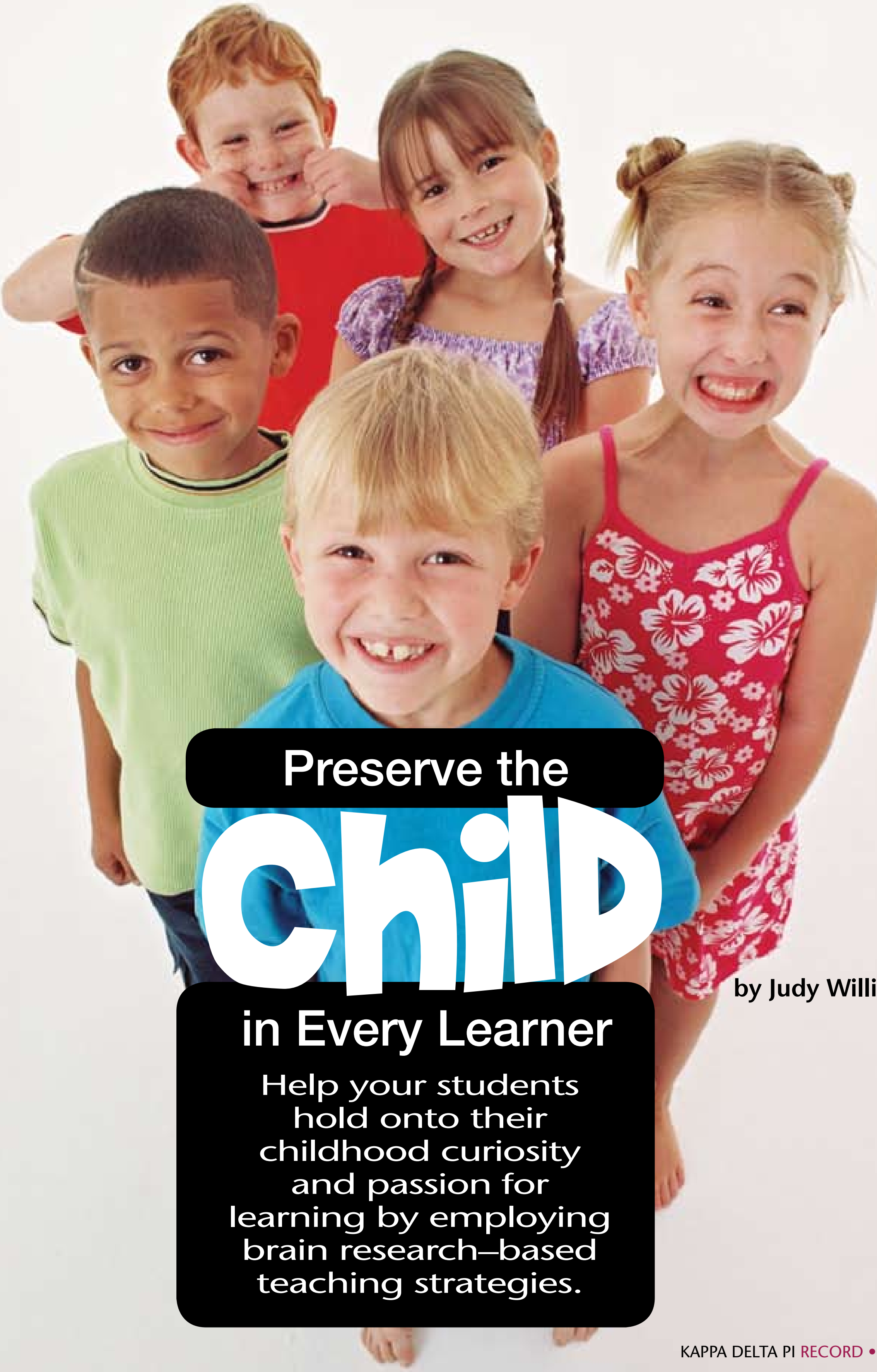

Preserve the Child in Every Learner

Help your students hold onto their childhood curiosity and passion for learning by employing brain research–based teaching strategies.

by Judy Willis

Childhood is a time when students are naturally curious and want to pursue their interests by learning all they can about the things that intrigue them. This interest-stimulated learning is a valuable template because it is compatible with the research discoveries of neuroimaging—what the brain looks like while it actively processes information.

The narrowing of curriculum, by NCLB and mandated standardized tests tied to sanctions, is reducing the opportunities for the student-centered learning needed to keep the curious child alive in students from kindergarten through graduate school. This article explores research about the affective filter in the brain's limbic system and the neurotransmitter *dopamine* to suggest neuro-*logical* strategies that keep students engaged with learning by reconnecting them to their childhood curiosity.

The **Problem**

More and more teachers are under pressure to prepare students for the rote memory output measured by standardized tests. Vested interest groups, from politicians to book publishers, lobby for increasingly structured, teach-to-the-test curriculum. Politicians opportunistically take public discontent with some aspects of the educational system and claim that public mandate has given them authority to make decisions about educational policy. As a result, teaching and curriculum decisions are being wrested from the hands of professional educators. Student-centered classrooms envisioned by Dewey (1916) and others, are being replaced by more direct instruction and rote memorization.

The trend to curriculum conformity has emphasized acquisition of facts without regard to developing students' skills in the processing of information through the executive functions of critical analysis, prioritizing of evidence, and judgment. If class discussions and idea sharing are replaced by one-way dispensing of data from teacher or text to student, these cognitive skills are not developed.

If engagement in learning through curiosity, strengths, interests, and prior knowledge is lost from school curriculum, students are at risk for losing their childhood passion for learning. This generation of students could become the most tested, least knowledgeable generation of public school students in decades.

The **Solution**

Teachers must add brain research–based teaching strategies, supported by educational and cognitive research, to their instruction. By doing so, they will have the tools of objective science to support keeping instruction engaging, creative, flexible, adaptable, enjoyable, and memorable.

During the 15 years I practiced adult and child neurology, I had neuroimaging and brain mapping as part of my diagnostic tool kit. I worked with patients of all ages with disorders of brain function, including learning differences. When I returned to the university to obtain my teaching credential and master's degree in education, these neuroimaging tools that I had used in my neurology practice had become available to researchers in the field of learning.

Neuroimaging brain research demonstrates that superior learning takes place when classroom experiences give active voice to students. Positive motivation impacts brain metabolism, conduction of nerve impulses through the memory filters, and the release of neurotransmitters that increase executive function and attention. When curriculum is relevant to students' lives, interests, and experiences, and students feel that they are partners in their education, they are engaged and motivated (Wunderlich, Bell, and Ford 2005).

Affective Filter in the **Amygdala**

Neuroimaging and neurochemical investigation provide several reasons to evaluate the impact of motivation. Research on the limbic system, especially the *amygdala,* reveals this deep brain region to be one location of an *affective filter* in the brain. During periods of high stress or anxiety, functional MRI studies show increased blood flow to this "emotional" portion of the limbic system. When the amygdala is in this hyperexcitable state, neural activity through the amygdala to the higher learning and association centers in the rest of the brain is profoundly reduced (Xiao and Barbas 2002; Pawlak et al. 2003).

The affective state of anxiety occurs when students feel alienated from their academic experience and anxious about their lack of understanding. Consider the example of the decodable books used in phonics-heavy reading instruction. These books are designed to review the phonics that students have studied by including words which can be decoded based on the phonics of the lesson. When the stories are not relevant to the students' lives, the ability to decode can be at the expense of authentic meaning. Reading, then, can become tedious, and for some students, confusing and anxiety-provoking if they don't know the meaning of the words (Reeve 1989). In this state, there is reduced stimulation of the neural pathways from the amygdala to higher cognitive centers of the brain, such as the prefrontal cortex, where information is processed, associated, and stored for later retrieval and executive functioning (McGaugh et al. 1990).

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Theories about the impact of an affective filter with respect to language acquisition are prevalent in the educational literature, starting with Dulay and Burt (1977) and later, Steven Krashen (1982). These educational theorists proposed that learning associated with strong positive emotion was retained longer, and that stress and anxiety interfered with learning (Cameron and Pierce 1994). Experienced teachers know from cognitive psychology studies and firsthand classroom experience that stress, boredom, confusion, low motivation, and anxiety can interfere with learning.

Neuroimaging literally shows what happens in the brain during these emotional states of raised affective filters. The evidence is now here, in vividly colored PET and functional MRI scans. These scans, taken when subjects receive information (through reading text, reciting word lists, listening to sentences, and looking for patterns), demonstrate that under stressful emotional conditions, the sensory input is blocked from entering the cortical areas of memory storage that lie beyond the amygdala. When scans show overactivity in the amygdala, responsive data processing, cognitive frontal lobe manipulation of information (thinking), and storing new information grind to a halt (Chugani 1998). If students are stressed or anxious, the information just doesn't get in.

More recent neurochemical studies have found that the amygdala is also activated, though to a lesser degree of metabolic activity, when students are in a positive emotional state. When subjects express feelings of contentment and safety, a stimulating, but comfortable amount of challenge has a positive influence on the amygdala's affective filter. During these emotional states, there is moderate stimulation (not the extreme hyperstimulation blockage seen during stress) in the amygdala. Students tested under these conditions show better working memory, improved verbal fluency, increased episodic memory for events, enhanced creative problem solving, focus, and higher order executive function and decision-making abilities (Kato and McEwen 2003). Subsequent research confirmed that engaging and nonthreatening challenging tasks were associated with moderate stimulation where the amygdala is "warmed up" to an alert state that actually facilitates active processing and neuronal transport of information (Wunderlich et al. 2005).

The right balance of activity comes from instruction that promotes mild to moderate challenge and stimulates students' authentic curiosity and engagement in lessons. In that learning situation, with students' brains turned to the ideal state of activation, the speed and efficiency of information flowing through the filter to the learning centers of the brain is optimal. Examples of these activities include engaging literature, student choice, and hands-on/minds-on discovery activities (Reeve 1989).

Dopamine Opens Doors

Dopamine is the chemical neurotransmitter most associated with attention, memory storage, comprehension, and executive function. Dopamine deficiency in the frontal lobes has long been associated with attention disorders such as ADHD. In the frontal lobes, as in the amygdala, there is an optimal metabolic state of enhanced neural stimulation—not hyperstimulation (overload)—that facilitates the passage of information through the learning pathways (Cooper, Bloom, and Roth 1996).

Early studies suggested that the brain released more dopamine while the individual was playing, laughing, exercising, and listening to books or stories read aloud (Depue and Collins 1999). It was later discovered that neuronal circuits going from the limbic system (emotional center) into the frontal lobe and other parts of the brain are rich in dopamine receptors that are activated by this dopamine release (Nader et al. 2002).

Many of the strategies teachers use to engage students in learning have been demonstrated to activate this dopamine release (Wunderlich et al. 2005). Examples are exploration and investigation activities, cooperative learning, allowing students to establish some of their own learning goals, student choice of subtopics to investigate, social collaboration, and physical activity connected to academic study.

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Bringing Brain Research to the Classroom

My understanding of the neuroimaging learning research has led me to plan lessons with emotional and intellectual opportunities, achievable challenge, and incorporation of students' interests and curiosity. My goal is to motivate students to work toward greater understanding through personal connection with the material—curiosity. The strategies and activities described here are those I developed or selected using my understanding of brain research. These are not original ideas, and it is likely that many teachers use similar strategies. What I share comes from my prior knowledge and experience, supported by my interpretation of the amygdala affective filter and dopamine neurotransmitter research.

Student-Centered Classrooms

Instruction that includes open-ended and student-initiated questioning offers a balance of emotional and intellectual opportunities and, therefore, helps students engage their motivation and higher-order executive functions. Before new units of instruction, I look for real-world examples to connect with students' interests that I have ascertained through interest inventories, peer interviews, and student autobiographical poems. When students ask questions, I turn them back to the class for responses or ideas. We discuss how to investigate the questions, and that is the entry point to exploring the topic together. The students are now invested in the topic through their own curiosity, and learning becomes ownership of knowledge, not passive one-way transfer of facts.

For example, before we study proportional reasoning, students are told that they each get $1,000 and can select a stock from the Internet or business section of the newspaper. They are told that any profits they make at the end of two weeks will be exchanged for math extra credit. They now want to know how to predict earnings, how to convert their money into shares, and how to tell how much their stock has gone up in value. Students soon realize that dollar amount increase is not the same as percentage increase. Suddenly, percentage calculation using proportional equations becomes valuable information they want to own.

The same excitement and engaging anticipation that promotes dopamine release and primes, but doesn't overstimulate, the affective filter is incorporated into geography lessons. Students select the country they want to investigate from the region we are studying and use books and the Internet to plan a trip to that country. They discover the historical points of interest they want to visit, the ethnic foods they want to try (and what crops, game, or fish are abundant and used in the regional food), and the climate and cultural and religious customs so that they know what clothes to bring and what behavior is appropriate. They also can choose to investigate the political or health situation in their country to decide whether travel is safe and what precautions to take. Students invest more attention in activities and lessons to which they feel an emotional and personal connection. Involvement in their simulated trip preparation heightens their ultimate attentiveness to the unit of study.

Cooperative Opportunities

Cooperative opportunities are interspersed in our learning activities so that students have smaller, safer places to try out ideas they might not express to the entire class. Small-group, cooperative activities give students opportunities to use special talents or areas of expertise. Most students also have less affective filter limitations when working in collegial small groups; they are more likely to express personal interpretations and experiment with critical thinking within the support system of the group.

Assessment

When students feel safe and in control of their potential for success, there is less stress to their affective filters. To help students feel that they have more control of their assessment outcomes, I offer several ways for them to know my expectations. I supply rubrics so that they know from the start what they can do to reach their achievement goals. I provide a binder with samples of A, B, C, and D student work from past years. The samples relate to assignments similar in character to theirs, but not the same specific topics. With the models available, students have the opportunity to emulate quality and creativity, not content.

Before starting tests, I have students visualize their successful performance. This visualization activates the memory circuits that will be called upon to solve the problems and answer the questions. Just as visualizing a tennis swing or soccer kick can activate the critical brain networks, this successful test visualization can bring the brain's memory circuits online.

A similar technique to activate thinking centers of the brain before an exam is a *priming session*, where students name things they think might be important to remember for the test. This priming is not the same as a review session that is held before test day. It is more of a brain pump to bring the important information "online" in memory networks that they will need to access during the test.

Teacher Self-Survey

Consider the following techniques that are consistent with my interpretation of brain research. Reward yourself for what you already do well. Take the suggestions that you find applicable to your situation and tweak them to suit your specific needs.

1. Is your classroom a place where students feel welcome, connected, safe, and sure they will be treated fairly?
2. Do your lessons have enough surprise, novelty, and variation to inspire awe or capture and hold attention?
3. Are there opportunities for students to explore a multitude of skills, abilities, and interests so they can discover one or more that engage them and use their learning-style strengths?
4. Do you use experiential learning, inquiry learning,

multisensory demonstrations, and cooperative activities to help students manipulate information by actively processing data through the executive function centers in their frontal lobes?

5. Are your lessons planned so the students can *own* the knowledge by making connections with personal meaning and prior experience, allowing the learning to be personalized and pleasurable? Those will be the lessons that will stimulate their pleasure-related release of dopamine.
6. Once you have their attention, do you help students stay connected by engaging their interests and creativity?
7. Are you preventing affective filter overactivation and promoting dopamine release by giving recognition for progress, not just success and final goal achievement?

The **Future**

The neuroimaging research presented here supports the concept that students experience a greater level of understanding when they discuss and inquire about information rather than just passively listen to a lecture or read a text. During engaging, motivating, brain-compatible learning activities, new information connects with prior knowledge, information processing isn't blocked by affective filters, and dopamine release increases attention and cognition. This is when information becomes knowledge.

The evidence from brain-imaging research reinforces the need for classrooms to once again become the places where the imagination, spirit, and curiosity of students are embraced, rather than left in the playground when the school bell rings.

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