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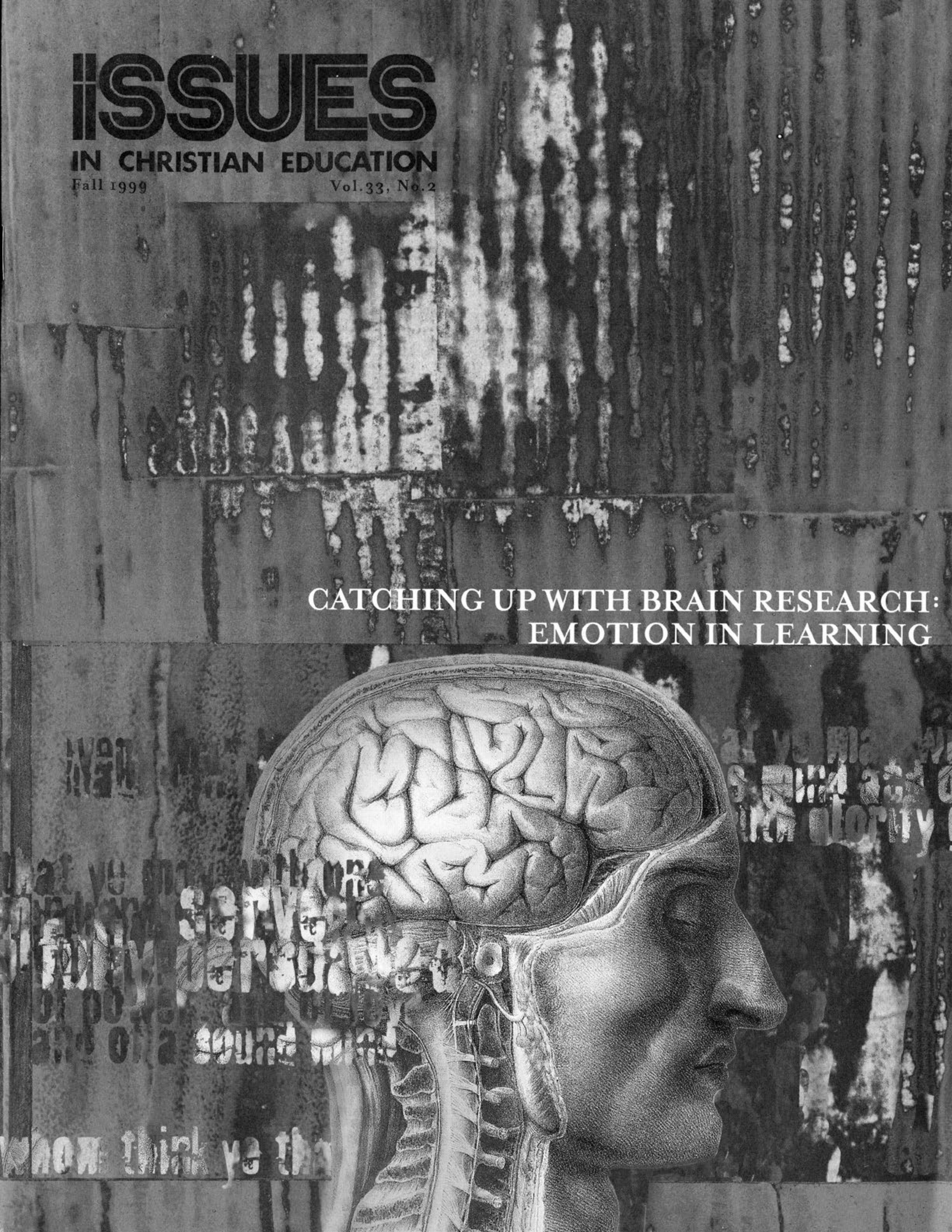

CATCHING UP WITH BRAIN RESEARCH: EMOTION IN LEARNING

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ISSUES IN CHRISTIAN EDUCATION

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Catching up with Brain Research: Emotion in Learning

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God hath not given us the spirit of fear; but of power, and of love, and of sound mind.

II Timothy 1:7

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TYPEFACES USED IN THIS PERIODICAL
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reflections

Orville C. Walz, President

As a student at Concordia in the late 1950s, I enrolled in a biology course taught by Dr. Carl T. Brandhorst. As a teacher education major with a concentration in the social sciences, I did not count biology among my favorite classes, but to this day I can still see Dr. Brandhorst standing in front of the class with that wonderful smile and gleam in his eyes, saying, "Folks, remember what the Psalmist said about the human body." He then quoted Psalm 138:14: "I will praise thee; for I am fearfully and wonderfully made: marvelous are thy works; and that my soul knoweth right well."

What better example is there of how wonderfully God has made us humans than the brain. It is difficult to comprehend some of the research findings of the human brain shared in this edition of *Issues in Christian Education*. Among others, consider: "How can a three pound organ the size of a grapefruit sporting the appearance of a walnut be the mediator of Einstein's formulas, Beethoven's symphonies and the teachings of Jesus? The human brain begins by literally exploding into existence. Within three months of conception neurons are being generated at the astounding rate of 250,000 cells a minute. By the time of birth, a baby's brain contains 100 billion neurons, roughly the same number as the stars in the Milky Way. Our brain's 100 billion neurons and trillion glial support cells combine to carry out a multitude of processing tasks, many simultaneously." Indeed, our Creator has made us fearfully and wonderfully!

The first chapter of Genesis records not only God's marvelous creation of the heaven and the earth, but also His charge to our first parents to have dominion over all of the earth. What does that mean for us soon entering a new millennium? The intent of this edition of *Issues in Christian Education* is to provide educators of the church with an overview of recent developments in brain research, with particular attention to research findings related to body-brain-emotion connections, and applications to teaching and learning.

Reading about recent discoveries of brain research can be frightening. Change is about us, rapid change, with technological explosions happening at a pace which we can scarcely comprehend. When I feel that way, one of my favorite hymn verses is reassuring: "Change and decay in all around I see; O thou who changest not, abide with me" (*Lutheran Worship*, 490, verse 3).

The theme for the 1999-2000 academic year at Concordia University is *Serving Through the Centuries*. This Christian institution of higher learning will soon be serving students in a third century since its founding in 1894. Numerous have been the changes these past 105 years, but "Jesus Christ is the same yesterday and today and forever" (Hebrews 13:8). As you read about the brain in this edition, and as scientists continue to make new discoveries about the human brain, called "the most wondrous of all the physical wonders of the universe," thank and praise our God!

Cognitive Correlates of Emotional States

Ask some friends what they were doing when they found out about the Challenger space shuttle disaster. Chances are the memory of the event is clear, unambiguous and readily recalled. "I was driving to my sister's house on I-94 when I heard the news on the radio," or "I was watching the event on television with my spouse," are typical reports. One could easily obtain fully descriptive, enriched and accurate recollections of *personally* relevant emotional memories as well (e.g., birthdays, graduations, etc.). Although clearly anecdotal, this is the kind of experiential evidence accrued by many who make the assertion that emotionally charged events are more easily learned and better recalled than neutral events.

The fields of psychology and neuroscience have formalized the investigation of the specific cognitive and neural mechanisms that allow emotional information a "special" status. Briefly, work has centered on the distinction between different affective states and the kinds of processing that find advantage in these specific states.

Considering the first issue, we may ask: What are the basic emotions that humans experience? Affective states do not always fall into tidy categories. For instance, I may be happy, but apprehensive and a bit shy at the same time. Should we call this melange an emotion in its own right, or can we think of this feeling as being some combination of a limited set of fundamental emotions? The evidence seems to favor the latter. The psychologist Paul Ekman has persuasively argued that there are "basic" emotions. Using data from a variety of social, ethnic and cultural contexts, Ekman finds neurological motor programs, revealed in facial musculature, to consistently indicate the presence of at least six basic emotions. These are: happiness, sadness, anger, disgust, surprise and fear. Other emotional states are thought to be produced by combining these basic ones in varying amounts and intensities.

With the possible exception of *surprise*, a summary inspection of these emotions indicates that they may be classified according to valence—positive or negative. In considering our behavioral responses to these states (that is, what we tend to do when in these states), we find that positive emotions lead toward a response of maintaining the situation at hand, while negative emotions call for us to change. These observations have suggested a possible role of emotions in our cognitive life. Instead of simply a feeling that *accompanies* our actions, emotions help *determine* our future actions. In this view, emotions serve as feedback regarding our current actions or plans and indicate the degree to which they need to be altered. Positive emotions accompany those actions and events that are successfully negotiated. Therefore, positive emotions indicate "stay the course." Negative emotions accompany failure to achieve or obtain goals. They inform the beholder that action plans need to be altered. Contemporary research has evaluated and supported this claim.

It is important to consider the aspects of information processing that correspond to the goals of "change" or "no change." Behavior associated with positive emotions, "no change," is relatively straightforward. Keep doing what you were doing. Understanding of the global, "big picture" of our actions in context is relevant here. In contrast, when we consider the negative emotions and their concomitant imperative to change, we must first ask "how?" (do we change), which ends up to be dependent on another question: "why?" To successfully change our goal-directed behavior in these circumstances, we must determine exactly why our prior strategies failed, and after a detailed analysis of the situation, propose and carry through with a new action plan. Thus, there are special kinds of mental processes associated with different affective states. Positive states lead to mental cognitive processing that is global, heuristic, creative and abstract. Negative states lead to processing styles that are detail-oriented, controlled and systematic.

Empirical evidence supports the above distinction. Laboratory work has found that subjects' visual attention is more "tightly" focused around negative emotion words than positive emotion words. Other work shows that individuals tend to report details of a negative pictorial scene better than a positive one. Still other work indicates that people in positive moods generate solutions to problems in greater quantity and more creatively than do people in negative moods. This indicates the impact that emotion has on thinking. Recall, though, that the thoughts (our plans and our personal registration of the success or failure of those plans) help give rise to the emotional state in the first place. It may be argued, therefore, that affect and thought are highly interactive systems, each playing a role in the production of the other.

Research on the cognitive and neural aspects of emotion is still in its infancy. However, advances are being made. As theorists carefully examine the interacting aspects of thinking and feeling, we find that the classic distinction between these two attributes of human life is perhaps no longer appropriate. Work discussed in this article suggests that thinking and feeling are more determinative of each other than had otherwise been suspected. Maybe we can provide an addendum to Descartes: *I think and feel; therefore, I am.*

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Emotional Intelligence: Links to Social Interaction

Though biologists and neuropsychologists have made significant strides in the area of brain research, sociologists, too, have come to understand the importance of emotional intelligence. Since the discipline of sociology deals with the impact of the larger group, society and culture on the individual, it is imperative to establish the links between social interaction and brain development. If emotional intelligence is defined as possessing the capacities for self-awareness, management of feelings, empathy and social skill, it makes sense that these capacities would be developed most optimally within a context of social interaction. Learning to be self-aware, managing one's feelings appropriately, developing empathy for others and acquiring the necessary skills to navigate successfully the complex terrain of social life require a very basic and necessary reciprocal relationship with other human beings.

It may be argued that emotional intelligence results solely from a complex web of neurological connections and transmissions. This, however, is a rudimentary way of comprehending a very complicated process which blends together the elements of both biological and social systems. As Daniel Goleman aptly points out, though our genetic heritage endows each of us with an emotional baseline that determines our temperament, the brain circuitry involved in this process is extraordinarily malleable. Temperament does not have to be destiny. The emotional lessons we learn as children at home and at school also shape our brain circuitry, making us more or less adept at coping with the challenges of social life. Sociologists have long realized the hazards that may ensue for those individuals who have not developed adequately within the emotional realm during childhood and adolescence. As adults, they are subject to a plethora of risks from anomie and depression to eating disorders, substance abuse and a life of violence.

How long will it take our highly individualistic culture to realize that how we collectively prepare our young people for life will have a significant impact on the quality of relations among people in our society? Do we want our children to become even more emotionally troubled, lonely, depressed, angry, anxious, impulsive and aggressive than they already are? Do we, as a society, want to cope with the increasingly public ramifications of these personal problems? The answer for most of us is "no." The challenge, however, lies in the implementation of the solution which means changing the way we do "business" as a society at a very fundamental level.

If psychology has taught us nothing else, it has taught us that childhood experiences shape people's relationships to the natural world, as well as their outlooks on work and family, as adults. These experiences also help inform our attitudes about gender, authority, interpersonal responsibility and community, and teach us acceptable ways of coping with distress. Culture, in tandem, determines much of our personality and influences the way in which we think, feel and interact with the world. If we want our children to be confident, assertive individuals, as well as empathetic and caring citizens, we need to provide a road map for their developmental journey through example. Charles Horton Cooley and George Herbert Mead, two prominent American symbolic interactionists, elucidated this notion during the early part of this century. Has it taken us this long to realize they were correct? A description of the social changes and implementation of programs and structures needed to facilitate the emotional development of our children is much too broad for this particular editorial. Suffice it to say that we, as adults, must begin to be accountable for the welfare and emotional health of one another. That means simply a switch to a more communal and less individualist world view. We can then take the opportunity to establish "real" communities with an emphasis on relational rather than material characteristics where each of us can intergenerationally connect and ultimately learn from one another.

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From Brain Research to Educational Practice

The human brain is the most wondrous of all the physical wonders of the universe. As far as we can tell, it is the only organ in creation that is aware of itself, the surrounding universe and the ever-present possibility of its own demise. The brain's significance has been recognized for centuries, long ago as the seat of the soul and more recently as the producer of the multiple functions of the mind. At first glance it appears anatomically unimpressive. How can a three pound organ the size of a grapefruit sporting the appearance of a walnut be the mediator of Einstein's formulas, Beethoven's symphonies and the teachings of Jesus?

Recent research has shown that a close examination of the cells which constitute the anatomy of the brain are anything but unimpressive. Many remarkable findings have come to light following the 1989 Congressional resolution that the 1990s would be "The Decade of the Brain." Genetic research has revealed that fully half of our 100,000 genes are programmed to construct and maintain our nervous system. The brain begins literally by exploding into existence. By the third month of human gestation the formative electrical activity of the brain-to-be is crackling away, and neurons are being generated at the astounding rate of 250,000 cells a minute. By birth the newborn's brain contains 100 billion neurons, about the same number as the stars in the Milky Way. These nerve cells can send and receive electrochemically transmitted signals to as many as 15,000 other nerve cells. This level of the highest density of neuronal interconnectivity is reached around the age of two and lasts until about age 10. Supporting of the neurons are the glial cells, from the Greek word for glue, which insulate, nourish and protect the vital brain cells. To understand the scale of these cells, 30,000 neurons or 300,000 glial cells can fit into a space the size of a pinhead. Our brain is made up of one trillion cells which can connect in some 1,000 trillion ways. Impressive indeed.

Fifty years ago most brain researchers tried to explain the functions of the mind by means of the preexisting structures of the brain. Then in the 1960s Eric Kandel's research showed how learning causes physical changes in the brain. Add to such research four decades of deprivation/enrichment research with both animals and humans, and a systematic program for the physical and psychosocial enrichment of the brain and mind is now potentially in place for both parents and educators, as the recent book, *Magic Trees of the Mind*, by Marian Diamond and Janet Hopson abundantly demonstrates. Not only is brain development far more flexible, plastic and open-ended than we once thought, but the very latest research shows, as reported in the May 1999 issue of *Scientific American*, that even the mature human brain spawns new neurons in the hippocampus, an area related to learning and memory.

At the same time our understanding of how to optimally enrich the brain was growing by leaps and bounds, a more complex interpretation of intelligence was being propounded by Howard Gardner, beginning in the 1980s. With his initial theory of seven multiple intelligences, Gardner expanded the more narrow I.Q. definition based on verbal, logical (including mathematics) and spatial dimensions to embrace musical, kinesthetic, interpersonal and intrapersonal forms of intelligence as well. The implication of this theory was that our educational system had by and large marginalized non-I.Q. forms of intelligence. The educational question was no longer how smart are our students, but rather, how are our students smart?

In the 1990s Peter Solovey and Daniel Goleman elaborated the latter forms of intelligence with the term "emotional intelligence." They defined emotional intelligence as having the capacities for self-awareness, management of feelings, motivation, empathy and social skill. The characteristic modern Western split between overdeveloped head and underdeveloped heart was shown to be neurologically false and humanly destructive of optimal learning and integrated personalities. Our students are not merely mechanical information processors like our computers but rather holistic blends of thinking and feeling in ongoing response to our social environment. In an attention deficit disorder culture, it is our emotions emanating from our limbic system which focus our attention on any given stimulus in the first place, thereby becoming the precondition for any and all learning.

We have made significant progress in recent decades in deepening our understanding of the brain and widening our conception of the mind. Some work has been done to inform parents and teachers of these new findings, and some implementation has been attempted in a number of schools. But much more remains to be done if many more of our children are going to benefit fully from the contemporary insights and implications of brain and mind research.

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Brain Research: Issues to Consider

In his article, *From Behavior to Biology*, Dr. Robert Sylwester states that we are on the edge of a major transformation that will center on our brain. On two previous visits to our campus here in Seward, he made similar predictions and urged us, instructors and students alike, to avail ourselves of this kind of information appearing in books, scholarly journals and popular literature: information that helps us assess our views and interpretations of the world in which we live. I believe we will become better learners and teachers via this information, and we will find our lives enriched, our world view enlarged and our appreciation of humanity deepened.

One issue that I, as a student of brain/mind research, would like to explore is a misleading dichotomy between mind and heart.

Ask yourself this question: "How many times have I heard people refer to something affecting or emanating from either their head or heart?" Such statements are heard often, and in recent years the question has seemed to occur more often. As a teacher of biology I am continually tempted to ask, "And just how does one 'feel' with an organ that is specialized to pump blood through the blood vessels?" Of course, the meaning is clear; it is a metaphorical statement regarding emotional response. However, it is one-half of an implied system for categorizing how many of us feel we function.

The system in use refers to the commonly expressed notion that we think or reason with our mind (head) and feel with our heart (gut reactions). The anatomical separation is not a literal one but conveys a confused impression of how the brain works. It is also symptomatic of a dichotomy of behavior that has persisted throughout the ages and continues to confuse many in terms of how the brain really does work.

For many centuries "emotions" (passions) were considered separate from "reason." Probably the most familiar distinction was made by the 17th century mathematician and philosopher, Réne Descartes, who postulated that humans were distinguished from animals in that humans operated by using the mind which was related to the spiritual realm. Animals operated by using emotions rooted in the physical, material basis of the world. Descartes also postulated that animals were created with innate or instinctive behaviors which enabled them to survive. It is interesting that males, specifically white European males, were depicted as using reason and intellect and were capable of making the important economic and political decisions. Women, on the other hand, thought to be ruled by emotions, were excluded from the intellectual and political life of western society until the twentieth century. People of color and/or the working classes were also considered incapable of higher mental functioning.

More recently, using reason is often referred to as an emotionless, analytical approach to problem solving. It is made to appear cold and devoid of human feeling. Emotion is presented often as the more human, warm-fuzzy approach to working one's way through life. The latter approach is more closely associated with the humanities, art and religious studies. Its emphasis seems to be on relationships and humanistic activities. (This is not to say that these areas do not also rely on rational thought.) Reason might be more often associated with mathematics and the sciences in which experimentation and analysis appear to be paramount. This dichotomy is not absolute by any means, but thinking of this sort kept emotion and reason separate for a long time.

In the earlier part of this century, students of the behavioral school said that emotions were not to be studied since they were too complex. Joseph LeDoux, a current authority in studies involving emotion, outlines in *The Emotional Brain* the sequence of events that first precluded the study of emotion and later promoted it. Steven Pinker in *How the Mind Works* also presents a study of emotions in a more general perspective of neuroscience. His chapter six is particularly interesting in this regard. LeDoux maintains that emotions are not only normal parts of human mental life but necessary for the rational functions of the brain/mind as well. Daniel Goleman, author of *Emotional Intelligence: Why It Can Matter More Than I.Q.*, documents the richness of the emotional sphere of mental activity and complements LeDoux.

As it turns out, emotions are as vital to human intellectual life as Descartes claimed they were to animals. Michael Gershon in his book, *The Second Brain*, maintains that the gut has a wisdom all its own and constitutes an alternate way of sensing, albeit not rational in the normal usage of the term. To make things even more complicated, Candace Pert in her book, *Molecules of Emotion*, asserts that the nervous system, actually the brain via its sensory endings, extends out into the body and especially in the skin. Are things getting more confusing?

The simple Cartesian explanation of emotion and reason as discriminating between humans and non-humans has died in an eruption of research pouring out of laboratories and clinics all over the world. *Phantoms of the Brain*, a recent book by V. S. Ramachandran and Sandra Blakeslee, provides fascinating reading as the authors take the reader through the bizarre world of phantom pain, phantom limbs and what new knowledge has been gleaned from those and similar studies as new proposals of brain/mind function are put forward.

As today's researchers are stating, emotions are what make us use our rational minds. Persons with "flat emotions," severely clinically depressed patients, are unable to make decisions that are in their best interests. They may even lack the motivation to be functional.

People with a condition known as alexithymia do not feel any emotions, and they have trouble being persuasive in trying to move other persons emotionally. This is clearly not in the best interests of the affected person because, as the biologist would say, one is not adaptive. It is ever more apparent that understanding our emotional lives can lead to a fuller appreciation of all things.

Brain science is in a state of continual revision as new discoveries are made and old ideas revised. The essential truths of salvation have remained constant throughout the history of the Christian church. Science of any sort, even the science of the brain/mind, will not change the truths central to Christian faith, and that is not the intent of science. Science is a different way of viewing our physical universe. It can add to the richness of understanding the miracles of the human brain in learning, but has nothing to say directly about the chief message of Scripture, God's justification of sinners, and Scripture as God's revelation. These are not the concerns of science, therefore we can explore these issues without fear of losing or violating our commitments.

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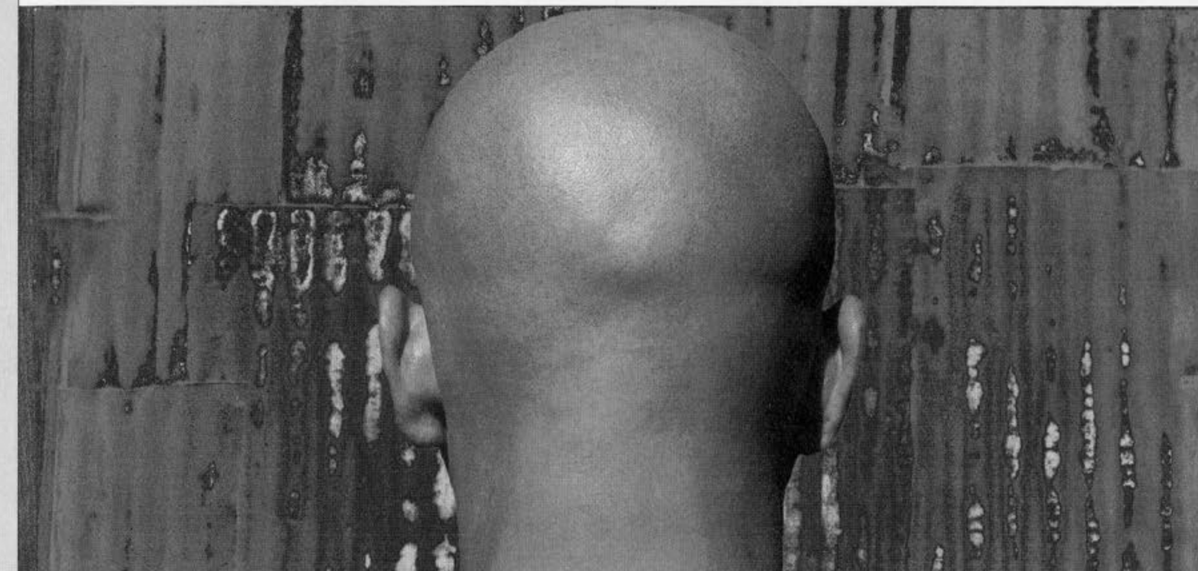


Robert Sylwester

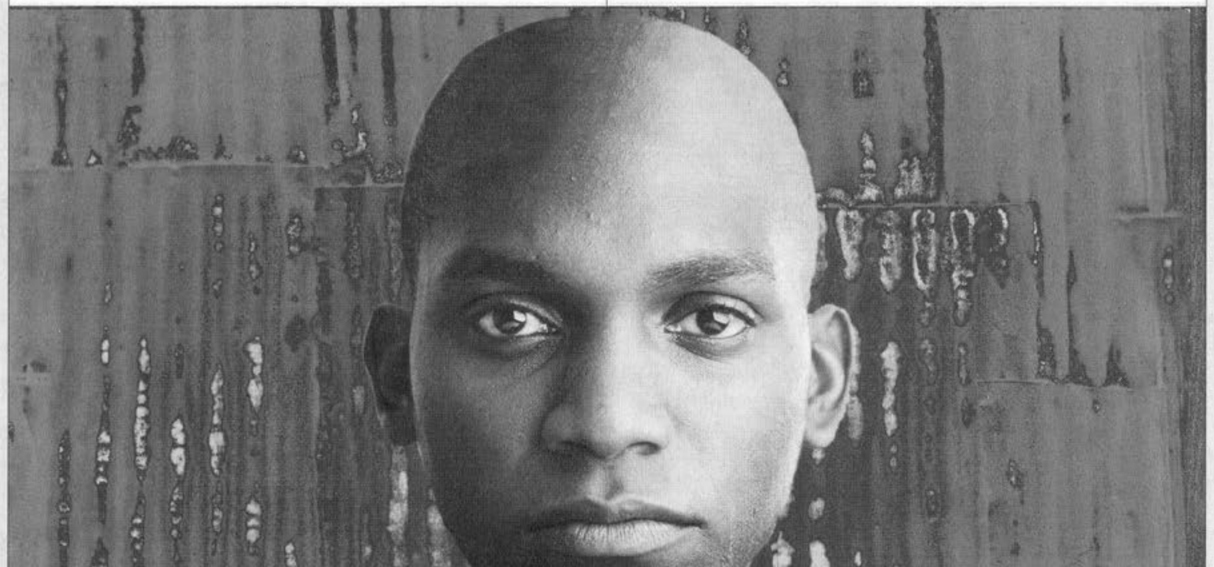
From Behavior to Biology: Recent Brain Discoveries, Traditional Educational Practices

Our culture and profession are at the edge of a major transformation that will center on our brain. Amazing as it may seem, scientists have discovered very much of what we now know about our brain during this decade. Perhaps more amazing, we have functioned quite nicely for millennia with a very limited understanding of our brain. But then, my knowledge of the inner workings of my car and computer are also rudimentary at best, and yet I drive and write with ease (although I would be hard-pressed to repair either machine).

Dr. Robert Sylwester is an emeritus professor of education at the University of Oregon who focuses on the educational implications of new developments in science and technology. He is the author of several books and dozens of journal articles. A forthcoming book, *A Biological Brain in a Cultural Classroom* (Corwin Press), will be published in Spring 2000.

Our innate curiosity about ourselves and our mental processes created a problem. We lacked the means to study the biological systems that regulate our brain—the 100 billion intricately connected neurons and the trillion glial support cells that create the most complex three pounds of regulatory matter in the universe. Philosophy and theology emerged over many centuries to propose metaphoric explanations that would help us to understand ourselves and our behavior. Philosophy focused on logical reasoning as the avenue to truth about ourselves, and theology focused on divine revelation.

We educators had our own dilemma. Our profession was defined by the maturation of a brain we could not comprehend. Our solution was to move toward a behaviorist perspective of education that focused on knowable environmental inputs and behavioral outputs, and ignored the intervening then unknowable biology of cognitive processes. We developed philosophies of education that could manipulate and measure behavior, but we could only infer the reasons for the behavior.



Philosophy and theology served us well, even though various competing systems disagreed stridently, and validation of any system was problematic at best. The competing beliefs stimulated thought, though, and so we discovered a lot about ourselves over time.

Philosophy and theology have a problem, however, that is analogous to my limited understanding of cars and computers. I know enough to operate them when everything is functioning smoothly, but I cannot repair them when problems arise. Philosophers and theologians likewise could be compassionate about those suffering from mental illness and learning disabilities, but they could not directly cure them (and some were not always compassionate either, burning schizophrenic *witches* at a stake). Educators likewise worked well with normally functioning students, but we always had problems with those beyond the normal range—the learning disabled, the gifted.

During the second half of this century, biology has emerged to confront scientifically the ancient task of explaining human systems and their behavior. Medicine came of age first, and now the cognitive neurosciences are exploding with the optimistic belief that a comprehensive understanding of our brain and its processes is within reach early in the next millennium. This emerging biological understanding already has led to spectacular developments in the diagnosis and treatment of mental illness and to beginning solutions to many sensory/emotional/attentional/learning/motor problems that have long distressed and perplexed parents and educators.

Science (the new kid on the block) has thus gone beyond compassion for the disability to add successful treatment, something philosophy and theology were not equipped to do. The cognitive neurosciences will thereby certainly create problems in the competition for allegiance. Folks might feel that if empirical biology can explain and cure the disability, what value are compassionate nonbiological systems that can neither explain nor heal? Will the philosophical and theological systems that emerged to dominate thought in this millennium become irrelevant in the next?

One would hope not, but that will depend much on whether the three systems can forge an accommodating alliance. It will not help the situation if those oriented primarily to philosophy, theology or science make no effort either to understand the other two belief systems or to appreciate the contributions they make to human life. It is thus important for Christian educators to begin their own part of the process—to make the effort to understand and then to participate in the dramatic developments in the brain sciences that will profoundly affect educational policy and practice in the years ahead.

Brain research initially is focusing on children with educational handicaps, because funding support for such research is available. Research efforts will then move toward a biological understanding of the instructional and management interactions that characterize normal classroom instruction. Christian educators can either become part of the process of determining how best to incorporate such cognitive research into education, or else allow others to do it and then complain. Like it or not, the cognitive neuroscience revolution is occurring on our watch, and schools and teacher education programs that ignore it will become irrelevant.

The discussion that follows may disturb you at times, but it will help you to begin the process of understanding your biological brain (as you had earlier discovered your theological and philosophical mind). It will operate out of the perspective of the cognitive neuroscience community (which has a different perspective than that of philosophers and theologians, and so you need to understand it, whether or not you agree with it). It will focus on 1) three areas of inquiry that have combined to create this decade's explosion of new information on our brain and its processes—cells, brains, and societies of brains, and 2) three key cognitive concepts that will profoundly shape future educational policy and practice—that we have a *modular* brain and an intellect that is *dynamic* and *distributed*.

The article that follows this one will continue the explanatory process by focusing on new developments in our understanding of our brain's emotion and attention systems, the systems that are perhaps the most important for religious educators to understand.

Three Forms of Body/Brain Inquiry

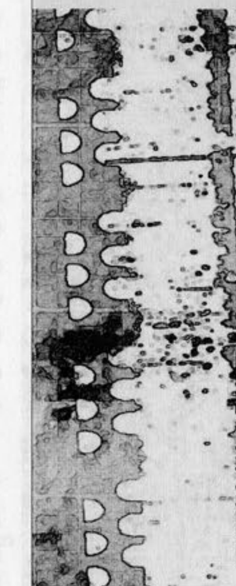
Genetics focuses on the processing systems that regulate cell activity and division. Our knowledge escalated with the 1953 discovery of DNA, the biological coding system (for protein synthesis) that most biologists believe validated the genetic principles Charles Darwin had proposed about 100 years earlier (Calvin, 1996). Genetics has simply exploded during this decade with major advances in medicine and genetic engineering. Further, it is basic to most recent dramatic discoveries in the brain sciences. Shortly after the turn of the century, scientists will complete their mapping of the entire human genome of perhaps 100,000 genes—3,000+ of which prescribe our brain's organization, 50 percent more than for any other organ in our body (Wilson, 1998).

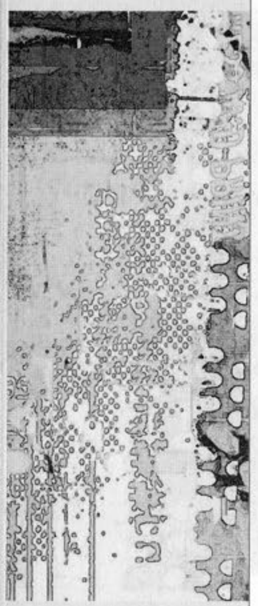
Knowing the location and sequence of all the human genes will profoundly affect the diagnosis and treatment of various genetically-related diseases and many emotional, attentional and learning disabilities that affect school policies and practices. These advances in gene manipulation also will carry a load of moral and ethical baggage that we will need to deal with, including issues that we cannot yet imagine.

How should today's curriculum prepare students to deal with the medical/educational/legal/religious/etc. issues in genetics that they will confront as (hopefully) informed citizens a decade or more from now? How many Christian educators have the functional understanding of DNA, genetic engineering and the issues that surround them to create such curricula?

Brain imaging technology monitors the operation of brain systems. The technology creates computerized representations of various brain properties, such as our brain's blood flow patterns, electro/magnetic fields and chemical composition. Dramatic advances in functional magnetic resonance imaging (fMRI) technology have attracted the most recent attention. fMRI can rapidly image 3 mm thick slices of brain tissue and so create a three-dimensional image of an entire brain within two to six seconds. Because the process can be repeated immediately, scientists can observe various changes in brain activity over the period of time that a subject carries out a cognitive task, a remarkable advance in our ability to directly observe and interpret normal brain behavior.

Further, less invasive advances in imaging technology will lead to the eventual solution of current limitations that require the subject to lie immobile in a claustrophobic laboratory setting. These advances suggest that educational researchers could begin to use simpler imaging technologies relatively soon. Costs and complexity have thus far focused the use of imaging





technologies on medical problems and not on the curricular, instructional and assessment problems that concern us (Posner, Raichle, 1994. Gevins, 1997. Davis, 1997).

The 66 doctoral dissertations I have advised during my university career gathered data through such tools as questionnaires, observation and literature analysis. We did reasonably well with what we had, but it is mind-boggling to imagine how much this next level of research capability will do to increase our biological understanding of the educative process.

Evolutionary psychology is an important area of scholarship that has emerged during the past quarter of a century to focus on the properties that unite (rather than separate) the human family. *Human nature* is probably a useful descriptive term. Insights from these studies have led to thoughtful explorations of why we do the things that we do, such as to develop cooperative communities, rear our children in a nurturing family environment throughout an extended childhood, develop technologies, and support the arts and religious organizations. Leda Cosmides and John Tooby (1992) provided the initial impetus, but others recently have written thought-provoking books on various aspects of the topic (Wright, 1994. Ridley, 1996. Pinker, 1997. Wilson, 1998).

Evolutionary psychology will be problematic for some, since it scientifically explores areas that have previously been the sole purview of theologians and philosophers. Evolutionary psychology looks more to our biological roots than to the powerful religious belief systems that have emerged within various cultures. Theologians and educators have been only moderately successful in dealing with the conflict over Darwinian developmental principles during the past 150 years, and the final accommodation, alas, is still down the road. Will we be able to work it out in a spirit that seeks to connect theology, philosophy and science with bridges, rather than to continue to separate them with walls?

We thus see the recent convergence of three important interrelated fields of scholarship: one focusing on cells, one on brains, and one on societies of body/brains. What emerges from their combined work is the knowledge that we have a modular brain and an intellect that is dynamic and distributed.

Three Key Brain Properties

A modular brain. Our brain's 100 billion neurons and trillion glial support cells combine to carry out a multitude of processing tasks, many simultaneously. The neurons are so highly interconnected that any neuron is only a few neurons away from any other neuron (much as any of the world's billion telephones is only a few key taps away from any other phone). Very many neurons are thus involved in any cognitive action. But how?

Modularity means that specific systems of neurons in a brain area are innately dedicated to processing certain tasks (much as certain library shelves are assigned to a given category of books), but that these neuronal systems can expand into and assimilate less-dedicated surrounding areas if they need more power to process their task (much as a library's shelves can be reorganized to accommodate an expanding collection of books in that category). We can observe this developing spatial inequality in the larger amount of motor cortex space dedicated to coordinating movement in a person's dominant arm/hand as compared to the other, or in the expansion of neuronal space devoted to left hand digital capabilities when a right-handed person becomes a violin student (Elbert et al, 1995).

This ability to adapt neural systems to environmental demands is called *plasticity*, and it is obviously central to what occurs through teaching and learning. Marian Diamond has spent decades researching the effects of a socially stimulating environment on the physical development of a brain. She has synthesized beautifully what scientists now know into a very useful book for parents and educators, *The Magic Trees of the Mind* (1998).

How does a brain organize its trillion+ cells for effective action? At the major systems level, our brain is composed of 1) subcortical areas (the brainstem and limbic system) that regulate many basic brain processes that look inward to our survival, emotional and nurturing needs, and 2) above it, the large six-layer sheet of deeply folded neural tissue called the cortex. The cortex encompasses 85 percent of our brain, and it processes rational logical behaviors that look outward to the time/space world we inhabit.

At the cellular level, our cortex is composed of hundreds of millions of highly interconnected hair-thin (100 neuron) minicolumns that extend through the six cortical layers. Each minicolumn is specialized to process a very specific unit of information (such as a vertical line or a specific tone). One hundred minicolumns combine to form a macrocolumn, which can process more complex functions related to the minicolumns it incorporates (perhaps differentiate between the cello and flute version of a tone). Ten thousand macrocolumns (a columnar aggregate of 100 million neurons) form one of the 52 Brodman Areas that each of our two brain hemispheres contain. Brodman Areas process even more complex functions, many currently ill-understood.

Thus, discrete columnar brain areas and systems process basic limited cognitive functions. These are incorporated into larger, specialized, widely distributed but highly interconnected areas and systems that collaborate on complex cognitive tasks. For example, our visual system has about 30 separate columnar subsystems that process such visual properties as shape, depth, color, quantity and movement. Thus, the subsystem that responds to the color red processes it on every red object we see, and the subsystem that responds to circular shapes processes balls/CDs/tires/donuts/etc. Several of these subsystems will combine to process a single red ball rolling across a table.

This modular system of brain organization means that recent dramatic advances in brain imaging technology can help scientists identify highly specific brain areas that do not function properly in children with a specific cognitive handicap. Locating such a neurological deficit is the first step in solving the problem.

The Fast Forward Program (1997) recently developed by the Scientific Learning Corporation emerged out of research discoveries of specific aural processing deficits in children who were seriously delayed in learning to speak and to comprehend speech. The program has achieved remarkable results through its use of stimulating videogame technology that speeds up the child's aural processing ability.

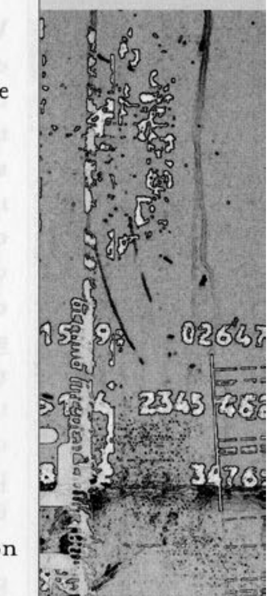
This may well be the technological prototype for future interventions that require extensive practice in order to speed-up/slow-down/rewire the various adaptable neural systems involved in a disability. And this emerging understanding of how specific brain systems mature will also inevitably drive the development of new instructional strategies that teachers will use with normally developing students.

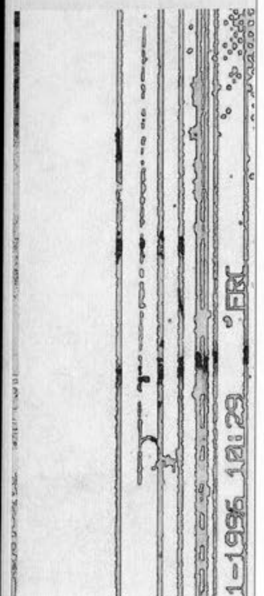
Our profession has become interested in theories of multiple intelligences in recent years, and these theories are based on our brain's modular organization. That the location of most neural systems, subsystems and interconnections involved in various intelligence categories have yet to be precisely identified does not diminish the reality of brain modularity as the biological substrate of the theories. Modularity is an important concept for educators who accept any theory of multiple intelligences—and imaging technology will shortly provide the brain map that lays out the organization of our brain's multiplicity.

This suggests that it is also important to think beyond multiplicity in intelligence. Most body/brain systems are multiple. We obviously have multiple sensory/motor systems, and we now know that we have multiple emotional and attentional systems. We have known for some time that we have multiple memory and problem solving systems. What we have is a multiple-everything body/brain, and intelligence is only one part of the quite intricate equation.

Dynamite intelligence. We are used to thinking of intelligence as something that occurs entirely inside our brain, but this is now seen as a very narrow view of a complex process that also involves our body and the environment in which we function. *Dynamic* is a better term, one that combines the interactions of the three (Clark, 1998).

Candace Pert, who achieved fame with her endorphin-related discoveries a quarter of a century ago, suggests in *The Molecules of Emotion* (1997) that biology no longer supports the notion of a body-brain separation. Hormonal peptides course throughout our body and brain to process the emotions that drive our behavior.





We are not centered in our brain, but in our completely combined body/brain. Consider the negative effects of an upset stomach on test taking, if you think that intelligent behavior is all in our head.

Further, we actually tend to off-load a lot of our decision-making, creating external procedures and technologies that adjust time/space/energy in our environment to simplify intelligent decisions. For example, consider how much cognitive energy we typically spend in trying to determine which supermarket checkout stand will move the fastest, as compared to the lack of any such thought in a post office or bank with a next-available-clerk system. Or consider the shape of a scissors—how we have created a marvelous technological extension of our hand/finger system that allows us to carry out easily a precise cutting function that would be impossible to do with our fingernails or teeth.

We use icons to simplify decisions in complex environments, an extension of the natural clues our ancestors followed to locate water and food. When driving along a succession of gaudy strip malls, easily visible corporate icons help us decide when and where to turn off for gas/food/lodging/etc. (and to ignore all other icons that contain information we currently do not need).

Calculators and post-it notes extend our limited short term memory capacity, and telephone books and dictionaries save long-term memory energy. The list goes on and on. We have created technological capabilities on the outside of our skull to extend our inside biological capabilities, and so we cannot measure internal intelligence without factoring in the effects of the external technologies we use.

Consider the foot-dragging that occurred in allowing students to use calculators in math tests, as if doing it with paper and pencil was somehow more intellectual. (Did ancient educators similarly decry the intellectual loss of finger counting when paper and pencils arrived?)

The recent explosion in electronic and computer technology has moved our dynamic brain/body/environment relationship to a new level. *Natural* time/space/energy have become *cyber* time/space/energy, and they have escalated our ability to rapidly organize and process vast amounts of information. One dilemma is that children tend to have a better understanding of the new electronic technologies than their parents. They have spent countless hours playing with them to explore all their possibilities, while we adults tend to master them only as limited tools—as an expensive typewriter, a means of keeping accounts.

Parents are thus at a disadvantage when trying to help their children understand the opportunities and dangers electronic media pose. Our 14 grandchildren are all connected by e-mail, which is a marvelous opportunity, but this capability means that they can also individually engage in chatline conversations with dangerous unseen predators. The school must confront the dynamic nature and processes of technology, and especially electronic technology; but we seem to be moving very slowly, not knowing how to proceed. We are the last pencil-driven institution in a society that has plugged its brain into a wall socket.

Distributed intelligence. Our upright stance and consequent necessarily narrow female birth canal have led to a brain that is born only one-third its adult size (as compared to most animals that are born with an almost fully developed brain). The biological solution to the problem is to be born with a full complement of neurons, but with many neural systems functioning only at a survival level. These protosystems then mature by expanding their connections, as environmental challenges dictate (and this explains the nature of the post-birth size increase). Thus, an infant can innately suckle and cry but must later learn how to use its mouth and voice to sing Bach arias. The startle reflex is innate, but the child must explicitly learn how to cross a busy intersection.

We need a long childhood and explicit instruction to expand the power of our complex of neural protosystems so they can function at the sophisticated level our culture requires. This requires some kind of extended bonding between parents and between parents and child. Add kinship extensions, and children grow up in a dependent society. Someone will care for them during their first two decades, but then the social contract is that they will spend the next several decades caring

for their children (and the children of others in our complex society).

So we are of necessity a social species. This innate sense of dependence means that everyone in a social group must be able to do some communal things (such as being able to speak the common language), but not everyone has to be able to do everything (such as being able to repair a car). Repairing a car requires specialized knowledge and skills that require extensive training, but we do not often need to repair our car. Thus, it is to everyone's advantage for a few people to specialize in car repair and to maintain their abilities by doing it as a vocation, and others to specialize in something else. It is a complex tit-for-tat arrangement (you repair my car, and I will teach your children) and an extension of the concept of a dynamic brain that provides our species with an additional powerful social brain.

One result is that school assessment programs have sought to identify individual student capabilities and limitations. It is good to help students discover how their interests and abilities can be channeled into an appropriate useful vocational specialization. The seeming need for precision in assessment led to a focus on factual/computational knowledge that can be assessed easily and precisely, at the cost of ignoring subjective knowledge (as in the arts and humanities) that is more difficult to assess precisely. So I look in vain for reports on the arts and humanities scores when the newspapers report the results of local public school testing programs. Are 26 letters and 10 digits and name/date/place factual information all that our brain is about?

The dramatic advances in our understanding of emotion (that will be the focus of the following article) alerted many educators to the terrible error we have made—to use assessment precision as a principal criterion for determining curricular importance. We have ignored the important role that emotion and emotion-related curricula play in intellect.

The marvelous thing about our modular brain and its dynamic distributed intellect is that its definitive properties include a wide array of capabilities that emerged over time to respond successfully to dangers and opportunities, but also to create a qualitative social life that involves loyalties, the arts, science and the humanities, religious belief systems and the ability to enjoy a beautiful sunset. We do disservice to our body/brain when we provide it with limited opportunities during its formative years. If children can do something, they ought to have an opportunity to learn to do it properly and effectively. That is the challenge our profession confronts as we now discover our brain as we never could before.

In considering three areas of scientific study and three educationally significant cognitive concepts, all have great potential, and all are problematic. The answers are not yet clear. But then, neither are the questions. How marvelous to be an educator during the most important period in the history of our profession—to be present at the beginning of the search.

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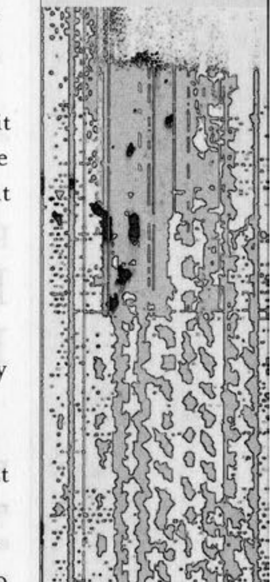


Robert Sylwester

Emotion and Attention: How Our Brain Determines What Is Important

Educational practice has tended to focus more on the mastery of factual information and automatic skills than on the emotional/attentional processes that drive such mastery. Although teachers may get irritated when students ask "Why do we have to learn this?" it is really the initial question a brain must always ask. It is possible to teach students things that are not meaningful to them, but it takes much more effort, plus the artificial support of rewards and punishments that tend to diminish the utility of the learned material.

Religious education confronts the same problem. I attended Lutheran schools from grade one through college, and I taught in the Lutheran school system for 16 years. My early formal religious education focused more on correctly memorizing passages than on emotionally connecting with them, and I regret to admit that my former elementary students would probably make the same assessment of my initial teaching.

Dr. Robert Sylwester served as a member of the faculty of Concordia University, Seward, Nebraska, 1959-1968. The Education Press of America gave him distinguished achievement awards for his 1994 and 1995 syntheses of cognitive science research published in *Educational Leadership.* He has made nearly 1,000 conference and inservice presentations on educationally significant developments in brain-stress theory and research.

What is the cost of ignoring the emotional connections? I supervised a well-designed study of about 600 students who had attended Seventh-Day Adventist schools from grades 1-12. The study discovered that the SDA schools had quite effectively taught the students the key elements of the SDA doctrines. Unfortunately though, the students *knew* far more than they *believed,* and they believed SDA doctrines far more than they *practiced* them (Noble, 1971).

It is not that memorized information is not important and useful. I recited the Nicene Creed yesterday while those standing nearby read it. Think rather of learned material as a book on a library shelf. For the book to be useful, a potential reader must know that it exists and relates to a current need and how to locate it. And so it is with our memories.

Recent developments in the cognitive neurosciences are beginning to explain the key roles that emotion and attention play in activating learning, memory and recall. To put it directly, it is counterproductive to try to teach things that do not connect emotionally with the lives of students, regardless of the importance of the information. What is the value of learning something important and thoughtful, like the Nicene Creed, if reciting it becomes mostly an automatic act, and something done only when it occurs in the liturgy.

Brain Activation Systems

How does our brain determine what is important and how best to respond to it? Potential dangers and opportunities rapidly and sequentially activate our brain's cognitive processing systems. Sensory information activates our arousal/alerting system (emotion),

which activates our focusing system (attention), which activates our various solution systems (learning/memory, reason/logic, problem solving), which activate our response systems (behavior, movement). We thus cognitively engage, solve and act.

It is biologically impossible to learn something if we are not attending to it, and we do not attend to things that are not emotionally meaningful to us. Educators have always intuitively known this, but we did not know what to do about it, because scientists did not really understand our activation systems. Since that understanding is now emerging, the discussion that follows will explain what scientists now know about brain activation and suggest how you might use this information to enhance learning and belief in students.

Senses

Our sensory system is our initial source of information on what is happening inside and outside our body's 20-square-foot mantle of skin. It is composed of a complex set of specialized receptors imbedded in our skin that monitors relatively narrow ranges of properties of the internal and surrounding environment. They respond especially to high-contrast changes in the composition and movement of molecules and light rays that strike our body—changes in temperature, air and physical pressure, reflected light rays, and the chemical composition of air, water and food. The human visual and auditory systems are dominant, but all systems play key initial roles in our brain's task of creating perceptual meaning out of abstract sensory information.

Recent educational thought strongly encourages educators to develop activities that develop and engage all elements of our sensory system.

Emotion

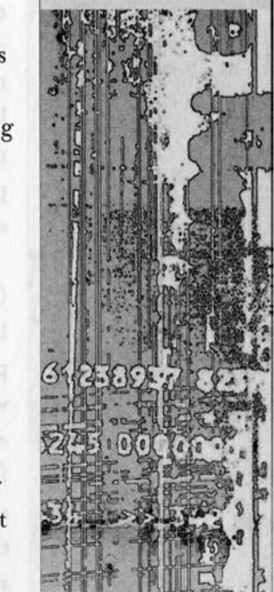
Emotion is a general term for a complex, critically important, three-part, thermostat-like arousal system that unconsciously interprets and evaluates sensory information, thus alerting us to current and potential dangers and opportunities that reach our emotional threshold and cause us to respond.

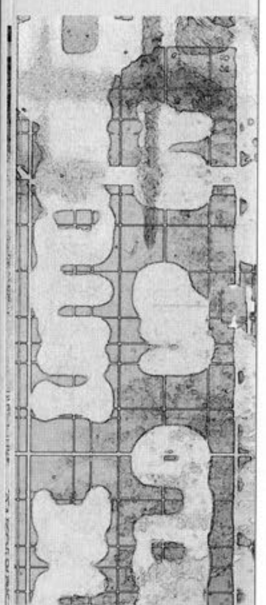
Temperament provides us with a (perhaps innate) lifelong initial emotional response bias to environmental challenges. A person's temperament typically centers somewhere along a continuum between anxious/inhibited and bold/uninhibited. Temperament is a useful human trait in that it allows us quickly and confidently to take the first step in response. The bold tend to go forward in curiosity (sensing an opportunity); the anxious tend to go backward in hesitant concern (sensing danger). Since we frequently follow our developing temperamental bias, we tend to become quite competent with it over time. For example, bold people tend to become skilled at responding boldly (similar to handedness, which develops exceptional competence with the favored hand).

It is important for children to realize that it is okay generally to operate out of either end of the temperament continuum. Our society profits from the strengths of those who are typically either cautious or bold (such as investors who specialize in either conservative or risky investments). Indeed, opposite temperaments often marry each other, and the relationship generally profits from the strengths of each (if they each respect their partner's temperament) since life confronts us with both dangers and opportunities. A congregation generally will exhibit a similar temperamental range, from those members who are stimulated by any novel idea to those who see any change as threatening.

One problem, however, is that bold/uninhibited students tend to dominate classroom life (while the anxious raise their hand and await their turn). Anxious/inhibited students may thus develop a sense of inferiority by incorrectly equating boldness with success. The aphorism, 'Fools rush in where angels fear to tread,' speaks to the value of caution, but anxious/inhibited students wistfully note the attention the bold/uninhibited tend to get.

So it is important that educators create an atmosphere that encourages students (and especially those at the anxious/inhibited end of the continuum) to understand and accept themselves for who they are, and to positively develop their temperamental bias, but also to





explore opportunities to widen their temperamental response range in appropriate situations. For example, cooperative group activities help students discover that the entire group can profit from temperamental diversity, and participants can assume group roles that challenge their temperamental bias.

Mood provides us with a useful short-term (hours to days) emotional response bias that we layer on to our temperament. Mood shifts probably emerge out of fluctuations in the various chemical cycles that regulate body/brain energy levels and functions. Mood thus informs us of our current and perhaps unconscious level of interest in the challenge and of the amount of response energy that we currently have. We may ignore behaviors on one day that would anger us on another.

It is important that we communicate our current mood to others, since they may then temper the demands they make on us, effectively enhancing our ability to respond appropriately to current dangers and opportunities. And we actually do effectively communicate mood through several poorly understood forms of body language. For example, a friend suggests, "I can see the anger in your eyes." Although one would be hard-pressed to state how a set of eyes can communicate such different moods as anger, joy, despair and excitement, they seem to do it. We do tend to sense the moods of others and adapt to them.

Churches similarly use a variety of techniques to stimulate similar ecclesiastical moods among members over the course of the church year—the somberness of Lent, the joy of Christmas and Easter.

Emotion itself (as we typically view it) is the most immediate and volatile of the three elements of emotion. Layered on to temperament and mood, it is regulated by sets of unconscious neuronal systems that continually provide a variety of immediate, often high-energy, positive-to-negative arousal biases to various challenges. When emotion reaches our level of consciousness, it becomes a *feeling* that we can communicate verbally or through tears/smiles/etc.

Until recently, it was very difficult to study the specific body/brain systems that regulate emotion, but the field is expanding rapidly, and we can expect further developments and a better understanding. It is currently not clear how to classify our various emotions. One way would be to group them temporally and topically—those that respond to events that have already occurred (such as surprise, acceptance-disgust-anger, and joy-sadness), and those that prepare us to respond to events that might occur (such as anticipation and fear). Emotion researchers currently best understand the neural systems that process fear and pleasure (or joy).

It is important for educators to realize that emotions are neither positive nor negative in themselves. The mechanisms for each emotion bias our response to a specific type of important human problem. The point is to avoid having such a low firing threshold for one emotion (such as fear) that it dominates all emotional responses, or to activate an inappropriate emotion (something that occurs when people cry during weddings and laugh during funerals).

Our overall emotional system is thus a complex biological thermostat that monitors our environment for potential dangers and opportunities—that something important has occurred or is about to occur. It draws on a lifelong temperamental bias, an awareness of our current general mood and its arousal/energy level, and the specific emotional nature of the immediate challenge. These subsystems all combine to pose an important question: Where is the problem located? To find out, our emotions activate attention.

Attention

ATTENTION IS a complex cognitive system that selects and focuses on key emotionally important elements in an often confusing environment and maintains goal-directed behavior in highly distractible situations. Our attentional system is composed of a number of distinct neural networks, each of which carries out specific attentional functions—by itself, or in interaction with other cognitive systems. Since experience and educational interventions can improve the efficacy of this complex system, it is important that educational programs include activities that enhance the development of the three separate functional systems that regulate attention:

The orienting system disengages us from what we were attending to and focuses us on the new target. We generally shift our attention to emotionally arousing things that contrast greatly with our current focus, and we ignore (or merely monitor) steady states, subtle differences and gradual changes. For example, when we leave a building, we consciously notice the temperature when it is much different outside than inside, but not when both are similar.

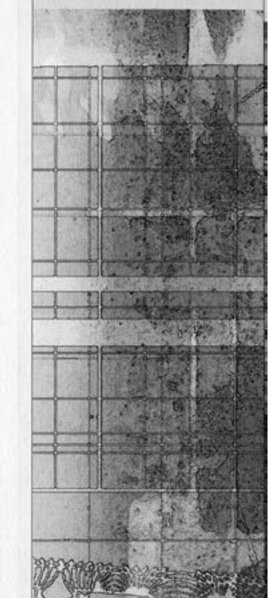
Our environment, however, is replete with serious dangers (such as pollution) that are often subtle and gradual. They are emotionally significant, but we tend to focus on them only when a high contrast catastrophe (such as a toxic spill) occurs. The *news* is about the unusual, not the normal. The news reports a single freeway pile-up of ten cars, but not the perhaps 100 isolated fender-benders that occurred in the same general area that day. Graphs and time-lapse photography are examples of the many technologies we have developed to observe changes that occur too gradually to activate our biological emotion and attention systems.

The executive attention system draws on memory to recognize the identity of the new target (foreground), determine its significance and separate it from the background information (which it then merely monitors or ignores). This is typically an unconscious process, but we do confront situations in which it is not obvious what we should focus on in a confusing situation, and so our executive attention system consciously makes the decision. The broad appeal of mystery stories suggests that this is a stimulating process. Teaching helps to direct this selection system when it identifies the important and unimportant in the topic being explored. Newspapers use such techniques as headlines, page placement and photographs to identify what is most important in today's news. Finally, reading the text before preaching the sermon helps to focus attention on the theme.

Our working (or short-term) memory is an important part of this system. It is a fragile limited-capacity buffer that allows us to briefly attend to and hold a few units of information while we use it (dial the phone number) or determine its importance (the name of a stranger in a party conversation). Its limited capacity is useful, since it forces us to combine related bits of information into larger units by identifying similarities, differences and patterns that can simplify and consolidate an otherwise large and confusing sensory field. Vocabulary categories emerged out of this system.

Children need many opportunities to develop this important system. Educational programs should incorporate many options that require participants to make choices that they can later reflect on to determine the wisdom of their choice. Further, working memory is enhanced by activities that require participants to rapidly classify large numbers of items into a smaller number of categories. Discussions and debates similarly require participants to select and attend to limited information for a limited time.

The vigilance system has the reverse task of our orienting system. Vigilance maintains a sustained focus while ignoring small random changes that occur while we are attending to something. The vigilance system can thus ignore minor but not major distractions. Major distractions may lead to an emotional arousal that activates our orienting system, and we are off to a new focus of attention. We can attend simultaneously to several non-competing things, such as to look at a person while conversing and arranging chairs around a table.



Many educational activities require students to maintain vigilant attention (such as while working math problems or studying a text). Vigilance is also an important component in most games children play (from tag to video games). Educational programs should include activities that enhance participants' ability to decide whether or not to maintain a current attentional focus, and then to make intelligent choices about short/long-term attentional tasks.

Our overall attention system thus moves us from arousal to focus. It is a sort of zoom lens that can zoom in to identify and carefully

examine details (foreground), or zoom out to focus on the context (background). Many mental illnesses result from a malfunction in one or more of the subsystems that regulate attention: anxiety, autism, bi-polar disorder, dyslexia, hyperactivity, mental retardation, obsessive-compulsive disorder and schizophrenia.

An emotionally aroused attentive brain can learn. But such activation requires a much more complex and involving cognitive process than the single dreary directive to (for example) "Clear your desk, take out your math book and turn to page 25."

Learning and memory

ALTHOUGH THIS ARTICLE focuses on our brain's activation systems and not on the very complex systems that regulate *learning* (the process of acquiring new information) and *memory* (how/where our brain stores it), it is important to briefly discuss learning and memory in order to explore the issues in religious education raised at the beginning of this article.

Since emotion is our brain's system for alerting us to the existence of immediate and potential dangers and opportunities, we have separate neuronal systems for creating and processing emotional memories (of things that can arouse), and their related factual memories (of things that can inform us about the circumstances that surround the arousal). Thus, factual memories relate to *what happened,* and emotional memories to *how I feel about what happened.*

Emotional memories are neurologically stronger than factual memories. For example, we tend to maintain strong emotional memories of our childhood but forget many specific childhood facts and events. Family get-togethers generally recall and so strengthen such weak factual memories (as church service attendance strengthens our memory of religious facts). I suggested earlier that education and religious education programs will tend to be ineffective if they focus principally on developing factual memories without creating an underlying emotional base. Let me use a metaphor to explain why.

When we humans are overwhelmed by information and/or challenge, we tend to reinvent the related body/brain process outside of our body and let that technology carry the load. Examples include phone books, dictionaries, calculators and photographs. Thus, in our search for a simple explanation for the roles emotional and factual memory play, it is useful to examine the systems outside of our skull that we have developed to store and retrieve complex combinations of information.

The combination of file cabinet, file folders and files might be a useful metaphor for memory, since it has many parallels to what our brain actually does as it gathers, organizes, stores, retrieves and uses information.

Think of our brain as a reasonably full and useful file cabinet. Think then of an emotional memory as a file folder within a cabinet drawer. The file folder contains many files—the factual memories of objects/events related to the emotion. When we pull out a file folder, we have easy access to all the files within it. When the file folder is in the file cabinet, though, we do not have easy access to the files.

It is useful to limit ready access to many of our factual memories to situations in which we are in the time/space/emotional *neighborhood.* Imagine a trip to the downtown area of a city we have visited, but not recently. Before going, we may have trouble recalling specific locations/stores/cafes/etc., but when we arrive, many factual memories easily return. The emotionally aroused state of being there automatically pops out the file folder, and we have ready access to the factual information we need. Imagine the cognitive overload if we had continuous easy access to all such memories even when we did not need them, when we were not in the neighborhood. Or think of a class reunion and how we effortlessly recall long dormant memories of people and events, or the instant recall of prior related negative experiences during an argument with a spouse or friend.

We thus have best access to weak factual memories (the files) through strong emotional memories (the file folders). Factual memories without emotional context are difficult to store and retrieve. The names/dates/places kinds of

curricular information we ask students to remember are a good example. Students often ask, "Will this be on the test?" If the answer is "yes," they then have a useful *emotions file folder* for the information: *test things.* During the test, they will pull out and use the file folder and its names/dates/places information, but it is quite problematic if the file folder will ever come out in any non-test situation.

Sad to say, my file for the Nicene Creed is similarly stored in my mind's *church liturgy* file folder, with copies nowhere else. So (perhaps also like many others) I access it only when it comes up in the liturgy during a church service. But then I can recite it perfectly, for whatever value that is, if it does not automatically connect with the rest of my life.

School simulation and role playing activities thus provide a useful emotional context (or file folder), because they are related to real-life emotional uses of the information. Conversely, multiple choice (and related) tests generally mask the context of factual information. The result is that students often associate the facts with the test rather than with their cultural utility. As indicated above, students who pass the test may still be unable to use the information in its cultural (or moral/ethical) context.

If the emotional overtones of an experience are very important, we may create especially strong emotional and weak factual memories of the event. Thus, an abused child who must continue to live in an abusive situation may be better off focusing on aversion strategies than on remembering all the details of past abuse. A strong related emotional stimulus years later may then trigger the recall of these weak factual memories of abuse (as it similarly does with long dormant class reunion memories).

Mass media, marketers, politicians and special interest groups often exploit our emotional/factual memory system by hammering us with emotion-laden terms and images that they design to pull out emotional file folders biased to their position. Two such placard-waving groups with opposite views on the issue of Internet regulations recently appeared in the same newspaper picture, one waving a sign with the message, *Stop Child Pornography*! and the other *Protect Our First Amendment Rights*! How newspaper readers will contemplate the issue will depend somewhat on which *file folder* popped up in a reader's mind upon seeing the picture, and whether or not the "facts" supporting the position were seriously biased.

Even if we do not already have an emotional file folder for an issue we confront for the first time (such as the unexpected 1997 announcement of cloning), we tend toward an almost immediate emotional response. Think of the organization of a library. If the book we seek is gone, we usually examine the two adjacent books, because libraries are organized so that the two adjacent books are always the closest in focus/content to any shelved book. Similarly, when we confront a novel challenge, our emotional system tends to begin our response sequence with something we consider similar. In the case of cloning, perhaps an emotional file folder that contained information related to your religious beliefs initially popped out; or perhaps it was of the Nazi genetic experiments, science fiction, a love of science, or the novel, *Brave New World.*

This suggests that when a religious education program explores a moral/ethical issue, it should focus initially on an emotionally-loaded dilemma that students will recognize as a danger or opportunity that relates to their stage of life and experience. This emotional activation has the potential to create an *emotional file folder* that subsequent instruction (drawn from the related religious literature) can fill with *files* that will help to resolve future related problems. When students later confront a similar moral/ethical dilemma, the file folder they developed through the religious education program will pop up in their mind, and they will have easy access in life to what they learned in school/church.

We also experience the reverse. A problem suddenly pops into our mind while listening to a sermon or singing a hymn. Often we do not even consciously know what occurred to spark the emotional memory. But that file is now out, and we tend to ignore whatever else is going on for a few minutes to page mentally through the file.

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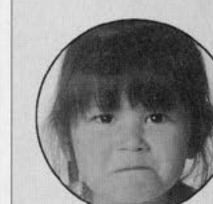

Dale Septeowski

Emotions and Learning: From Theory to Practice

Education of the "whole person" is an identified goal of many educational institutions. Such a goal indicates a recognition that the educational mission is to provide instruction and learning in domains other than only the cognitive domain. Other domains might include the physical, spiritual, affective and social domains. The way education often attempts to do this is by identifying specific courses or activities that affect each domain. Therefore, mathematics, English, history and other core subject areas are for the cognitive domain. The physical domain is affected by recess and physical education class. The social domain is influenced at lunch and by club and social activities. The spiritual domain belongs in religion class and chapel. The affective domain is covered by art and music and possibly through religious instruction. The "whole learner" is split into pieces and given classes that educate each part.

It is probably true that some subject areas lend themselves to learning in one domain more than another: it is difficult to imagine just how physical mathematics can get. However, this splitting of the whole person suggests that one can actually select instruction to affect only one domain at a time. Is there evidence to support that instruction and subsequent learning can be so selective?

Robert Sylwester's article in this edition, "From Behavior to Biology," describes how this question of evidence and support would have been answered in the past with the knowledge available to scientists and educators at the time. Today, with advancing technology and increasing knowledge of the brain, the question of evidence and support is stated and answered differently. Recognizing the brain as the organ of learning, we can ask, "Is there any evidence to support or to suggest that when the brain learns, it learns in one domain only? Can instruction be pinpointed to affect only one part of the brain and not others?"

The emerging answer appears to be "no." Though the brain may use different structures for various kinds of learning and may process certain kinds of information in specific areas, learning in the brain is more holistic. One specific area where this holistic aspect of the functioning brain can be seen most clearly is the relationship between cognitive learning and emotions. In the past, educators often saw emotions and feelings as by-products of learning: "it feels good to learn or achieve." As researchers have pointed out:

> It used to be assumed that concepts and emotion could be totally separated. That is simply wrong. Emotion and cognition interact and 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, Caine, and Crowell, 1994, p. 117).

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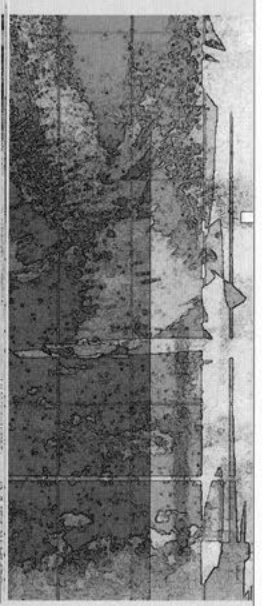
Brain 101

Before looking at the relationships of brain, emotions and learning, a short lesson in brain structure and function is in order. The brain is



organized so that specific sensory, motor and processing functions are localized in specialized brain areas. For example, an area at the back of the brain has some specific involvement in vision processes. Areas at the sides of the brain are involved with specific aspects of hearing. However, any behavior may involve a number of different brain areas as well as other parts of the body. This is usually described as a *system*. So the visual system will include various vision areas of the brain (including the area at the back of the brain) and will even include parts of the eye. Similarly, the digestive system includes various brain areas and body areas such as the mouth, tongue and stomach. Systems exist because of communication (nervous system activity) among the various parts. The emotional system is even more diffuse, including brain areas, stomach, adrenal glands and numerous other areas. This is why an emotion seems to be "felt all over."

For our discussion of brain, emotions and learning, a few specific brain areas need identification and description. The outer layer of the brain, the convoluted part that most people associate with the brain, is called the *cortex*. Cortex is considered to be the most distinctively human part of the brain. Behaviors of reasoning, language, conscious awareness and much of human learning require significant cortex involvement. Deep inside the brain lies another structure called the *thalamus*. The thalamus is the sensory relay station. Information from our senses often goes first to the thalamus which then relays this information to other brain areas. A third area, very important to our discussion, is the *amygdala*. The amygdala lies deep within the brain and in close proximity to the thalamus. The amygdala has been identified as the sentinel (Goleman, 1995) of the emotional system. These three brain areas can and do communicate with each other, thereby affecting each other. Brain research suggests two findings. First, sensory information received by the thalamus goes to *both* the amygdala (emotional sentinel) and to the cortex (human information processing, cognition). Second, the amygdala and cortex appear to connect with each other, suggesting that the emotional sentinel and the rational, cognitive cortex can affect each other.

From these two points, two general conclusions follow. First, human learning is both emotional and cognitive. Sensory information, the beginning of the learning process, goes to both emotion areas and to cognitive areas of the brain. Second, emotions and cognition interact in important ways. In fact, to some extent, cognition relies on emotion. In some instances, emotions can overrule reason, as in "losing one's head." Inversely, cognition or control can be exercised over emotions, as in "count to ten before you react." With this basic understanding of brain structure and function, it is now possible to look at the relationship between emotions and learning and to identify some possible implications for the teaching/learning process.

Emotions and Motivation to Learn

SYLWESTER, in his second article in this edition, briefly describes the role of emotion in arousal, activation, or what is also called attention. The amygdala receives sensory information and is involved in triggering an emotional response. These emotions signal "pay attention to this, this is important," but they do even more. Emotions add a "flavor" or a "color" to learning and memory (Jensen, 1996). Emotions add a "richness" to learning that can sustain interest. Brain research suggests that the brain learns best when it is engaged, and emotions are engaging.

The use of emotions to engage learning should not be confused with making learning fun. Certainly, learning can be fun, but not all learning is fun. Learning not to put your finger in the electrical outlet, by receiving a shock, is not fun, but it certainly is emotionally engaging. People quickly learn the relationship between putting a finger in the outlet and pain. Emotions then bring attention and sustained interest which can make for more effective learning.

Note the power of emotion. The relationship between electrical outlet and shock is learned after just one trial-and-error experience. However, learning the relationship between electrical outlets and pain is not a high level of learning. For the kind of learning that takes place in schools, strong, positive emotions are needed. According to Jensen (1995) emotions are engaged and complex learning is enhanced when the learner perceives a challenge. The operative word here is "perceives." Perception is a subjective process, which is to say that perception involves the emotions. One person's perceived challenge may be another person's perceived non-challenge. Significantly, challenge also may be perceived as a threat. Threat, like pain, is emotionally engaging, but its effect, like pain, is to interfere with effective learning.

When Emotions Interfere with Learning

THE AMYGDALA, as stated earlier, is one part of the emotional system. Much of the emotional system has been known to brain researchers for quite some time and is usually described as the "fight-or-flight response" of an organism. When sensory input is received, the amygdala, working with other brain areas, can trigger this response. The "fight-or-flight response" is viewed as an adaptive mechanism readying the organism to deal with the perceived threat. It should be noted here that this same "fight-or-flight" response is also activated with the condition known as stress. Stress is defined as the emotional response to a perceived threat. The physiological changes associated with the emotion of fear or stress include increased heart rate and respiration, increased production of glucose, increase in adrenalin, sweatiness and other physiological changes which are designed to help the organism take action—"fight or flight."

The action of the amygdala that prompts all these physiological changes makes for an emotional hijacking of the brain (LeDoux, 1996). According to LeDoux, when the emotional system takes over, higher brain functions of the cortex are interfered with and inhibited. Reflection stops so that survival processes can take over. Leslie Hart (1985) was one of the first to describe this process and referred to it as "downshifting," or a reverting back to more primitive or self-preserving modes of thinking. No matter what term is used, reason, rationality, problem solving and other cognitive processes associated with human learning are reduced, and more immediate, emergency processes are activated. Strong emotions, then, such as fear, anger, and the common emotions related to stress can interfere with complex learning.

Emotions and Memory

BRAIN RESEARCH also suggests that there is a strong relationship between emotions and memory. Personal experience can validate this. Often we can remember the emotions and feelings associated with a particular event much better than we can remember the details of the event. This same triggering of memories from emotions can be seen with post-traumatic stress disorder. Memories of highly emotional events are triggered some time after the events not by factual information or memories, but by an emotional trigger. Given the role of the amygdala, something perceived as a threat or challenge is processed as an emotional memory, not merely a factual type of memory.

A common method of describing memory is to liken it to a filing system for storage and, when organized efficiently, for retrieval. Describing memory as a filing system is a useful metaphor. However, memories are not on 3 x 5 index cards in our brain, nor are they organized in manila folders. Memories are stored chemically in the brain. Anything that enhances the chemical process of memory improves memory consolidation. Anything that disrupts the chemical process interferes with memory. Stress can interfere with learning because under stressful conditions the adrenal glands secrete the hormone cortisol. Cortisol enhances the production of glucose for energy in a stressful emergency. However, glucose is produced at the expense of protein synthesis, and protein (of which there are many types) has been identified as an important chemical of memory storage. Interference with protein synthesis disrupts memory consolidation (Rosenzweig, in Martinez and Kesner, 1998). There are other chemicals (hormones, neurotransmitters, and neuro-peptides) which also enhance memory and are produced when we experience more moderate emotions.

Implications for Instruction

"THE BRAIN is extremely complex, and most researchers study small aspects of brain functioning, often in artificial or limited environ-

ments" (Caine & Caine, 1998, p. 14). This is an important caution to keep in mind when attempting to draw possible implications of research to the instructional process. It would seem, however, that a number of general implications can be cited for educational instruction.

Lesson plans that engage the emotions can help improve instruction and subsequent learning. Jensen, in his books, *The Learning Brain* (1995) and *Brain-Based Learning* (1998), recommends strategies that educators can employ to make learning more "brain-based," including the use of drama, suspense and celebration. Other educators and writers suggest the use of debates, role playing and gaming to provide challenge to learners. Competition can also engage the emotions of some learners by challenging them with individual or group goals. It is important to remember, however, that just as there are differences in learning abilities and learning styles, learners also differ in what they perceive as challenging.

Strong negative emotions—those that are associated with pain, fear, anger, and most importantly, perceived threat—may bring about an emotional hijacking of the brain. Our instructional aim is to make the learning environment one of high challenge and low threat. The classroom needs to be perceived by the learner as a safe, secure, non-threatening environment, including both the actual physical setting and instructional methodology.

Teachers can make many significant contributions to creating a classroom environment that limits threats. But teachers have less influence over other threatening issues that also interfere with learning. Problems at home, fearful thoughts of forgetting to get some homework done, anxiety about upcoming tests and concern over peer relations are common sources of threat in the classroom. Sensitive educators have known for some time the importance of a comforting smile, a hug and an ear to listen. Providing class time to express emotions or talk about emotion-arousing experiences can be important. Some teachers encourage students to keep journals so that they have another way of expressing themselves in a more "private" manner. Other teachers actively teach students basic relaxation exercises that can be used in the classroom and at home. Current brain research now validates how important integrating the emotional domain with the cognitive is in effective teaching/learning.

At this point, the reader might be thinking that the emotional life of the human being is totally at the mercy of that small, almond-shaped brain structure called the amygdala and other substructures of the limbic system. A fair question would be "Aren't there areas of the brain, areas that show our distinctively human nature, that also play a role in human emotion?" The answer would certainly be "yes." It is important to keep in mind that much of our understanding about the brain comes from research on animals and by studying humans with brain damage. Therefore, trying to identify uniquely human qualities of the functioning brain does not always yield clear results and conclusions. However, the research does have implications for educating what Daniel Goleman calls our emotional intelligence.

Earlier under *Brain 101*, it was stated that the emotional sentinel, amygdala, and frontal cortex are connected. This connection suggests that each can influence the other. The amygdala's emotional sentinel may hijack the frontal cortex and reduce our ability to reason. Inversely, the rational, reasoning part of our brain, the more distinctively human part, can exercise control over the emotional amygdala. (Perhaps this emotional-rational relationship makes us distinctly human.) The relationship between the frontal cortex and the amygdala is described by Goleman as characterizing our emotional intelligence.

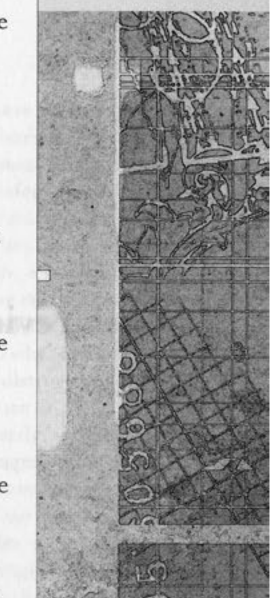
> These two fundamentally different ways of knowing interact to construct our mental life. One, the rational mind, is the mode of comprehension we are typically conscious of: more prominent in awareness, thoughtful, able to ponder and reflect. But alongside that there is another system of knowing: impulsive and powerful, if sometimes illogical—the emotional mind (1995, p. 8).

Perhaps the reader is familiar with Gardner's Multiple Intelligences and Sternberg's Triarchic Intelligence. Both theories present a concept of an emotional intelligence. Like other forms of intelligence, emotional intelligence may have a biological and genetic aspect. Temperament research documents that infants, moments after birth, clearly show differing emotional manners of reacting to their world (Kagan, 1998). Also, some research supports that humans differ in the reactivity of their sympathetic nervous system, the system most active with the fight-or-flight response (Shields, 1983). Some people are more "excitable" or "nervous" than others.

Significant to our discussion, though, is that "emotional intelligence" may, like other forms of intelligence, have an environmental or learned component. Since the frontal cortex can affect the amygdala, it would follow that we can learn to use reason and rationality to influence our emotional life. We can learn to find acceptable outlets for our emotional energy. We can even learn to understand our emotions, how they work and how they influence our life. The tragic event last spring at a high school in Littleton, Colorado, emphatically points to the importance of learning how to deal with our emotional brain. Schools and congregations can choose to play a significant and purposeful role in providing emotion education.

Goleman, in his book, *Emotional Intelligence*, has an entire chapter devoted to "Schooling the Emotions." Summarizing his chapter, he points out that some schools have adopted formal programs in which entire classes are devoted to learning to manage emotions. Goleman identifies courses in Self Science, Life Skills Training, Conflict Management, and Violence Education as examples. Certainly, these programs can be led by teachers. Schools also use trained school counselors who are capable and interested in providing such education. Specific classes are not the only approach. It is also possible to integrate such emotion education into existing classes. Obviously, within Christian schools, religion classes have the potential for such integration, but so do other classes. Some integration of emotion education would be consistent with the emerging brain research in emotions and cognition.

We have learned more about the brain in the last five years than we have in the past 100 years (Wolfe and Brandt, 1998). Our new abilities to study the brain will continue to provide a wealth of information regarding human behavior, including learning and memory. Scientists who study the brain, how it learns and how it stores memories, usually do not make the application to educational practice. It therefore seems necessary that those involved in education make the applications. To make appropriate application, educators will need to learn more about the brain, our organ of learning. One final implication of the research on emotion and learning: educators need to develop a better understanding of the brain and how it functions in order to become critical consumers of brain research findings.



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book reviews

Rethinking the Brain: New Insights into Early Development

Rima Shore
New York: Families and Work Institute, 1997

The author, in easy to understand prose, has written an important book on brain research as it applies specifically to young children and their families. She states that new research always follows a medical breakthrough. In this case it was the PET (Positron Emission Tomography) that gave the neuroscientists the technology to look at the brain in a variety of new and exciting ways. Now we can look at how the brain is reacting to certain stimuli; before we had to use the deceased or children with brain injuries.

Shore tells us that a baby is born with about 100 billion neurons, but these neurons need to connect or form synapses to function. The axon of one neuron connects to a dendrite of another to form a synapse. Each neuron can form thousands of connections. Shore relates this to telephone trunk lines that connect from city to city. It is during this time of building synapses that foundations are established for how a child feels, thinks and relates to others.

Pruning of dendrites occurs within the brain when areas are not stimulated or activated. Shore says we, as humans, "lose our minds" as we become adults. Brain development is truly a "use it or lose it" process.

This is quite different from our previous thinking that children were born with their brains hard-wired. For young children, their world consists of the people who care for them. It is the loving environment with plenty of interaction that determines the density of the neural pathways.

One can clearly see that the experiences a child has in the first years of life will have a decisive effect on how one's brain will be wired for life, negative or positive.

Shore states there are five lessons to be learned from the research:

1. Human development hinges on the interplay between nature and nurture.
2. Early care and nurturing have a decisive and long-lasting impact on how people develop.
3. The human brain has a remarkable capacity to change, but timing is crucial.
4. The brain's plasticity also means that there are times when negative experiences or the absence of appropriate stimuli are more likely to have serious and sustained effects.
5. Substantial evidence amassed by neuroscientists and child development experts over the last decade points to the wisdom and efficacy of early intervention.

Rima Shore has succeeded in making this book "must" reading for anyone who has a child, who works with a child as a care provider or a teacher, or who has an impact on the life of a young child in any way.

Roberta Nelson
Director of Early Childhood Education
Concordia University
Seward, Nebraska

The Biology of Violence

Debra Niehoff
New York: Simon and Schuster, 1999

Debra Niehoff earned a doctorate at Johns Hopkins University in neuroscience. She is the author of a number of scholarly articles, abstracts and chapters in books. She currently is the founder of Biotext, a biomedical communications company.

This book is one of the first to attempt to elucidate the ways in which violence is generated in individuals and society based on recent discoveries in neuroscience. Niehoff emphatically states that the debate between the "nature–nurture" causation of behavior, especially violent behavior, is over. She does an excellent job of summarizing what is known regarding the origins of violent behavior from both perspectives. In the light of continuing violent acts in our own country and around the world, her insights are important in helping us make some sense out of what is happening.

Using dramatic introductions of real individuals who have been intimately affected by violence and examples of violence in her own life, she draws the reader into the complicated story of how violence is generated in the brains/minds of all sorts of individuals.

It is a bit longer than many of the current more popular books on neuroscience, Stephen Pinker excepted, but it is full of valuable information for the lay reader and academic alike. In some parts the book becomes a bit technical; however, a general perusal gives one a good overview of what is happening today in the area of neuroscience and human behavior.

She begins with a bit of history and the laying down of positions taken by various researchers throughout the history of the study of behavior and the brain. It is a swift journey through some of the triumphs, but mostly tragedies, of behavioral research through the relatively recent past.

The second chapter titled *The Vicious Circle* explores relationships of genetics, development and behavior. It is a short but important survey of recent discoveries in brain research. Her discussion of genetics and human behavior is developed in a sensible fashion, and she does not imply a biological determinism in behavior. She makes the important point that violence is part of all animal life and serves a variety of functions for most species.

Investigating the geography of violence in urban Philadelphia, she relates in an interesting and unusual approach how the geography of the brain and the component parts are linked in violent behavior. The influence of neurochemicals and hormones on violent behavior establishes how the "marching orders" for violent behavior are initialized and carried out; however, she carefully includes how the social setting is involved in the very complex business of behavior.

Niehoff outlines the causes of so much violent behavior and the interactions of the social setting, an individual's genetic predisposition, and people's habits. Treatment of individuals who exhibit deviant or violent behavior is discussed rationally, with current research results seen as a basis for future progress.

Finally, she advocates procedures and policies that would be helpful for dealing with violence in our culture today. She issues an urgent call for compassionate treatment of getting children off to a good start by providing more social support for entire families. Preventive measures will not be merely economically advantageous, but may save thousands, if not millions, of children from a dismal future of violence.

By using our national will and the knowledge pouring out of research laboratories all over the world, we can save ourselves and especially our children from the continuing cycles of abuse.

The *Biology of Violence* is not the easiest book to read; however, it can be a very important book. The author helps us to see that we as a people need to dedicate ourselves to a course of action guided by the highest intentions and best information available.

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The Language Instinct

Steven Pinker
New York: Harper Perennial, 1995

As a cognitive scientist, Steven Pinker looks at language from a different perspective than those of us who spend our professional lives writing, lecturing and coaching students to refine their communication skills. Pinker, who directs the Center for Cognitive Neuroscience at the Massachusetts Institute of Technology, devotes his time to exploring the big questions: "Why do humans have languages? What makes languages work? How do we acquire them and pass them on?" In this publication, Pinker leads his readers through a thoroughly enjoyable overview of key topics exploring language and its development. Along the way he provides concise, easily understood synopses of scholarship relating to the history and cognitive processing of language. He also debunks myths about how language works and pokes fun at "language mavens" who attempt to guard the purity of Standard American English.

Pinker's choice of title neatly capsulizes his perspective on the talent which perhaps most clearly separates human beings from the animal kingdom. Pinker walks his readers through the inner workings of human language to reveal astounding complexities which we take for granted. He then demonstrates how naturally youngsters of all cultures learn their native tongues, unraveling grammatical formulas and amassing a vocabulary of thousands of words as easily as they master the intricacies of bipedal locomotion. Building on the theoretical foundation of his colleague, Noam Chomsky, Pinker asserts that all human languages incorporate the same basic grammatical components, consistently follow similar conventions and ultimately reach the same levels of richness and precision. Furthermore, Pinker says these characteristics apply equally to regional and ethnic dialects such as Black English Vernacular.

In Pinker's view, languages are in the midst of evolutionary journeys, being born out of necessity, adapting to change and passing into extinction. Pinker sees attempts to safeguard standard language as exercises in futility and snobbery. He supports his arguments with lessons in the lineage of contemporary English, explaining how "foti" became "feet," where the rule against split infinitives originated, why Mark McGwire "flied out" instead of "flew out" and why, in his opinion, no one will bother to distinguish "who" from "whom" in the near future.

Pinker does not deal directly with current controversies surrounding language arts education, but it is not hard to guess how he would respond to the "traditionalist" movement. Pinker characterizes prescriptive rules of grammar as modern day "shibboleths"—vestigial, illogical laws which serve only to distinguish the well educated from the rest of the masses. Rather than trying to cure the alleged linguistic deficiencies of today's students by drilling grammar trivia, Pinker suggests:

> . . . a banal but universally acknowledged key to good writing is to revise extensively. . . . Anyone who does not appreciate this necessity is going to be a bad writer. Imagine a [language maven] exclaiming, 'Our language today is threatened by an insidious enemy: the youth are not revising their drafts enough times.' Kind of takes the fun out of it, doesn't it? It's not something that can be blamed on television, rock music, shopping mall culture, overpaid athletes, or any of the other signs of the decay of civilization. But if it's clear writing they want, this is the kind of home remedy that is called for."

Pinker offers similarly strong opinions throughout his book. But even his critics are bound to appreciate his gift for conveying vast amounts of information with clarity and wit.

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New insights from the cognitive neurosciences are thus helping educators and religious educators to better understand teaching and learning and the key role that our brain's activation systems play in the process. The challenge for educators now is to discover how best to activate the systems, and for me, to get the Nicene Creed into some additional emotional file folders.

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