe, but the moment you trust in yourself you are in great peril. He who is in harmony with God will continually depend upon Him for help" (p. 223).

Though Ellen White does not include *regularity* in her list of eight "true remedies," she often mentions this factor in relation to its importance for health and brain and body function. She speaks of the need for regularity in sleep patterns, but even more, she talks of regularity in dietary practice. The following subsection reviews her comments and emphasis on regularity.

White is definitive concerning the necessary element of trust in God for physical, mental, and moral health. She clearly indicates that He is the only safe, reliable source of strength and power upon whom humanity can depend.

Regularity

"The observance of temperance and regularity in all things has a wonderful power" (1903b, p. 206), White states, but she is most enthusiastic about giving emphasis to regularity in eating patterns. "Regularity in eating is very important for health of body and serenity of mind" (1952b, p. 146) she proffers.

"You should never let a morsel pass your lips between your regular meals. Eat what you ought, but eat it at one meal, and then wait until the next" (p. 180), White (1938a) advises. Even for children, White (1952b) prescribed this regimen:

> Children should be taught that they must not have their own way, but that the will of their parents must guide them. One of the most important lessons in this connection is the control of appetite. They should learn to eat at regular periods and to allow nothing to pass their lips between these stated meals. (p. 82)

Speaking to the not-so-young as above, White (1977a) advises, "Arrange your work so that you can have your meals at regular hours. . . . Remember that to live the truth as it is in Jesus requires much self-discipline" (p. 387).

White (1938a) suggests spacing meals five hours apart.

> After the regular meal is eaten, the stomach should be allowed to rest for five hours. Not a particle of food should be introduced into the stomach till the next meal. In this interval the stomach will perform its work, and will then be in a condition to receive more food. (p. 179)

"Supper, when taken at an early hour, interferes with the digestion of the previous meal. When taken later, it is not itself digested before bedtime. Thus the stomach fails of securing proper rest" (p. 205), White (1903b) states. When the stomach is full of food during the night-time hours, "sleep is disturbed, the brain and nerves are wearied, the appetite for breakfast is impaired, the whole system is unrefreshed and is unready for the day's duties" (p. 205).

For young children, White (1938a, pp. 182, 229) recommends three meals a day, but as they get older, she suggests (White, 1903b) that "in most cases two meals a day are preferable to three" (p. 205). These meals should be provided at regular times each day, White (1954) counsels with supporting rationale:

> Neither should the meals be delayed one or two hours, to suit circumstances, or in order that a certain amount of work may be accomplished. The stomach calls for food at the time it is accustomed to receive it. If that time is delayed, the vitality of the system decreases and finally reaches so low an ebb that the appetite is entirely gone. If food is then taken, the stomach is unable to properly care for it. The food cannot be converted into good blood. If all would eat at regular periods, not tasting anything between meals, they would be ready for their meals and would find a pleasure in eating that would repay them for their effort. (p. 387)

Commenting on the pattern of regularity typically seen in successful business-men, White (1915a) urges church workers to adopt similar practice. She states, "Men of business can be truly successful only by having regular hours of rising, for prayer, for meals, and for retiring. If order and regularity are essential in worldly business, how much more so in the work of God!" (p. 278).

Parental Influence

Ellen White wrote entire books of counsel to parents and teachers. She included much emphasis on how indelibly the parental model impressed upon the mind of the child.

Importance of the Family Structure and Moral Training

"Society is composed of families, and is what the heads of families make it," says White (1952a). "In the formation of character, no other influences count so much as the influence of the home" (White, 1903b, p. 283). Comparing the family to the heart, she (1952a) comments.

> Out of the heart are "the issues of life"; and the heart of the community, of the church, and of the nation is the household. The well-being of society, the success of the church, the prosperity of the nation, depend upon home influences. (p. 15)

Addressing the importance of depending on God for guidance as parents responsible for the eternal welfare of their children, White (1896b) proffers,

> The grandest, most effectual work can be done by parents who follow the instruction of the Lord, and who train their children physically, mentally, and morally according to the Lord's directions. If parents neglect to properly instruct their children, and the youth are left to have their own will and way from the days of their childhood, their characters will be greatly perverted; for the enemy will step in and rejoicingly take into his hands the work of training the children and youth. (paragraph 4)

Training children to fear and love God is a moral and "most solemn obligation," White (1977b) cautions. Continuing, she adds,

> In the home the purest morals are to be preserved. Strict obedience to Bible requirements is to be taught. The teachings of the Word of God are to control mind and heart that the homelife may demonstrate the power of the grace of God. Each member of the family is to be "polished after the similitude of a palace" (Psalm 144:12) by the divine principles and precepts.—RH, Nov. 10, 1904. (p. 163)

"Fathers and mothers should have clear, unclouded minds, unaffected by the indulgence of perverted appetite,—such minds as God can connect with himself for the salvation of souls who are ready to perish," White (1896b) advises. In counsels to parents, White condemns the use of "wine and fermented liquors." She indicates that these "weaken their physical and mental powers. Their minds become so clouded that it is impossible for them to discern sacred things." Instead of debilitating parental influence for good with these negative properties, White suggests that "if the human agent shall cooperate with divine agency, his physical and mental development will become higher and better. His mind will enlarge, and he will grow in power to do good" (paragraph 4).

Stressing the importance of the mother becoming "acquainted with the wonderful human organism, the bones, muscles, stomach, liver, bowels, heart, and pores of the skin, and to understand the dependence of one organ upon another for the healthful action of all," White (1913) states that few mothers become qualified in this regard. "They know nothing of the influence of the body upon the mind, or of the mind upon the body" (p. 78). Understanding this relationship is critical to the nurture of health and morality. "The first great object to be attained in the training of children is soundness of constitution which will prepare the way in a great measure for mental and moral training. Physical and moral health are closely united," White (1977b, p. 140) counsels.

Unity and Cooperation Among Parents and Teachers

Preparation for optimal collaboration with their children's future teachers begins with a model of cooperation within the home, White (1977b) advises. Unity between mother and father is a critical element in family structure, she suggests. Angels will not dwell in a home where "discord reigns supreme."

To parents, White counsels, "Let fathers and mothers cease all faultfinding and murmuring. Let them educate their children to speak pleasant words, words that bring sunshine and joy" (p. 179).

Parents should work together with "sanctified intelligence," White (1985a) suggests. "The husband, wife, and children are a firm" and a "divine institution." Providing prescriptive counsel, she continues,

> The parents are to instruct their children wisely, and patiently, teaching them line upon line, precept upon precept, here a little and there a little. With faith and perseverance they are to educate, train, and discipline, requiring their children to be obedient, allowing no disrespect. Thus the seeds of reverence and respect for the heavenly Father are sown. The home should be a preparatory school, where children and youth may be fitted to do service for the Master, preparatory to joining the higher school in the kingdom of God. (p. 93)

Recognizing the teacher as a partner with parents in the child's moral and academic development, White encourages parents to provide educational environments where the Bible can be taught along with the normal courses. She admonishes parents to team with teachers who are working "for the salvation of their children" (White, 1915b, p. 184). By modeling a spirit of cooperation between themselves in the home, parents prepare children to "be a support to their teachers, and an example and encouragement to their fellow pupils" (White, 1903b, p. 283). Cooperating with the teacher becomes a natural next step for students and parents.

As partners together with teachers, parents are to be especially careful to respect the "one upon whom their [children's] well-being in so great degree depends" (White, 1903b, p. 284). They are to do nothing to "weaken the children's respect" for the teacher. Additionally, White suggests,

> If criticism or suggestion in regard to the teacher's work becomes necessary, it should be made to him in private. If this proves ineffective, let the matter be referred to those who are responsible for the management of the school. (p. 284)

Atmosphere of Nurture

White (1977b) places utmost importance on surrounding children "with an atmosphere of cheerfulness, courtesy, and love." She counsels parents to provide a "home where love dwells and where it finds expression in looks, in words, in acts" so that the home will be a "place where angels delight to dwell." Continuing, she advises:

> Parents, let the sunshine of love, cheer, and happy content enter your own hearts, and let its sweet influence pervade the home. Manifest a kindly, forbearing spirit, and encourage the same in your children, cultivating all those graces that will brighten the home life. The atmosphere thus created will be to the children what air and sunshine are to the vegetable world, promoting health and vigor of mind and body.—CT 115 (1913). (p. 63)

Further cautioning parents on the importance of loving nurture, White (1977b) advises mothers to "speak a word of commendation for the good conduct of her children" whenever they find opportunity to do so. "These [words] will be as sunshine to the heart of a child and will lead to the cultivation of self-respect and pride of character.—3T 532 (1889)" (p. 145).

Ellen White (1903b) counsels mothers as the child's "first teacher" to prepare well for the responsibility of nurturing their children "during the period of greatest susceptibility and most rapid development." However, White recognizes that typically this preparation does not happen. "The one whose influence in education is most potent and far-reaching is the one whose assistance there is least systematic effort" (p. 275), she states. When this is the case, White cautions, there is great loss of opportunity "to mold the character for good" (p. 275).

"Fathers and mothers should carefully and prayerfully study the characters of their children," White (1882, paragraph 8) suggests. Desirable traits should be encouraged, but traits that are "too prominent" should be repressed and restrained. Traits that are deficient should be encouraged so that "harmonious development" may be secured. "This is no light matter," White cautions. Continuing, she specifically addresses the father's responsibility:

> The father may not consider it a great sin to neglect the training of his children; but thus does God regard it. Christian parents need a thorough conversion upon this subject. Guilt is accumulating upon them, and the consequences of their actions

> reach down from their own children to children's children. The ill-balanced mind, the hasty temper, the fretfulness, envy, or jealousy, bear witness to parental neglect. These evil traits of character bring great unhappiness to their possessors. (paragraph 8)

Parents should give special care to "children of quick, passionate disposition," White (1878b) counsels. "Perverse temper should be checked in the child as soon as possible; for the longer this duty is delayed, the more difficult it is to accomplish" (paragraph 2). White suggests guidelines for working with children with such problems in order to avoid ingraining negative patterns:

> They should be dealt with in a particularly kind but firm manner; there should be no wavering or indecision on the part of the parents, in their case. The traits of character which would naturally check the growth of their peculiar faults should be carefully nourished and strengthened. Indulgence of the child of passionate and perverse disposition will result in his ruin. His faults will strengthen with his years, retard the development of his mind, and overbalance all the good and noble traits of his character. (paragraph 2)

Discipline

"The object of discipline," according to White (1903b), "is the training of the child for self-government" (p. 287). "To direct the child's development without hindering it by undue control should be the study of both parent and teacher" (p. 288), she continues, and adds:

> Too much management is as bad as too little. The effort to '"break the will" of a child is a terrible mistake. Minds are constituted differently; while force may secure outward submission, the result with many children is a more determined rebellion of the heart. . . . Those who weaken or destroy individuality assume a responsibility that can result only in evil. While under authority, the children may appear like well-drilled soldiers; but when the control ceases, the character will be found to lack strength and steadfastness. . . . The will should be guided and molded, but not ignored or crushed. (pp. 288-289)

White (1903b) provides counsel on discipline for parents and teachers throughout her writings on child training and education. In the book *Education*, she offers specific advice:

1. "Suspicion demoralizes, producing the very evils it seeks to prevent" (pp. 289-290)

2. "It is better to request than to command" (p. 290)

3. "Rules should be few and well considered; and when once made, they should be enforced" (p. 290)

4. "The greatest wrong done to a child or youth is to allow him to become fastened in the bondage of evil habit" (p. 291)

5. "A child frequently censured for some special fault, comes to regard that fault as his peculiarity, something against which it is vain to strive" (p. 291)

6. "The true object of reproof is gained only when the wrongdoer himself is led to see his fault and his will is enlisted for its correction" (p. 291)

7. "There is wonderful power in silence" (p. 292)

8. "So far as possible, [never make] public the faults or errors of a pupil" (p. 293)

9. "It is better to err on the side of mercy than on the side of severity" (p. 294)

10. "As ye would that men should do to you, do ye also to them likewise' (Luke 6:31)" (p. 292)

11. "The true way of dealing with trial is not by seeking to escape it, but by transforming it" (p. 295).

Teacher Influence and Characteristics

Ellen White wrote entire books to support those who aspire to be teachers. She addressed a wide range of related topics. This section deals with only some of those issues—the ones on which she focused most of her attention.

In 1954 the Ellen G. White Publications released a book titled *Child Guidance.* This book was prepared to benefit teachers and parents in nurturing the growth of the child. It is a 616-page compilation of counsels Ellen White wrote from time to time on this subject. Listed below are the major categories she addressed.

1. The importance of the home and the role of parents
2. Proper ages to begin the child's training
3. Methods of teaching
4. The Bible as a textbook
5. The book of Nature and its practical lessons
6. Teacher preparation and qualifications
7. The importance of obedience, self-control, quietness, respect, reverence, care in handling property, health principles, cleanliness, neatness, order, regularity, and purity
8. Lessons in practical virtues, such as: helpfulness, industry, diligence and perseverance, self-denial, unselfishness, thoughtfulness, economy, and thrift
9. Development of Christian qualities, such as: simplicity, courtesy and reserve, cheerfulness and thankfulness, truthfulness, honesty and integrity, self-reliance, and sense of humor
10. The paramount task of character development

11. Fundamental elements of character development, such as: advantage of early years, power of habit, study age, disposition, temperament, the will as a factor for success, exemplification of Christian principles

12. Discipline—its administration, its faulty applications

13. Development of the mental powers

14. Primary importance of physical development

15. Importance of physical labor and practical training

16. Maintaining physical fitness through nutrition, diet, and temperance in all things

17. Selection of appropriate clothing

18. Preservation of moral integrity

19. Spiritual nurture

20. Preparation for Christ's return

This book *Child Guidance* has served as a handbook for many Seventh-day Adventist teachers. Often it is referred to as a resource on White's comments on a given topic. *Child Guidance* pulls together statements White made in her many manuscripts; whereas, the book *Education* provides a philosophy for education, and it is an original manuscript, not a compilation.

In the book *Education*, White focuses on the role of the teacher in a section called "The Underteacher," signifying that Christ was the Master teacher and all others follow His model. In this section of the book, White addresses three major issues: preparation for the teaching profession, cooperation with other entities in the child's learning environment, and discipline.

Since two of these three areas—cooperation and discipline—have already been discussed, this section will concentrate majorly on *preparation* for the role of a teacher. A subsequent section will provide additional references which will add to the list of teacher characteristics White presents.

Teacher Preparation

Though Ellen White (1903b) recognizes and encourages the importance of a comprehensive education and preparation for teaching, she insists that that alone is not enough. "He who appreciates the responsibility involved in the training of the youth, will realize that instruction in scientific and literary lines alone cannot suffice." Defining what additionally is necessary, White says, "The teacher should have a more comprehensive education than can be gained by the study of books. He should possess not only strength but breadth of mind; should be not only whole-souled but large-hearted" (p. 276).

Without a vital relationship with the divine creator—"He who created the mind and ordained its laws," the one who "can understand its needs [and] direct its development" (pp. 276-277) best—a teacher cannot expect to fulfill the weighty responsibility of molding lives for service on earth and for the life to come (White, 1903b, p. 281; 1923a, p. 581). A dynamic connection with God through the Holy Spirit will empower the teacher to put her students in touch with that same source of energy to empower the mind and soul (White, 1903b, pp. 277-282). In another manuscript, White (1915b) elaborates on this concept:

> If instructors have not the love of Christ abiding in the heart, they are not fit to be brought into connection with children, and to bear the grave responsibilities placed upon them, of educating these children and youth. (p. 104)

Individuals who exhibit this lack are not qualified to deal with human minds, White maintains, and she explains her rationale:

> There is the spirit of their own insubordinate, natural hearts that is striving for the control; and to subject the plastic minds and characters of children under such a discipline is to leave scars and bruises upon the mind that will never be effaced. (p. 104)

White (1898c) offers a methodology for gaining divine empowerment as a teacher. She writes:

> When the teacher will rely upon God in prayer, the spirit of Christ will come upon him, and God will work through him by the Holy Spirit upon the minds of the students. The Holy Spirit fills the mind and heart with sweet hope, and courage, and Bible imagery, and his will be communicated to the students, the words of truth will grow in importance, and assume a breadth and fullness of meaning of which you have never dreamed. The beauty and riches of the word of God have a transforming influence upon mind and character; the sparks of heavenly love will fall upon the hearts of the children as an inspiration. (p. 9)

Every teacher should be a master in the *science of salvation*, according to Ellen White (1915b). "Christ risen from the dead, ascended on high, our living intercessor in the presence of God, is the science of salvation which we need to learn and teach to children and youth" (p. 106). Citing the example of Christ and His self-less service for others, White adds, "This is the work that ever devolves upon every teacher" (p. 106).

The teacher cannot expect to "gain the respect of his pupils" without "revealing in his own character the principles which he seeks to teach them" (White, 1903b, p. 277). Students are quick to detect the false and insincere. "Only as he does this in his daily association with them can he have a permanent influence over them for good" (p. 277).

"Experience in practical life is indispensable" for the teacher. "Order, thoroughness, punctuality, self-control, a sunny temper, evenness of disposition, self-sacrifice, integrity, and courtesy are essential qualifications," White (1903b, p. 277) indicates.

When the teacher values "outdoor exercise, especially in useful labor" as a "means of recreation for body and mind," his example "will inspire his pupils with interest in, and respect for, manual labor" (p. 278). This emphasis on physical fitness and "uprightness of character should be combined with high literary qualifications. . . . No teacher who is satisfied with superficial knowledge will attain a high degree of efficiency" (p. 278).

Never content with "dull thoughts, an indolent mind, or a loose memory," the "true teacher" will "constantly seek higher attainments and better methods. . . . In the work of such a teacher there is a freshness, a quickening power, that awakens and inspires his pupils" (p. 278).

The true teacher exhibits:

1. "aptness for his work"
2. "wisdom and tact required in dealing with minds"
3. acquired "respect and confidence of his pupils"
4. readiness and quickness in discerning and improving "every opportunity for doing good"

- enthusiasm combined with "true dignity"
- self control
- ability to "inspire thought, arouse energy, and impart courage and life"
- "patience and firmness"
- "sympathy and appreciation" (pp. 278-280), White posits.

It is important for the teacher to develop pleasant social relationships with her students and to look for opportunities to demonstrate sympathy and tenderness. Speaking of the contrasting role teachers often assume, White (1903b) says,

> They manifest . . . too much of the dignity of the stern judge. While the teacher must be firm and decided, he should not be exacting or dictatorial. To be harsh and censorious, to stand aloof from his pupils or treat them indifferently, is to close the avenues through which he might influence them for good. (p. 280)

Partiality in favoring some students over others must never occur, White (1903b) cautions. The true test of a teacher's qualifications is proved when she deals with difficult, trying students. "To favor the winning, attractive pupil, and be critical, impatient, or unsympathetic toward those who most need encouragement and help, is to reveal a total misconception of the teacher's work" (p. 280).

The true teacher will be eager to continue learning.

> He will spare no pains to reach the highest standard of excellence. He who discerns the opportunities and privileges of his work will allow nothing to stand in the way of earnest endeavor for self-improvement. . . . All that he desires his pupils to become, he will himself strive to be. (p. 281)

Cooperation in the Classroom

"Co-operation should be the spirit of the classroom, the law of its life," White (1903b, p. 285) posits. In the context of the value of cooperative learning, she establishes the value of the multi-grade classroom and the importance of encouraging self-respect and intrinsic motivation. Adding to her previous comment, she states,

> The teacher who gains the co-operation of his pupils secures an invaluable aid in maintaining order. In service in the schoolroom many a boy whose restlessness leads to disorder and insubordination would find an outlet for his superfluous energy. Let the older assist the younger, the strong the weak; and, so far as possible, let each be called upon to do something in which he excels. This will encourage self-respect and a desire to be useful. (p. 285)

Other Related Issues That Characterize a True Teacher

Regarding methodologies that best foster learning, Ellen White addresses the issue of providing rewards and prizes for accomplishments. Expressing concern especially for students who are already highly motivated, White (1913) says,

> More harm than good results from the practice of offering prizes and rewards. By it the ambitious pupil is stimulated to greater effort. Those whose mental powers are already too active for their physical strength, are urged on to grasp subjects too difficult for the young mind. (p. 270)

Adding another dimension and additional rationale—the negative effect on children who are less capable—White (1938b) proffers,

> The offering of rewards will create rivalry, envy, and jealousy; and some who are the most diligent and worthy will receive little credit. Scholars should not try to see how many verses they can learn and repeat; for this brings too great a strain upon the ambitious child, while the rest become discouraged. (p. 182)

While addressing this same point on a different occasion, White (1885b) commented on the matter of test taking.

> The examinations also are a trying ordeal for pupils of this class [over achievers]. Many a promising student has suffered severe illness, perhaps death, as the result of the effort and excitement of such occasions. Parents and teachers should be on their guard against these dangers. It is unwise to develop the intellectual at the expense of physical powers. (paragraph 16)

Ellen White (1903b) was opposed to teachers requiring students to laboriously crowd "the mind with knowledge, very little of which could be utilized." Not only is such information irrelevant to practical life, it does not model for students the value of the educational process. "The mind thus burdened with that which it cannot digest and assimilate is weakened; it becomes incapable of vigorous, self-reliant effort, and is content to depend on the judgment and perception of others" (p. 230), she says.

Summary of Chapter 3

This chapter addresses the 12 major principles educational specialists on the writings of Ellen G. White identified. These principles are presented in the context of White's perspective—a strongly based Judeo-Christian theology that embraces the foundational concepts of a divine Creator. An overriding theme that is consonant with all White's teachings is the assumption that life on earth is lived amid warring factors—the struggle between good and evil.

Though a cursory view of this body of information might impress the casual reader to consider that White was totally focused on the spiritual aspect of human function, a more in-depth view reveals otherwise. White was an ardent proponent of balance between cognitive, affective, and psychomotor functions in the educational process. Because she embraces an intimate relationship between these three aspects of learning, her writings mirror that philosophical stance. It is difficult to separate out her counsels on physical activity from counsels on mental and spiritual function. Each of these three factors is tied to the other.

White's insistence that God is the source of all power, knowledge, and being also seems to be a mirror of the triad relationship that she promotes in counsels to educators. Total dependence on God empowers totally, she suggests.

Through study of Holy Scripture, prayer, and study of the book of nature, humanity connects with the knowledge of God and light from Heaven. When human beings receive this knowledge from God and light that infuses energy into the brain and body, human potential is maximized—physically, mentally, and spiritually. The whole being is potentiated.

The nature of this potentiation benefits the individual, the individual's environment, and those with whom the individual associates. The influence of this initiated state of ecological balance is promoted and sustained through maintaining a connection with the Creator God. However, the antithesis of God's goodness is an ever-present threat to God's empowerment.

When humanity chooses to separate from the vital connection with God, the balance of life is undermined. Life is drawn into a state of deterioration and ultimate extinction. The triad balance becomes distorted and mutated through self-destructive choice to separate from the Source of Life.

However, when humanity chooses to exercise will power to overcome the influence of evil, moral sinew develops and contributes to supporting the re-creative relationship with God. This relationship is evidenced in service to others, respect for the body as the temple of God and a lifestyle that is productive and beneficial to global community.

It is the privilege of humanity to procreate and to nurture the young in learning of God and His perfect plan for restoring His image in mankind and providing opportunity for all to rise above the detrimental effects of evil which controls life on earth.

CHAPTER FOUR

CROSS-CASE ANALYSIS: EDUCATIONAL BRAIN RESEARCH AND ELLEN G. WHITE'S COUNSELS ON EDUCATION

Introduction

Brain science currently offers new data that may be helpful in aiding educators in better understanding how the brain learns. One hundred years ago, Ellen G. White wrote on similar topics. A comparison of these two bodies of information reveals similarities and differences. This chapter deals with those areas that are "aligned," "somewhat aligned," and others that are "not aligned."

As reported in chapter 1, the two bodies of information being compared appear to be founded on two different philosophical positions. To provide the reader with a context for interpreting the reported data, philosophical differences are reviewed again, but briefly, in the following paragraphs.

Naturalism assumes that the world we know likely came to be as a result of a cataclysmic occurrence billions of years ago, and that man has evolved from elements of matter as a result of chance occurrence. "Some shrink from the conclusion that the human species was not designed, has no purpose, and is the product of mere mechanical mechanisms—but this seems to be the message of evolution" (Johnson, 1995, p. 9).

White's biblical, theistic account of humanity's origin is based on a literal, 6-day creation week in which man was created perfect and in the image of God (White, 1903b, pp. 128-129). She contends that God had a specific plan in mind when, as an act of love, He created humanity (pp. 13-19).

Natural science appears to align with the idea that self-preservation is a major driving force in human existence (Caine & Caine, 1991, p. 61; Sylwester, 1995, p. 43). Ellen White contends that self-preservation ultimately is accomplished through believing in God's ability to preserve mankind, self-sacrifice and love for others (White, 1903b, p. 110). Though White does not contest the idea that in a fallen world, the fittest survive, she counterpositions her counsels to the idea that the fittest survive as a result of self-effort or natural selection apart from empowerment by a loving God. White would likely suggest that the drive for self-preservation may extend life temporarily, but it does not ensure eternal life (White, 1903b, pp. 13-19).

Naturalism holds that life is not dependent on a *vital force* (Johnson, 1995, p. 13; Mautner, 1999, p. 373). Marian Diamond and Robert Sylwester both reference the influence Francis Crick, Gerald Edelman, and others have had on how brain study is contextualized in Darwinian, naturalistic, and/or evolutionist philosophy. On the other hand, White teaches that life on Earth is totally dependent on a supernatural being, who is the source of all life, light, energy, and power (White, 1903b, pp. 99-104, 130-131).

Referring to a U. S. Supreme Court case that considered the issues of creationism and naturalism, Johnson (1993, pp. 7, 8, 28, 122, 125, 127-129, 172, 202) states,

> The National Academy of Sciences told the Supreme Court that the most basic characteristic of science is 'reliance upon naturalistic explanations,' as opposed to 'supernatural means inaccessible to human understanding.' (p. 28)

Reporting further on the National Academy of Science's report (1984) to the Supreme Court, Johnson (1993) indicates that the Academy, which represents the nation's most prestigious scientists, said,

> Creation science is not science, . . . "Creation science" is . . . manifestly a device designed to dilute the persuasiveness of the theory of evolution. The dualistic mode of analysis and the negative argumentation employed to accomplish this dilution is, moreover, antithetical to the scientific method.(pp. 7, 8)

Scientists tend to shy away from immeasurable topics such as emotion, mind, and spirit. Reflecting on the scientific community, Pert (1997) states,

> Measurement! It is the very foundation of the modern scientific method, the means by which the material world is admitted into existence. Unless we can measure something, science won't concede it exists, which is why science refuses to deal with such "nonthings" as the emotions, the mind, the soul, or the spirit. (p. 21)

White's most common topics of discussion are immeasurable concepts. She often refers to the immeasurability of God's love and His sacrifice for humanity. In fact, these two immeasurable concepts are key ideas in her counsels to educators—counsels that are filled with references to love, mind, soul, and spirit. The spiritual element is a pervasive thought in all her writings, whether on health, religion, or education. Formal measurement and quantification are not typical of White's counsels to educators.

Naturalism promotes the idea that "the only way of finding out what conduct is right is by empirical inquiry, mainly in the human, social and biological sciences. Evolutionary ethics is an example (Mautner, 1999, p. 373). In naturalism "there are no inherent moral or ethical laws, no absolute guiding principles for human society" (Johnson, 1993, pp. 126-127). Ellen White speaks of the profound immutability of the Word of God (the Bible) as a depository of all knowledge and wisdom. Scripture, she insists, contains the ultimate standard for moral and ethical guidance.

Modern science offers that "human beings are marvelously complex machines. The individual human becomes an ethical person by means of two primary mechanisms: heredity and environmental influences" (Johnson, 1993, pp. 126-127). Sylwester (1995) summarizes a section in which he also discusses the roles of heredity and enrichment:

> Thus, learning becomes a delicate but powerful dialogue between genetics and the environment: the experience of our species from eons past interacts with the experiences we have during our lifetime. Our brain is powerfully shaped by genetics, development, and experience—but it also then actively shapes the nature of our own experiences and of the culture in which we live. Stimulating experiences create complex reciprocal connections among neural networks. (p. 21)

Ellen White aligns with modern science in that heredity and environmental influences are profoundly contributive to individual growth, development, and ethics; however, she expands upon this concept. In every heart, she explains, exists "not only intellectual but spiritual power, a perception of right, a desire for goodness" (White, 1903b, p. 29). However, against these virtuous properties, she suggests that

> there is struggling an antagonistic power. The result of the eating of the tree of knowledge of good and evil is manifest in every man's experience. There is in his nature a bent to evil, a force which, unaided, he cannot resist. To withstand this force, to attain that ideal which in his inmost soul he accepts as alone worthy, he can find help in but one power. That power is Christ. Cooperation with that power is man's greatest need. (p. 29)

White identifies two forces of power—good and evil—that are influential on every human being. How the individual chooses to relate to these two powers is a life and death issue, she contends. Naturalism, on the other hand, suggests that "naturalistic ethical theory is one in which moral concepts are analysed entirely in terms of natural facts or properties (Mautner, 1999, p. 373).

Modern science concludes "that when we die, we die and that is the end of us" (Johnson, 1993, pp. 126-127). Ellen White teaches that by establishing a positive relationship with God, eternal life is humanity's reward (White, 1947, pp. 388-390, 425-429).

Finally, evolutionistic thought holds that "free will as traditionally conceived—the freedom to make uncoerced and unpredictable choices among alternative possible courses of action—simply does not exist. . . . There is no way that the evolutionary process as currently conceived can produce a being that is truly free to make choices" (Johnson, 1993, pp. 126-127).

A major strand of White's philosophy on education and spirituality is her belief that God created humanity with the "power of choice—the power to yield or to withhold obedience" (White, 1903b, p. 23). God so honored the human will, she explains, that He allowed mankind to exercise the power of choice in a test case of humanity's loyalty to the love of God. Knowing that Adam and Eve could potentially choose to violate the laws of perpetual life, God devised a plan of sacrificial pain on God's part in behalf of humanity. He provided a second chance for man to choose to embrace the ultimate Law of Life—oneness with God. Humanity's degraded condition today is a result of God's willingness to honor the power of choice (White, 1903b, pp. 23-30). White contends that education is all about aiding humanity in making wise choices (White, 1903b, p. 289).

Regardless of the stated differences between the two philosophical positions represented in this study, the exercise of comparing two significant contributors to educational practice offers potential benefit for both entities. Comparing two bodies of data for agreement from two varying perspectives can provide additional knowledge to support or reject aspects of the current knowledge base.

It was not the purpose of this study to defend or deny naturalism or creationism. It is important, however, to recognize the differences and similarities that exist between these two bodies of data and to consider that those similarities and differences could influence the comparative analysis of the two.

Several factors contribute to the rationale for this comparison study: First, the fact that Ellen White's counsels on health science and education have yielded a profound influence in the medical and educational professions is one indicator of the worth of her counsels. Millions of people continue to read and respect White's writings, even 85 years after her death.

Second, large numbers of adherents support both naturalism and creation theories, even though creationists may tend to be less vocal about their position when discussing scientific matters (Johnson, 1995; Sylwester, 1995). Two belief systems are represented in this document, and both are popularly supported in the general public. Neither creation nor evolution is provable. On the premise that both evolution (a term used broadly to refer to naturalism and Darwinian thought) and creation are unproven theories, it is appropriate to analyze two large bodies of information for their similarities and differences.

Third, neuroscience has recently revealed new findings regarding concepts that could be considered a step toward promoting a higher regard for spiritual concepts in science. Emotion and its influence on cognition and health, heart-brain coherence, mind-body connections, and similar topics are now commonly discussed in neuroscience literature. These data, documented by Goleman (1997), Pert (1997), Pribram (1991), Sylwester (1995), Hannaford (1995), and others, provide additional reason for openness to new constructs in conceptualizing cognition. The spiritual element is not so foreign today in science as it was previously as a result of a better understanding of how emotion integrates mind and body.

In summary, having become acquainted with the emerging data issuing from educational brain research and with the writings of Ellen White, principles and themes emerged that were aligned, somewhat aligned, and not aligned. On eight points, brain research and White's counsels show major concurrence: (1) body and mind are integrally related, (2) exercise and movement empower learning, (3) health habits affect learning, (4) emotions and neurochemistry profoundly impact learning, (5) social influences contribute to learning, (6) plasticity and enrichment shape learning, (7) stages of development provide critical periods for brain growth and nurture, and (8) individualism typifies learning.

In eight other areas additional, though less, concurrence is evident: (1) learning is multisensorial, (2) music and the arts facilitate learning, (3) language contributes to brain development, (4) making meaning is a complex, harmonious process, (5) motivation primes learning, (6) memory is a dynamic process resulting from changing stimuli and may occur in locations within the body other than the brain, (7) character development is a desired outcome of the learning environment, and (8) attention is driven by physiological factors as well as levels of motivation. Appendix III provides a chart that shows the alignments between brain research themes and White's principles. Each of the topics listed above is discussed in the following sections.

Aligned Themes From Brain Research and Ellen G. White

This section looks at those themes and principles in educational brain research and Ellen G. White's counsels to educators that are most closely aligned. On these issues the brain educators and Ellen White closely identify with each other. In most cases even terminology and meaning are specific and are easily recognized when the themes and principles are compared.

Body and Mind

A study of brain anatomy and physiology clearly indicates that mind and body function as a dynamic, complex, interdependent network. As Candace Pert explains, the "old Newtonian mechanistic view" has controlled our thinking of the mind and the body as separate entities functioning in a linear, reactive pattern. Her study of neurochemistry has helped establish a reconceptualization of mind and body relationships. The definition of mind and body function that she suggests appears to be endorsed by most of the significant educational brain researchers in this study (Caine & Caine, Diamond, Hannaford, Jensen, Sylwester). Jane Healy is not as specific in addressing this matter; however, she does imply agreement.

"What the mind is," Pert (1997, p. 185) states, "is the flow of information as it moves among cells, organs and systems of the body." Though it is immaterial," she continues, "it has a physical substrate, which is both the body and the brain" (p. 185). It also has a "non-physical substrate" which involves information flow. "The mind . . . is that which holds the network together . . . linking and coordinating the major systems and their organs and cells in an intelligently orchestrated symphony of life" (p. 185).

"Information carriers known as neuropeptides" serve to join the various organs (brain, glands, bone marrow, etc.) in a "multidirectional network of communication," Pert (1997, p. 184) adds. These "molecules of emotion" have a profound influence on linking mind and body.

Caine and Caine (1997a) classify the oneness of mind and body as an important part of what brain research has revealed. The "body and the brain are not separate," they explain. "Peptides—chemical molecules—literally link the nervous system, the endocrine system, and the immune system into a single psychosomatic network" (p. 87).

No longer is it appropriate to split brain and body functions as separate entities, considering the brain as "regulating body functions, and our body providing support services to the brain," Sylwester (1995) echoes. This "duality" has been replaced with an "integrated body and brain system" (p. 75).

Though Ellen White does not use terms such as *neuropeptides, neurotransmitters,* and *molecules of emotion*, she does discuss mind and body in the context of these concepts. "The influence of the mind on the body, as well as of the body on the mind, should be emphasized," she states (White, 1903b, p. 197).

White (1903b) describes the mind and its influence on the body in the context of emotional factors:

> The electric power of the brain, promoted by mental activity, vitalizes the whole system, and is thus an invaluable aid in resisting disease. . . . The power of the will and the importance of self-control, both in the preservation and in the recovery of health, the depressing and even ruinous effect of anger, discontent, selfishness, or impurity, and on the other hand, the marvelous life giving power to be found in cheerfulness, unselfishness, gratitude, should also be shown. (p. 197)

Recognition of the mind as the lead entity in the dynamic relationship between the mind and the body is clearly indicated in White's writings. Speaking about mothers who are not well-informed as to the intimate relationship that exists among all the organs of the body and brain, she states (White, 1913):

> They know nothing of the influence of the body upon the mind, or of the mind upon the body. The mind, which allies the finite to the Infinite, they do not seem to understand. Every organ of the body was made to be servant to the mind. The mind is the capital of the body. (p. 78)

When Ellen White speaks of the moral centers of the brain in relation to mind and body function, she reveals even further awareness of a dynamic relationship between the mind, the body, and the emotions. “Whatever hinders the circulation of the electric current in the nervous system, thus weakening the vital powers and lessening mental susceptibility,” she writes (White, 1903b), “makes it more difficult to rouse the moral nature” (p. 209).

White writes much about how bodily physical activity is critical to brain/mind function. (This will be addressed further in a section that follows.) Probably the strongest point Ellen White makes throughout her counsels to educators, other than the importance of a vital relationship with God, is the critical need for honoring physical, mental, and spiritual functions as a dynamic relationship. One function cannot occur without the other two functions, if wholeness is to exist, she insists.

Exercise and Movement

Brain research data continue to accumulate to support the importance of movement in learning and brain function. As reported in chapter 2, neuroscientists admit to having been “blinded by years of prejudice” to the significance of movement as a strong link between the cerebellum (a movement coordination center in the brain) and “memory, spatial perception, language, attention, emotion, nonverbal cues, and even decision making” (Jensen,1998, p. 84).

Also alluding to a condition of *blindness* in her counsels to educators regarding the importance of moral training and physical activity and learning, Ellen White (1923b) states:

> We should not close our eyes to the defects in the present system of education. In the eager effort to secure intellectual culture, physical as well as moral training has been neglected. Many youth come forth from institutions of learning with morals debased, and physical powers enfeebled; with no knowledge of practical life, and little strength to perform its duties. (p. 71)

On another occasion, White (1932) admonished, "The most astonishing ignorance prevails in regard to putting brain, bone, and muscle into active service. Every part of the human organism should be equally taxed. This is necessary for the harmonious development and action of every part" (p. 296).

As early as 1855 White appears to have been convinced of the importance of physical exercise for learning. "If students will develop brain, bone, and muscle harmoniously," she said, "they will be better able to study and better qualified to cope with the realities of life" (1855/1909c, p. 218).

Diamond (1998), Gardner (1983), Hannaford (1995), Jensen (1998), and Sylwester (1995) concur that movement is a major function of the body and brain. Without movement, we lose capacities to thrive. Movement maintains health and physical fitness; it is a possible aid for reducing violence and behavior problems in schools; and it is critical for stimulating the brain to action. Physical movement strengthens the basal ganglia, cerebellum, and corpus callosum—major portions of the brain.

Similarly, White (1903b) indicates that "the whole body is designed for action; and unless the physical powers are kept in health by active exercise, the mental powers cannot long be used to their highest capacity" (p. 207). "Physical inaction lessens not only mental but moral power" (p. 299), she states.

White (1913) also speaks of physical inactivity engendering behavior problems. She writes:

> A constant strain upon the brain while the muscles are inactive, enfeebles the nerves and gives to students an almost uncontrollable desire for change and exciting amusements. When they are released, after being confined to study several hours each day, they are nearly wild. (p. 288)

Elaborating on this thought, White adds,

> When the brain is constantly taxed while the other organs are left inactive, there is a loss of physical and mental strength. The physical powers are robbed of their healthy tone, the mind loses its freshness and vigor, and a morbid excitability is the result. (p. 295)

Though White refers to only a few of the specific parts of the brain in her counsels to educators and parents, she has much to say about the inter-relatedness between the brain and the body. "A sound body is required for a sound intellect" (White, 1913, p. 287). "Those who give proper attention to physical development will make greater advancement in literary lines than they would if their entire time were devoted to study" (White, 1903b, p. 209).

Because physical activity induces higher intake of oxygen—a necessary element for brain function—memory seems to be enhanced. Additional oxygen intake also increases neurotropins (high nutrient food) in the brain, which is necessary for growth and neuron connections, according to Jensen (1998). As well, such movement stimulates the production of BDNF—brain-derived neurotrophic factor—and other neurotransmitters which enhance cognition (p. 86).

White (1923a) counseled heavily on the importance of exercise in the fresh air and sunshine. This is good for "body and mind" she says. These (pure air, good water, sunshine, beautiful surroundings) are "God's medicine for the restoration of health" (p. 166).

When an insufficient supply of oxygen is taken in, she (White, 1905) cautions,

> The blood moves sluggishly. The waste, poisonous matter, which should be thrown off in the exhalations from the lungs, is retained, and the blood becomes impure. Not only the lungs, but the stomach, liver and brain are affected. The skin becomes sallow, digestion is retarded; the heart is depressed; the brain is clouded; thoughts are confused; gloom settles upon the spirits; the whole system becomes depressed and inactive, peculiarly susceptible to disease. (p. 273)

Restricted movement for children can interfere with normal development, Hannaford (1995) suggests. Long periods of reading "without relaxing the focus" could irritate the eyes and possibly result in enlargement of the eyeball leading to myopia or near-sightedness" (p. 105). Up until the age of 9 the eyeball is still developing to be able to tolerate longer periods of time reading. Before that age the eyeball is not completely shaped with collagen fibers, Hannaford says.

Again, White (1977a) indicated similar concern for the developing child in regard to lack of physical activity. She writes,

> During the first six or seven years of a child's life special attention should be given to its physical training, rather than the intellect. After this period, if the physical constitution is good, the education of both should receive attention. Infancy extends to the age of six or seven years. Up to this period children should be left like little lambs, to roam around the house and in the yards, in the buoyancy of their spirits, skipping and jumping, free from care and trouble. (pp. 149-150)

Compared to current practice in American schools, White assumed an ultra-conservative position regarding the time for a child to enter school. This counsel seems aligned with her concern about schools emphasizing intellectual development over physical and spiritual development. "The only schoolroom for children until eight or ten years of age should be in the open air, amid the opening flowers and nature's beautiful scenery, and their most familiar textbook the treasures of nature" (White, 1913, p. 80). Adding further, White states,

> In the early education of children, many parents and teachers fail to understand that the greatest attention needs to be given to the physical constitution, that a healthy condition of body and mind may be secured. It has been the custom to encourage children to attend school when they were mere babes needing a mother's care. (p. 80)

Hannaford (1995) and Jensen (1998) cite studies which suggest that physical activity for approximately one-third of the school day raises academic performance. Yet, educational systems tend to include physical education in the first cut when budget restrictions arise. Rather than first cut, there is mounting evidence to suggest that perhaps physical education should be the last cut (Jensen, 1998; Sylwester, 1998).

Ellen White (1981/1993d, p. 220) uses the same proportional term of *one-third* as she prescribes the ideal balance of activity in schools.

> If one third of the time now occupied in the study of books, using the mental machinery, were occupied in learning lessons in regard to the right use of one's own physical powers, it would be much more after the Lord's order. . . . The right use of one's self includes the whole circle of human obligations to one's self, to the world, and to God. Then use the physical power proportionately with the mental powers. (p. 220)

Hannaford (1995) indicates that the "more closely we consider the elaborate interplay of brain and body, the more clearly one compelling theme emerges: movement is essential to learning (p. 96). Likewise, White (1903b) indicates, "Since the mind and the soul find expression through the body, both mental and spiritual vigor are in great degree dependent upon physical strength and activity; whatever promotes physical health, promotes the development of a strong mind and a well-balanced character" (p. 195).

Along with this strong emphasis on the importance of exercise and movement, White counsels that rather than encouraging amusements for youth, recreational activities are more beneficial. Amusement, she says, "is sought for the sake of pleasure and is often carried to excess; it absorbs the energies that are required for useful work and thus proves a hindrance to life's true success" (White, 1903b, p. 207). "Recreation, when true to its name, re-creation, tends to strengthen and build up. . . . It affords refreshment for mind and body, and thus enables us to return with new vigor to the earnest work of life" (p. 207).

White places much importance on inclusion of work and practical functions in the curriculum as a means of ensuring balance between mental and physical activity and as a means of tying academic functions to real-life situations (White, 1903b, pp. 214-222). God intended labor to be a blessing to humanity, she suggests. It was meant to provide for "development, power, and happiness" (p. 214). Idleness fosters self-indulgence, and the result is a life empty and barren—a field inviting the growth of every evil" (pp. 215-216).

Health Habits

Nutrition, water intake, oxygen (fresh air), sleep, and exercise are concepts neuroscience promotes as influential on brain/body function. Ellen White indicated the same throughout her writings. This was one of her main emphases to all her audiences and readers, not just to educators.

One of the major health habits that is identified by both the brain educators and Ellen White is exercise and movement. That was discussed in the previous section and, therefore, will not be discussed under health habits.

White addresses 8 specific health habits that maintain health and happiness: pure air, sunlight, abstemiousness, rest, exercise, proper diet, the use of water, and trust in divine power. She proposes that these eight factors are "true remedies" for many of the ailments humanity experiences. These "true remedies" align the individual with nature's laws of "health of body and health of mind" (White, 1958).

Neuroscience touches on the importance of most of these 8 health habits White endorses, except for "trust in divine power." While neuroscience discusses the negative influence of drug abuse, alcohol, tobacco, and other excesses, White emphatically recommends total abstinence from all these substances, and to this list she adds coffee and tea, as well.

Nutrition

"You think what you eat," says Barbara Given (1998). Others (Pert, Jensen, Diamond) echo the importance of nutrition because of its direct relationship to body and brain chemistry. Neurotransmitters that are responsible for transmission of information throughout the body and brain network are dependent on nutritive intake for cognitive processes as well as organ, bone, tissue, cellular, etc., structural support and upkeep.

Pierce J. Howard (1997), author of *The Owner's Manual for the Brain,* states, "It is becoming clearer that our brain influences what and how we eat, and that what and how we eat influences how we think and feel" (p. 70).

Ellen White's counsels on diet and foods agree with brain research emphases with few exceptions. White agrees that good nutrition is vital for body and mind functions, but she also places a strong emphasis on how nutrition influences moral judgment. Overeating, consuming stimulating foods (tea, coffee, meat, condiments, spicy foods, etc.), and irregularity in mealtimes she indicates are detrimental to mental attitude. "Gross and stimulating food fevers the blood, excites the nervous system, and too often dulls the moral perceptions so that reason and conscience are overborne by the sensual impulses" (White, 1977b, p. 322).

White recommends a return to the diet prescribed for humanity in Eden, according to Scripture. "Grains, fruits, nuts, and vegetables, in proper combination, contain all the elements of nutrition; and when properly prepared, they constitute the diet that best promotes both physical and mental strength" (White, 1903b, pp. 204-205).

In contrast to some of the counsels emerging from brain research, which suggest eating small amounts often during the day, White recommends that a regular routine of no more than three meals a day, taken at the same time, is ideal. For adults she suggests two meals a day, with nothing eaten within 5 hours of bedtime. White (1903b) wrote,

> In most cases, two meals a day are preferable to three. Supper, when taken at an early hour, interferes with the digestion of the previous meal. When taken later, it is not itself digested before bedtime. Thus the stomach fails of securing proper rest. The sleep is disturbed, the brain and nerves are wearied, the appetite for breakfast is impaired, the whole system is unrefreshed, and is unready for the day's duties. (p. 205)

Regularity, not just in mealtimes, but in daily routines as well, is an important part of maintaining body and mind health, according to White (1977a). "If the youth would form habits of regularity and order, they would improve in health, in spirits, in memory, and in disposition" (p. 617).

Water

Water is a fundamental building block of the body, comprising approximately 90% of the brain and 76% of the total body weight (Hannaford, 1995). When ample amounts of water are not available to the body and brain, function and efficiency are affected. Though pure water—rather than coffee, tea, soft drinks, or fruit juices—is needed by the body, the average student is dehydrated, according to Jensen (1995), who lists multiple advantages in water's benefits to learning. Adequate water is basic to optimal body and brain function.

Water, White (1897) states, is the "best liquid possible to cleanse the tissues" (p. 226). It is the "beverage God provided to quench the thirst of animals and man. Drank freely, it helps to supply the necessities of the system, and assists nature to resist disease" (White, 1926, p. 151).

Similar to Jensen's comments, White classified coffee and tea as poor choices for satisfying the body's liquid needs because of their caffeine and caffeine-like properties. Brain research, as mentioned above, concurs with White regarding water as being the better choice as a beverage, but the brain research position appears to be based on the data that classify coffee, tea, soda drinks, and fruit juices as diuretics. Today caffeine drinks are sometimes promoted by medical personnel as beneficial for children with certain attentional deficit disorders. White assumes a conservative position in relation to what most consider mild stimulants. She cautions against the common use of caffeinated drinks. Her rationale is discussed further in a following subsection.

Oxygen (Fresh Air)

Without adequate oxygen, carried by the blood, the brain loses consciousness in seconds (Jensen, 1998). Deep breathing is promoted by physical activity, but Jensen (1998) and Hannaford (1995) report that only 36.3% of school children in America have daily physical education classes. Oxygen is critical in the body's processes for breaking down food particles and releasing energy for production of ATP—a needed element in converting food for cell structure support (Hannaford, 1995).

White often cautioned her readers to guard against failure to get plenty of fresh air. She states, the "fashionable life" weakens and "destroys the physical, mental, and spiritual powers." Life in the outdoors, in "the pure air, the glad sunshine, . . . and exercise amid these surroundings" is the only "medicine that many invalids need" (White, 1923a, p. 170). These elements combined with pure water act to restore and maintain health, she suggests.

The body and mind thrive in the open air, White indicates. Fresh air purifies the blood, which sustains the brain and body organs. Good respiration soothes the nerves. Not only are the lungs affected, but the stomach, liver, and brain as well (White, 1977a). Without an ample supply of oxygen, she says, "the skin becomes sallow, digestion is retarded; the heart is depressed; the brain is clouded; thoughts are confused; gloom settles upon the spirits; the whole system becomes depressed and inactive, peculiarly susceptible to disease" (White, 1905, p. 273).

Regarding air polluted by tobacco smoke, White (1897a) made strong comments. Tobacco smoke is especially harmful to small children, she warned. She aligned such poor air quality with the possibility of what now may be classified as Sudden Infant Death Syndrome (SIDS). She states,

> While it [tobacco] acts upon some [infants who are compelled to inhale its fumes] as a slow poison, and affects the brain, heart, liver, and lungs, and they waste away and fade gradually, upon others it has a more direct influence, causing spasms, paralysis, and sudden death. (p. 201)

Though the eight brain research authorities considered in this document do speak of the importance of fresh clean air for optimal brain function conditions, they do not address the same specific complications of tobacco smoke as does Ellen White. However, medical research in the last 2 years contains reports on a number of studies which also seem to point a finger at tobacco smoke and its negative affects on children, especially infants. These reports are similar to White's counsels.

Children often are exposed to second-hand smoke from adults who smoke tobacco. Some research indicates that when this occurs while the child is *in utero* low birth weight probability increases (Jones et al., 1999). These smoke-exposed children may not reach their full intellectual potential, Jones indicates. In addition to this research Young and Fleming (1998) explain that:

> Exposure of babies to tobacco smoke from other members of the household, before and after birth, also increases the risk of death: the greater the exposure the higher the risk (see Figure 1). This figure shows that for every hour of the day that babies habitually spent in a room in which people smoked, the risk of SIDS increased by almost 100 per cent. The risk to babies who spent more than eight hours a day in such a room was more than eight times that to babies who were not exposed to tobacco smoke.
>
> Evidence from at least 24 cohort and case-control studies worldwide, which have investigated the relationship between maternal smoking and SIDS, strongly suggests that smoking is causally related to SIDS4. The population attributable risk of 61.2 percent found in the CESDI SUDI investigation implies that the number of deaths from SIDS in the UK could be reduced by almost two thirds if parents did not smoke.

Clearly, the body's and brain's need of pure fresh air is uncontested in the area of neuroscience and in Ellen White's writings. In both bodies of data, it is promoted as an important part of learning and maintaining body and brain function.

Sleep (Rest)

Sleep is critical for creating, editing, and erasing memories (Sylwester, 1995). It is vital for refreshing energy stored in the body and brain. Rapid Eye Movement (REM) is thought to be an important function in the brain's processing of the day's events and the developing, maintaining, and retrieving of long-term memory (Hannaford, 1995; Jensen, 1995; 1998; Sylwester, 1995). Regular sleep habits of adequate amounts of sleep promote "circadian rhythm" patterning that regulates body functions during sleep time (Howard, 1997, p. 94).

Ellen White strongly recommends that sleep best benefits the body and mind when it begins about two hours before midnight. In order to have a clear and balanced mind, proper rest is important, she says. "Since the work of building up the body takes place during the hours of rest, it is essential, especially in youth, that the mind may not become unbalanced and excited from being subjected to a constant strain" (White, 1884, paragraph 10).

White differs with some educational brain researchers who suggest that high-school-age youth should be accommodated with school schedules that begin later in the morning because these youth have sleep pattern variations that require such accommodation. White indicates that intemperate use of time in the evening hours causes youth to prefer longer sleep hours in the morning. She states, "How prevalent is the habit of turning day into night, and night into day. Many youth sleep soundly in the morning, when they should be up with the early singing birds and be stirring when all nature is awake" (White, 1954, p. 111). White does not refer to neurological or developmental causes for variations in sleep patterns for youth as compared to other ages, other than a need for more sleep in the earlier years when growth is a major factor in development.

Abstemiousness and Temperance

Ellen White has much to say about health habits in regard to *abstemiousness and temperance*. Not as much attention is given to these concepts in the brain research. However, neuroscience does have a considerable amount to say about the negative effects of drug abuse (alcohol, tobacco, and other drugs) on the brain. In oral presentations

Marian Diamond often projects slides of autopsied brains that reveal the damaging effects of alcohol and drugs on the brain.

Though brain research findings are not focused on total abstinence from stimulants used commonly—coffee and tea—White does take a definitive stand on these issues. Such stimulants are mild forms of narcotics, she indicates. Coffee, she says, "temporarily excites the mind . . . but the after-effect is exhaustion, prostration, paralysis of the mental, moral, and physical powers." Explaining the effect on the nerves, she says, "The mind becomes enervated, and unless through determined effort the habit is overcome, the activity of the brain is permanently lessened" (White, 1949, p. 34). Without considering the long-term disadvantages to using stimulants such as tea and coffee, White (1905) says, the effects these substances have on the body and brain may appear beneficial.

> The nerves of the stomach are excited; these convey irritation to the brain, and this in turn is aroused to impart increased action to the heart and short-lived energy to the entire system. Fatigue is forgotten; the strength seems to be increased. The intellect is aroused, the imagination becomes more vivid. (p. 326)

But, these are mild forms of narcotics, White (1938a, p. 430) explains, and they are "injurious alike to the brain and to the other organs of the body." White lists coffee and tea at the beginning of an ordered list of stimulants that are increasingly more harmful: Tea, coffee, tobacco, alcoholic drinks. Tea and coffee, she cautions, develop an appetite for tobacco and liquor (White, 1926, 1938a, 1949). All forms of tobacco and alcohol consumption were condemned by White as detrimental to health. She placed these substances at the extreme negative side on a continuum of properties taken into the body.

White assumes a conservative position in relation to all bodily intake, even of healthful substances. She maintained that excessiveness in even the positive nutrients for the body and brain are objectionable. Overeating "even of food of the right quality, will have a prostrating influence upon the system, and will blunt the keener and holier emotions" (White, 1938a, p. 55).

Trust in Divine Power

Though current brain research is saturated with relatively new information on the importance of emotional/social factors in cognition—to some extent related to the spiritual element to which White refers—and though brain research promotes the triad relationship between physical, mental, and emotional/social function, it does not recognize a divine Creator.

Eric Jensen (2000) does provide a brief reference to morality and its impact on learning. However, he stops short of saying that a connection with a higher power is empowering.

> The ethical, spiritual, and moral values that a child's family holds is going to impact what, when, how, and why a child does or doesn't learn something. . . . Positive messages conveyed by a family's moral values can give learners a feeling of empowerment, internal reward, and self control. (p. 75)

As mentioned previously, brain researchers typically imply a bias toward naturalistic thinking and evolutionary biology, which excludes the concept of a "vital force" from outside the material body. However, research such as that being conducted at Institute of HeartMath (IHM) draws attention to emotional and attitudinal factors that are powerfully influential in brain and heart function. These studies were reported at a 1998 brain symposium at University of California, Berkeley, conducted by Dr. Marian Diamond and associates, and they are referenced in studies currently being conducted at

Harvard University in the "Zero Tolerance" case studies. The Harvard project is focused on studying ways schools in various state educational systems, that have adoped "zero tolerance" policies, are controlling the tendency toward violence and other emotional outbursts among youth (Harvard University, 2000). HeartMath consultants train teachers and students to concentrate on controlling the negative emotional conditions of the heart. Trainees practice controlling anger through willful concentration on thoughts of love, compassion, care, and concern rather than defensiveness and reactive aggression.

Whereas, Institute of HeartMath encourages dependence on self to control emotion, Ellen White promotes the idea that by connecting with the divine source of love the human element is infused with power that aids in self-control and provides a beneficial, life-giving spirit (White, 1977a, p. 760).

Not only does White indicate that trust in God has affective benefit for mind and body health, she implies that trusting in God can connect the human mind with the mind of God, which she describes as the source of all truth, wisdom, knowledge, power, and life. Through belief and trust in God the individual receives dynamic power (light) which maximally potentiates mental, physical, and spiritual processes, White (1903b, p. 30) posits. Describing the effect of the "light" to which White speaks, and referring to scriptural texts, she (White, 1979b) states,

> He who commanded the light to shine out of darkness sheds light into the mind of every one who will properly behold Him, loving Him supremely, showing unswerving faith and trust in Him. His light shines into the chambers of the mind and into the soul temple. The heart is filled with the light of the knowledge of the glory that shines in the face of Jesus Christ. And with this light comes spiritual discernment. (p. 135)

Adding yet another dimension to the healthful properties she attributes to trusting in divine Power, White suggests that such connection—belief and trust in God—endows the individual with eternal life. In fact, again referencing Scripture, White indicates that by believing and trusting God, the individual has access to eternal life at the very moment of belief. "The gates of eternal life are thrown open to all who believe on Jesus Christ. . . . In dying, Jesus has made it impossible for those who believe on Him to die eternally" (1988a, p. 345).

At another time, and beginning with reference to Scripture, White (1988a) writes,

> "In him was life; and the life was the light of men." It is not physical life that is here specified, but eternal life, the life which is exclusively the property of God. The Word, who was with God, and who was God, had this life. Physical life is something which each individual received. It is not eternal or immortal; for God, the Lifegiver, takes it again. . . . But the life of Christ was unborrowed. No one can take this life from Him. "I lay it down of myself," He said. . . . This life is not inherent in man. He can possess it only through Christ. He cannot earn it; it is given him as a free gift if he will believe in Christ as his personal Saviour. "This is life eternal, that they might know thee the only true God, and Jesus Christ, whom thou hast sent" (John 17:3). This is the open fountain of life for the world. (p. 261)

Throughout her writings Ellen White majors on the power of the "light" that comes to the human mind when belief and trust in God is exercised. This concept is absent in the writings of the educational brain researchers.

In summary, brain educators and Ellen White both agree that health habits—diet and nutrition, ample amounts of water, oxygen, and sunlight, plenty of sleep with regularity, and exercise—play critical roles in promoting and maintaining brain/body function. In addition, Ellen White includes total abstinence from stimulants, an even stronger emphasis on regularity in schedule, and trust in divine power as other equally important factors. Brain research recognizes all of these concepts to some extent, except *Trust in Divine Power.*

Emotions and Neurochemistry

The concept of emotion semantically elicits various meanings, both positive and negative. In the past, emotion has often been referred to as an undesirable aspect of human function—especially when contrasted with rational thought. However, with the new data from neuroscience relative to the nature, origin, and function of emotion, it is now recognized as an important part of cognitive function (Caine et al., 1999; Diamond & Hopson, 1998; Hannaford, 1995; Healy, 1990; Jensen, 1998; Pert, 1997; Sylwester, 1995).

Though neuroscience today recognizes that the affective nature of emotion is difficult to accurately describe and to quantify, it provides data to indicate that emotion involves much more than uncontrollable and unpredictable passion. Brain research now defines emotion as the product of a biochemical system (Pert, 1997). This system creates, transports, and assigns function to molecules of neurochemistry that regulate and influence body function (Sylwester, 1995). From the biochemistry of the body and brain, emotion evolves (Pert, 1997).

Though historically emotion has been recognized as a part of brain function, it has often been diminished to a position of lesser importance than rational thought. Behaviorists have attempted to deal with emotion by trying to find ways to quantify it, as they have maintained a distinctive separation between emotion and thinking (Caine, 1991). However, because of recent focus on the function of emotion within the neurochemistry of the body and brain, neuroscience now refers to an emotional/cognitive continuum. Brand (1999), suggests that cognition without emotion would preclude memory and learning. Adding to this concept, Caine, Caine, and Crowell (1999) state, "Emotion and cognition interact, energize, and shape each other. It is useful and appropriate, at times, to speak of them separately, but they are inseparable in the brains and experiences of learners" (p. 30).

Referring to LeDoux's (1996) analysis of the anatomy of an emotion, Jensen (2000) states,

> LeDoux argues that emotions or "arousal" is important in all mental functions and "contributes significantly to attention, perception, memory, and problem solving." In fact, "without arousal," he continues, "we fail to notice what is going on—we don't attend to details. But too much arousal is not good either."

In the past emotion has been thought of as separate from thinking. Jensen (2000) comments,

> The old way of thinking about the brain is that mind, body, and feelings are separate entities, but there's really no division between these functions. Our emotions help us to focus our reason and logic. Our logical side may help us, for example, set a goal, but it is our emotional side that provides the passion to persevere through trying times. Certainly excessive or undisciplined emotions can harm our rational thinking, but a lack of emotion can also make for equally flawed thinking, Damasio (1994) reminds us. (p. 199)

At times Ellen White refers to emotion as separate from higher level thinking (White, 1977b, p. 326). She writes about emotion as both a potentially negative element *and* as an integral part of the thinking process. In addition, she seems to imply that there are at least two levels of emotion: one that is unguided by moral judgment, and another that is subjected to moral judgment.

Often White indicates that emotion is constantly changing and is not a reliable foundation upon which to base trust. "There are thousands who are being deceived by trusting to some special emotion, and discarding the word of God. They are not building upon the only safe and sure foundation—the word of God" (White, 1895b, paragraph 3). Speaking to ministers who play on emotion without emphasizing the Word of God, she says, "When the emotion has passed away, it will be found that the Word of God has not been fastened upon the mind" (White, 1946b, p. 279).

Speaking to the point that emotion is not a suitable anchor for trust, White (1973) states,

> At times a deep sense of our unworthiness will send a thrill of terror through the soul, but this is no evidence that God has changed toward us, or we toward God. No effort should be made to rein the mind up to a certain intensity of emotion. We may not feel today the peace and joy which we felt yesterday; but we should by faith grasp the hand of Christ, and trust Him as fully in the darkness as in the light. (p. 84)

Referring to the functions of the limbic area of the brain or the mid-area system, Paul MacLean (1978) suggests that this area cannot read or write, but that it creates feelings that tell us what is true, and real, and important. As human beings we have a tendency to believe what we feel, he says.

White (1977b) counsels that emotions should be subjugated to higher mental powers because they are capable of controlling the mind. In a discussion regarding the forces of Good and Evil, she cautions concerning the need to control the emotions because of their ability to shape thinking:

> He [Satan] will endeavor to excite the emotions, to arouse the passions, to fasten the affections on that which is not for your good; but it is for you to hold every emotion and passion under control, in calm subjection to reason and conscience. Then Satan loses his power to control the mind. (p. 31)

Some of the passions and emotions to which White (1977a) refers are: "jealousy, envy, hatred, malignity, revenge, lust, and ambition that surge through the soul" (p. 526). These, she indicates, result from the influence of "spiritual evil in our characters. [These] natural tendencies are to be overcome . . . and the will placed wholly on the side of Christ" (White, 1961, p. 87). "Every thought of your mind, every emotion of your soul, every word of your tongue, every act you perform, is seed that will bear fruit for good or evil" (White, 1855/1909b, p. 63).

Further describing the feelings that drive us, White (1899, paragraph 7) speaks of "conflicting emotions" that struggle for supremacy in the mind. She advises against allowing feeling to take the place of thought. White (1988b) counsels that

> God would have all move calmly, considerately, choosing our words in harmony with the solid truth for this time, which requires to be presented to the mind as free from that which is emotional as possible, while still bearing the intensity and solemnity that it is proper it should bear. We must guard against creating extremes, guard against encouraging those who would either be in the fire or in the water. (p. 292)

Just as brain research indicates there is a dynamic, integrated relationship between emotion and the mind and body, so White similarly speaks of this merged relationship. However, she does this from a perspective of spiritual emphasis.

Though White often speaks of the harmonious relationship between mental, physical, and spiritual powers, she also suggests a hierarchical relationship between mental, emotional, and spiritual influences as a result of divine influence. "God's Spirit moves upon the mind and controls the emotions of the soul" (White, 1981/1993d, p. 236). Aligned with her suggestion that emotions are constantly changing and cannot be trusted as consistent, she contrasts the influence of divine love. She writes, "The Spirit of God alone can make a lasting impression on the mind" (White, 1896a, paragraph 11), and He does this via love.

Describing love, White (1900e) says,

> This love [the love of God] is more than an impulse, an emotion. It is a living, active working principle. It is not guided by the feelings, but by the will. In it is comprehended the stern resolve of a mind subdued and softened, which lays hold of the strength of the Infinite, saying, I will serve Thee even unto death. (paragraph 4)

Love is commonly accepted as an emotion. However, according to White it is more than an emotion because it is influenced by the will. Pert (1997) seems to indicate a similar inference as does White in respect to emotion and its affiliation with willpower. Pert discusses a meeting she had with Paul MacLean, the National Institute of Mental Health researcher who popularized the concept of the triune brain theory and the limbic brain as the seat of emotions. Pert and MacLean spoke about the "fact that opiate receptors are by far the densest in the frontal lobes of the cerebral cortex of the human brain, which share many inter-connections with the amygdala, one of the so-called limbic structures" (p. 134). The frontal lobes are commonly believed to be the seat of planning and other leadership functions (Diamond & Hopson, 1998;Pert, 1997; Sylwester, 1995). Reflecting on this conversation with MacLean, Pert states:

> I thought about the physiological and biochemical pathways that had had to be forged between that cortex and the rest of the brain to enable humans to learn to control their emotions and act unselfishly. . . . Willpower is the uniquely human "ghost in the machine," and Paul [MacLean] was sure that it resided only in the frontal cortex. (p. 135)

Pert's and MacLean's reference to controlled, unselfish emotion and the role of willpower in the context of emotion and neurochemistry seem related to White's description of love. This will-shaped something, which White refers to as a "living, active, working principle" is a curious combination of descriptors. White (1953/57, vol. 5) provides further definition of this powerful construct:

> Love is not simply an impulse, a transitory emotion, dependent upon circumstances; it is a living principle, a permanent power. The soul is fed by the streams of pure love that flow from the heart of Christ, as a well-spring that never fails. O, how is the heart quickened, how are its motives ennobled, its affections deepened, by this communion! Under the education and discipline of the Holy Spirit, the children of God love one another, truly, sincerely, unaffectedly—"without partiality, and without hypocrisy." And this because the heart is in love with Jesus. (p. 1140)

White (1953/57, vol. 5) places this special power she calls love in juxtaposition with a counter force—selfishness.

> The love of Christ in the heart is what is needed. Self is in need of being crucified. When self is submerged in Christ, true love springs forth spontaneously. It is not an emotion or an impulse, but a decision of a sanctified will. It consists not in feeling, but in the transformation of the whole heart, soul, and character, which is dead to self and alive unto God. (p. 1100)

Considering Paul MacLean's description of the prefrontal cortex (what he considers to be the seat of willpower) and its linkage with the amygdala (Pert, 1997, pp. 134-135) and comparing this to Ellen White's curious description of love provides reason for further investigation. White's explanation of *divine love* as a higher-ordered power, which rises above emotion and links with firm resolve or willpower, seems somewhat congruent with MacLean's thoughts.

Is love, or the absence of it, the governor of biochemical emotion? Is it a strange positive attractor that potentiates human existence as White seems to indicate? And could an antithesis of love—selfishness—confound emotions and the biochemistry of the body and brain? Was Pert (1997) touching on similar considerations when she said, "Although the capacity for learning is to some extent present in even the simplest creatures, willpower is the uniquely human 'ghost in the machine,' and Paul [MacLean] was sure that it resided only in the frontal cortex" (p. 135). These questions are intriguing and perhaps are worthy of future study.

Pert (1997), a respected biochemist at a recognized research center, poses a question and provides her own answer: "Where does the intelligence, the information that runs our bodymind come from? . . . It cannot belong to the material world we apprehend with our senses, but must belong to its own realm, one that we can experience as emotion, the mind, the spirit—an inforealm! . . . [*Some*] call it God" (p. 310, italics supplied).

The questions posed above lead to a review of several other issues neuroscience is now offering regarding the role of neurochemistry and brain function: (1) that emotion and neurochemistry are profoundly influential throughout the entire body and brain; and (2) that emotion's effect on the body and brain holds profound implications for body/mind health, especially the immune system

Emotion's Influence on the Body and Brain

Candace Pert's discovery of the opiate receptor was a significant find in the field of biochemistry. Subsequent research has revealed that the information transfer that takes place at the synaptic gap is only one part of the neurochemical communication network within the body and brain. According to Pert (1997), her associate researcher—Miles Herkenham—estimated that "less than 2 percent of neuronal communication actually occurs at the synapse" (p. 139). Receptor sites located on cell bodies are where the majority of information is received. At these sensory input sites located throughout the body and brain there is a "high concentration of neuropeptide receptors"—nodal points, or hot spots—"where a great deal of information converges" (p. 142).

The cells' receptor sites are believed to be specialized—each to receive a particular neuropeptide—emotion carrier. As this information is received, it is "carried by axons and dendrites from many nerve cell bodies that are passing near or making synaptic contact with each other" (p. 142).

The neuropeptides process information, prioritize it, and bias it to "cause unique neurophysiological changes," Pert (1997) states. "Emotions and bodily sensations are . . .

intricately intertwined, in a bidirectional network in which each can alter the other" (p. 142), she adds.

As sensory input undergoes the neuropeptide filtering process, Pert explains, it migrates across "one or more synapses, eventually (but not always) reaching the areas of higher processes, like the frontal lobes. . . . There the sensory input . . . enters our conscious awareness" (p. 142). The quantity and quality of the receptors at the nodal points determine the "efficiency of the neuropeptide filtering process, which chooses what stimuli we pay attention to at any given moment" (p. 142).

The brain, says Pert, can be thought of in terms of filtering and storing this sensory input, but also for "associating it with other events or stimuli occurring simultaneously at any synapse or receptor along the way—that is, learning" (p. 142). Diamond (1998), Hannaford (1995), Healy (1994), Jensen (1998), and Sylwester (1995) also reference research that concurs conceptually with Pert's discussion of the interconnectedness of body, brain, and emotion.

White also concurs with these findings. Though she is not always specific in referring to emotion's role in the body/brain network, a broad perspective on her writings reveals agreement. "The brain nerves which communicate with the entire system are the only medium through which Heaven can communicate to man and affect his inmost life," White (1977b, p. 73) states. "Whatever disturbs the circulation of the electric currents in the nervous system lessens the strength of the vital powers, and the result is a deadening of the sensibilities of the mind" (White, 1952b, p. 148).

White (1981/1993c) indicates that emotions are fickle and can be negatively influential on body and mind.

> The Word must enlighten the mind as to the true character of the emotions, for they are often changeable, and very unreliable. As long as feeling in no way takes the lines of control, and interferes with the healthful life of the human agent in religious experience, there is no danger. The emotions are not always misleading; but as soon as they take control of the soul, body, and spirit, they must be sensibly considered and restrained. Feelings are no guide; they are ever to be kept under the control of a firm, intelligent principle, in conformity to the divine will; the balance of the mind needs to be preserved. (p. 391)

Emotion and Immunity

Pert references Mayo Clinic's Dr. Elmer Green, a pioneer in biofeedback for treatment of disease. Green postulates,

> Every change in the physiological state is accompanied by an appropriate change in the mental emotional state, conscious or unconscious, and conversely, every change in the mental emotional state, conscious or unconscious, is accompanied by an appropriate change in the physiological state. (Pert, 1997, p. 137)

White also refers to this symbiotic relationship between the body and brain and its neurochemistry. Addressing the topic of *Imagination and Illness*, White (1977a) advises regarding psychosomatic reality:

> The mind needs to be controlled, for it has a most powerful influence upon the health. The imagination often misleads, and when indulged, brings severe forms of disease upon the afflicted. Many die of diseases which are mostly imaginary. (p. 681)

On another occasion, White (1977a) addressed the powerful influence of fear and other disequilibrating emotions upon those who are ill.

> Those who minister to the sick should understand the importance of careful attention to the laws of health. Nowhere is obedience to these laws more important than in the sickroom. Nowhere does so much depend upon faithfulness in little things on the part of the attendants. In cases of serious illness, a little neglect, a slight inattention to a patient's special needs or dangers, the manifestation of fear, excitement, or petulance, even a lack of sympathy may turn the scale that is balancing life and death and cause to go down to the grave a patient who otherwise might have recovered. (p. 477)

Referring to the converse effect—the body's effect on emotions, White (1923a) states, "Intemperance in eating, even of food of the right quality, will have a prostrating influence upon the system and will blunt the keener and holier emotions" (p. 123).

Green's explanation of an integrated physiological-emotional network is no longer a unique concept among only a few neuroscientists. Research data accumulate daily to support his and related positions suggesting that "neuroscience, endocrinology, and immunology, with their various organs—the brain; the glands; and the spleen, bone marrow, and lymph nodes—are actually joined to each other in a multidirectional network of communication, linked by information carriers known as neuropeptides" (Pert, 1997, p. 184).

Pert (1997) suggests that the mind is "that which holds the network together, often acting below our consciousness, linking and coordinating the major systems and their organs and cells in an intelligently orchestrated symphony of life" (p. 185). The old Newtonian paradigm, which depicts the organism in mechanistic terms, is no longer applicable, Pert says. Though there is some linearity in brain function, "it's not a matter of energy acting on matter to create behavior." A more dynamic process is in operation. "There is an intelligence running things" in the form of information (p. 185). Walter B. Cannon referred to this as the "wisdom of the body."

Ellen White (1958) proposes that God is the intelligence running things in all of His creation. "God 'is the fountain of life.' Not only is He the originator of all, but He is the life of everything that lives" (p. 164) she explains. Adding further, she states:

> A mysterious life pervades all nature—a life that sustains the unnumbered worlds throughout immensity, that lives in the insect atom which floats in the summer breeze, that wings the flight of the swallow and feeds the young ravens which cry, that brings the bud to blossom and the flower to fruit.

> The same power that upholds nature, is working also in man. . . . The laws that govern the heart's action, regulating the flow of the current of life to the body, are the laws of the mighty Intelligence that has had the jurisdiction of the soul. (p. 164)

Again and again throughout her writings, White reiterates the sanctity of the balance God has established in life—balance between mind, body, and emotion.

> From Him all life proceeds. Only in harmony with Him can be found its true sphere of action. For all the objects of His creation the condition is the same—a life sustained by receiving the life of God, a life exercised in harmony with the Creator's will. To transgress His law, physical, mental, or moral, is to place one's self out of harmony with the universe. (p. 164)

One of the most specific references White (1977b) makes in connecting emotion and immunity she wrote in 1905.

> The love which Christ diffuses through the whole being is a vitalizing power. Every vital part—the brain, the heart, the nerves—it touches with healing. By it the highest energies of the being are roused to activity. It frees the soul from the guilt and sorrow, the anxiety and care, that crush the life-forces. With it come serenity and composure. It implants in the soul joy that nothing earthly can destroy—joy in the Holy Spirit—health-giving, life-giving joy. (p. 205)

Pert (1997), Karl Pribram and the Institute of HeartMath (as cited in Diamond, 1998, p. 127), Goleman (1997), and others specifically speak of the influence of emotion on the heart and the immune system. Diamond, Sylwester, Jensen, and Hannaford refer to related concepts. White (1952b) also establishes this connection. She aligns immunity with the role that Love Himself (Christ) plays in sustaining life and health. She offers,

> The Savior in His miracles revealed the power that is continually at work in man's behalf to sustain and to heal him. Through the agencies of nature, God is working, day by day, hour by hour, moment by moment, to keep us alive, to build up and restore us. When any part of the body sustains injury, a healing process is at once begun; nature's agencies are set at work to restore soundness. But the power working through these agencies is the power of God. All life-giving power is from Him. When one recovers from disease, it is God who restores him. (p. 135)

"The healing oil of love removes . . . disease and soreness of . . . wrong," White (1982, p. 106) counsels. Quoting Scripture, she states, "A merry heart doeth good like a medicine. Proverbs 17:22" (White, 1952b, p. 151).

In summary, clearly there is alignment between brain science and Ellen White in reference to some emotional aspects of the human experience. There will be further discussion of the emotional component in the final chapter.

Social Influences

In the past the brain was considered to be relatively unchangeable from birth through death, except for the increase in size which takes place with most organs as the individual matures. For many years cognitive potential was believed to be determined by heredity. However, brain research studies within the last 25 years indicate that the brain's intellectual quality can be improved through enrichment—opportunities to stimulate the brain and thus encourage growth. This concept will be reviewed more specifically in a following section titled *Plasticity and Enrichment.*

Social influences play a major role in providing variety and stimulation in the environment. At the youngest ages, an infant is exposed to social experiences that indelibly impress the brain and mind. Both animate and inanimate objects gradually become meaningful and serve to develop mental schema that allow the growing child to make meaning in the new world he experiences (Diamond & Hopson, 1998; Hannaford, 1995; Healy, 1990).

Brain research approaches these influences by addressing topics such as the *nature versus nurture debate, plasticity and enrichment, language, stages of* *development*, and *making meaning*. Each of these topics is discussed in chapter 2 and is reviewed in subsequent sections of this chapter.

One of the most significant social influences on the young brain occurs at a time when the brain is most impressionable. Parents, even before the child is born, influence the ways a child's brain will function in capacities such as: adjustment to learning, attention spans, attitudes, connective thinking, enrichment, health habits, imitation, language skills, listening skills, values, problem-solving abilities, self-confidence, self-assertiveness, etc.

Diamond (1998), Hannaford (1995), and Healy (1990) give considerable attention to these aspects of parental influence. They also speak to similar influences teachers bring to bear on children as young minds are molded by the adult world. Diamond directs specific attention to the importance of avoiding the use of drugs, alcohol, and other substances known to be detrimental to the unborn and the young child. She impresses audiences with graphic slides of autopsied brains from children born of parents who used these abusive substances and with slides that show the direct effects of these substances on the abuser individually.

Ellen White had much to say about social influences that influence brain development and function. Six of the twelve principles identified in her educational counsels relate specifically to social influences. They are: character development; service; harmonious development of physical, mental, and spiritual powers; work and practical functions; parental influence; and teacher characteristics and influence.

White wrote entire books—4 major ones—to support parents and teachers in their important role of child nurture. The parental role, she says, is of highest importance and value because parents represent God to the developing child (White, 1903b, pp. 33, 40). Parental nurture is one of the first of the social influences that impact the child's developing brain.

"The child's first teacher is the mother," White (1903b) writes. She adds,

> During the period of greatest susceptibility and most rapid development his education is to a great degree in her hands. To her first is given opportunity to mold the character for good or for evil. She should understand the value of her opportunity, and, above every other teacher, should be qualified to use it to the best account. Yet there is no other to whose training so little thought is given. The one whose influence in education is most potent and far-reaching is the one for whose assistance there is the least systematic effort. (p. 275)

Because of this deep concern over the proper training of parents to perform their function effectively, White wrote volumes to meet this need. She often spoke of the profound influence parents have upon the developing child, even before birth.

Not only did White speak to mothers, she also addressed counsels to fathers. "Upon fathers as well as mothers rests a responsibility for the child's earlier as well as its later training, and for both parents the demand for careful and thorough preparation is most urgent" (p. 276), she writes, and then prescribes a course of preparatory action.

> Before taking upon themselves the possibilities of fatherhood or motherhood, men and women should become acquainted with the laws of physical development—with physiology and hygiene, with the bearing of prenatal influences, with the laws of heredity, sanitation, dress, exercise, and the treatment of disease; they should also understand the laws of mental development and moral training. (p. 276)

White's counsels to teachers are equally as direct as to parents. "Instruction in scientific and literary lines alone cannot suffice," she states. "The teacher should have a more comprehensive education than can be gained by the study of books. He should possess not only strength but breadth of mind; should be not only whole-souled but large-hearted," White (1903b, p. 276) counsels.

Listing specific qualities of a good teacher, White (1903b) states, "Experience in practical life is indispensable. Order, thoroughness, punctuality, self-control, a sunny temper, evenness of disposition, self-sacrifice, integrity, and courtesy are essential qualifications" (p. 277). Another of her lists of teacher qualities includes even more characteristics of a good teacher: "aptness for his work," "wisdom and tact required in dealing with minds," acquired "respect and confidence of his pupils," readiness and quickness in discerning and improving "every opportunity for doing good," enthusiasm combined with "true dignity," self control, ability to "inspire thought, arouse energy, and impart courage and life," "patience and firmness," and "sympathy and appreciation" (White, 1903b, pp. 278-280).

In the voluminous pages Write wrote to educators, the recurrent theme is the importance of the development of the whole person. True education, she says, is the "harmonious development of the physical, mental, and spiritual powers" (White, 1903b, p. 13). This resounding message reminded teachers and parents again and again of the importance of nurturing the whole child. This message was her standard, her counsel, and her measuring stick for the worth of work done by teachers and parents.

Another strongly emphasized point White makes throughout her counsels to parents and teachers, regarding the importance of the social experience for the developing mind, is the matter of service to others. "Unselfishness underlies all true development," she states. "Through unselfish service we receive the highest culture of every faculty. More and more fully do we become partakers of the divine nature" (White, 1903b, p. 16). White counseled that service to others, rather that self-indulgence found in amusement, was a more worthy aim. She indicates that service to others is the "same law of service [that is] written upon all things in nature. . . . Lake and ocean, river and water spring—each takes to give" (White, 1903b, p. 103). Likewise, she suggests, we become a benefit to humankind when we embrace a spirit of service. And in doing so, the benefit returns to us.

The affective response to the felt needs of others is inspired by a Higher Power, White suggests, and it should be viewed as an opportunity, not an obligation. The spirit of service must pervade parents' and teachers' mentalities, and they must train children to assume the same global attitude (White, 1903b, p. 268).

Another common issue on which Ellen White counsels parents and teachers, regarding the social development of children, is the importance of work and practical functions. She regards this phase of educational development so highly, she suggests that if one has to be eliminated—textual study which deprives the body of physical activity or practical experience—practical experience should be dropped last (White, 1923a, p. 180). White advocated a balanced curriculum, but her emphasis here was to focus on the need for balance and on the importance of making education relevant to life the student will meet after leaving school.

Though brain science educators do address the important role of experiential learning, they do not stress the value of work and practical functions to the extent that Ellen White does in her counsels. However, increased emphasis on the importance of physical activity in learning may eventually lead to a greater emphasis on practical function and experiential learning.

Diamond (1998), Hannaford (1995), Healy (1990), and Jensen (1998) all discuss television and electronic media and their effect on learning. A major concern is that excessive time spent in this type of activity may produce more passive learners, when active involvement is more likely to stimulate holistic brain growth. This matter is especially important as it relates to the critical periods for learning and brain development, according to Healy (1990, pp. 72-76). Diamond's research on brain plasticity confirms the weight of this issue. Results of her studies are discussed in a following section titled "Plasticity and Enrichment."

Healy (1990) comments, "Brains of youngsters who spend lots of time in front of a TV set, for example may be expected to develop differently from those who pursue the physical, interpersonal, and cognitive challenges of active play" (p. 74).

The television was unknown at the time Ellen White lived; however, she does comment on the influence of amusement on the child's learning patterns. Like Healy, White strongly encouraged balanced development of the physical, mental, and spiritual powers. Based on White's position regarding holistic development, she no doubt would have cautioned against the free use of television, especially for young children.

Though White was an ardent supporter of recreation as a means of providing relief from heavy mental and/or physical routines, she was not a proponent of amusement. She indicated that recreation tends to build up the energy and mental stores; whereas "amusement, on the other hand, is sought for the sake of pleasure, and is often carried to excess; it absorbs the energies that are required for useful work, and thus proves a hindrance to life's true success" (White, 1903b, p. 207).

Herbert Douglass (1998) synthesizes White's (1903b, pp. 210-213) counsels regarding the quality of recreation. He lists five specific principles that are seminal to her position on the importance of recreation:

1. Students must have vigorous exercise, but it should be done, whenever possible, in the open air.
2. Sports of violence, as well as athletic games carried to excess, in addition to promoting the "love of domination [and] the pride in mere brute force . . . stimulate the love of pleasure and excitement, thus fostering a distaste for useful labor, a disposition to shun practical duties and responsibilities."
3. Parents and teachers "can do much to supply diversions wholesome and life-giving" instead of "frivolous associations, habits of extravagance, or pleasure-seeking."
4. The highest form of recreation, filled with blessings to students, are those activities "which make them helpful to others."
5. "The preoccupation of the mind with good is worth more than unnumbered barriers of law and discipline." (p. 349)

Though White does not use the terms *active learning* or *passive learning* as does Jane Healy (1990), she does have much to say about the need to involve students in active participation in the learning process. Her emphasis on work and practical functions, on planned activities involving physical exercise in the fresh air, and on the importance of service to others, all are additional indicators that she highly valued the benefits social relationships bring to the learning environment.

Plasticity and Enrichment

Plasticity and Enrichment are major points of discussion in educational brain research. Ellen White aligns with this topic in her discussions of: harmonious development of physical, mental, and spiritual powers; work and practical functions; parental influence; and teacher characteristics and influence.

In the early 1960s, a group of University of California, Berkeley, researchers—Kresh, Resensweig, Bennett, and Diamond (1999)—

> demonstrated that rats living in enriched conditions, including lots of social activities and challenging objects with which to interact, increased some chemical measures and some structural measures in the cerebral cortex, the area involved with higher cognitive processing. At the same time the Berkeley group demonstrated that lack of stimulation, shown by impoverishment, including reduced social activities and no

> challenging or stimulating objects to play with, caused some chemical measures and anatomy of the brain to decrease. (p. 1)

Prior to these findings, says Diamond, "the mammalian brain was considered by most to be immutable [unchangeable]" (p. 1, italics supplied). Heredity was thought to be the major determiner of the brain's functional capacities. Today, however, because of studies conducted by Diamond and others, the brain is described as *plastic*—capable of changing as a result of environmental influence.

Since the 1960s, Diamond has continued her research at Berkeley. Over the years her studies have shown that of the three environments—impoverished (in a cage alone with no toys), enriched (in a cage with other rats and with toys), and natural (the natural environs in which rats typically live)—the natural environment produces the greatest levels of dendritic growth in the brains of the experimental rats.

Speaking of the *nature versus nurture* debate, Jensen (1998) indicates that current thought suggests that heredity and environment both affect brain potentiation about equally (pp. 29-30). These estimates connote a need to seriously consider the quality of environmental influences, especially those influences on young minds that are in prime stages of development.

Brain research now provides much commentary on the brain's capacity for change (plasticity). Judging by the numbers of articles and books currently appearing on brain-related topics, attention is focused on issues such as: the extent to which these plasticity research findings apply to human brains; the nature of enrichment for humans; critical periods of development, social affects, and making meaning; language development; etc.

More than ever, there is evidence now to support the idea that requiring children to quietly sit in neat rows in classrooms and to stay on task for long periods of time doing paper-and-pencil textual work is not the most conducive activity for brain development and function. Though this kind of activity may be legitimate for a portion of the school day, there now seems to be evidence that such activity needs to be balanced with an abundance and variety of other activities that promote physical and emotional/social stimulation, as well. Caine and Caine (1991), Diamond (1998), Hannaford (1995), Healy (1990), Jensen (1998), and Sylwester (1995) all decry traditional patterns of schooling that emphasize sedentary, mental processes with diminished emphasis on physical and emotional/social involvement. Each of these contributors focuses attention on the need to involve students in active learning that stimulates balanced activities.

One hundred years ago, when thought about the brain was steeled with the idea that the brain was unchangeable, Ellen White wrote about the plastic nature of the mind. “Be sure, mothers, to have an indwelling Christ so that on your child’s plastic mind may be impressed by the divine likeness,” she counseled (White, 1952a, p. 436). Her use of the term *plastic* aligns with the current meaning of that word. Using metaphor, she commented to teachers, “In order to have the wax take a clear, strong impression of the seal, you do not dash the seal upon it in a hasty, violent way; you carefully place the seal on the plastic wax, and quietly, steadily press it down, until it has hardened in the mold. In like manner deal with human souls” (White, 1938b, p. 101).

Touching on the important role parents play in the enrichment of children’s environments, White (1954) states, “Parents, be careful what example and what ideas you give your children. Their minds are plastic, and impressions are easily made” (p. 545). In a similar vein, White (1913) counseled regarding what is expected of teachers in reference to working with *plastic minds*:

> A teacher may have sufficient education and knowledge in the sciences to instruct, but has it been ascertained that he has tact and wisdom to deal with human minds? If instructors have not the love of Christ abiding in their hearts, they are not fit to bear the grave responsibilities placed upon those who educate the youth. Lacking the higher education themselves, they know not how to deal with human minds. Their own insubordinate hearts are striving for control; and to subject the plastic minds and characters of the children to such discipline is to leave upon the mind scars and bruises that will never be removed. (p. 193)

Evidence that White (1903b) was entirely supportive of the concept of an enriched environment is seen in her insistence that children be allowed to develop holistically—physically, mentally, and spiritually (or morally) (p. 13). Educating the "whole being," she suggests, "prepares the student for the joy of service in this world and for the higher joy of wider service in the world to come" (p. 13).

White stressed the need for teachers and parents to provide enriched, relevant, educational environments by incorporating practical application into the curriculum. Manual labor, she suggested, should be beyond the dignity of no one, including teachers, clerks, merchants, physicians, lawyers (pp. 214-222). All should acquire a broad range of practical skills, she indicates. Speaking of practical functions around the home (and in the context of gender equality), she states,

> Since both men and women have a part in homemaking, boys as well as girls should gain a knowledge of household duties. To make a bed and put a room in order, to wash dishes, to prepare a meal, to wash and repair his own clothing, is a training that need not make any boy less manly; it will make him happier and more useful. And if girls, in turn, could learn to harness and drive a horse, and to use the saw and hammer, as well as the rake and the hoe, they would be better fitted to meet the emergencies of life. (pp. 216-217)

Work and practical functions were significant enriched-learning issues as White (1903b) counseled parents and teachers:

> For every child the first industrial school should be the home. And, so far as possible, facilities for manual training should be connected with every school. To a great degree such training would supply the place of the gymnasium, with the additional benefit of affording valuable discipline. (p. 217)

It is apparent that both brain science educators and Ellen White are proponents of the concepts of brain plasticity and enrichment. Marian Diamond's research and the consensus of the Caines, Hannaford, Healy, Jensen and Sylwester all emphasize the plastic nature of the brain. Diamond suggests that enrichment and heredity both contribute about equally to intellectual ability. White's emphasis on holistic learning that incorporates the entire being, her counsels to parents and teachers, and her position on work and practical experience, all attest to this possibility, as well.

Stages of Development

Ellen White speaks to *stages of development* as she writes about harmonious development and parental and teacher influences. Each of these alignments is referenced in the subsections that follow.

Among the brain educators referenced in this study, much is written regarding the stages through which the brain progresses as it matures. However, as Diamond (1998) explains, there is much that is not known. "Someday neuroscientists will be able to match many of a baby's budding behaviors with growth in specific regions of the brain," but that has not yet happened. These abilities "will await new ways of studying the brain" (p. 118).

Some of the major issues most often discussed relative to the stages of development focus on the effects of prenatal influence on the developing child, the early development of emotional literacy, the effects of stress and threat on the young child, the influence of parents and caregivers on the young child, the importance of physical activity or motor function during the early years, critical periods for visual and auditory perception development, and language development. Each of these will be briefly mentioned and discussed in relation to White's counsels. For a more thorough review of these concepts, please refer back to chapters 2 and 3.

Prenatal Influence

Parental health habits, mental attitude, and heredity all come to bear on the child while it is still in the womb. Diamond (1999), Healy (1990), and Hannaford (1995) are specific regarding the profound impact prenatal influences have on the developing child. "The most important things a pregnant woman can do are eat well, avoid drugs, and keep the stress down," says Jensen (1998, p. 19). Marian Diamond echoes this concern throughout her book, *Magic Trees of the Mind,* and in her presentations to educators wherever she speaks.

White was direct in her counsels to individuals considering parenthood. She cautioned that prenatal influences are "deserving of our most careful thought" (White, 1977b, p. 131). Every woman, she states, "should encourage constantly a happy, cheerful, contented disposition, knowing that for all her efforts in this direction she will be repaid tenfold in the physical, as well as in the moral, character of her offspring" (p. 131).

> The thoughts and feelings of the mother will have a powerful influence upon the legacy she gives her child. If she allows her mind to dwell upon her own feelings, if she indulges in selfishness, if she is peevish and exacting, the disposition of her child will testify to the fact. Thus many have received as a birthright almost unconquerable tendencies to evil. (p. 132)

Disposition is not the only heritage transmittable from the mother to the child, White (1977b) adds. Other habits also are influential.

> Before the birth of her child the mother is to be careful in her habits. She must not indulge a perverted appetite, or partake of wine or strong drink, or eat of any unclean

> thing. The habits of a mother have an influence upon the appetites and passions of her child. (p. 139)

In presentations Marian Diamond makes relative to how alcohol can impact the unborn fetus, she issues strong precaution. Even one drink can have detrimental effects on the developing child, especially if that drink is taken at a critical time in fetal development.

Not only mothers are responsible for the transmission of qualities, traits, and habits. White (1977b) speaks also to fathers, suggesting that "animal passions" practiced by the parents—fathers and mothers—are repeated in their offspring. In 1870 she wrote,

> Children are born with the animal propensities largely developed, the parents' own stamp of character having been given to them. . . . The brain force is weakened, and memory becomes deficient. . . . The sins of the parents will be visited upon their children because the parents have given them the stamp of their own lustful propensities. (p. 136)

Emotional Literacy and Stress and Threat

Caine, Caine, and Crowell (1999) speak to the brain's developmental stages, and specifically the emotional development. In the first 3 years after birth, they suggest, "the rate of growth is prodigious as a great many new connections are made. Within this period, the capacity to experience emotions is much more developed than the capacity to think" (p. 36).

Daniel Goleman (1997), author of *Emotional Intelligence*, also indicates there is evidence that emotional intelligence develops during the earliest years after birth. Experiences that occur during that time powerfully influence the child's future, including the child's learning abilities. Deprivation of nurture, touch, and other social aspects of development can even be life-threatening.

Stress and threat can be especially harmful to young children. Jensen (1998) describes the effect of cortisol, an adrenal gland peptide that in chronic situations can be detrimental to neuronal health and growth and to short-term and long-term memory.

White (1977b) counsels parents to "deal gently with little ones." Sensitive children can be wounded by indifference, she states.

> Young children love society. They cannot, as a general thing, enjoy themselves alone, and the mother should feel that, in most cases, the place for her children, when they are in the house, is in the room she occupies. . . . The mother should not wound the heart of her sensitive child by treating the [insignificant] matter with indifference or by refusing to be troubled with such small matters. That which may be small to the mother is large to them. And a word of direction, or caution, at the right time will often prove of great value. An approving glance, a word of encouragement and praise from the mother, will often cast a sunbeam into their young hearts for a whole day. (p. 168)

Parental Influence

Diamond (1998), Hannaford (1995), and Healy (1990) each discuss the significant influence parents have on the child as she passes through stages of development—from before birth through to maturity. The values and practices of parents tend to be replicated in their offspring in genetic as well as social respects. When children are deprived of opportunities for development at critical times of brain maturation, the effects can be relatively irreversible. Additionally, the quality of experiences parents provide for children also makes a lasting difference.

Hannaford (1995) explains, "I strongly agree with Joseph Chilton Pearce's stand and Jane Healy's suggestion that TV be banned before the age of 8 so that imagination and language skills have a chance to be established" (p. 66). Hannaford also bases her position on television on the need for children to be more actively (physically) involved rather than passively engaged, as is the case with television. Her book, *Smart Moves*, highlights the importance of physical activity for more optimal brain development.

Parents determine whether or not and to what extent children are exposed to television and other electronic media. Hannaford stresses the importance of physical, mental, and emotional/social balance that is necessary for optimal brain development. A more complete discussion of these considerations can be found in chapter 2, and the section titled Mind/Body/Emotions/Social Connections.

At a brain conference conducted by the Association for Supervision and Curriculum Development, Marian Diamond (1999) presented research to emphasize the powerful impact a mother's choices can have on her unborn child. Nutritional practices profoundly impact the birth weight of the child, and use of drugs and other stimulants can impact the brain structurally and functionally.

"Education begins with the infant in its Mother's arms," White (1954) comments. (However, as mentioned earlier, she indicates that parents begin influencing their children even before they are born.) "While the mother is molding and fashioning the character of her children, she is educating them. . . . As soon as a child is capable of forming an idea, his education should begin" (p. 26). Furthermore, White (1954) states, "It is then that the mind is most impressible, and the lessons given are remembered" (p. 26). Adding further, she says, "Before reason is fully developed, children may catch a right spirit from their parents" (p. 27).

White (1977b) represents the first 7 years of life as an especially critical period for physical development. She cautions against early introduction of academic emphasis.

> During the first six or seven years of a child's life special attention should be given to its physical training, rather than the intellect. After this period, if the physical

> constitution is good, the education of both should receive attention. Infancy extends to the age of six or seven years. Up to this period children should be left like little lambs, to roam around the house and in the yards, in the buoyancy of their spirits, skipping and jumping, free from care and trouble. (pp. 149-150)

Hannaford (1995) and Diamond (1998) also focus on development years from birth until 7 years of age. Hannaford stresses the need to honor physical readiness before a child is expected to do the activities typical of formal education. As an example, some children are not ready for reading until the age of ten, while others may be ready at age 4.

Marian Diamond speaks to negative aspects of "hothousing" children—rushing them to learn skills before the child is developmentally ready. Though desired learning may appear to have been gained, future difficulties in neurological function can result from by-passing the natural developmental process.

White (1954) believed that "the first 7 years of life have more to do with forming . . . character than all that [the child] learns in future years" (p. 193). It is during this period of a child's life that "his mind is most susceptible to impressions either good or evil" (p. 193).

Stating that the "parents, especially [the mother], should be the only teachers" of the child during the first 6 or 7 years, White (1977b) based her position on the belief that children are especially "susceptible to demoralizing influences" at this time in life (p. 148). Placing a child in an environment controlled by those who are not aligned with God's ideal for child rearing is a moral wrong, according to White (1954, pp. 199-201).

Even other children can be an endangerment to a child's mental and moral development during their most impressible years, White (1954, p. 200) counsels. "Every soul is surrounded by an atmosphere of its own—an atmosphere, it may be, charged" with evil or good, she (White, 1977b, p. 207) cautions. When children are not "perseveringly and patiently trained in the right way" (White, 1954, p. 200) their influence can easily influence children of more noble training.

Narrowing this 6-or 7-year period of prime development even further, White (1954) indicates that "the first three years is the time in which to bend the tiny twig. Mothers should understand the importance attaching to this period," she says. "It is then that the foundation is laid" (p. 194).

Cautioning parents in a similar way, Jane Healy (1990) advises parents to be careful in choosing caregivers for young children. When the caregiver's language skills are deficit, their language can indelibly impress upon the mind of the child.

Though White (1954) recognized that the first 3 years of the child's life are the most critical, she indicates that the time after that period is still formative, but not as much so (p. 194). "If you have waited until your children were 3 years old to begin to teach them self-control and obedience, seek to do it now, even though it will be much harder" (p. 194).

"The first 12 or 15 years" of a child's life is optimal time for impressing upon the mind "book knowledge" and "arts essential for practical life," White (1954, p. 195) indicates. However, "The latter should not be neglected for the former," she advises.

Speaking to parents who believe that they should wait until the child is older to "repress wrong and educate them in the right," White says, the very time for them to do this work is when the children are babes in their arms (p. 194).

White speaks of the ingraining effect habit makes on the mind. "It is by a repetition of acts that habits are established and character confirmed" (p. 199). Adding further to this thought, White alludes to the nature versus nurture discussion that long has been argued.

> The character is formed, to a great extent, in early years. The habits then established have more influence than any natural endowment, in making men either giants or dwarfs in intellect; for the very best talents may, through wrong habits, become warped and enfeebled. The earlier in life one contracts hurtful habits, the more firmly will they hold their victim in slavery, and the more certainly will they lower his standard of spirituality. (p. 199)

"What the child sees and hears is drawing deep lines upon the tender mind, which no after circumstances in life can entirely efface" (p. 199), White counsels. "The intellect is now taking shape, and the affections receiving direction and strength. Repeated acts in a given course become habits. These may be modified by severe training, in afterlife, but are seldom changed" (pp. 199-200).

"Young children, if left to themselves, learn the bad more readily than the good. Bad habits agree best with the natural heart, and things which they see and hear in infancy and childhood are deeply imprinted upon their minds" (p. 202), White posits. "We shall be individually, for time and eternity, what our habits make us. . . . More than any natural endowment, the habits established in early years decide whether a man will be victorious or vanquished in the battle of life" (pp. 202-203).

Brain educators—Diamond (1998), Hannaford (1995), Healy (1990), Jensen (1998)—also provide schedules to indicate expectations in regard to stages of development. White tends to recommend later entry into formal schooling than is commonly practiced today. Similarly, Hannaford (1995) and Jensen (1998) reference studies that appear to confirm White's rationale regarding the need to honor the developmental process over emphasis on formal schoolwork that stresses mental function.

Physical Activity

Hannaford (1995) emphasizes the benefits of physical movement in preparing the young child's brain to move toward higher levels of proficiency. "We must get away from the notion that we simply experience the world until we go to school at the age of five and **then** we learn" (p. 83).

Like Hannaford, White (1977b) states,

> During the first six or seven years of a child's life special attention should be given to its physical training, rather than the intellect. After this period, if the physical constitution is good, the education of both should receive attention. Infancy extends to the age of six or seven years. Up to this period children should be left like little lambs, to roam around the house and in the yards, in the buoyancy of their spirits, skipping and jumping, free from care and trouble. (pp. 149-150)

Visual and Auditory Development

Hannaford indicates that up until about 7 years of age, most children are not ready for two-dimensional visual activity that is often emphasized in schools, even in the earliest grades. Failure to recognize such landmarks, or developmental turning points, and "thus to accommodate each individual's specific learning pace is a root cause of many problems in education today" (p. 81). Emphasis on formal school work before the eyes are developmentally ready can permanently impair visual acuity, according to Hannaford (1995). Refer to chapter 2 for more details on these studies.

During critical periods of development, neural connecting and pruning occur and demonstrate "the resilience of a child's brain and the way use, disuse, and the environment mold it," according to Diamond (1998, p. 57). This is especially evident in studies of the development of vision and hearing. Currently, it is believed that visual development is associated with a critical period in the stages of development. Diamond and Sylwester cite studies done by Hubel and Wiesel in which kittens' eyes were sewn shut during early development time. The visual impairment that was evident when the stitches were removed seems to indicate that if the brain is prevented from its natural progression, developmental losses occur. This area of research continues to be studied. See chapter 2 for greater detail on studies done by Hubel and Wiesel and others.

Information surfacing from research on critical periods of development appears to confirm the plasticity of the brain. Such research also indicates that each function of the brain has its own timetable for development (Diamond, 1998, p. 62). Diamond comments on some specific educational implications regarding this topic:

> There are various periods in children between six months and eight years of age for developing sensitivity to dim or bright light and to the direction of light; for sharpness of vision; for the dominance of one eye over the other or a balance between the two; and for the formation of stereoscopic vision so the baby has depth perception. There also seem to be several critical periods for acquiring language, for learning to play music, even for emotional maturity, while certain aspects of these domains, and others are probably open to lifelong modification. (p. 63)

Ellen White makes no comment that specifically aligns with visual and auditory development, but she does place heavy emphasis on the importance of honoring physical development over academic concerns until ages 7 or 8. During that time, she suggests, children should be free to move and play without the encumberments of formal school settings.

In summary, it is clear that educational brain research and Ellen White's counsels are closely aligned in regard to the data relative to stages of development. Brain science emphasizes the important roles of prenatal, parental, and other social influences on the developing brain. Ellen White does the same. Brain science offers data to indicate that critical periods of development come and go, and that in some areas of the brain these periods are more determinative than are others. Ellen White is more wholistic in how she refers to these developmental times. Brain educators mark the levels of development based on the average child's performance for a given age. Ellen White seems to establish levels of demarcation based on honoring time frames that give all children ultimate advantage. Consider the following example in this regard:

Concern regarding the moral and physical development of the child's mind, was a high priority for White. In this she takes a stand contrary to current educational practice. Most states require students to attend school by the age of 6 years. White (1900d) states that "parents should be the only teachers of their children until they have reached eight or ten years of age. . . . Many children have been ruined for life by urging the intellect and neglecting to strengthen the physical powers" (p. 14).

This position regarding when to begin school may be viewed as extreme. However, considering that some children are not ready to learn to read and write when other children are, such counsel may be appropriate. Hannaford (1995) and Jensen (1998) both reference educational systems and schools that refuse to "force" learning until a child shows interest and readiness. These schools boast that they have relatively no drop outs from school and that all their children learn to read successfully and to succeed academically. Certainly this area deserves more focused study.

Individualism

Brain research provides abundant data to establish the uniqueness of individual brains. This implies individual differences in brain processing. Hannaford (1995) states that a "unique set of connections which each of us makes from the very first moment we encounter the world, shapes our understanding of the world and of ourselves" (p. 70).

Because of the uniqueness of each individual, it is important for teachers to "provide for individual differences and intrinsic motivation," stress Caine and Caine (1991, p. 123). Allowing students to actively process new information according to their own unique differences is a way to promote "consolidation and internalization of information" by the learner, they suggest (1991, p. 147).

Much attention in education has focused on the importance of accepting that students have differing learning styles and on the importance of structuring curriculum to include learning opportunities that honor what Gardner calls *multiple intelligences.* Educational brain science confirms that each individual brain is unique and processes differently than all others.

White (1903b) echoes the thought that each brain is unique and individual, but she approaches this concept from a different perspective—again from a spiritual context. She explains that God sacrificed His Son in order to preserve for humanity the individual's power of choice. Even when God observed Eve and Adam in the Garden of Eden as they exercised their power of choice to sin, He refused to violate their will. According to White, in spite of the fact that He knew such a violation of the laws that He had established would cause them to die, He chose to honor their right to choose. Knowing that their choice would require the sacrifice of His own Son, God refused to deprive Adam and Eve the right to decide for themselves. White proffers,

> God might have created [Adam and Eve] without the power to transgress His requirements, but in that case there could have been no development of character; their service would not have been voluntary but forced. Therefore He gave them the power of choice—the power to yield or to withhold obedience. And before they could receive in fullness the blessings He desired to impart, their love and loyalty must be tested. (p. 23)

Because God created man in His own image, He could not have deprived humanity of the power of choice and maintained the dignity and intent of His creation (White, 1903b, pp. 15-19). God treasures individual fortitude that reflects noble purpose, White suggests. One of her best-known quotations mirrors this thought. Though she uses the word *men* throughout this quotation, it is consonant with her teachings to be inclusive of both genders:

> The greatest want of the world is the want of men—men who will not be bought or sold, men who in their inmost souls are true and honest, men who do not fear to call sin by its right name, men whose conscience is as true to duty as the needle to the pole, men who will stand for the right though the heavens fall. (p. 57)

White (1903b) also spoke about the responsibility of teachers to honor individual uniqueness.

> In all true teaching the personal element is essential. Christ in His teaching dealt with men individually. . . . Christ discerned the possibilities in every human being. . . . The same personal interest, the same attention to individual development, are needed in educational work today. . . . The true educator, keeping in view what his pupils may become, will recognize the value of the material upon which he is working. He will take a personal interest in each pupil and will seek to develop all his powers. (pp. 231-232)

Like current brain research, Ellen White honored self-development, but she recognized its value only in the context of preparing self to benefit mankind. She valued self-development as a useful means of supporting God's holy purpose for humanity—to help restore security in the universe (White, 1898a, p. 759; 1973, p. 370). White (1923a) comments,

> The Lord is calling us to awake to a realization of our responsibilities. God has given to every man his work. Each one may live a life of usefulness. Let us learn all that we can and then be a blessing to others by imparting a knowledge of truth. Let every one do according to his several ability, willingly helping to bear the burdens. (p. 218)

Separated from this divine purpose, self-development promotes humanistic values and detracts from unselfish service to others, White suggests. Using a contrasting example, White (1903b) describes a scenario that is counter to this position. Citing cases in which students have crowded "the mind with knowledge very little of which could be utilized," she states,

> The mind thus burdened with that which it cannot digest and assimilate is weakened; it becomes incapable of vigorous, self-reliant effort, and is content to depend on the judgment and perception of others.
> Seeing the evils of this method, some have gone to another extreme. In their view, man needs only to develop that which is within him. Such education leads the student to self-sufficiency, thus cutting him off from the source of true knowledge and power. (p. 230)

"Each soul has an individuality," White (1977a) proffers, but "each soul must live in hourly communion with Christ; for He says, 'Without me ye can do nothing' (John 15:5)" (p. 430).

Providing direct counsel for teachers regarding individuality, White (1977a) cautions:

> Teach every soul to lean heavily on the arm of infinite power. There is an individuality in Christian experience that must be preserved in every human agent, and the responsibility cannot be removed from any soul. Each one has his own battles to fight, his own Christian experience to gain, independent in some respects from any other soul; and God has lessons for each to gain for himself that no other can gain for him.—MS 6, 1889. (p. 430)

Again, there is strong concurrence between the brain research and Ellen White's counsels regarding the uniqueness of each individual and the need to honor that individuality with appropriate educational nurture. The diverging point within this alignment appears to be the in the context of the spiritual realm.

Somewhat Aligned Themes From Brain Research and Ellen G. White

In this section focus is on those areas of comparison where alignment is implied and is not as specific and direct as it was in the preceding sections titled *Aligned Themes From Brain Research and Ellen G. White.*

Senses and Learning

Learning is a multisensorial, integrated process, which involves the whole body, not just the brain. Each of the major brain educators cited in this document describes brain function as heavily influenced by sensorial input. Sight, smell, sound, touch, taste, and proprioception provide a continuous flow of information to the brain and Central Nervous System.

Pert (1997) adds a new dynamic, however. She indicates that sites for sensory reception—located throughout the body, not just in the brain—contain large numbers of neurotransmitter receptors, which strongly influence the neurochemistry of the body and brain, emotions, thinking, and overall function (pp. 139, 142).

These receptor sites throughout the body and their matched ligands function to process, prioritize, and bias incoming data even before the new information is passed on to the brain. In a broad sense, these receptor sites could be considered as part of the brain, even though they are extended beyond traditionally defined parameters of the brain organ (Pert, 1997, pp. 138,139, 142). Thinking of sensory input as merely a linear communication of information via neurons and synaptic gaps from the sensory site to the brain is no longer accurate, according to Pert. As cited by Pert (1997), Miles Herkenham estimates that "less than 2 percent of neuronal communication actually occurs at the synapse" (p. 139).

Such factors as prior experience, from childhood or recently, and food consumed can determine the quality and quantity of the neuropeptides produced at the receptor sites— also called nodal points—where new sensory information is being received. As this information gets associated with the brain and its filtering and storing processes, learning occurs, Pert (1997, p. 142) explains.

Brain research takes the position that the greater the sensory input, the better the outside world is represented in the mind. White seems to agree with this position. However, she approaches sensory input from the perspective of needing to guard the mind against impurities which may come into the brain and body via the senses. She speaks of humanity's need for a *filtering system* for the pervasive influence of sensory input.

Ellen White (1897) uses metaphor to describe sensory input into the brain. "The senses are the avenues to the soul" (p. 54), she states. White's use of the word *soul* seems to indicate that the senses have a relationship with the wholeness of the individual. In using the term "avenues to the soul," it seems evident that White was aware of the strong impact the senses have on the human spirit.

Certainly, it can be stated that Ellen White was aware of a major role the senses play in cognition. Does she also imply that sensory perception involves the whole body, and not just the brain? A number of statements seem somewhat related.

White speaks of positive and negative sensory influence, and she speaks of *moral senses,* which seems to suggest an elaboration on the more common reference to sensory input. One such use of the term *moral senses* occurs in context of speaking of Christ's sacrifice for humanity (White, 1961). In this statement, she seems to use the word *moral* to refer to profound influences within the being:

> The cross of Christ testifies to every man that the penalty of sin is death. . . . Oh, must there be some strong bewitching power which holds the moral senses, steeling them against the impressions of the Spirit of God? (p. 44)

Since *morals* refer to an abstract construct of the mind, White's use of "moral senses" may imply a level of sensory processing that represents another substrate of function occurring after the initial sensory signal is perceived. Perhaps this combination of the terms *moral* and *senses* is related to the concept Jensen (2000) attributes to Paul MacLean (1978): "The mid-area system, this primitive brain that can neither read nor write, provides us with the feeling of what is real, true, and important" (p. 199).

Though she is not specific as to how sensory input integrates with the emotions and moral judgment, White (1923a) does allude to the complexity of sensory integration. Speaking of the influence of appetite as sensory input, she says,

> Between the mind and the body there is a mysterious and wonderful relation. They react upon each other. To keep the body in a healthy condition to develop its strength, that every part of the living machinery may act harmoniously, should be the first study of our life. To neglect the body is to neglect the mind. . . .To indulge the taste at the expense of health is a wicked abuse of the senses. (p. 122)

White (1961) suggests that a pervasive effect takes place when the individual yields to *immoral senses.* Her comments here begin with the negative influence of the ungodly:

> But if they will listen to those who will address them and try to lead their thoughts away from God and their eternal interests, then their whole senses are perverted by that which their eyes rest upon. Jesus says, "If . . . thine eye be single, thy whole body shall be full of light. But if thine eye be evil, thy whole body shall be full of darkness." Matt. 67:22, 23. (p. 334)

"Give no encouragement to indulgence in appetite, in selfish gratification of the senses, in pride, ambition, love of dress and display, love of praise and flattery, and strife for high rewards and honors as a recompense for good scholarship" (White, 1894a, paragraph 3). Sensual pleasures to White were, in most cases, a deterrent to self-discipline and the development of character because the senses so powerfully impact the whole system.

An additional indicator of the likelihood that White (1897) believed the senses, emotion, and moral judgment were intimately networked and were a pervasive influence throughout the body and mind may be reflected in this quotation:

> Christians must practise temperance in all things. We have no right to neglect the body and strength and soul and mind, which are to be given to the Lord in consecrated service. We are made up of body and senses, as well as of conscience and affections. Our impulses and passions have their seat in the body; therefore there must be no abuse of any of our organs.

Without question Ellen White (1981/1993h) viewed the mind and body as "one complete whole" made up of different parts "fitted to work harmoniously." This whole functions optimally when it is attune to the voice of God "speaking to the senses, telling us to preserve the organs in their beautiful arrangement that they may do service for God." It is man's part, she says, to cultivate "every organ in the order of God," not acting in accordance with perverted ideas and customs, "but in the intelligence which God has given." This is done best when we "preserve simplicity, . . . maintain the natural form and motions of the body, and not educate the mind and body to meet the customs of fashions of this degenerate age" (p. 373).

Though Ellen White's educational counsels definitely speak to the topic of sensory function, and though conceptually in some ways she aligns with current brain science, there appears to me to be a lesser degree of congruence here compared with those areas considered to be aligned. Her references to the senses in terms of brain function are not as specific as they are in terms of morality. In addition, the contributors of the educational principles for Ellen G. White's writings did not include the *senses* as one of her 12 principles for education. For these reasons this comparison between brain theme and Ellen White's counsels to educators is classified as "somewhat aligned."

Music and the Arts

Jensen (1998) promotes the idea that music empowers learning in three different ways, at least: (1) for arousal, (2) as a carrier of words, and (3) as a primer for the brain's neural pathways. Sylwester (1995) adds that music goes beyond words to "insert emotion in communication" (p. 109).

Weinberger (1998) suggests that music has the ability to: "facilitate language acquisition, reading readiness, and general intellectual development; to foster positive attitudes and to lower truancy in middle and high school; to enhance creativity; and to promote social development, personality adjustment, and self-worth" (p. 36). Others also promote the idea that the arts, movement, and sports benefit learning in other disciplines.

Though the authorities on Ellen White's writings did not list music as one of the major principles in her counsels to educators, White (1903b) does emphasize the importance of poetry and music in the curriculum (pp. 159-168). "The melody of praise is the atmosphere of heaven; and when heaven comes in touch with the earth, there is music and song" (p. 161). In her book *Education* Ellen White made *Poetry and Song* an entire chapter. The following 2 quotations indicate that she did link music and poetry to the educational process.

> There are few means more effective for fixing His words in the memory than repeating them in song. And such song has wonderful power. It has power to subdue rude and uncultivated natures; power to quicken thought and to awaken sympathy, to promote harmony of action, and to banish the gloom and foreboding that destroy courage and weaken effort.
>
> It is one of the most effective means of impressing the heart with spiritual truth. (pp. 167-168)

> "The value of song as a means of education should never be lost sight of" (White, 1903b, p. 168).

Because White did not elaborate more on this topic, and because this was not included in the list of educational principles received from the authorities on her writings, *music and the arts* is classified as only "somewhat aligned."

Language

Jane Healy (1990) and Marian Diamond (1998) both emphasize the profound role language plays in cognitive development and function. Body language, caregiver language influence, deprivation of language experience, language disabilities, hearing problems, inner speech, language development, listening skills, parental teaching of language, syntax, and television's impact on language skills are some of the many related areas one or both of these brain educators address. The study of language and brain function is a broad area and attracts considerable attention from researchers.

Michael Merzenich at University of California at San Francisco and Paula Tallal at Rutgers University have conducted research among children with language problems that seem to result from auditory delay in sensory perception. Tallal (1993, 1996) suggests that these language problems may result from stressful pregnancies. Typically, auditory memory is processed on the left side of the brain. Stressful pregnancies may be responsible for interfering with structural lateralization in the brain's hemispheres, according to this study.

White says little about the physiological aspects of language development. She speaks often about the importance of parents modeling well in language usage (White, 1903b, pp. 234-237), and she speaks of the importance of parents reading to children (pp. 186-192). In addition, she suggests that reading fascinating and fictitious stories can cause the children to have a lesser desire to hear the character building stories of the Bible.

Regarding prenatal influences on physical development, White was specific in strongly counseling parents regarding the profound effects of prenatal conditions. She does not mention language (including hearing) development in this context; however, she does refer to the importance of maintaining a positive emotional state—an concept considered in Tallal's study. The following quotation (1977b) is typical of many in her writings.

> Every woman about to become a mother, whatever may be her surroundings, should encourage constantly a happy, cheerful, contented disposition, knowing that for all her efforts in this direction she will be repaid tenfold in the physical, as well as in the moral, character of her offspring. (p. 131)

Later, in 1905, White (1977b) again addressed this matter, and she also spoke of the brain's elasticity in conjunction with prenatal influences.

> If the mother is deprived of the care and comforts she should have, if she is allowed to exhaust her strength through overwork or through anxiety and gloom, her children will be robbed of the vital force and of the mental elasticity and cheerful buoyancy they should inherit. (p. 132-133)

When parents talk often to children, share reading experiences, and use large vocabularies, they contribute to their child's future reading-skill development, according to Huttenlocher (1987) and Begley (1996). Reports, indicate, however, that time spent reading with children is often usurped by television and video games.

Another language-related issue that may pose a problem in more cases than commonly admitted is the matter of when is the best time for a child to learn to read. Jensen (1998) states,

> Surprisingly, there is no absolute timetable for learning to read. Differences of three years are normal. Some children will be ready to read at 4 years, others, just as

> normal, will be ready at 7 or even 10 years. The child who reads at 7 might not be "developmentally delayed" as many have diagnosed. (p. 23)

Jensen (1998) describes Sudbury Valley School in Framingham, Massachusetts, where students learn to read when they are ready without any pressure from the school. Some children learn at age 5. Others learn as late as age 10. Jensen reports that the school has "100 percent truly functional, literate graduates. There are no reading disorders or dyslexia, and everyone likes to read" (p. 24).

Ellen White has little to say about early language development, however, she has much to say about not forcing a child to learn a language skill like reading before she is developmentally ready. The age numbers she uses in regard to school readiness are surprisingly similar to those being suggested by brain research educators. As mentioned earlier in the section on stages of development, White was conservative on this point. She seemed to stress the importance of play as most important in the earliest years.

White (1900d) states that "Parents should be the only teachers of their children until they have reached eight or ten years of age. . . . Many children have been ruined for life by urging the intellect and neglecting to strengthen the physical powers (p. 14). Regarding the curriculum up until age ten, White (n.d.) says, "The only schoolroom for children from eight to ten years of age should be in the open air, amid the opening flowers and nature's beautiful scenery. And their only textbook should be the treasures of nature (p. 2).

Though brain science is specific in regard to honoring developmental readiness, and though some of the brain educators do indicate that some children are not ready to read until the age of ten, it does not so boldly state that there should be no formal education in a classroom other than the home and that the child should have no teachers other than the parents before the age of eight to ten years.

Ellen White refers to the importance of language and language experience; however, the alignments with current brain science in this regard are often implied or inferential. And because *language* was not one of the educational principles specified by the Ellen G. White authorities, it is concluded that brain science educators and Ellen G. White are only "somewhat aligned" on this issue.

Making Meaning

The brain's ability to construct meaning out of sensory input is a complex, dynamic process. As sensory information enters the multi-layered, interconnected systems throughout the body and brain, there are billions of possible meaning connections that potentially can be made, consciously and subconsciously. Jensen (1998) suggests that we use less than 1% of 1% of "our brain's projected processing capacity" (p. 15).

How do we make sense or meaning out of all these billions of possible connections? That consideration is a challenge and a problem for neuroscientists. To completely understand how this happens would place an individual beyond the comprehension of all who study the brain. This study is so complex and dynamic, no one claims to have all the answers.

It is commonly believed at this time that the brain processes happen symbiotically in simultaneous ways. It cannot be reduced to a simple explanation or a nicely ordered, predictable sequence. With that thought in mind, consider the following observations as limited but providing some of the major points for this consideration of how meaning is constructed.

This study seems to indicate that three major points are seminal in the literature emerging from this vast area of focus relative to how we construct meaning:

Second, something takes place to stimulate the brain to function. Jensen (2000) explains that sensory input can initiate cognitive processing.

> All sensory input gets sorted, prioritized, processed, stored, or dumped on a subconscious level as it is processed by the brain. Every second a neuron can register and transmit between 250 and 2,500 impulses. When you multiply this transmission ability by the number of neurons we're estimated to have (approximately 100 billion), you can begin to fathom just how unfathomable our human learning potential is. (p. 25)

First, consider that the mind and the body represent one continuum, rather than two separate entities. What affects one affects the other. One cannot function exclusive of the other. All contributing brain educators—Caine and Caine, Diamond, Hannaford, Healy, Jensen, Pert, and Sylwester—concur on this matter.

Second, neurochemistry is the substance that conducts the flow of information throughout the body and mind. As information is received from the environment, it is processed, biased, and transferred symbiotically from the many receptor sites and along the many neuronal pathways to other processing areas. Eventually the information flow enters the cerebral cortex where higher-order thinking takes place and where subsequent messages are passed on as a result of meaningful connections that are made. During this process, many functions are happening simultaneously rather than in a mechanistic, linear process. Again, all contributing brain educators seem to concur on this point.

Jensen describes this second point in terms of how learning is initiated. Learning begins as a result of chemical signals being converted into electrical signals and back again as one neuron communicates with another. This happens at a microscopic level in response to stimuli coming in from the environment (Jensen, 2000, p. 27). However, it should be mentioned that brain function can take place as an internal process, also. A pain in the stomach, for example, can initiate thinking and meaning making.

Third, though the second point seems to depict a mechanical information flow along a physical substrate of the body and brain, another level of information flow is evidenced, according to Pert (1997). The mind, she says, "is that which holds the network together, often acting below our consciousness, linking and coordinating the major systems and their organs and cells in an intelligently orchestrated symphony of life." Some reference the mind as the body's "innate intelligence" (Pert, 1997, p. 185).

Not all of the brain educator contributors speak to this matter as specifically as does Pert. Certainly they do not all write about a "spirit" or even reference "God," as does Pert (p. 310).

Over 100 years ago it was not uncommon to discuss the physical, mental, and the spiritual powers. Ellen White was one of those who did enter into this discussion. Her writings are filled with references to the concept that there is an integral relationship between the mind and the body. Over and over she stressed the point that the mind cannot function well without a balanced relationship with the body and the spirit. On the first of the above three points, White was vocal and aligned.

Ellen White also refers to the electrical functions of the nerves in the brain. Writing about how physical activity can benefit the mind and the heart, White (1903b) describes electrical connectivity that takes place when the human mind connects with the mind of God.

> Physical inaction lessens not only mental but moral power. The brain nerves that connect with the whole system are the medium through which heaven communicates with man and affects the inmost life. Whatever hinders the circulation of the electric current in the nervous system, thus weakening the vital powers and lessening mental susceptibility, makes it more difficult to rouse the moral nature. (p. 209)

Though White refers to the electrical flow within the brain, she is not specific in describing the neurochemistry. She does reference the effects of emotion and their powerful influence on the mind, but because she is less specific about neurochemistry, and because she does not speak of the interaction between the chemical and electrical aspects of neuronal function, it seems that she is only somewhat aligned on this point.

To a certain extent, perhapsWhite would agree with the inference that the mind is a unifying “innate intelligence.” However, based on the preponderance of evidence in her writings, it is likely that she would identify with this point only in context of meaning that God resides within the individual to cause intelligence to be “innate” and that He is not confined to the prefrontal cortex or any other part of the brain or body. She would explain that all knowledge and wisdom come from God—the external spirit that unifies the mind and body as a whole internally. When White refers to the *spirit,* she speaks of the *divine spirit* and she speaks of the *human spirit*. It seems apparent in her writings that there is a significant difference between these two.

When “Heaven” uses the electrical communication pathway, White (1977b) claims, vitalizing, healing energy results:

> The love which Christ diffuses through the whole being is a vitalizing power. Every vital part—the brain, the heart, the nerves—it touches with healing. By it the highest energies of the being are roused to activity. It frees the soul from the guilt and sorrow, the anxiety and care, that crush the life-forces. With it come serenity and composure. It implants in the soul joy that nothing earthly can destroy—joy in the Holy Spirit—health-giving, life-giving joy.—MH 115 (1905). (p. 250)

On the point that electrical energy pulses through the body and brain as part of the neural communication, there seems to be alignment between brain science and Ellen White. However, White does not address as specifically the issue of making meaning as does brain science. Her references to this are embedded in other issues. For this reason, and for the reason that *making meaning* was not one of the 12 principles identified in her educational counsels, this issue is classified as "somewhat aligned."

Motivation

Four major discussions emerged from this study of motivation and the brain: (1) the prevalent emphasis on extrinsic motivation in traditional educational practice, (2) the lack of intrinsic motivation in schools, (3) positive and negative aspects of rewards, and (4) the importance of play.

Increased sociability, fewer behavior problems, and what Csikszenkmihalyi terms *flow* in mental processing tend to occur when students have choice and control over their environment. More than rewards can do, these factors increase motivation (Jensen, 1998). Healy (1990) indicates that "children need stimulation and intellectual challenges, but they must be actively involved in their learning, not responding passively while another brain—their teacher's or parent's—laboriously develops new synapses in their behalf" (p. 72)

Academic failure, according to Healy (1990), may result from overdoses of extrinsic motivation. "I would contend that much of today's school failure results from academic expectations for which students' brains were not prepared—but which were bulldozed into them anyway" (p. 69).

"The brain makes its own rewards," says Jensen (1998, p. 65) when children are interested in learning. Punishment and rewards are suspect in light of current studies emerging from brain research. There is a pull away from this behavioristic practice. Diamond (1998) states, "Rewards lead to interest only in the reward itself, not the activity, and punishment leads to frustration, dependence, and hopelessness" (p. 226).

Children perform best when they are allowed opportunity to experiment with learning concepts, as in play or play-acting situations and compelling activities that align meaningfully with curricular instruction.

Ellen White says little about motivation or desire to learn. However, she does speak often of the importance of providing in the curriculum activities that are practical and aligned with relevance to future work expectations. She implies that practical application programming is more important than academic, theoretical knowledge if an either/or choice were to be made. Alluding to the importance of intrinsic motivation and experiential learning, she comments,

> Experience is said to be the best teacher. Genuine experience is indeed superior to mere theoretical knowledge, but many have an erroneous idea as to what constitutes experience. Real experience is gained by a variety of careful experiments, made with the mind free from prejudice, uncontrolled by previously established opinions and habits. The results are marked with careful solicitude, and an anxious desire to learn, to improve, and to reform on every point that is not in harmony with physical and moral laws. (White, 1890a, p. 109, paragraph 1)

Again, as has been referenced often previously, White stressed over and over the need for parents to avoid placing children in formal schoolrooms during the time when the brain was most impressionable. Her concerns appear to be that the child's individual differences might not be honored and that negative influences could indelibly impress upon their "plastic" minds. She stresses the profound role the mother plays in the years prior to 8 or 10 years of age and suggests that the parents be the only teachers up until that time.

White (1977b) emphasizes the importance of play, suggesting that the first 6 or 7 years of life be a time when children be allowed to play freely in the home and especially outside—"like little lambs," "buoyant in spirit, skipping and jumping, free from care and trouble" (pp. 149-150). If after the age of 6 or 7, and if the "physical constitution is good," intellectual training can be added to physical training.

It is evident that Ellen White recognized the importance of motivation in learning; however, she does not address this topic specifically. Rather, it is embedded in her wholistic counsels that stress the development of the physical, mental, and spiritual powers. For this reason, and because *motivation* was not listed as one of her principles for education, Ellen White is classified as "somewhat aligned" with brain science educators on the issue of *motivation*.

Memory

Memory, Pert (1997) explains, is "encoded or stored at the receptor level, [and this] means that memory processes are emotion-driven and unconscious (but, like other receptor-mediated processes, can sometimes be made conscious)" (p. 143).

Memory and emotions are closely intertwined, says Pert. Neuropeptides "can act as internal ligands to shape our memories as we are forming them, and put us back in the same frame of mind when we need to retrieve them. This is learning" (pp. 144-145). The hippocampus, "without which we can not learn anything new, is a nodal point for neuropeptide receptors, containing virtually all of them" (p. 145).

Memory Storage

Review or recall of remembered events helps to maintain memory stores. Some of the most current research on memory indicates that it may be stored in the immune system, in the heart, and in other locations throughout the body and brain. Sensory stimulations of various kinds can activate memory stores spontaneously, and specific strategies aimed at assisting recall can promote memory retrieval. Multisensorial experiences are said to be more easily accessed from memory storage.

Sleep patterns play an important role in maintaining and storing memory. These points can be more thoroughly reviewed in chapter 2.

Only tangentially are the writings of Ellen White aligned with brain research on memory. White (1878a) does indicate that emotion is a powerful way for promoting memory. She says, “The thought of Calvary will awaken sacred and living emotions in the Christian’s heart” and that with this emotion, the heart keeps “fresh in memory the scenes of Calvary” (paragraph 8).

Music, she suggests (White, 1988b),

> is one of the most effective means of impressing the heart with spiritual truth. How often to the soul hard-pressed and ready to despair, memory recalls some word of God’s—the long-forgotten burden of a childhood song—and temptations lose their power, life takes on new meaning and new purpose, and courage and gladness are imparted to other souls. (p. 407)

Ellen White (1903b) also speaks of activity that is counterproductive to memory storage.

> Students have spent their time in laboriously crowding the mind with knowledge, very little of which could be utilized. The mind thus burdened with that which it cannot digest and assimilate is weakened; it becomes incapable of vigorous, self-reliant effort, and is content to depend on the judgment and perception of others. (p. 230)

Because Ellen White does not specifically refer to memory processing, but rather implies physiological functions more from a cause and effect perspective, and because *memory* was not listed as one of White's principles for education, *memory* is classified as a "somewhat aligned" theme in this comparison study of White's counsels and brain science educational themes.

Character Development

Character development is not a major theme in brain research; however, several of the brain educators allude to its importance. Marian Diamond (1998) provides substantive counsels to parents and teachers on this issue as she approaches brain development (both prenatal and postnatal) in her writings on the importance of enrichment.

Carla Hannaford (1995) touches on this topic when she writes about the importance of developing value-centered altruism at the earliest ages. Jane Healy (1994) speaks to this issue as she writes about the effects of electronic media on the child and the importance of intrinsic motivation and parental modeling. However, Daniel Goleman (1997), author of *Emotional Intelligence*, and an author to which many of the brain science educators refer, is most direct in addressing the issue of *character development*. He approaches it from the angles of emotional development, altruism, morality, and the arts of democracy.

Character development is a major component in Ellen White's counsels. She promotes its importance as one of the most pressing obligations for parents and teachers in child nurturance. Major portions of her book *Education* are dedicated to stressing the importance of character development. White (1903b) comments, "It is the work of true education to develop this power [power to think and to do], to train the youth to be thinkers, and not mere reflectors of other men's thoughts. . . . Let them contemplate the great facts of duty and destiny, and the mind will expand and strengthen" (p. 17). See chapter 3 for a more elaborated review of White's position on this principle of character development.

Brain science educators referenced in this study are not specific in addressing this issue, though they do allude to its importance. However, even though character development is not one of the 15 themes in educational brain science today, it does appear that this principle from Ellen G. White's writings to educators is "somewhat aligned" with the current emphasis on the role of emotions in education.

Attention

Again, educational brain science and White's counsels on education are only "somewhat aligned" on the issue of attention. Attention is not one of Ellen White's 12 major principles of education; however, it is one of the 15 brain research themes. When the term *attention* is used to search White's writings, the resulting data does not seem to relate to brain research findings. On the other hand, when the terms *mind* and *concentration* are entered, a number of related references seem "somewhat aligned."

Brain science discusses attention in terms of physiological function. It suggests that emotion drives attention and attention drives learning. The reigning mental model in educational practice is that reason and logic, not emotion and attention drive learning. Brain science promotes the idea that whole system processes rely on balanced function between emotion and logic. Internal and external influences are at play in learning.

White is a strong proponent of whole system processing, but she includes more than just brain power or emotional and logical involvement. She stresses the importance of the harmonious functions of the physical, mental, and spiritual processes as being mutually beneficial to each other.

In the following quotation, White (1903b) seems to be wedding—somewhat—the concepts of emotion, rational thought, and concentrated attention:

> In daily study the verse-by-verse method is often most helpful. Let the student take one verse, and concentrate the mind on ascertaining the thought that God has put into that verse for him, and then dwell upon the thought until it becomes his own. One passage thus studied until its significance is clear is of more value than the perusal of many chapters with no definite purpose in view and no positive instruction gained. (p. 189)

White further explains that "one of the chief causes of mental inefficiency and moral weakness is the lack of concentration for worthy ends" (White, 1903b, p. 189). This willful concentration seems to align with Hannaford's (1995, pp. 55, 175), Jensen's (1998, pp. 13, 65, 116), and Sylwester's (1995, pp. 157-159) descriptions of the functions of gamma aminobutyric acid.

Neurochemistry is described by brain science as a powerful factor in levels of attention. Gamma aminobutyric acid (GABA) and cycles in neurochemistry are discussed in chapter 2 and here briefly. We can willfully activate neurons to secrete GABA through focused concentration. At night we concentrate on the bed and its impress on our body, and we block out other sounds and sensations as a part of the process of focusing attention and activating the production of GABA (Hannaford, 1995, p. 175).

The importance of downtime—allowing the brain to have a reprieve in concentration time is discussed by brain science educators as an effective way to improve the quality of attention and learning. Additionally, control of stress and threat also are discussed in regard to their detrimental impact on levels of attention and on learning.

Ellen White (1923b) implies the importance of downtime, as well. She counsels,

> Some students put their whole being into their studies and concentrate their mind upon the object of obtaining an education. They work the brain, but allow the physical powers to remain inactive. The brain is overworked, and the muscles become weak because they are not exercised. When these students graduate it is evident that they have obtained their education at the expense of life. They have studied day and night, year after year, keeping their minds continually upon the stretch, while they have failed to sufficiently exercise their muscles. They sacrifice all for a knowledge of the sciences, and pass to their graves. (p. 34)

Further elaborating on the negative influence of heavy concentration, White (1977a) posits,

> Overconcentration Wears Our Vital Organs.—The power to concentrate the mind upon one subject to the exclusion of all others is well in a degree; but the constant exercise of this faculty wears upon those organs that are called into use to do this work; it throws too great a tax upon them, and the result is a failure to accomplish the greatest amount of good. The principal wear comes upon one set of organs, while the others lie dormant. The mind cannot thus be healthfully exercised, and, in consequence, life is shortened.—3T 34 (1872). (p. 507)

Jensen (1998) refers to the need for balance within the body's and brain's neurochemistry. Neurotransmitters, he says,

> will either deliver an excitatory message to a NMDA (N-methyl-D-aspartate) receptor site or an inhibitory message to a GABA (gamma-aminobutyric acid) receptor. Without these "on" and "off" switches in the brain, the brain cells would fire indiscriminately. That would give all life experiences the same weight, and learning would be either impaired dramatically or nearly impossible. (p. 65)

White (1988b) adds yet another dimension to this consideration of the power of concentration. She suggests that the forces of good and evil are at play in regard to how mental, physical, and spiritual balance is maintained. She includes reference to the struggle between good and evil in promoting healthy function of the mind and the body.

Imbalance between mental and physical exercise by overemphasizing the power of concentration, she indicates, has detrimental mental, physical, and spiritual outcomes.

> If men would be used to work for God, let them put to the stretch their powers, and concentrate their minds in earnest application. It is Satan that would keep men in ignorance and inefficiency, that they may be developed in a one-sided way which they may never be able to correct. He would have men exercise one set of faculties to the exclusion of the exercise of another set, so that the mind will lose its vigor, and when there is a real necessity, be unable to rise to the emergency. God wants men to do their best, and while Satan is pulling the mind in one direction, Jesus is drawing it in another—(FE 256., 1988, pp. 179-180)

In regard to empowering thinking processes, White (1903b) further comments on the negative influence of mingling good and evil, she describes what took place when in the Garden of Eden Adam chose to listen to the "deceiver" rather than to "Him who is Truth, who alone has understanding." She comments, "By the mingling of evil with good, his [Adam's] mind had become confused, his mental and spiritual powers benumbed" (p. 25).

Ellen White has much to say about the power and impact of love in the learning environment. Whole chapters in her book *Education* are devoted to the importance and role of love in education. She does not specifically use the brain science terms—*stress* and *threat*— as she speaks of the impact of emotion on learning (which is driven by attention, according to brain science), rather she concentrates on the positive benefits of emotion. Discussing discipline, she (White, 1903b, p. 289) states, "The will should be guided and molded, but not ignored or crushed." She adds, "The wise educator, in dealing with his pupils, will seek to encourage confidence and to strengthen the sense of honor. Children and youth are benefited by being trusted. . . . Suspician demoralizes, producing the very evils it seeks to prevent" (p. 289). "Love," White (1903b) states, "is the basis of true education. . . . Unselfishness underlies all true development" (p. 16).

In addition to this emphasis on love, White (1903b) also strongly advocates the value of purposeful learning, which connects with the interest of the learner's attention. "True education is not the forcing of instruction on an unready and unreceptive mind. The mental powers must be awakened, the interest aroused" (p. 41). Then, she continues, when inquiry is made, the instruction given will be "impressed on the mind and heart" (p. 41).

Summarizing, brain science and Ellen White both address the role of attention in learning; however, brain science approaches this topic from a physiological perspective. Ellen White describes it from a behavioral stance, concentrating on the importance of love, holistic balance, and purposeful focus. Because White is not specific in referring to attention levels in the brain, the comparative value is classified as "somewhat aligned."

Non-Aligned Themes From Brain Research and Ellen G. White

Three of Ellen G. White's principles for education are not addressed by the brain science educators referenced in this study. Chapters 1, 2, 4, and 5 speak to possible reasons for this non-alignment. This chapter discusses this issue in its beginning pages.

Briefly, it is possible that the reason for this non-alignment is the difference in philosophical stance upon which each body of information is situated. Neuroscience is not known for its position in favor of creationism, and upon that base is where Ellen G. White establishes the following three principles for education. Chapter 3 provides a more complete explanation of these three principles.

Biblical Foundation

There was no alignment between the identified principles of brain research and the principles of Ellen White's writings on education—the issue of *Biblical Foundation*.

Ellen White (1900c) contends that the Bible is supportive of all quests for knowledge, including science:

> The Bible is God's great lesson book, His great educator. The foundation of all true science is contained in the Bible. Every branch of knowledge may be found by searching the word of God. And above all else it contains the science of all sciences, the science of salvation. (p. 107)

White proposes that it is in knowing scripture that humanity can understand reality beyond the boundaries of human existence. The brain research educators in this study, on the other hand make little reference to spiritual issues, and no mention of the biblical foundation upon which Ellen White says education is founded.

Knowledge of God

There was no alignment between the identified principles of brain research and the principles of Ellen White's writings on education in regard to the issue of *Knowledge of God*. White's position on this principle is that the Creator God is all-powerful, all-knowing, and all-present. White holds that God's character of love is impressed upon all creation, and, in fact, it is this love that sustains all life and life processes. Humanity exists in a depraved condition because of separation from God, White contends, and through knowing God and a positive relationship with Him, the individual can access the once lost state of perfection and ability to access true knowledge.

Brain educators draw attention to the value of studying natural science but not in alignment with a supernatural spirit. White indicates that humanity connects to the supernatural power of the Godhead through the study of nature, Bible study, and prayer. Addressing the study of nature, White (1915b) indicates:

> Nature is full of lessons of the love of God. Rightly understood, these lessons lead to the Creator. They point from nature to nature's God, teaching these simple, holy

> truths which cleanse the mind, bringing it into close touch with God. These lessons emphasize the truth that science and religion can not be divorced. (p. 186)

"Man's wisdom cannot originate the science which is divine" (p. 186), White explains. Christ came to this earth—"to teach men the mysteries of the kingdom of God" (p. 186) for this reason. God leads the mind that is yielded to Him to understand physical and eternal truths through the study of Scripture and lessons in nature.

> When man is reconciled to God, nature speaks to him in words of heavenly wisdom, bearing testimony to the eternal truth of God's Word. As Christ tells us the meaning of the things in nature, the science of true religion flashes forth, explaining the relation of the law of God to the natural and spiritual worlds. (p. 186)

By becoming acquainted with the knowledge of God, White (1903b, p. 134), suggests, humanity gains access to an understanding of the connections between science and religion and/or salvation. Without this knowledge, she counsels, humanity is restricted to truncated potential.

Brain research makes little reference to spiritual issues, and no mention of the knowledge of God of which Ellen White speaks as being the source of all knowledge and wisdom. Because of this, *knowledge of God* is classified as "non-aligned" in this comparison study.

Redemption and Restoration of the Image of God

There was no alignment between the identified principles of brain research and the principles of Ellen White's writings on education regarding the issue of *Redemption and Restoration of the Image of God*. However, this is a major theme in Ellen White's counsels to educators. White (1903b) explains that:

> By infinite love and mercy the plan of salvation had been devised, and a life of probation was granted. To restore in man the image of his Maker, to bring him back to the perfection in which he was created, to promote the development of body, mind, and soul, that the divine purpose in his creation might be realized—this was to

> be the work of redemption. This is the object of education, the great object of life. (pp. 15-16)

White places a heavy responsibility upon educators, suggesting that if students are not made aware of this plan for humanity, the object of true education will be thwarted. Education focuses on the dissemination of knowledge, but White (1903b, pp. 13-19, 21, 34, 81) maintains that knowledge purged of the knowledge of God falls short of truth. White (1903b) suggests a divine opportunity is available to every educator who chooses it:

> To aid the student in comprehending these principles [of education], and in entering into that relation with Christ which will make them a controlling power in the life, should be the teacher's first effort and his constant aim. The teacher who accepts this aim is in truth a co-worker with Christ, a laborer together with God. (p. 30)

"In the highest sense the work of education and the work of redemption are one, for in education, as in redemption, 'other foundation can no man lay than that is laid, which is Jesus Christ,'" White (1903b, p. 30) explains.

> Sin not only shuts us away from God, but destroys in the human soul both the desire and the capacity for knowing Him. . . .The faculties of the soul, paralyzed by sin, the darkened mind, the perverted will, He has power to invigorate and to restore. . . . Christ is the 'Light, which lighteth every man that cometh into the world.' John 1:9. As through Christ every human being has life, so also through Him every soul receives some ray of divine light.(p. 29)

Brain research makes little reference to spiritual issues, and no mention of *redemption and restoration of the image of God* of which Ellen White describes as being a critical element in understanding the nature of man, the condition of life on earth, and the ultimate object of education.

Summary

As evidenced here, Ellen White's principles of education were broad and inclusive. The brain research principles tended to be more narrow and discrete. White specifically addresses 8 of 15 brain research themes, and she implies agreement with the remaining 7. Brain research, on the other hand, aligns or somewhat aligns with 9 of Ellen White's 12 principles. Three of these 12 are totally non-aligned with brain research, possibly resulting from the philosophical differences between naturalism and creationism.

CHAPTER FIVE

FINDINGS

Introduction

The purpose of this study was threefold: (1) to review current, education-relevant brain research for the major principles and themes; (2) to review the educational writings of Ellen G. White to determine the principles and themes she suggests; and (3) to compare these two large bodies of information for similarities and differences. This comparison revealed the principles and themes that were aligned and somewhat aligned and not aligned. These were discussed in depth in the previous chapter. In addition, it is postulated that comparing these two bodies of data has revealed a fractal-like pattern that can be useful in thinking about the educational process. This concept will be discussed first as a triad relationship, and then it will be considered as a fractal-like pattern.

A Dynamic Triad Relationship

Perhaps the most pervasive theme to emerge from this comparison of educational brain research and Ellen White's writings on education is the idea that a dynamic relationship exists among three brain function components—mental, physical, and emotional/social/spiritual. The writers who applied brain research to education tend to talk about the triad as mental, physical, and emotional/social, while White tends to speak of the triad as mental, physical, and spiritual. For the purpose of this discussion, I refer to this triad as mental, physical, and emotional/social/spiritual. Further discussion of the third component, emotion/social/spiritual, comes later in this chapter.

In the 1970s, when Paul MacLean proposed the *triune brain theory*, he described three levels of the brain—the cortex, the limbic center, and the brain stem. At that time MacLean believed each of these areas functioned as a brain within the brain. Since that time, however, MacLean has joined with others in a different stance. Current thought suggests that each of these three areas functions as a part of a dynamic whole. One area is dependent on the other two as simultaneous and symbiotic processing takes place.

Though MacLean's original concept has changed, the three major areas he identified are still considered as the basic areas of the anatomical brain. Each of these three major areas is believed to be multifunctional and is integrated functionally with the other two parts. Still, however, the three areas continue to be identified with major functions that take place in each area. The cortical area is identified with higher order processing; the limbic center is associated with emotion, sensory input affected by the environment, and memory; and the brain stem is considered the site of incoming information from the muscles, organs, and other aspects of the physical body.

One hundred years ago, Ellen White promoted the idea that learning was a result of the "harmonious development of the physical, mental, and spiritual powers" (White, 1903b, p. 13). Her use of the term "harmonious development" is a curious usage in view of the fact that as recently as 30 years ago the brain's mental, emotional/social, and physical aspects were being discussed in terms of separateness.

The brain and the body are united by neurochemistry that is both produced and transmitted throughout the body as an information carrier. Previously this neurochemical information transfer was thought to take place primarily at the synaptic gap in the brain. Candace Pert's discovery of the opiate receptor and other related neuroscience findings provide evidence that vast amounts of neurochemical information transfer also occur at the cellular level throughout the body. Pert indicates that the flow of information within this neurochemical network enables and facilitates the functions of both body and brain. It is within this information flow that emotion originates, according to Pert, who, along with many other current researchers, emphasizes the profound influence of emotion on all body and mind functions.

Recent brain research has evolved out of a long history of traditional thought that has dealt with the body and the brain as two separate entities, and emotion has occupied a spot of less than highest regard. As far back as Plato's writings on Socrates, a *separationist* rather than integral concept was prevalent. At that time the senses and bodily functions were described as detractors from the purest of mental processes. Writing in *Phaedo*, Plato (cited in Kaplan, 1950, p. 81) paraphrases Socrates in a dialog which reportedly transpired on the day of Socrates' fateful end. Socrates expounded on the subject of *life and death* and the less than virtuous influence of bodily senses on the mind and soul, and he concludes, "And what is purification but the separation of the soul from the body?" (p. 81).

It is true that Socrates' emphasis here was the issue of life and death. However, in this discussion it seems clear that Socrates valued mental above physical function. Though his position may seem extreme now, this concept has deeply impacted philosophy for centuries. Hierarchical ordering of mental over physical and emotional/social function is still evidenced in pedagogy today.

Both White and brain educators acknowledge that educational practice has tended to honor the mental component above the physical and emotional/social/spiritual components. What is now revealed by brain research may classify educational diffidence toward any one of these three components as disregard for the brain's natural processes for learning. Metaphorically, an equilateral triangle, rather than isosceles—with the longest leg labeled *mental*—might more appropriately represent the needed balance within this three-part construct. This seems to be the message from current brain research, and White certainly agrees.

The data from this study promote a more equalized emphasis on the three parts of this triad relationship, yet educational practice, according to most of the brain science educators referenced, does not always promote this equality or balance. The mental component continues to be honored above the physical and emotional/social capacities. The emotional/social/spiritual function is often seen as extra-curricular or superfluous. For various reasons, such as budgetary restrictions and insurance purposes, physical education, music, and the arts are often cut from school curricula. Academics are seen as the primary reason for formal education. However, those who study the brain suggest that to honor one part as more important than the other two components compromises the integrity of whole-person development.

The overriding theme that emerges in this study is that mind and body function as one unit. This oneness is promoted by the role of neurochemistry and emotion. All eight of the brain educator contributors—Geoffrey Caine, Renate Caine, Marian Diamond, Carla Hannaford, Jane Healy, Eric Jensen, Candace Pert, and Robert Sylwester—discuss the interconnectedness of mind, body, and emotional/social functions. Some speak to this triad relationship with greater elaboration than others, but all recognize it as foundational to learning. Following are some of the most specific references to this triangulated construct:

Caine and Caine

> It [brain-based learning] involves the entire learner in a challenging learning process that simultaneously engages the intellect, creativity, emotions, and physiology. (Caine & Caine, 1991, pp. 8-9)

Marian Diamond

> The cognitive, physical, social, and emotional progress of these years may be less obvious and more gradual than in earlier periods, but viewed through a longer lens, the child's evolution is impressive. (Diamond & Hopson, 1998, p. 192)
>
> The mental, physical, emotional, and social development of the middle years requires brain growth and the bootstrapping effects of experience. (Diamond & Hopson, 1998, p. 194)
>
> Regardless of a child's kinesthetic intelligence, physical activity is an enrichment for the motor cortex and other parts of the brain (not to mention the whole body), as long as the play is safe and fun. . . . Interpersonal intelligence is a capacity for self-awareness, morality, responsibility, even spirituality. (Diamond & Hopson, 1998, p. 208)
>
> One recent study of American children reveals that as many as one in five have problems with learning, behavior, or emotions stemming from the effects of their physical and emotional environments before and after birth. (Diamond & Hopson, 1998, p. 67)
>
> But the frontal region is just one player in the team of brain structures that help govern emotion. Researchers know that normal emotional responses involve (1) circuits in the frontal cortex, the brain's seat of planning and organizing; (2) additional circuits in the amygdala, hypothalamus, and thalamus—all part of the limbic system that governs emotion and memory; and (3) others in the brain stem's reticular formation, which controls alertness. (Diamond & Hopson, 1998, p. 125)

Hannaford

> Body, thought and emotion are intimately bound together through intricate nerve networks, and function as a whole unit to enrich our knowing. And research in the neurosciences is helping to explain how and why rich emotional development is

essential for understanding relationships, rational thought, imagination, creativity and even the health of the body. (Hannaford, 1995, p. 50)

This ties to Damasio's findings that emotion, body and reason are physiologically inseparable. (Hannaford, 1995, p. 54)

Healy

Certainly, trying to teach the head while ignoring the body and emotions may account for a great deal of school failure. (Healy, 1990, p. 7)

Brains of youngsters who spend lots of time in front of a TV set, for example, may be expected to develop differently from those who pursue the physical, interpersonal, and cognitive challenges of active play. (Healy, 1990, p. 74)

Both physical and mental environments help develop the ability to pay attention. Because attention requires the use of many different areas of the brain, and severe trauma, "insult," or biochemical abnormality may affect it. As we all know, even transient emotional states can knock this delicately balanced block off the tower of learning abilities. (Healy, 1990, p. 159)

The physical, emotional, and cognitive events that transpire during the early years of a brain's development have a lifelong impact, not only on that brain itself but also on the society in which it will inevitably make its mark—for better or for worse. (Healy, 1990, pp. 237-238)

Children are "disadvantaged" to the degree they do not receive adequate physical, social-emotional, or intellectual nurturing. Long-standing deprivation in any of these domains puts children at risk; when factors overlap and accumulate, learning, lives, and society are proportionately endangered. (Healy, 1990, p. 237)

Jensen

The affective side of learning is the critical interplay between how we feel, act, and think. There is no separation of mind and emotions; emotions, thinking, and learning are all linked. (Jensen, 1998, p. 71)

All learning involves our body, emotions, attitudes, and physical well being. Brain-based learning advocates that we address these multiple variables more often and more comprehensively. (Jensen, 2000, p. 200)

Pert

The mind as we experience it is immaterial, yet it has a physical substrate, which is both the body and the brain. It may also be said to have a nonmaterial, nonphysical substrate that has to do with the flow of that information. The mind then, is that

> which holds the network together, often acting below our consciousness, linking and coordinating the major systems and their organs and cells in an intelligently orchestrated symphony of life. Thus, we might refer to the whole system as a psychosomatic information network, linking psyche, which comprises all that is of an ostensibly nonmaterial nature, such as mind, emotion, and soul, to soma, which is the material world of molecules, cells, and organs. Mind and body, psyche and soma. (Pert, 1997, p. 185)

Sylwester

> The basic genetic developmental pattern for our brain is thus quite simple and straightforward: . . . use emotion, experience, and learning to strengthen the useful connections. (Sylwester, 1995, p. 126)

> Our profession pays lip service to educating the whole student, but school activities tend to focus on the development of measurable, rational qualities. (Sylwester, 1995, p. 72)

> John Dewey began this century with an eloquent plea for the education of the whole child. It would be good for us to get around to it by the end of the century—and emotion research may well be the catalyst we need. (Sylwester, 1995, p. 77)

Ellen White also is specific in identifying the triad relationship as critical to the educational process. More than 200 times there are references in her publications to the "physical, mental, and spiritual powers" and she always emphasizes the harmonious balance that they require. (Note: The search engine used yields a maximum of 200 hits for any search inquiry. It is possible there may be even more references in her publications.)

Though this triad construct is recognized by both bodies of data studied here, as mentioned previously, concern is expressed that all three areas of this triumverate relationship are not equally as respected. Both current brain research and Ellen White provide substantive rationale to indicate a need for rethinking the established order of honoring mental function over physical and emotional/social/spiritual functions. This study reveals both scientific and spiritual rationale that indicates a need for valuing physical and emotional/social/spiritual functions as much as mental function.

A Point of Divergence

White's counsels and brain research are not entirely consonant in regard to the three elements of this triad relationship. The component described in this document as *emotional/social/spiritual* introduces an element of dissonance or confusion. Brain educators most often refer to the limbic function component in the triad construct as *emotional/social.* Occasionally the term *spiritual* is used, but this use is rare.

Ellen White, on the other hand, most often uses the term *spiritual* as she discusses this triad relationship. In these discussions of the spiritual element, however, she occasionally includes references to emotional, social, moral, esthetic, vocational, and religious considerations. It would not be true to the data to suggest that Ellen White would refer to harmonious development as balance between physical, mental, and emotional/social factors only. White clearly indicates that her use of the term *spiritual* is not limited to emotional/social factors. She stresses the importance of the *divine* element for learning empowerment. Her use of the term *spiritual* appears to be tied to her creationist position. She defines learning and physical and spiritual well-being as dependent on the power and influence of Love, which is one and the same with God. White speaks of the *human spirit* and of the *divine spirit.*

A legitimate question arises out of this consideration. Is it fair to equate the *emotional/social* component with the *spiritual* concept? It appears to me that there are similarities between these terms, in spite of the difference expressed above. I have aligned Ellen White's use of the term *spiritual* with the brain science term *emotional/social,* because of the semantical meaning the word *spirit* evokes today.

Webster's Dictionary describes *spirit* as an "animating principle of life" or an "attitude or principle that pervades thought, stirs one to action, etc." (Braham et al., 1999, p. 1262). Though it is clear that Ellen White includes far more than just human spirit in her use of the term *spiritual*, it also seems clear throughout her writings that she would agree that *spirit* does refer to an attitude or principle that *pervades thought and stirs to action.*

How does the brain science term *emotional/social* fit with the above definition of *spirit*? Does *emotional/social* refer to an "animating principle of life" or to an "attitude or principle that pervades thought and stirs to action"? Typically, in the brain science referenced emotion is not referred to as a principle. However, Candace Pert's explanation of the activating role of emotion within the body and brain seems to fall into the parameters of *pervading thought and stirring to action.* It seems reasonable to consider these two terms (emotional/social and spirit) as related enough to categorize them together. Occasionally some of the brain educators referenced also imply a similar alignment. They do not, however, go so far as to speak of a supernatural power, though some do reference the benefits of love and altruism. When they speak of spirit, human spirit seems to be implied.

While there seem to be connections between emotional, social, and spiritual aspects, the relationship is not clear. In what ways are these three concepts of the human experience similar and different? That question should be the focus of further research.

A Fractal-like Concept for Learning Empowerment

As a result of this study it appears that this triad relationship of mental, physical, and emotional/social/spiritual power is operant in numerous aspects of learning and at varying levels of brain and body function. Anatomically, physiologically, and neurochemically, it can be identified at multiple levels of body/brain study. Though ancient philosophers and more current learning theorists have often referred to this triad construct, it has not been identified as a fractal-like pattern within the body and brain. In the literature reviewed for this study this triad pattern seems to be implicitly referenced but not explicitly aligned with brain anatomy and physiology, in spite of the fact that more recent knowledge about the brain supports the mutual dependency of physical, mental, and emotional/social/spiritual functions.

This study provides reason to consider that this three-part relationship functions as a *fractal-like* pattern in holistic learning. For clarification, definition of a fractal is necessary.

Benoit Mandelbrot, a French mathematician, in 1975, introduced *fractal theory* to the worlds of math and geometry. Fractal study can be complex and it also can be considered in simpler terms. Fractals are typified by patterns within patterns. With technology, mathematical configurations (patterns) are developed and replicated at varying levels of size. Intricate repetitive patterns can be created, and they are often dealt with as an art form as well as for strategic functional purposes.

Webster's Dictionary (Braham et al., 1999) provides this definition of a fractal:

> A geometrical structure that has a regular or an uneven shape repeated over all scales of measurement and that has a dimension (fractal dimension), determined according to definite rules, that is greater than the spatial dimension of the structure. (p. 518)

A fractal is and contains a repeated pattern at varying levels, and the repetitious pattern of smaller units exemplifies the pattern of the whole unit. Whether the design is viewed microscopically or macroscopically the pattern structure is seen. The example of a fern is often used to describe a fractal in simple terms. Each of the smaller segments of the fern replicates the shape and pattern of the whole. The pattern not only is the whole, it also is seen as the constituent parts of the whole.

In this study of learning and brain function, application of the term *fractal* is metaphoric and philosophical, *not* mathematical. A mathematical formula may be operant; however, that consideration is beyond the intent of this discussion. Implied here is the concept that the triad relationship of physical, mental, and emotional/social/ spiritual powers is foundational and structural to holistic learning, and that this relationship is fractal-like in all of life function. It appears to be a pattern in the academic, the physical, and the social worlds as well, though that investigation deserves a closer look than this study provides. This study *has* identified this pattern as repeated throughout brain and body functions, the learning process, brain structure, etc. To distinguish the use of *fractal* from mathematical connotations, in the context of this document it is italicized and/or referred to metaphorically.

A Triune Brain *Fractal*

As an example of how this *fractal-like* concept of physical, mental, and emotional/social/spiritual powers is reflected in neuroscience, consider the structure of the brain—a model itself of this three-phased consideration. Referring to the *triune brain,* neuroscience describes the brain as containing three major areas—the hindbrain or brainstem (pathway into the brain from the *physical* body), the limbic system (center for *emotion,* memory and sensory reception coming in from the *social* environment), and the cerebral cortex (area for higher levels of thought or *mental* processing). The postulation here is that the structure of the brain reflects the three parts of this proposed *fractal-like* construct.

Paul MacLean first indicated that the three areas of the triune brain represented three brains in one. Current knowledge about the brain still recognizes the anatomical areas MacLean identified, but it now suggests that those three areas of the brain are intimately connected and though they are primarily known for three major areas of specialization, they are more multifunctional than previously considered.

Brain science clearly indicates that all three areas of the brain are critical to cognition, health, and attitude. In order for mind and body to function well and to facilitate learning, holistic brain function is required.

It seems apparent from this study that the three areas of the triune brain align with the three areas of the triad relationship referred to by White and the eight brain educators referenced in this document. The cortical area aligns with the mental component, the limbic area with the emotional/social/spiritual component, and the brain stem with the physical component.

Micro- and Macro-Level *Fractal* Function

As is typical of a fractal, this *fractal-like* pattern is seen at large-scale and diminished levels of brain function. The pattern seems apparent at the macro level in the way the brain is structured as well as at the microscopic level in cellular function.

Cell Function

Applying the *fractal-like* concept to the cellular level, this metaphoric pattern appears to be relevant. Candace Pert's *Molecules of Emotion* (1997) concentrates on the relationship of cell function to mental, physical, and emotional factors. Each of these factors plays a role in cell function and stability.

First, cortical function (higher-order thinking) impacts cell function throughout the body. Pert's studies, Paul MacLean's description of the connections between cortical function and the emotion center, and Marian's Diamond's reference to HeartMath studies all draw attention to this possibility as they discuss the cortical brain's impact on all function—brain, body, and emotion, including the neurochemical and immune system.

Second, the physical state of the entire system influences individual cells throughout the body and brain. Physical activity, movement, and fitness affect and are affected by the integrity of cells that compose the body and brain. Cellular structures throughout the body and brain operate according to the neural (electrical and chemical) messages being received from both the brain and the body.

Third, emotional factors (neurochemistry and memory) impact the function of cells throughout the body. Again, Pert, MacLean, Goleman, Diamond, Kagan, and others substantiate the influence that neurochemistry (and emotion) has on cells and cell systems throughout the brain and body. All three components affect individual cell structures, which collectively constitute and affect the whole.

Networked System Replications

Considering additional replication of the *fractal-like* pattern, Pert discusses mind, body, and emotion as related to broader, networked systems of neuroscience, endocrinology, and immunology (p. 184). In each of these areas as well, the triad relationship is operant.

This *fractal-like* metaphor application remains true to fractal characteristics in that the pattern is seen replicated in its integral parts, as is typical of geometric fractals. Just as the segments of the fern reflect the same pattern as the whole, the *mind, body, and emotional/social/spiritual fractal pattern* is repeated in each of its constituent parts.

For example, looking inward on the three *fractal-like* components themselves, interdependence can be seen. Consider first the *physical* factor. It is both affected by and contributive to emotional and mental conditions. This study evidenced that physical well-being is dependent on mental attitude, physical activeness, and emotional state. Brain research and Ellen White are conclusive that the physical component is dependent on all three elements—mental, physical, and emotional/social/spiritual functions.

Next, mental states are directly affected and stimulated by physical activity and neurochemistry (emotion, as Pert describes). These two factors (physical and chemical-emotional) promote overall brain activity and specifically cortical function—higher-order thinking. All sensory input coming in from the environment is transmitted via the body's and brain's chemistry. In addition, proprioceptors in muscles throughout the body feed into the vestibular system and reticular activating system, a part of the brain that must be communicating with at least one cortical area if consciousness (mental activity) is to be maintained. Additionally, it is currently believed that the neuronal structures of the cortex cannot communicate with each other without chemical and electrical transfer. All three components (physical, mental, and emotional/social/spiritual) are critical to maintaining mental health, stability, and function. Ellen White also is congruent with this concept throughout her educational and health reform counsels.

Last, as explained in the previous two component discussions, the emotional/social/spiritual condition affects and is affected by mental attitude, physical condition, and neurochemistry as well. Sensory information is processed in the limbic center before being transferred to the cortical area of the brain or before being sent to other points in the body. How these incoming sensory data are received and processed is influenced by the current state of the mental and physical aspects of the brain and body. This bi-directional influence involves emotional state, feelings, and relationships with others.

Brain science and Ellen White affirm that all three components—mental, physical, and emotional/social/spiritual—are contributive as interdependent parts of the whole. In a sense, Paul MacLean may have been right after all when he said that each part of the triune brain was like a brain in itself. This seems more feasible from the perspective of this *fractal-like* construct—that offers the idea that the pattern of the whole is repeated in the constituent parts. According to the brain science represented by the authorities cited in this study, it remains true that no one part of the brain can maintain body and brain function on its own. The three parts are three in one.

Recognition of the *Fractal-like* Construct

Though brain educators discuss the triad relationship, it is not evident that brain science and education have identified this construct as a *fractal-like* pattern at play throughout various functions of the body, the brain, and the emotions. The pattern is discussed at differing levels of function, but recognition of a *fractal-like* pattern as a distributed unit of a larger whole is only postulated here as a conclusion of this study. Similarly, in Ellen White's writings, as in the brain science referenced, she also refers to this functional pattern but without using the term *fractal*. Fractal theory was not introduced by Benoit Mandelbrot until 1975, at least 65 years after White wrote her counsels to educators. Both brain science and Ellen G. White imply a *fractal-like* status within the body and brain, but this implication has not been articulated in fractal terms.

Repeatedly White stresses the need for physical, mental, and spiritual balance, and she applies this counsel to various aspects of life—learning, health, and spiritual life. White perhaps comes closer to identifying the *fractal-like* concept than does brain science, possibly due to her tendency to discuss the harmonious relationship in the three areas of intellectual, health-related, and spiritual development. She addresses these areas in an integrated way. In the past, brain science has tended to be more discrete, molecular, and fragmentary in its discussions of the mental, physical, and emotional/social functions. However, with new findings in brain science to substantiate the symbiotic functions of the brain, "harmonious" relationship discussions now are more commonly occurring.

The *Fractal* Potentiated

Ellen White's teachings reiterate the importance of the critical balance that is necessary to life functions. "True education," she counsels, "is the harmonious development of the physical, the mental, and the spiritual powers" (White, 1903b, p. 13), and to this she adds emphasis on the importance of service to humanity. She seems to imply that love for others potentiates the triad function. White dwells on the importance of this triangulated relationship in conjunction with her emphasis on recognition of God as the source of all power, wisdom, and love.

Some of the brain educators in this study extrapolate their interpretations of brain science into applications for practice in the classroom. However, service learning was not a common point of discussion in the literature reviewed. On the other hand, it *is* discussed commonly among educational practitioners today. The benefits of involving students in outreach to others is recognized as an effective way to bring meaningful experience to learning environments. Again we have to wonder, How does service fit into the *fractal-like* model? This could be another important question for future research.

Concluding Comments

This study of two large bodies of information has revealed a number of similarities and differences. Without question, there is consonance within both bodies of information regarding the major education-focused themes now brought forward by neuroscience. Both brain research and Ellen White strongly endorse the idea that a dynamic relationship exists between physical, mental, and emotional/social/spiritual functions. This relationship appears to me to be so integral to each body of data that I have come to think of it as a *philosophical fractal*—a structural and functional pattern that is repeated at macro and micro levels in brain science, in education, and in the philosophical reasoning that seems to govern education. In fact, this *fractal-like* pattern that appears to represent brain function seems to apply to life processes in general.

The study of these two bodies of information revealed differences in regard to the spiritual element, though some brain researchers do hint at evidences of a vital force at play in body and brain processes. Ellen White promoted the concept that light, life, and love are critical elements in learning and in life processes. She counsels that humanity was created *by* a loving God and *in* the image of that loving God—the embodiment of light, life, and love.

In contrast, brain research appears to be strongly influenced by naturalistic thought that promotes the ideas that no vital force is at play in brain function and that humanity moves forward in the evolutionary process without purpose or design.

Standards for intellectual, behavioral, and altruistic function seem to rest on the integrity of the human element in and of itself. Control of impulsive emotional drive seems to be dependent on external and internal conditioning that develops naturally and enables cortical, limbic, and physical functions to self-manage. As part of a process of natural selection, neural functions are perpetuated within a dynamic, interconnected web. The research of Francis Crick, Gerald Edelman, and others is commonly referenced in regard to new brain hypotheses and theories that seem founded in naturalistic philosophy.

Still another philosophical factor was at play as this research study progressed. According to Sylwester (1995), those who study the brain use either a bottom up or top down approach. Bottom up tends to be the preferred approach of neuroscientists, according to Sylwester. They focus on the workings of "small units—individual cells, or small systems of cells within more complex systems. This research perspective promotes the idea that understanding the basic units of a system is essential to understanding the entire system" (p. 7). Such scientific endeavors typically honor measurement as a standard for research integrity (Pert, 1997). When factors such as spiritual issues are introduced, typical scientific method is challenged by the question, 'How can such abstractions be measured?'

This qualitative study looked to individuals with ability to bridge the gap between top-down and bottom-up considerations of brain function as it relates to education. By looking at what many were saying about the same topic, and maintaining an openness to the philosophical tensions, similarities and differences were teased out. As a result interesting data evolved. A postulated, metaphoric *fractal-like* concept is offered.

Finally, as the educational themes and principles promoted by brain science and Ellen White are considered and practiced, perhaps more children will benefit mentally, physically, and emotionally/socially/spiritually. That would be a valuable outcome for any study.

APPENDIX

APPENDIX 1

BRAIN RESEARCH THEMES AND SOURCES

TABLE 2
BRAIN RESEARCH THEMES AND SOURCES

ATTRIBUTE	Caine	Diamond	Hannaford	Healy	Jensen	Pert	Sylwester
1. Body and Mind	X	X	X	X	X	X	X
2. Senses and Learning	X	X	X	X	X	X	X
3. Exercise and Movement	X	X	X	X	X	X	X
4. Health Habits		X	X		X	X	
5. Emotions and Neurochemistry	X	X	X	X	X	X	X
6. Music and the Arts	X	X	X	X	X		X
7. Attention	X	X	X	X	X	X	X
8. Social Influences	X	X	X	X	X	X	X
9. Plasticity and Enrichment	X	X	X	X	X		X
10. Stages of Development (Critical Periods)	X	X	X	X	X		X
11. Language Development	X	X	X	X	X		

Table 2--Continued

ATTRIBUTE	Caine	Diamond	Hannaford	Healy	Jensen	Pert	Sylwester
12. Making Meaning (Making Connections)	X	X	X	X	X	X	X
13. Individualism	X	X	X	X	X	X	
14. Motivation	X	X		X	X		
15. Memory	X	X	X	X	X	X	X

TABLE 3
Themes by Researcher
Ranked by Frequency

	ATT	CMU	ENP	EMO	HTH	LAN	MMK	MDB	MUA	MEM	MOT	MOV	SEN	SOC	STG
Caine & Caine	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Diamond	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hannaford	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Healy	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Jensen	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pkg. of 200			X	X	X	X			X	X		X			X
Pert	X	X		X	X		X	X		X		X	X	X	
Sousa	X			X	X		X			X			X		X
Sylwester	X		X	X		X	X	X	X	X		X	X	X	
Wolfe	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Legend:

ATT = Attention
CMU = Complex, Unique Individual
ENP = Enrichment & Plasticity
EMO = Emotion & Neurochemistry
HTH = Health Habits

LAN = Language
MMK = Meaning Making
MDB = Mind & Body
MUA = Music & the Arts
MEM = Memory

MOT = Motivation
MOV = Movement & Exercise
SEN = Senses
SOC = Social Influences
STG = Stages of Development

APPENDIX 2

ELLEN G. WHITE PRINCIPLES BY CONTRIBUTOR

TABLE 4

ELLEN G. WHITE PRINCIPLES BY CONTRIBUTOR

Principles	Akers	Cadwallader	Douglass	Knight
1. *Biblical Foundation*		• The only true education is Christian education, or education that includes instruction in religion based on the Bible—the most important textbook on all levels of education.		• The Bible is the integrating focal point of all knowledge and is foundational and contextual in education.
2. *Knowledge of God*			• The first and constant aim of Christian education: To aid "the student in comprehending these principles," and to enter "into that relation with Christ which will make [these principles] a controlling power in the life."	• Higher education is leading a student to know God.

Table 4—Continued

Principles	Akers	Cadwallader	Douglass	Knight
3. *Redemption and Restoration of the Image of God*	• Redemptive Discipline		• School curriculum must be organized to fulfill education's highest aim (to develop in the student the likeness of the Creator God.)	• A primary function of education is the re-creation of the image of God in human beings—humanity created in God's image. • Holy Spirit is essential in educative/redemptive process. • Education is an agent in the plan of restoration and redemption. • God's plan of restoration. The fall of humanity.
4. *Power of Choice and Human Will*			• Towering motivation for reaching one's full potential.	• Education should focus on the correct use of the human will. Discipline is self-control.
5. *Character Development*	• Character (conscious)			• Character development follows conversion.
6. *Service*	• Selfless Service		• The highest forms of recreation, filled with blessings to students, are those activities "which make them helpful to others."	• Service to others as an ethical end product and an expression of God's love.

Table 4—Continued

Principles	Akers	Cadwallader	Douglass	Knight
7. *Harmonious Development: Mind, Body, & Spirit*		• True education is the harmonious development of the physical, mental, moral, spiritual, esthetic, vocational, emotional, social, and religious aspects of man's nature.		• Education should meet needs of each aspect of the unified whole person. • Unity of each person in his/her social, intellectual, vocational, physical, and spiritual aspects.
8. *Amusement & Recreation*		• Amusement should be minimized in the life of the student and useful work substituted as a means of securing recreation, relaxation, and healthful exercise.		• Students should be taught to appreciate recreation (re-creation) rather than amusement.
9. *Work & Practical Functions*	• Practical	• As much as possible of the work of caring for the institution should be done by the students, and all should have some work experience. • The curriculum should be sufficiently vocational in nature to insure that every student will leave school with a worthy means of earning a livelihood.	Occupational skills [are] imperative.	

		• Education should prepare a person to be useful and should inspire him with the ideal of service. • Education should be practical as well as cultural and academic.		

Table 4—Continued

Principles	Akers	Cadwallader	Douglass	Knight
10. *Health Habits*	• Health (balance)	• Health is a major factor in the success of the student; both the school and the student should be concerned with health principles.	• Essential courses of study (all of which are seated in a Biblical context) should include: First, physiology; then other areas such as vocal training (speech).	
11. *Parental Influence*			• The role of the parents as educators is supreme over all others.	• The parents are the primary teachers and the home the primary school.

Table 4—Continued

14. *Teacher Influence and Characteristics*	• Love (Agape)	• The teacher's work is viewed as second only to that of the ministry, if not equal in importance. • Teachers should be well qualified scholastically, but above all should be practical Christians possessed of a missionary spirit.	• Teacher credibility is based on an individual's ability to bridge the gap between religion and theology, between experience and knowledge.	• Teaching is a form of ministry.

APPENDIX 3

BRAIN RESEARCH THEMES AND

ELLEN G. WHITE PRINCIPLES COMPARED

TABLE 5
BRAIN RESEARCH THEMES AND E. G. WHITE PRINCIPLES COMPARED

Brain Research Theme	E. G. White Principle
1. Body and Mind (Aligned)	6. Service 7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Functions 10. Health Habits
2. Senses (Somewhat Aligned)	7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Functions 10. Health Habits
3. Exercise and Movement (Aligned)	7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Functions 10. Health Habits
4. Health Habits (Aligned)	4. Power of Choice and Human Will 7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Functions 10. Health Habits
5. Emotions and Neurochemistry (Aligned)	1. Knowledge of God 2. Biblical Foundation 3. Redemption and Restoration of the Image of God in Humanity 4. Power of Choice and Human Will 5. Character Development 6. Service 7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Function 10. Health Habits
6. Music and the Arts (Somewhat Aligned)	7. Harmonious Development 8. Amusement and Recreation
7. Attention (Somewhat Aligned)	6. Service 7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Functions 10. Health Habits

Table 5—Continued

Brain Research Theme	E. G. White Principle
8. Social Influences (Aligned)	6. Service 7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Functions 11. Parental Influence 12. Teacher Influence and Characteristics
9. Plasticity and Enrichment (Aligned)	1. Knowledge of God 2. Biblical Foundation 3. Redemption and Restoration of the Image of God in Humanity 4. Power of Choice and Human Will 5. Character Development 6. Service 7. Harmonious Development 8. Amusement and Recreation 9. Work and Practical Function 10. Health Habits 11. Parental Influence 12. Teacher Influence and Characteristics
10. Stages of Development (Aligned)	7. Harmonious Development 11. Parental influence 12. Teacher Influence and Characteristics
11. Making Meaning (Somewhat Aligned)	6. Service 7. Harmonious Development 9. Work and Practical Functions 10. Health Habits
12. Individualism (Aligned)	4. Power of Choice and Human Will 7. Harmonious Development
13. Language (Somewhat Aligned)	7. Harmonious Development 11. Parental Influence 12. Teacher Influence and Characteristics
14. Motivation (Somewhat Aligned)	4. Power of Choice and Human Will 7. Harmonious Development
15. Memory (Somewhat Aligned)	7. Harmonious Development

APPENDIX 4

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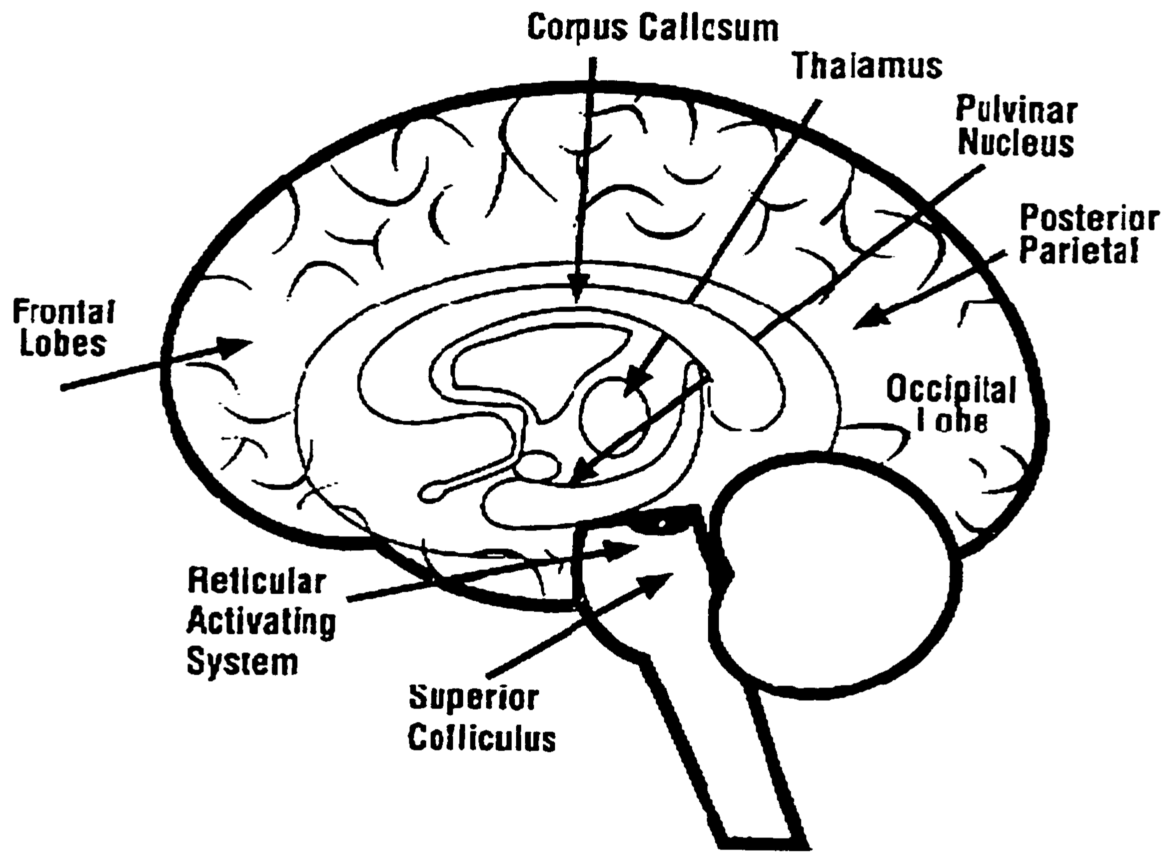

Figure 1. Areas of the brain affected in gaining and maintaining attention.

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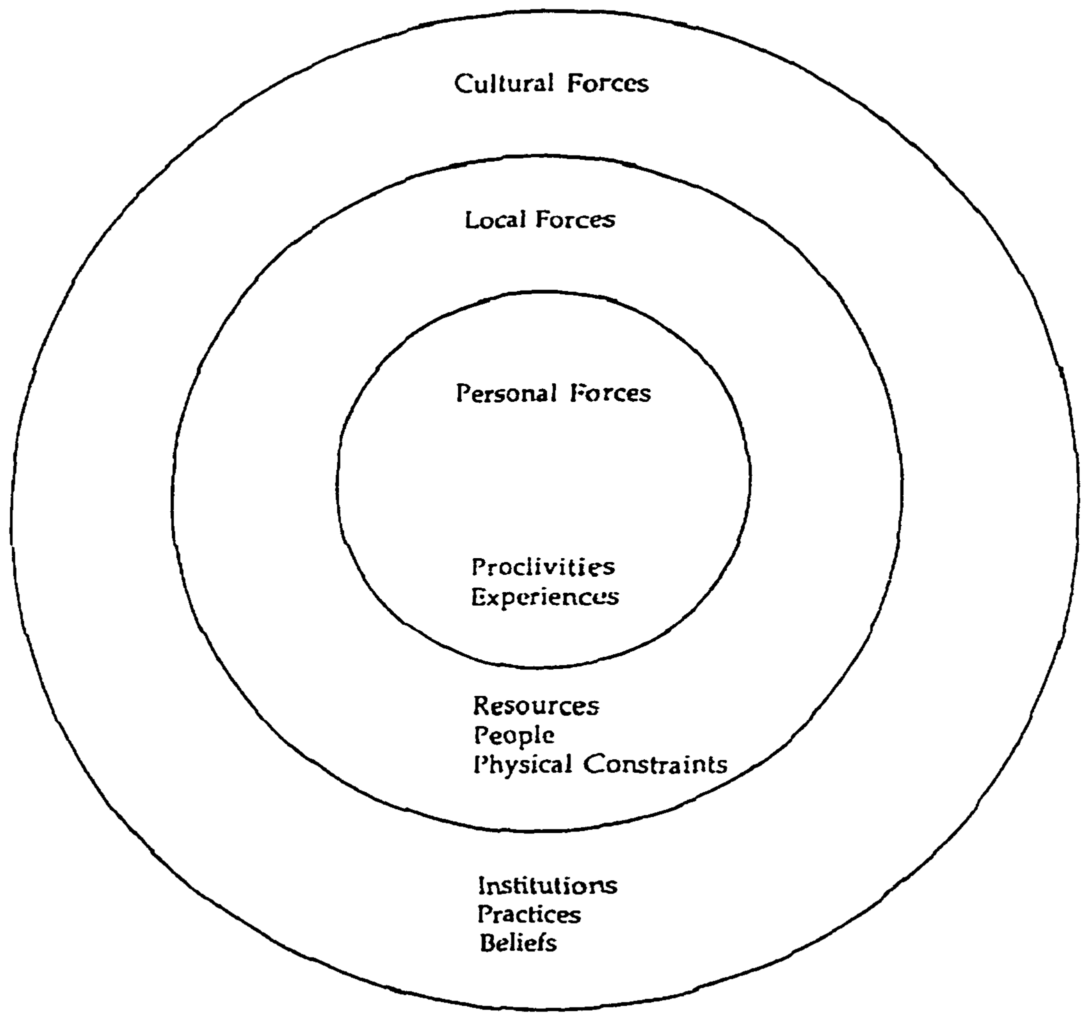

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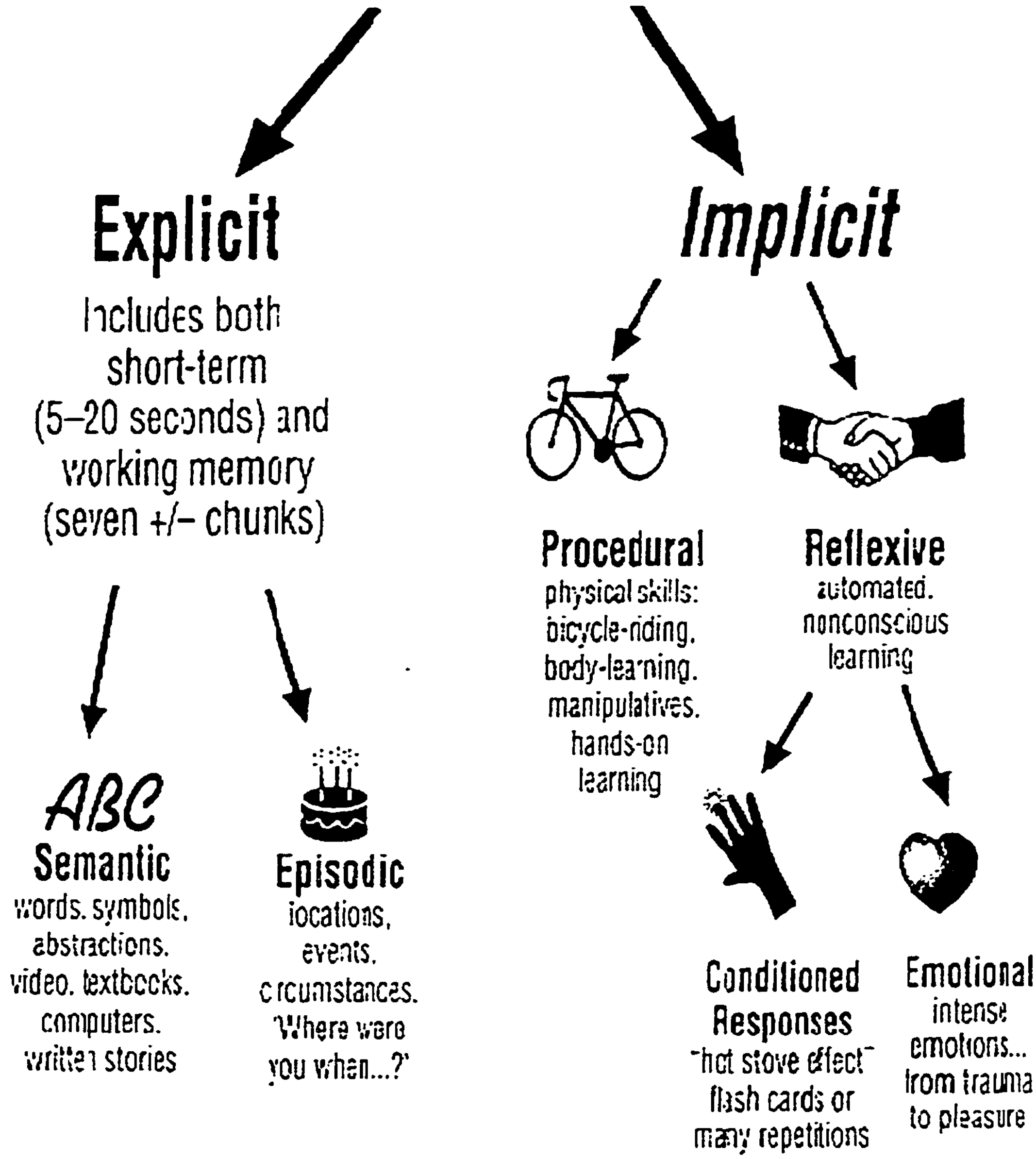

Figure 3. Memory pathways.

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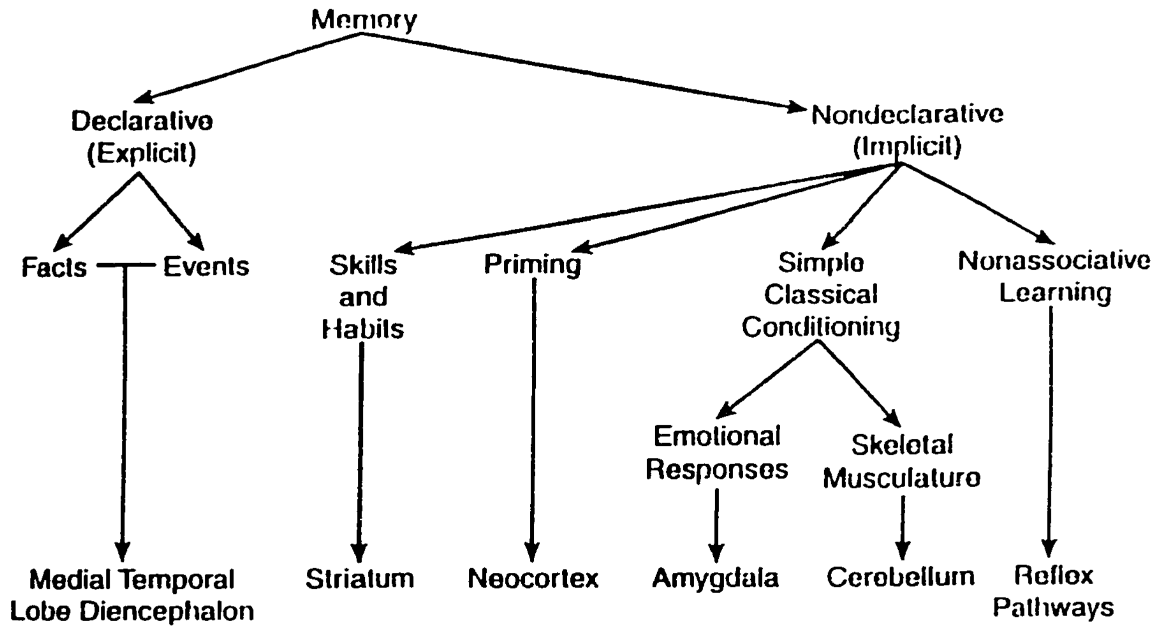

Figure 4. Taxonomy of memory and associated brain structures.

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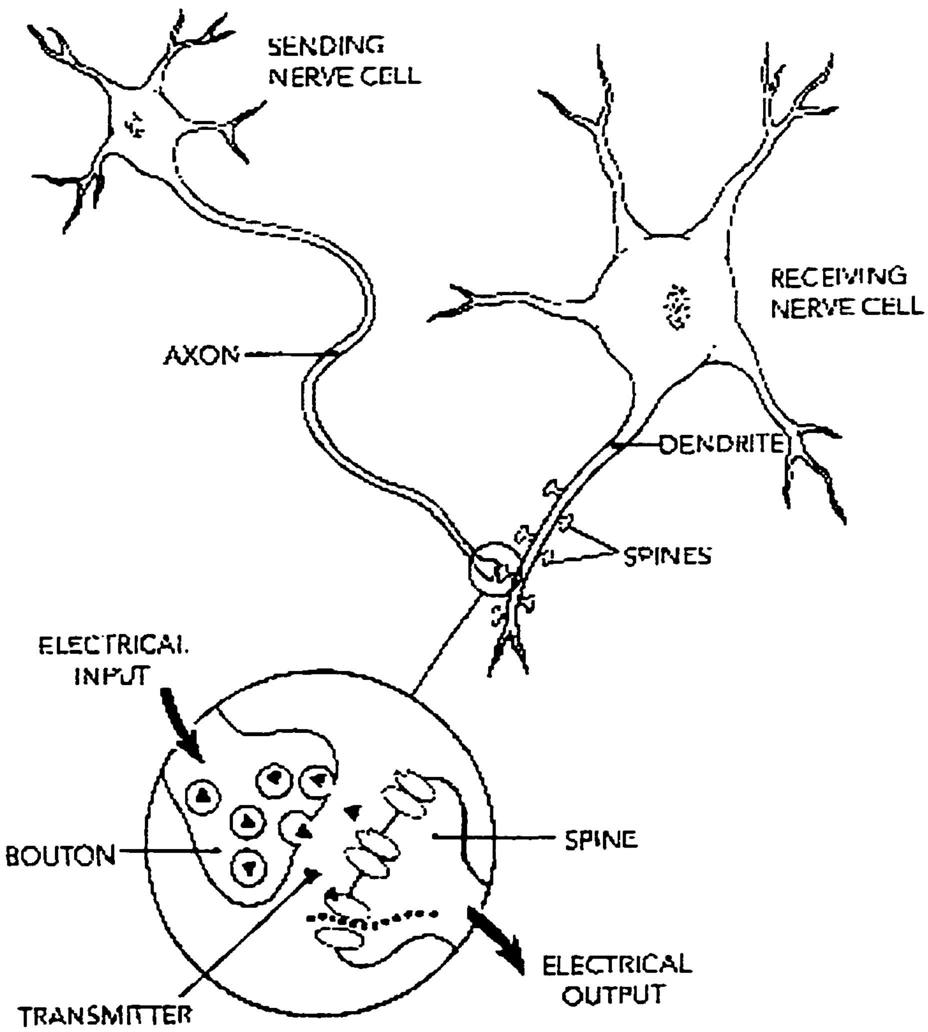

Figure 5. Schematic representation of neuronal and synaptic structures.

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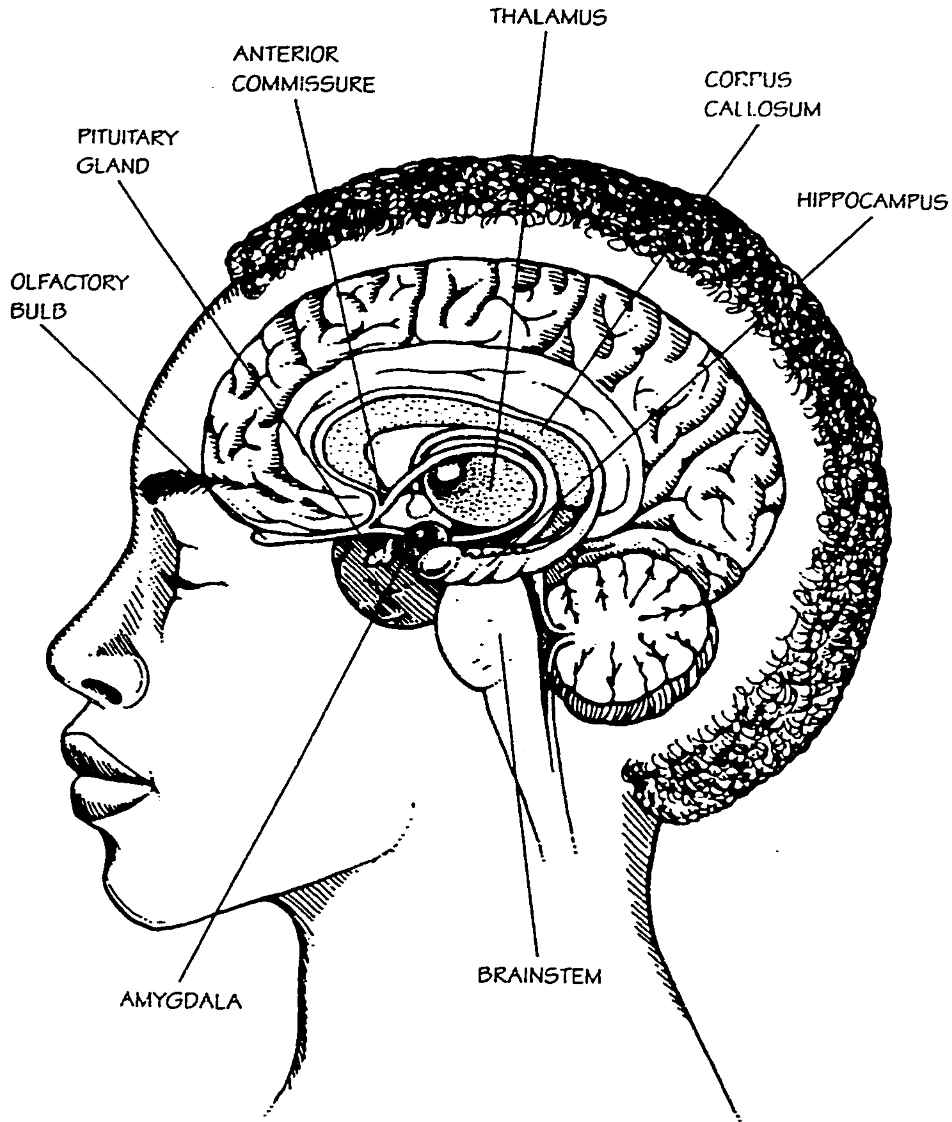

Figure 6. Schematic model of limbic system and brainstem.

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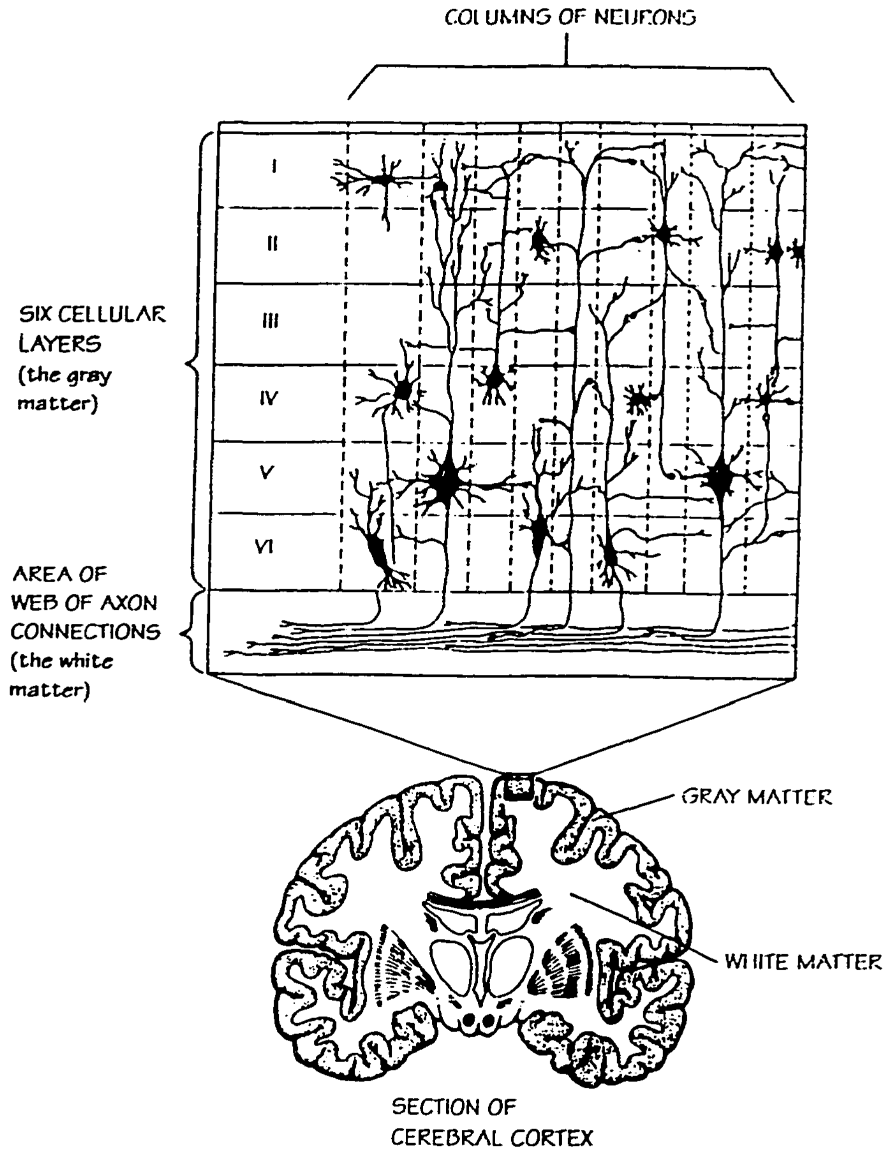

Figure 7. Schematic representation of orders in branching of dendrites.

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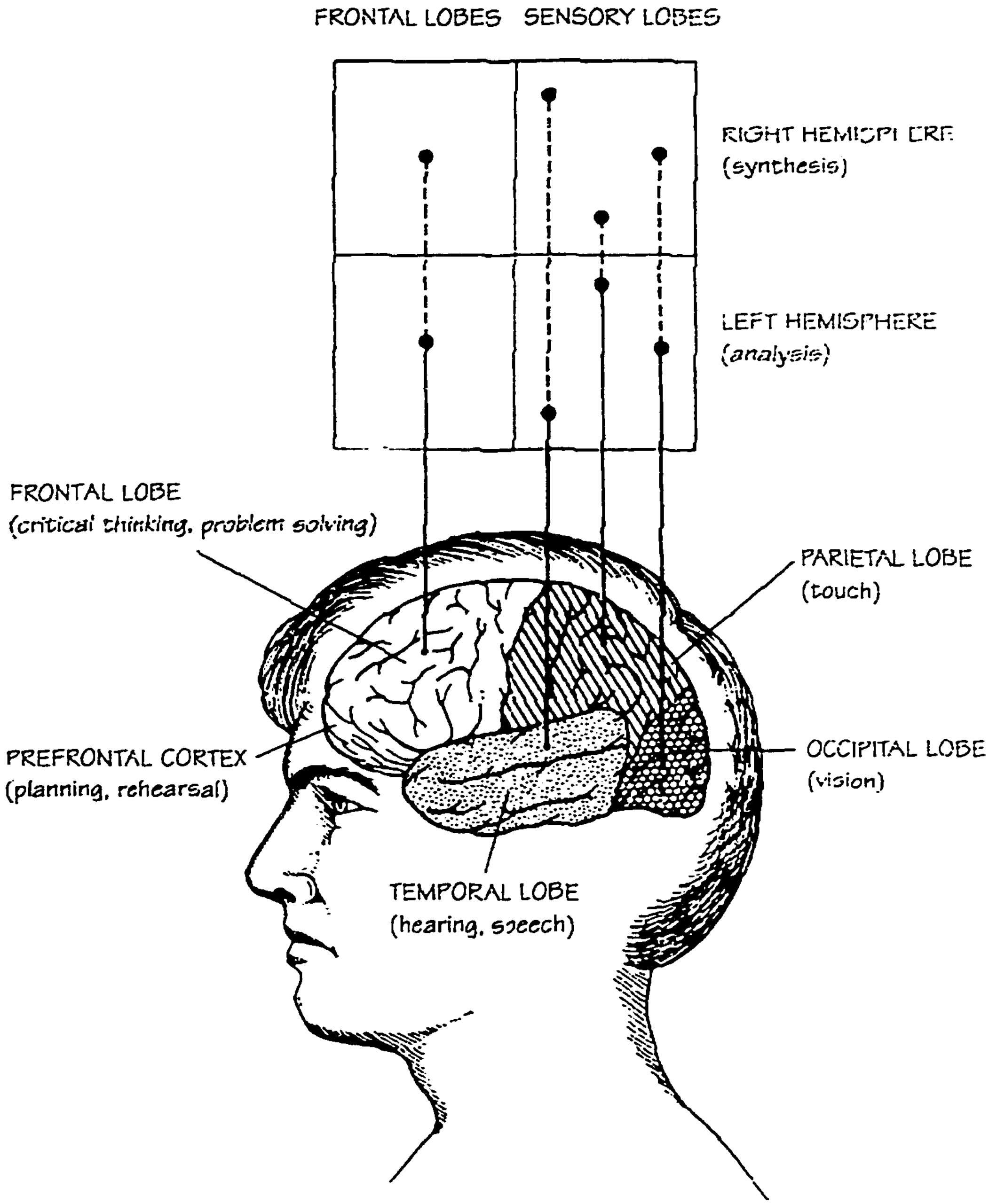

Figure 8. Schematic top view of cerebral cortex.

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APPENDIX 5

AN OVERVIEW OF THE PHYSIOLOGY OF THE BRAIN

AN OVERVIEW OF THE PHYSIOLOGY OF THE BRAIN

Introduction

The cerebrum (cerebral hemispheres), Hannaford (1995) says, is about the size of your two fists loosely placed together with thumbs aligned side-by-side and pointing upward. The neocortex covering on the cerebrum is sometimes called the cortex or *cerebral cortex.* The term *neocortex* is used to indicate a more developed cortical area than that seen on non-mammalian brains. "It's hard to believe that this narrow sheet could contain all of an animal's cunning or a person's intellect. But it does" (p. 17), says Marian Diamond (1998).

> In a living animal, the cortex is pink, like the rest of the brain, since it is crisscrossed with a hundred miles or more of minute blood vessels. But the seventeenth-century scientists began calling the cortex the "gray matter" due to the ashen hue it turns when a brain is pickled in alcohol or another fixative. The rest of the mass enveloped by the cortex layer contains nerve fibers sheathed with a white fatty covering (called *myelin*). In common parlance, it is the "white matter." (p. 19)

Two types of cells are found in the cortex—neurons and glia. There are approximately ten times as many glial cells as neurons. Glia metabolically and structurally support the neurons—the information transmitters. Glial cells produce a white fatty substance called myelin that forms an insulating wrapper around the axon of the neuron. (Diamond, 1998, pp. 37-48) "Of its [the brain's] 100 billion neurons, more than one third are jammed into the cerebral "bark" and branch luxuriantly into dendritic trees" (p. 23), Diamond (1998) explains. The dendrites reach out to receive incoming information, and the axon serves to send information on to other cells. (See Figure 6.)

A metaphor of the hand and arm may help the reader to envision a neuron. The palm would represent the cell body, the fingers the dendritic appendages that reach out to receive incoming messages, and the arm the axon, which transmits information to other neurons.

Describing the brain's capability for establishing connections, Diamond (1998) says,

> Every neuron makes virtually every conceivable contact point with its neighbors—upwards of 15,000 contacts per cell in many places and in a few, upwards of 200,000! With 85 billion neurons forming in the cerebral cortex, each making thousands of synaptic connections, its not hard to see where neurologists get the figure of 1,000 trillion contact points in the brain. (p. 45)

Commenting on the vast number of potential connections within the brain, Diamond (1998) says it is hard to envision "how the brain could work smoothly with such an overload of random connections" (p. 45).

This complex network of neural reception and transmission receives input brought in from sensory sites located throughout the body. As information proceeds toward the cerebral cortex, most first passes through the limbic part of the brain—the emotion center. Sylwester (1995) suggests that in the limbic area "the thalamus is our brain's initial processor of external sensory information, and the hypothalamus is the monitor of most of our body's internal changes" (p. 58). He continues to describe how information is processed:

> Our body's various endocrine balance systems and immune defense mechanisms are also linked to our brain, and so we can view them as part of a general internal sensory/regulatory system that helps to keep us upright, and that recognizes and destroys harmful substances that enter our body.

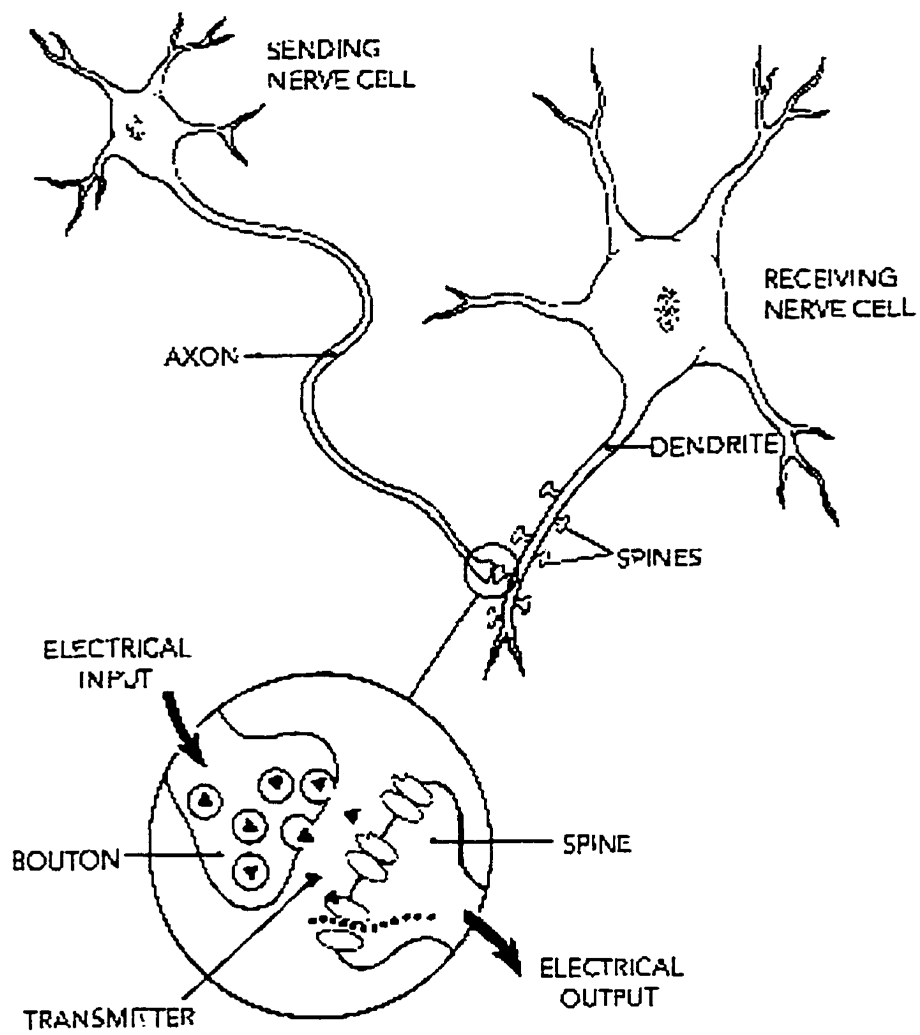

Figure 5. Schematic representation of neuronal and synaptic structures. From Magic Trees of the Mind (p. 26), by Marian Diamond and Janet Hopson, 1998, New York: Dutton (Penguin Putnam). Copyright 1998 by M. Diamond. Reprinted with permission.

> We are, therefore, a body bombarded by a rich blend of initially meaningless molecular fragments and light rays that represent complex outside and inside environments—*flickering shadows* that enter our brain and modify the neural networks that consciously and unconsciously analyze and synthesize our relationships with our environment. (p. 58)

"These subtle, invisible transactions among sensory/emotional/motor areas of the brain allow us to create meaning from our experience" (p. 73), says Hannaford (1995). The "amazing feat of neural development—taking in sensory experiences and creating mental models—will continue to be refined and augmented constantly throughout a lifetime" (p. 73). Referring to early development of the major areas of cerebral function, Hannaford states:

> The occipital, temporal and parietal areas partially develop along with the brain stem and limbic systems, but exhibit a major spurt at approximately age four. It is not until approximately age eight that we get a major growth spurt in the frontal lobes. (p. 76)

Sylwester (1995) explains this developmental process further by referring to Jean Piaget's theoretical stance on developmental stages:

> The Piagetian stages of cognitive development roughly divide the maturation of the cortex, with the earlier-developing sensorimotor and concrete operations stages concentrated in the back half, and the later-developing formal operations stage concentrated in the front half. (p. 52)

Diamond (1998) speaks of the brain's ability to link together different areas of the brain in the process of maturation and in the increasing ability to construct meaning. She describes brain function as modular, but interconnected.

> Our brains are amazingly modular; the dozens of separate regions act in concert to allow us to see and hear and think, but they mature at varying speeds and to varying degrees. When you look at the way a child's brain develops, one thing becomes absolutely obvious: . . . *input from the environment helps shape the human brain.* (p. 63)

The brain is commonly described as a three-part organ (or the triune brain): the hindbrain (or lower brain), the limbic area, and the cerebral cortex. The hindbrain (brain stem/reticular area) includes the upper spinal chord--medulla oblongata--and the pons, and the cerebellum.; the limbic area involves the amygdala, thalamus, hypothalamus, hippocampus, and basal ganglia; and the cerebral cortex includes the pre-frontal and frontal, parietal, occipital, and temporal lobes. Figure 6 emphasizes the hindbrain (sometimes referred to as the brainstem) and the limbic area. Figure 8 pictures the lobe divisions in the cerebral cortex.

The functions of these three major areas are intricately entwined. For example, motor function involves all three areas, though specific sections of each area may be more specialized for that function than for others. Because each of these areas plays a significant role in how the brain learns and makes meaning, focuses attention, becomes motivated, etc., the following biological descriptions of each of these three areas should help to reader to understand better the information in Chapter 3.

The Lower Brain

This part of the brain is sometimes referred to as the *brain stem,* the *reptilian brain,* the *hindbrain*, or the *reticular formation.* The brain stem is located at the base of the brain, and it is the pathway for sensorimotor input to the limbic area of the brain from the rest of the body. It is intimately tied to the functions of "body organs and systems" (Sylwester, 1995, p. 43). Sylwester explains that our "limbic/brainstem responds relatively slowly (in periods from seconds to months) as it regulates basic body functions, cycles, and defenses, including circulation, respiration, appetite, digestion, sexuality, and fight-or-flight behaviors" (p. 43). Early in life the roles the limbic/brainstem structures will play are formed, Sylwester says. We can't change these roles easily "once they're set. Our temperament and emotions simply exist." We may learn to override them with "rational processes," he continues, but we do not change the actual feelings that necessitate the adaptation.

Diamond (1985, p. 1-2) describes the lowest part of the hindbrain--the medulla oblongata—as continuous with the spinal chord. "Just above the medulla is the pons (bridge), which serves as part of a relay between cerebral hemispheres and the cerebellum. . . . The cerebellum deals with muscle coordination and balance involved in such action as writing and walking" (p. 1-2)

Healy (1990) ascribes to the brain stem area responsibility for "basic alertness (e.g., staying awake when it is appropriate), screening out or letting in various types of stimuli (e.g., focusing without being distracted by background sights or sounds), filtering information, and getting the higher centers of the cortex "in gear."

Limbic Area

The limbic brain is next in ascending order above the brain stem. Healy (1990) describes the limbic area:

> Second come centers for emotion and memory, which are located in the middle of the brain in an area technically called the *limbic system*. In these "subcortical" areas, the incoming stimuli are connected with motivation (how important is it for me to pay attention to this right now?) and some centers for memory. I find it particularly interesting, although not intuitively surprising, that attention, emotion, motivation, and memory have such a close physical link in the nervous system. (p. 160)

The limbic system is "loaded with peptide receptors," and "it's our brain's principal regulator of emotions," according to Sylwester (1995, p. 44). "It also influences the selection and classification of experiences that our brain stores as long-term memories. It's powerful enough to override both rational thought and innate brainstem response patterns" (p. 44).

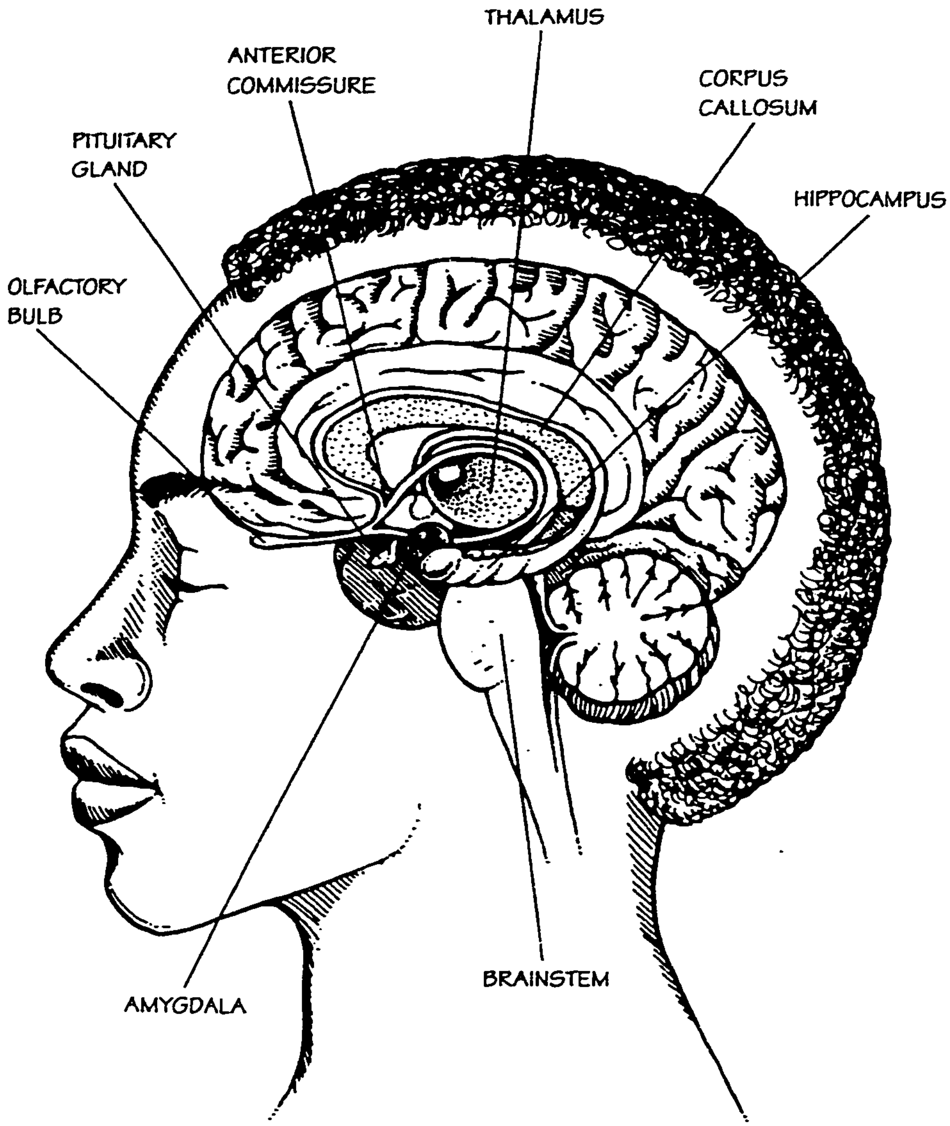

Figure 6. Schematic model of limbic system and brainstem. From *A Celebration of Neurons* (p. 42), by Robert Sylwester, 1995, Arlington, VA: Association for Supervision and Curriculum Development. Copyright 1995 by R. Sylwester. Reprinted with permission.

Describing the limbic brain's profound influence on body and brain function, Marian Diamond (1985) says:

> The limbic system, also known as the visceral or emotional brain, is concerned with behavioral and emotional expression. It appears to include within its repertoire most of those strategies necessary to the preservation of the organism, such as feeding behavior, fight, and flight, as well as those vital to the continuance of the species, such as mating, reproduction, and care of the young. In additional, it is centrally involved in memory processing and in relating the organism to its environment, both in the immediate sense and over time. The limbic system receives continuous samples of all incoming sensory information, while its output, directly or indirectly, affects all endocrine, visceral motor, and somatic motor effectors. (p. 5-26)

The limbic system is composed of many components, but the major parts are the the amygdala, hippocampus, thalamus, hypothalamus, and basal ganglia. These five major organs in the limbic area and their functions are described below:

Amygdala

Aggleton (1992) describes the amygdala as the main organ in the limbic system for processing emotion. Daniel Goleman (1997) refers to it as the "seat of all passion" and "the storehouse of emotional memory." Without it, he says "the result is a striking inability to gauge the emotional significance of events; this condition is sometimes called 'affective blindness'" (pp. 14-15).

At the Center for Neural Science at New York University, a neuroscientist, Joseph LeDoux, (1993) has concentrated extensive study on the importance of the amygdala in the limbic system. He explains that the amygdala is capable of taking control of mental function even while the neocortex is in the process of making a decision.

> The amygdala complex is composed of two almond-shaped, fingernail-sized structures [one in each of the two hemispheres] that are richly and reciprocally connected to most brain areas, especially advanced sensory-processing areas. Its principal task is to filter and interpret sophisticated incoming sensory information in the context of our survival and emotional needs, and then to help initiate appropriate responses. Thus, it influences both early sensory processing and higher levels of cognition (e.g., ignoring the feel of a comfortable shoe, but responding to a shoe with a tiny pebble in it). (Sylwester, 1995, p. 44)

Hippocampus

As a result of Joseph LeDoux's research, the hippocampus is no longer considered the seat of emotional reactions, but rather appears to be the structure in the limbic system that "is more involved in registering and making sense of perceptual patterns than with emotional reactions" (p. 20), according to Daniel Goleman (1997). Goleman adds:

> While the hippocampus remembers the dry facts, the amygdala retains the emotional flavor that goes with those facts. If we try to pass a car on a two-lane highway and narrowly miss having a head-on collision, the hippocampus retains the specifics of the incident, like what stretch of road we were on, who was with us, what the other car looked like. But it is the amygdala that everafter will send a surge of anxiety through us whenever we try to pass a car in similar circumstances. As LeDoux put it to me, "The hippocampus is crucial in recognizing a face as that of your cousin. But it is the amygdala that adds you don't really like her." (p. 20)

The hippocampus adjoins the amygdala, says Sylwester (1995). It, the hippocampus, is "two integrated finger–sized structures that appear to convert important short-term experiences into long-term memories" (p. 45). Each of the two hippocampal structures is located in a different hemisphere in the normal brain.

Thalamus

Marian Diamond (1985) describes the thalamus as a "processing station for all sensory pathways (except olfactory) en route to the cerebral cortex" (pp. 5-17).

Currently, the thalamus, a walnut-sized area in each of the two hemispheres, is believed to represent "the level in the central nervous system at which sensations are first consciously experienced. Sensory and motor-related pathways passing up the brain stem, synapse in the thalamus before proceeding on to the cerebral cortex for more elaborate integration and analysis" (pp. 5-17), Diamond says.

LeDoux's (1994) research uncovered additional information regarding the function of the thalamus. In the case of survival response, a shorter than usual circuitry is enacted. Goleman (1997) describes the brain's ability to simultaneously route information to two different sites when survival may be threatened.

> The conventional view in neuroscience had been that the eye, ear, and other sensory organs transmit signals to the thalamus, and from there to sensory processing areas of the neocortex, where the signals are put together into objects as we perceive them. The signals are sorted for meanings so that the brain recognizes what each object is and what its presence means. From the neocortex, the old theory held, the signals are sent to the limbic brain, and from there the appropriate response radiates out through the brain and the rest of the body. That is the way it works much or most of the time—but LeDoux discovered a smaller bundle of neurons that leads directly from the thalamus to the amygdala, in addition to those going through the larger path of neurons to the cortex. This smaller and shorter pathway—something like a neural back alley—allows the amygdala to receive some direct inputs from the senses and start a response *before* they are fully registered by the neocortex.
>
> This discover overthrows the notion that the amygdala must depend entirely on signals from the neocortex to formulate its emotional reactions. The amygdala can trigger an emotional response via this emergency route even as a parallel reverberating circuit begins between the amygdala and the neocortex. The amygdala can have us spring to action while the slightly slower—but more fully informed—neocortex unfolds its more refined plan for reaction. (pp. 17-18)

At Marian Diamond's U. C. Berkeley Brain Symposium in 1998, she commented on the nature of the limbic area of the brain in contrast with the plasticity of the cortical area. With certainty she described the changeable nature of the cerebral cortex; however, she indicated strong interest in determining if the limbic brain is truly as hardwired (unchangeable) as we have supposed it to be in the past.

Hypothalamus

The hypothalamus is about the size of an olive, and it assists the thalamus in "regulating our emotional life and physical safety" (p. 45), according the Sylwester (1995). Whereas, the thalamus "informs our brain about what's happening outside our body . . . the hypothalamus monitors our internal regulatory systems, and so informs our brain about what's happening in a variety of systems and organs inside our body" (p. 45). Regulating levels of salt, sugar, and water in the blood or governing sexual orientation are examples of hypothalamal function, as Sylwester posits.

Marian Diamond (1985) describes the hypothalamus as "without peer in its authority over body adjustments to our external and internal environments" (p. 5-20).

> This region, located just under the thalamus (hypo, "under"), weighing 4 grams and taking up about 0.5 percent of the volume of the entire brain, regulates body temperature, hunger, thirst, sexual activity, goal-seeking behavior, endocrine functions, affective (emotional) behavior, and the activity of the visceral nervous system. (p. 5-20)

Basal Ganglia

The basal ganglia represent the limbic system's major connections with the brain/body's motor functions. As a child develops movement patterns, the limbic system is significantly operational (Hannaford, 1995, p. 31). Hannaford further describes the function of this part of the limbic system.

> The basal ganglion connects and orchestrates impulses between the cerebellum and frontal lobe, thus helping to control body movements. It facilitates the fine motor control in our facial and eye muscles necessary to communicate our emotional states to others and in learned, motor based memory like learning to play the piano. The basal ganglion is one of the areas connected with the frontal lobe through the substantia nigra that coordinates thought involved in planning the order and timing of future behaviors. This ties into Damasio's findings that emotion, body and reason are physiologically inseparable. (p. 54)

Describing the complexity of this part of the limbic area, Marian Diamond (1985) says:

> The basal ganglia are large, rounded masses of neural tissue that . . . surround and overhang the thalamus and internal capsule. Although we still know little about the roles and modes of action of the basal ganglia, it has become increasingly clear that they are responsible not only for the integration of motor activity but probably also for the programming, inception, and termination of such activity. One has only to watch a person with a typical basal ganglion affliction, such as Parkinson's disease, characterized by a masklike face, "zombielike" shuffling gait, and difficulty in starting or stopping the walking sequence, to realize how profoundly these nuclei are involved in daily life. (p. 5-24)

The Cerebral Cortex

The third major area of the brain is the cerebral cortex, also called the cortex or the neocortex. This is a "large, divided, six-layer sheet of neural tissue that folds deeply around the limbic system. It occupies 85 percent of our brain's mass" (Sylwester, 1995, p. 47). There are distinctive differences in the layers of the cortical area.

The *gray matter* is the more outward part of the cortex, closest to the skull. Actually this area is pink in the live brain, but because it turns gray when it is preserved for future study, it is referred to as the *gray matter* (Diamond, 1998, p. 19). It is composed of six cellular layers "created by the size, shape, and density of the neural cell bodies that predominate in each layer in the cortex" (Sylwester, 1995, p. 47). Sylwester describes the neuron growth in this gray matter area as vertical columns—like needles sticking into the layers at right-angled position. (See Figure 7.)

The axons of the neurons in the gray matter extend down into the area of the web of axon connections, called the white matter. This area is termed such because of the abundance of white myelin, a lipid (fatty) substance, that coats the axonal structures proceeding from the cell bodies in the gray matter. Rather than vertical, columnar formations, as seen in the gray matter, the axonal pattern in the white matter tends to be horizontal.

From the white matter area, axons eventually connect with neurons in a "related column or to project into another brain area" (Sylwester, 1995, p. 47).

Because of the vast numbers of potential connections that can be made both in the white and the gray matter, information such as a symbol on a page, a fragrant odor, or a musical tone can be connected with other incoming signals to create meaningful representations in the brain. Both electrical current and neurochemistry play significant roles in this process. (Diamond, (1998); Pert, 1997; Sylwester, 1995)

Sylwester (1995) lists major functions of the cortical area:

> The cerebral cortex is organized into a myriad of highly interconnected and outwardly focused neural networks that respond very rapidly (in milliseconds to seconds) to various spatial and temporal demands. The system (1) receives, categorizes, and interprets sensory information, (2) makes rational decisions, and (3) activates behavioral responses. (p. 47)

Four major lobes compose the cortical area: frontal and prefrontal, parietal, occipital, and temporal.

Prefrontal and Frontal Lobes

The prefrontal lobes of the brain are located just behind the forehead in the anterior portion of the brain. They include right and left hemispheric portions. This area of the brain aids in decision making, solving problems, planning, and relating.

The Frontal lobes are an extension of the prefrontal areas. Moving to the top of the forehead and backward, this area of the brain is "involved with purposeful acts like judgment, creativity, problem solving and planning" (Jensen, 1998, p. 8).

Parietal Lobes

On top of the head and moving back is the area called the *parietal lobes*. This area is involved in "processing higher sensory and language functions" (Jensen, 1998, p. 9).

Occipital Lobes

Located at the middle back of the head are the occipital lobes. They are responsible, primarily, for vision.

Temporal Lobes

In both hemispheres (right and left) are located the temporal lobes. These areas are above and around the ears. They process "hearing, memory, meaning, and language.

Sylwester (1995) describes the lobe functions in terms of back to front positioning and time-relevance—past, present , and future. "Events occur in the present, but they often result from previous events and they lead to future events," he says.

> Our brain's principal concern is to identify and respond to potentially beneficial or harmful environmental changes, and much of this problem-solving activity is centered in our cerebral cortex. We must be able to draw on our past experiences and predict what might occur in the future if we are to avoid becoming a prisoner of the absolute present, viewing each current problem as a novel challenge. (p. 52)

With this rationale in mind, Sylwester suggests that the organization in the cortex is related to past, present, and future function; however, he also recognizes that these temporal functions are embedded in "highly interconnected mechanisms" that are "spread across the cortex." Sylwester believes that "both the location and maturation of specific functions suggest the following general organization also exists: the back of the brain

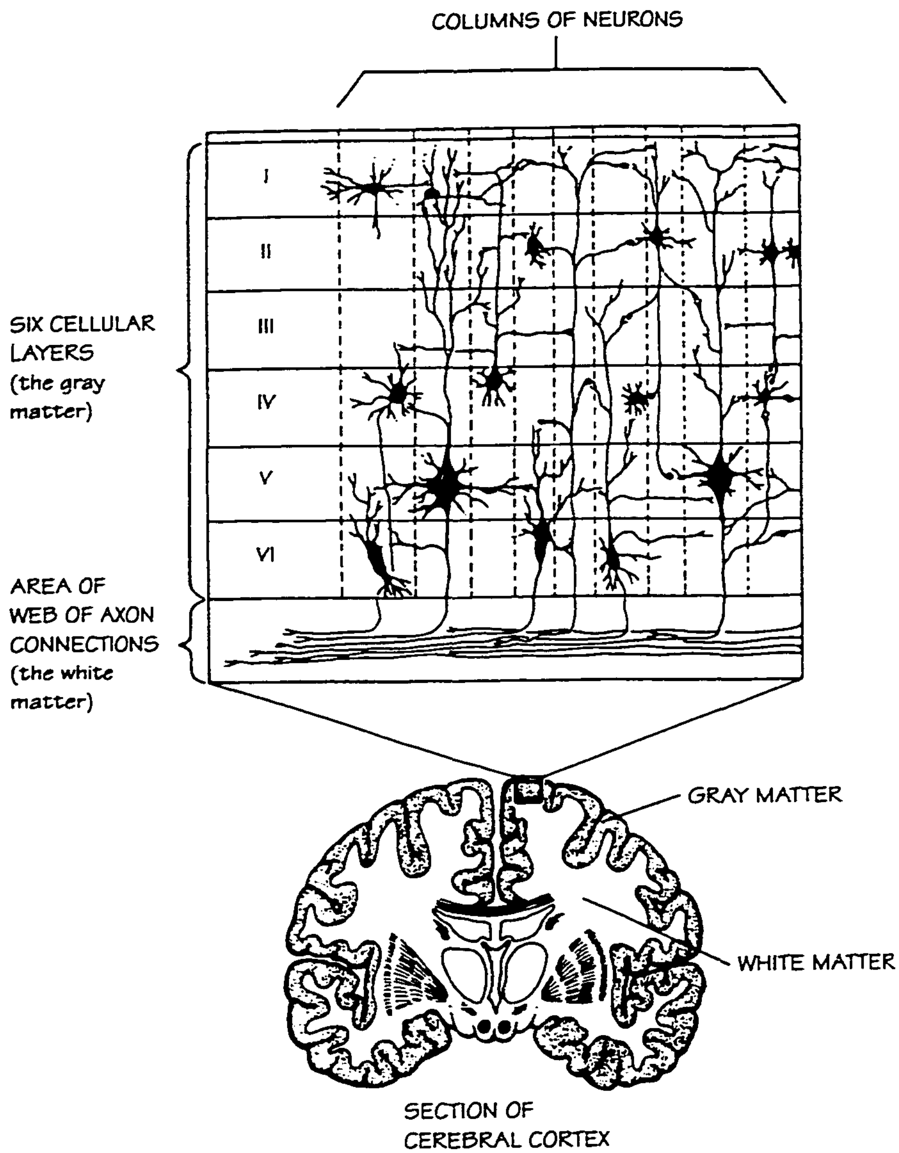

Figure 7. Schematic representation of orders in branching of dendrites. From *A Celebration of Neurons* (p. 46),), by Robert Sylwester, 1995, Arlington, VA: Association for Supervision and Curriculum Development. Copyright 1995 by R. Sylwester. Reprinted with permission.

handles the past [memory]; the middle, the present [critical thinking and problem solving]; and the front, the future [planning and rehearsal]" (p. 52). (brackets supplied)

The past (memory) functions to which Sylwester refers involve the back of both cerebral hemispheres. Imagine a line drawn from the back of one ear, up over the top of the head to the back of the other ear. The section behind that line would include both the portions of the temporal lobes that are located behind the ear (on both sides and involved in processing hearing and speech; the parietal lobes (the top of the head and involved in processing touch and motor control); and the occipital lobes (the back of the head and involved in processing vision). Sylwester describes how these lobes work together to construct meaning:

> Important connections combine sensory information and memories, so that when we hear the word *banana,* we can see and feel a banana in our mind, even though no banana is present. These sensory lobes represent the past in this discussion because they process the existing categories that humans must master. A child asks what something is, and the parent responds with the appropriate nouns and adjectives that have evolved over time. Thus, children are introduced to the past—and they store many of these sensory facts in the back half of their cerebral cortex. (p. 53)

The present (critical thinking and problem solving), Sylwester says, mainly occurs in the frontal lobes. This area plays "an important role in regulating our emotional states and judgments. Our frontal lobes' regulation of critical thinking and problem solving permits us to override the execution of automatic behaviors and potentially destructive, illegal, or immoral behaviors sparked by emotional biases" (p. 54).

The future (planning and rehearsal) functions center in the prefrontal lobes, located just behind the "high forehead in the front part of the frontal lobe," Sylwester describes. "The

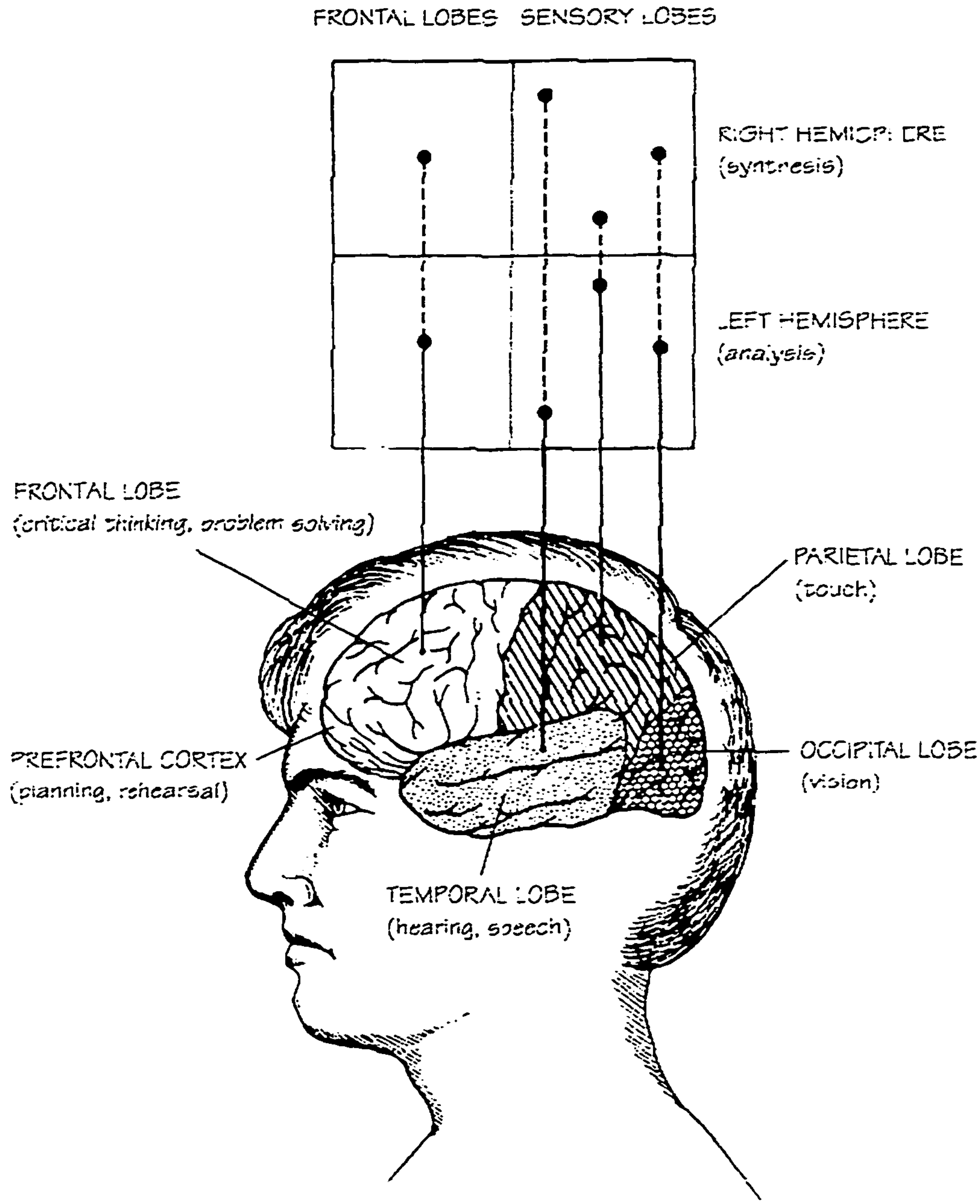

Figure 8. Schematic top view of cerebral cortex. From *A Celebration of Neurons* (p. 48), by Robert Sylwester, 1995, Arlington, VA: Association for Supervision and Curriculum Development. Copyright 1995 by R. Sylwester. Reprinted with permission.

prefrontal cortex is responsible for budgets, hotel reservations, and lesson plans. It's the final part of the cortex to mature, during our late adolescence" (p. 54).

Of the four lobes of the cortex, the frontal lobes take up the greatest amount of space. Describing the frontal and prefrontal lobes as the "frontmost parts of both right and left hemispheres," Healy (1990) comments on their importance in cognition:

> This part of the brain, which is the human animal's unique neural possession, is often called the *executive of the brain* because it is responsible for planning and regulating behavior. It consists of the motor cortex, which helps plan and implement physical movement, and the *prefrontal* areas, which, when (and if) fully developed, become the "boss" of thinking. (The terms "frontal" and "prefrontal" are used interchangeably. (p. 161).

Where *crucial connections* come together for synthesis and interpretation (meaning making) is in the neocortex—the bark like, 2 to 5 mm. thick covering on the surface of all the "convolutions of the cerebrum," according to Hannaford (1995). Here the world gets associated for us through the constant integration of "movement, the senses, and emotions." (3) Though the neocortex is "totally interdependent with the body as a whole"—as are other parts of the brain--it follows its "own timetable in unfolding and developing. It is important to understand this process because it "gives us a much clearer view not only of our enormous capabilities—particularly in the area of learning—but also of the ways the development of these capabilities can be impeded or helped to flourish" (Hannaford, 1995, p. 71).

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Following is a list of terms and definitions, which may be unfamiliar and/or useful to educators:

Accelerated Learning: Relates to planned effort to quicken learning in terms of time, environmental influence, and/or developmental readiness.

Amygdala: A limbic area, almond-shaped organ critical to sensory processing. Connects with hippocampus (a memory center). Contains many opiate receptor sites, which are involved with rage, fear, and sexual attitudes.

Attention: Brain's ability to focus and to maintain connections relative to thought.

Axon: The long fiber extending from the neuron and responsible for electrical current output. One axon per neuron, but the axon can branch to connect with more dendrites. Often coated with a white, fatty substance (myelin), which increases efficiency of signal transmission.

Basal Ganglia: Control ability to move smoothly. Located deep inside the cerebrum, above the brain stem.

Brain-based Instruction: Teaching methods, which focus on cognitive and brain physiology processes.

Brain Chemistry: Refers to chemicals in the brain, which function to facilitate and/or interfere with thinking, memory, attention, autonomic activity, etc.

Brain Stem: Sometimes called the lower brain or reptilian brain. Located at the top of the spinal chord. Links the spinal chord to the limbic area and to the cerebral cortex.

Broca's Area: Also known as Broca's Wart. Usually located in the left hemisphere frontal area of the cerebral cortex. Receives information from Wernicke's area. Converts thoughts into sounds or written words. Sends converted information to the motor area.

Cerebellum: Below the occipital lobe of the cerebral cortex. More finely folded surface than the cerebral hemispheres. Deals with muscle coordination and balance as in writing and walking.

Cerebral Cortex: Also known as cerebrum and neocortex. Is located in both hemispheres. Includes four main sections—frontal (and prefrontal), parietal, occipital, and temporal lobes. Is believed to be the area for higher order thinking.

Chemical Learning: Refers to the ability to control brain function through the increase or decrease in levels of neurotransmitters in the brain.

Choline: A nutrient found in tofu, peanuts, and other food. Known to benefit brain function.

Cingulate Gyrus: Coordinates communication between the cerebrum and the limbic area. Located just above the corpus callosum, which divides the hemispheres.

Corpus Callosum: A four-inch-long (approx.), tough, white-matter bundle of 200-300 million nerve fibers that conduct communication between the right and left hemispheres. Located at the top of the midbrain.

Cortisol: Produced by the adrenal gland. Activates important body and brain defense responses. Induces stress. At chronic high levels is believed to destroy dendritic growth and to interfere with learning and memory.

Dendrites: The tree-like branching structures emanating from the neuron to receive input from other neurons. Dendrites receive, axons give. The greater the levels of branching, the higher the number of possible connections that can be made with other neurons (possibly higher intelligence).

Dopamine: A common neurotransmitter believed to maintain positive moods and attitudes and to affect movement. Produced in the substantia nigra (which connects to the basal ganglia), midbrain, and hypothalamus. A chemically-modified amino acid (protein).

Emotional Intelligence: A neuropsychological term, which distinguishes between rational thought and affective function. EI relates to limbic influence on prefrontal cortical operations. The emotional brain, which controls rage, compassion, etc., differs from cortical area function, which supposedly is assessed by IQ (intelligence quotient) testing.

Endorphin: A natural opiate (neurotransmitter). Acts like morphine to protect pain. Produced in the pituitary gland.

Fornix: Connects the hippocampus (memory) to the hypothalamus (body function regulator). Fibers lying in a circular pattern.

Fractal: Simply stated, a pattern that is replicated in a given entity at all levels of form or function. Mathematically and geometrically, fractals are considered in much greater detail and complexity. In this document the term *fractal* is used metaphorically to denote the holistic nature of learning and the repetitive importance of the triad relationship between physical, mental, and emotional/social/spiritual powers.

Frontal Lobes: Located between the forward most pre-frontal lobes and the parietal lobes of the cerebrum. Controls planning, voluntary movements, verbalizing, problem solving, and willpower. Separate from the other three major cerebral cortex areas: parietal, occipital, and temporal.

GABA: Gamma-aminobutyric acid. A neurotransmitter. Functions as does an on-off switch for electrical impulses moving down the axon. Believed to be a benefit for maintaining attention and focus.

Glial Cells: Most abundant of the two major types of brain cells. Provide structural support and nourishment for the neuron structures, the second most common cell structure in the brain. Glia are capable of dividing (unlike neurons), but not capable of electrical transmission (currently believed) themselves.

Hippocampus: A crescent-shaped organ believed to strongly influence learning and memory. Located in the temporal lobe toward center of the brain.

Hypothalamus: Located below the thalamus toward the bottom of the limbic area in the midbrain center. Acts like a thermostat. Regulates what goes on inside the body: sleep, digestion, appetite, sexuality, hormone secretion, circulation, and emotions. Olive-sized. Works in tandem with thalamus.

Lateralization: Usually refers to the use of one side of the brain more than another. Often qualified as “relative lateralization” meaning favoring one side while both sides are active.

Limbic System: In the midbrain the area arranged in the junction of the cerebral hemisphere (outer layer of the brain) and the brain stem (leading to the spinal chord). Includes hippocampus, fornix, thalamus, hypothalamus, cingulate gyrus, and amygdala.

Lower Brain: Also referred to as reptilian brain, hindbrain, or brain stem. Regulates breathing, heart rate, and other survival functions. Pathway for incoming sensory input from the body to the brain. Includes medulla oblongata, pons, upper spinal chord, and some include the reticular formation which sits above the brainstem.

Medulla Oblongata: A major part of the brain stem. Continuous with the spinal chord. Transfers information from the spinal chord to upper brain areas. Controls heart rate, respiration, and other vital functions.

Memory: Brain's ability to remember and retrieve relevant information, thoughts, associations, etc. Is currently believed to be a function of more than one area of the brain. Hippocampus known as a significant area for memory and learning.

Metacognition: Thinking about thinking.

Midbrain: Sometimes referred to as the limbic area. Located to area behind frontal lobes of the cerebral cortex, below the parietal lobes, in front of the occipital lobes, and above the brain stem. Includes thalamus, hippocampus, and amygdala.

Myelin: A white, fatty substance that forms as a shield around the axon of the neuron in order to increase electrical impulse transmission time (up to 12 times). This substance is composed of neuroglia or glial cells (glia means glue).

Neural Function: Pertains to the physiological structures and cell operations in the brain.

Neurochemical: Same as neurotransmitters.

Neuron: A major cell structure in the brain. It receives and transmits information from and to other neurons. This process is conducted electrically and chemically.

Neuroscience: Study of brain function. In this paper, the study of brain function as it relates to learning.

Neurotransmitters: Chemical substances that relay messages from one nerve to another or from one cell to another. They can promote or inhibit cell or nerve function. More than 50 types currently known.

Neurotropin: A nutrient (food, medication, or hormone) for neurons or brain function.

Noradrenalin: Neurotransmitter. Involved in fight or flight responses, metabolic rate, mood, emotions, blood pressure, etc.

Occipital Lobe: Posterior portion of the brain, including right and left hemispheric portions. That portion of the brain located at the back of the skull. Processes vision. Separate from *frontal, temporal,* and *parietal lobes.*

Parietal Lobe: Cranial, superior, dorsal portion of the brain, including right and left hemispheric portions. That portion located at the topmost part of the head (in standing position). Processes sensory information, writing, reading, language, and calculations. Separate from *frontal, occipital,* and *temporal lobes..*

Peptides: Amino acids (proteins) chained together to form hormones. Function as messengers for states, moods, and thinking. Glial cells are peptide factories. Substrates of emotion. Promote communication among neural, hormonal, gastrointestinal, and immune systems. Pert describes peptides as the conductor for the music of emotion.

Plasticity: A quality of the brain's ability to grow and change with environmental nurture and stimulation.

Pre-frontal Lobe: Anterior portion of the brain, including right and left hemispheric portions. The part of the brain located behind the forehead. Most forward part of the frontal lobe. Separate from *parietal, occipital, and temporal lobes*—the other major lobes of the cerebrum. Aids in choosing, solving problems, planning, and relating.

Pons: Near the top of the brain stem, just above the medulla. Serves as a relay between the cerebral hemispheres and the cerebellum.

Reticular Formation: Located at the junction of the midbrain area and the brain stem. The central core of the brain stem. Diamond (1998) describes it as "the only intracranial neural structure without which our life is impossible" (p. 1-2). Deals with attention, arousal, sleep, and consciousness. "A chemical net that fluctuates in 90-minute cycles across the 24 hours to allow different amounts of sensory/motor informatin to enter and leave our brain" (Sylwester, 1995, p. 145).

Reticular Activating System: See Reticular Formation.

Serotonin: Neurotransmitter. Induces relaxation. Regulates sleep and mood.

Substantia Nigra: Connect to the basal ganglia to control movement. Darkly stained neurons. Located in the midbrain. Contain high levels of dopamine.

Synapse: Where the axon of one neuron connects chemically with the dendrite of another neuron, a minute gap (synapse) exists. Trillions of synapses exist in the adult brain.

Temporal Lobe: That portion of the cerebral hemisphere located closest to the ears and extending to the area of the temples. Located in both hemispheres. Processes hearing, language, listening, learning, and memory storage. Separate from *frontal, occipital,* and *parietal lobes.*

Thalamus: Attends to what is going on outside of the body. Located near the center of the brain in the limbic area. A sensory relay station.

Vasopressin: A stress hormone that stimulates aggression.

Vestibular: In inner ear mechanism. Helps maintain balance and spatial judgment—with or without vision.

Wernicke's Area: Located in the temporal lobe at the upper back edge. Converts thoughts into language.

Whole Systems Learning: A holistic approach to the learning process, which includes rational and emotional thought, as well as an integration of mental, physical, social, and spiritual aspects of being.

REFERENCE LIST

REFERENCE LIST

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Education

Andrews University Berrien Springs, Michigan	Ph.D.	Leadership in Education (Cognitive Processing)	September, 2000
University of California, Berkeley	M.A.	Education in Language and Literacy	December, 1989
Andrews University Berrien Springs, Michigan	B.A.	Speech and Communications	June, 1968

Employment History

La Sierra University Associate Professor Director, Student Teaching	Riverside California	October, 1999- Present
Pacific Union Conference ATIE Marketing Director	La Selva Beach California	August, 1998- September, 1999
Educational Management Group EMG/NADSDA Liaison	Scottsdale Arizona	September, 1997- August, 1998
Reno Junior Academy Principal	Reno Nevada	June, 1995- June, 1997
Pleasant Hill Junior Academy Vice Principal, Teacher, English/Reading	Pleasant Hill California	July, 1988- July, 1995

Other employment experience includes: Public School—Sixth Grade, Pre-school, Public Relations (Hospital and University), Human Resources, Director of Summer Reading Camp Programs for Children and Adults.

Certification

Professional Credential, North American Division, General Conference of Seventh-day Adventist.

Honors

Zapara Award for Excellence in Teaching, 1990, (peer and national-level administration review)
Pacific Union Conference of Seventh-day Adventist Outstanding Teacher Award (by student nomination), 1993
Who's Who Among America's Teachers, 1992, 1993, 1994, 2000
Pi Lambda Theta, U. C. Berkeley, Omega Chapter Member and President, 1992-Present
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