Thinking about the Brain to Balance Classroom Literacy Programs

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ABSTRACT

In this paper, we discuss the link between effective literacy practices recommended by the International Reading Association and current research on how the brain learns derived from MRI and PET scan studies begun in the 1990's. Five key areas of brain-based research discussed include time and attention, emotion, the nature of memory, the learning environment, and differentiation. The purpose of this article is to provide classroom practitioners a new lens by which to view the most important and effective literacy practices, and shape their language arts programs.

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You are walking down the hall in the fifth-grade wing of a middle school. You peek into one classroom; students are seated in rows, performing a comma-editing task on worksheets while the teacher is seated at her desk at the front of the room. Students are individually and silently completing the task. Take a closer look. Their eyes are half closed, faces expressionless. Continuing down the corridor, you hear noise coming from another fifth-grade room. You look in and ask yourself, "Where is the teacher?" and then you find her, sitting amongst a group of students who do not notice your entrance. You observe different configurations of groups, even individual students, engaged in a project, the construction of original books about the rainforest. It is evident from the classroom environment that this is an on-going project. The classroom includes texts, trade books, colorful photos, wall charts, and bulletin boards. In the corner, there are interest centers for observing biomes and camouflaging techniques in nature. Although the overarching theme is the rainforest, no two projects look alike. There is intense conversation and movement. At times, students run to consult texts as models for their book captions or layout. Several other students are conferring and getting feedback from peers. These students are also reviewing a rubric and a checklist for project components. The teacher hardly notices you as she is interacting with the groups and circulating among them. Some children have already finished and are helping others with their projects. Still others are recording observations about the live insect display at the far end of the classroom. A pair of students is seated at the computer, searching a website to double check information. It's obvious in which classroom the students are more engaged and challenged to grow as learners. The question is: why?

The teacher in classroom one is involved in a skill and drill approach, influenced, perhaps by a well-intentioned but narrow view of preparing students for high-stakes educational testing. The classroom teacher may be influenced by what she has discovered through years of practice and observation. However, she, too, may not be aware of why her practices have been successful.

Recent state mandates and federal No Child Left Behind legislation have focused on raising the literacy bar for all and measuring progress in a relentless sequence of high-stakes standardized tests. The linchpin of these mandates is evidence-based literacy instruction. In response, the International Reading Association issued a position paper (2002) which suggested that practices, not programs, have been verified by scientific research. The IRA stated, " There is no single instructional program or method that is effective in teaching all children to read" (IRA, 2002). As support for their conclusion, the IRA cited a list of 10 research-based literacy instructional practices developed by Gambrell, Morrow, Neuman & Pressley (1999) which represent "an effective template for understanding best literacy practice" (IRA, 2002).

In this article, the authors present additional support for Gambrell and her colleagues' ten literacy instructional practices. This support is offered by what neuroscientific research is beginning to reveal about how the brain learns. This body of research dramatically expanded in the 1990's, the so-called "Decade of the Brain" (Sousa, 2000). At that time, scientists began utilizing non-invasive techniques of positive emission tomography (PET scans) and magnetic resonance imaging (MRI) for the purposes of mapping the structures and physiology of the human brain. The new technologies permit scientists to observe the human brain in action, make hypotheses, and design experiments to examine normal and abnormal brain functioning. Current research has emerged from the overlapping of three disciplines: neuroscience, cognitive psychology and education The purpose of this article is to provide classroom practitioners with a new lens by which to view the most important and effective literacy practices, and to shape their language arts programs, keeping the brain in mind.

In reflecting upon classroom literacy practices, what should teachers know about the brain? The work of Caine and Caine (1991), Sylwester (1995), Jensen (1995, 1997), Sousa (2000), Sprenger (2000), Kovalik and Olsen (2002) and others have provided educators with numerous examples of how to integrate research about the brain with effective classroom practice. It is our belief that effective literacy practice aligns with brain research when teachers: (1) consider how to best use time and natural attention cycles for learning; (2) recognize the uniqueness of memory-making in each learner and providing ways to access diverse memory pathways; (3) create an enriched learning environment; (4) understand the difference between challenge and stress; and (5) provide opportunities to facilitate a body-mind connection for learning. These five principles are the underpinnings of the IRA's list of ten best literacy practices.

Practice #1: Teach reading for authentic meaning-making literacy experiences: for pleasure, to be informed, and to perform a task.

Why is it important for the teacher to provide more authentic meaning-making literacy experiences? By providing interactive, hands-on simulation activities or role plays, the teacher embeds sense and meaning for the learner. Sousa (2000) stated, "Two necessary conditions for learning are 'Does it make sense?' and 'Does it have meaning?'" (p.46). (e.g., Do I understand this, and is it relevant to me?) As the learner becomes engaged, the reading activates pleasure, stimulates the mind and introduces new information which is more likely to be stored in memory and accessed for future use." Sprenger's (1998) work on memory pathways in the classroom shows that when a teacher uses

simulation, role play and more authentic, interactive tasks, students are more likely to access one or more of the five memory pathways (episodic, semantic, procedural, automatic and emotional memory) in order to retrieve information from prior learning.

Smith and Wilhelm 's work (2001) suggested that teaching literature for authentic tasks help the reader reach Vygotsky's "Zone of Proximal Development." In an interview study of over two dozen adolescent males and their literacy habits, and by studying two different classrooms, Smith and Wilhelm noted a "striking contrast between a classroom that was not engaging students in activity and one that was" (p. 103). In the non-engaged class, students were busy following along with recorded performances of Shakespeare and performing translation and paraphrase tasks. Wilhelm noted many students refusing to read the text and using "get by strategies" such as canned notes. The teacher spent class time reviewing and helping the students understand the previous night's assignment. In the second class, the students were reading and preparing various scenes from *Romeo & Juliet*, exploring and discussing issues such as family feuds and the concept of dueling. In this class, all students were engaged in dramatic activity, performance, or videography. Students made personal connections such as inter-cultural conflicts and beliefs. From observing these activities and interviewing the students, Smith and Wilhelm concluded that stronger long-term memories and personal connections were built, as well as a heightened understanding of Shakespeare's plot and universal themes.

The co-author of this article had a classroom experience that validated Wilhelm's observations about the importance of engagement in more authentic and purposeful reading and writing tasks. She conducted a series of lessons on reading and writing book reviews. The desire to empower students to be proactive in both the selection and recommendation of books is what guided these lessons. Students studied the genre by reading actual reviews and then developed their own criteria and structure for writing reviews. When students read and wrote for authentic purposes and real audiences, they became more motivated and engaged. Then, the project culminated in their publishing a book review magazine entitled, "By Kids for Kids," which was distributed to other classrooms for peer use. Another positive by-product of this task was an increase in student self-image as a critical reader, and their increased time spent in independent reading.

Practice #2: Use high-quality literature.

What are the attributes of "high-quality literature" and how does its use facilitate the thought-making processes? Descriptors of high-quality literature include: (1) rich story content; (2) imagery and metaphor to create a mental picture; (3) character development; and (4) strong thematic content which force making connections and applications to real life. Thus, Cullinan (1989) called literature "both a window and a mirror to the world." Fisher, Flood and Lapp (2001) suggested that high quality literature should be used for the following reasons: (1) modeling language structure; (2) accessing prior knowledge; and (3) motivating through emotional connections. In summarizing how brain research should guide instruction, Caine and Caine (1991) wrote that brain-based teaching involves: "(1) designing and orchestrating lifelike, enriching, and appropriate experiences for students; and (2) ensuring that students process experience in such a way as to increase the extraction of meaning" (p. 8). They described the tendency of the brain to create "maps" to organize information in either spatial as well as in thematic ways, such as personal relationships or political behavior. Thus, Caine and Caine wrote: "Our natural mental maps, therefore, seem to be at the heart of thematic teaching. Memory maps are created through stories, metaphors, celebrations, imagery and music, all of which are powerful tools for brain-based learning" (p. 42). Caine and Caine recommended literature as a vehicle to engage the senses,

stimulate thought and self-identification, and encourage pupils to make connections. Elias et. al. (1997) pointed out that "Great literature deals with themes that are universal such as friendship, courage, duty, and loss" (p. 61). High quality literature provides opportunities for teachers to design lessons that ask students to "relate these themes to their own lives" (p. 61), while at the same time, promoting divergent thinking.

In a Yale study of the meaning of intelligence, Sternberg (1997) concluded that at any grade level and in any subject, we must teach students in four ways: recall of what happened, analysis and comparison/ contrast; creation, imagination or hypothesizing; and finally, putting the event into some practical use. Experienced language arts teachers develop lessons to help students understand great literature using these four processes. Successful teachers often implement activities that harness the power of emotion to increase retention, implicitly adhering to Cahill's (Wolfe, 2000) belief that "anything you do that engages students emotional and motivational interest...will result in stronger memories" (p. 108). Neurological research suggests that the emotional interest is the hook that helps the brain transfer information to long-term storage (LeDoux, 1995; Sylwester, 1995; Sousa, 2000). Literature rich in story content and imagery, that also displays character strong character and thematic development, challenges and engages the reader in the thought-making process.

An example of the power of high-quality literature was evident in a series of culminating lessons for Katherine Paterson's *Bridge to Terabithia* conducted by the co-author of this article with a fifth-grade class. A simulation of a funeral for Leslie, one of the two main characters of the book, was planned with the students. The teacher introduced the class to a variety of eulogies which were used as models for original tributes to Leslie written through the point of view of the other main character, Jess. The class then planned and implemented a memorial service for Leslie. The students dressed in appropriate formal clothing and invited the parents to attend the service. Parents signed a visitor's book. Classical music was played to help increase the solemn mood. The classroom was converted into a funeral home with flowers, a podium, and an enlarged photograph of Leslie. Each child went to the microphone and delivered his or her eulogy to the audience. Later on, students commented on the powerful emotional experience of learning about, then writing and performing eulogies. Students felt that having this experience would help them in the future when facing real-life tragedies. Lessons drawn from good literature can have application in later life.

Practice #3: Integrate a comprehensive word study/phonics program into reading/writing instruction.

While there is no one consistent vision or one specific method of teaching phonics, there is a prevailing view, reflected in the IRA's best literacy practices list, that phonics and word study skills enable the beginning reader to get out of the starting gate on his or her way to processing text for meaning. Sousa's information processing model provides a useful theoretical base that enables us to understand how increased phonic and word recognition skills enables the reader to process text fluently and focus attention on constructing meaning. Sousa's model includes a short-term memory worktable upon which information is temporarily placed. This "working memory" has a limited storage capacity and duration. Sousa compares it to "a clipboard where we put information briefly until we make a decision on how to dispose of it" (Sousa, 2000, p. 41). The limited capacity refers to a specific number of "chunks", or pieces, of information. Chunking occurs when working memory perceives a set of data as a single item, which "allows us to deal with a few large blocks of information rather than small fragments." (Sousa, 2000). The ability to chunk information, in Sousa's view, is more a function of the

expert's knowledge base and experience than perceptual ability. Extending this concept to reading, Sousa points out that the teaching of reading should begin with a recognition that spoken words must be broken into sounds represented by letters, and then flow to vocabulary, meaning, context and syntax (Sousa, 2000).

Therefore, it is not an efficient strategy to process 44 separate phonemes of the English language by adding together individual bits during reading. Phonics/word study instruction includes strategies for chunking using language structure clues, such as onset and rime, word families, syllables, meaningful word parts, and spelling. This, in our view, is a necessary prerequisite to what Samuels (1979) called automaticity. Samuels argues that readers who recognize words effortlessly can bypass the limitations of working memory and attain greater speed and accuracy. Slowing down to "sound out" a word, decreases reading rate dramatically (DeVries, 2004, p. 248). Automatic or fluent readers expend less cognitive energy on word recognition and more time on sense and meaning. When explicit phonics instruction is integrated into instruction with authentic text, novice readers develop the skills needed to streamline their working memory and become proficient readers. Finally, as Sousa points out, "the key for beginning readers and writers is the right mix of phonemic awareness and interesting, developmentally appropriate literature" (Sousa, 2000, p. 186).

Practice #4: Use multiple texts that link and expand concepts.

How does the use of multiple texts help the brain learn? Caine and Caine (1991) pointed out that the brain is a pattern-detecting organism. When the brain's natural capacity to integrate information is acknowledged and invoked in teaching, then vast amounts of initially unrelated or seemingly random information can be assimilated (Caine & Caine, 1991). Wolfe (2001) stated: "One of the most effective ways to make information meaningful is to associate, or compare, a new concept with a known concept to hook the unfamiliar with something familiar" (p. 205). Typically, teachers attempt to relate new concepts to prior learnings through such techniques as metaphor–making, journal writing (Sousa, 2000), or differentiated texts and literature circles. (King-Shaver & Hunter, 2003). The use of multiple texts as well as multiple contexts, helps students to connect new learning to prior experience. In the classroom, teachers often link social studies or scientific concepts with literature. When introducing a new historical period, the social studies teacher often uses historical fiction as a read-aloud to help build background information and associations. For example, Collier's *My Brother Sam is Dead*, is a literary work frequently used to build schema and develop a deeper understanding of the Revolutionary War time period. Through discussion, parallels are drawn between the experiences of characters and setting in the text that bring reality to abstract concepts and information as presented in their textbooks. Middle school language arts teachers frequently use genre studies and literature circles to parallel social studies or science units. During their study of the Holocaust, for example, eighth-grade language arts students are involved in literature circles reading three or four different novels related to that study. Thus, teachers have accomplished curriculum integration in the form of thematic, inter- or multi-discipline centered units that are enhanced through the use of multiple texts (Hackman & Petzko, 2002).

Another example of how using multiple texts can facilitate the brain's pattern detection mechanism is the practice of engaging in "author studies," focusing on more than one text written by the same author. This practice enables students to study author's crafts and helps to build higher-order thinking skills, such as the ability to compare and contrast. For example, picture books, such as those by Leo Lionni, can be used to build the same process in visual, verbal and artistic areas. This pattern

recognition can also inform the writer. Thus, after studying Joanne Ryder's creative informational books, students were encouraged to write original animal books using Ryder's works as mentor texts.

At best, schools can only simulate real-life experiences; the more connections made by students, the greater the possibility for memory-making and application and transfer of learning to new situations. As Kowalik and Olsen (2002) pointed out, life-long learners constantly connect (i.e., scaffold) new learning with concrete or vicarious experiences. Through immersion and training, the meaning-making process and connections are accelerated.

Practice #5: Balance teacher and student-led discussion.

In recommending that effective instruction provide a balance between teacher and student led discussion, the IRA recognizes the mutually supportive role of mentoring and peer-directed learning. The careful application of both of these would appear to address several important principles about learning and the brain: (a) learning is a social activity; and (b) the brain has a natural capacity for change and adaptation to its environment, a concept known as neuroplasticity. Diamond's (1985) pioneering research on the effect of environment on rats suggested that a stimulating environment, copious food, and space made a significant difference in the quantity and quality of neural connections and the overall thickness of the cerebral cortex. However, Diamond also found that when mature rats were placed with younger rats in an enriched environment, the older rats played with toys and were stimulated by the environment, but the younger rats were not.

Sylwester (1995) extended Diamond's research implications to the classroom, where the teacher dominates discussion, initiates all the questioning, and determines the evaluative activities. Sylwester concluded: "It isn't enough for students to be in a stimulating environment, they have to help create it and directly interact with it" (Sylwester, p. 131). Werner and Smith's (1995) forty-year longitudinal study of 200 at-risk children on the Hawaiian island of Kauai, found that about one-third of these children were "resilient" and became happy and successful adults. One of the key factors distinguishing the resilient group from the problem group was that "they had family and non-family mentors" (p.137) who encouraged them by exposure to curiosities and hobbies. These mentors also assigned them tasks and family responsibilities which provided opportunities for students to have a role in their own development. In an interview case study of adolescent males, Smith and Wilhelm (2001) concluded that literacies grew out of relationships between students and students and teachers. In reviewing social conditions essential to literacy learning, Cambourne (2002) suggested that engagement with text is enhanced by discussion in small groups. Potential learners must engage with [teacher] demonstrations if they are to learn from them. It is difficult to rehearse demonstrations in a whole-class setting; however, in small groups novices can try out developing skills, and more expert students can provide feedback and further modeling. A variety of grouping models such as interest grouping, focus grouping, direct instruction grouping and mixed-ability grouping can move focus away from the teacher at the front of the room and put it on the interaction of learners in a social setting. Such practices such as those based on Adler's Great Books Program bridge the gap between teacher-led and student-led discussion because students are trained to engage in whole-class discussion. Here the teacher takes the role of facilitator and uses the Socratic method of open-ended questioning, and students learn to generate their own questions and make new connections with the literary work. Thus, by varying types of discussion frameworks, the teacher maintains an environment that stimulates learning, and promotes long-term understanding.

Practice #6: Build a whole-class community that emphasizes important concepts and builds background knowledge.

A classroom community is an environment in which learners function as an interdependent and emotionally supportive ecosystem. Neuroscientific evidence supports the idea that an emotionally, as well as physically safe environment, is essential to learning. McLean (1985) developed the "triune brain" model, which showed that the areas involved with survival and emotional well-being affect cognition. Caine and Caine (1993) stated that learning is enhanced by challenge and inhibited by threat, a finding supported by Sylwester (1995), Jensen (1998), and Wolfe (2000). Sousa (2000) pointed out that the brain gives priority first to incoming information related to safety and survival, followed by emotional learning, and then finally, factual information. Bender (2001) noted that physical safety in the classroom is not enough; a positive emotional climate between learners and teacher and among learners, must be present for effective learning. Overly critical or unsympathetic teachers or teachers who do not address social problems in the classroom can also be a serious deterrent to learning. To address such social problems, schools have instituted character education, social skills training, peer mediation groups, programs on social tolerance, anti-bullying initiatives, and cooperative learning.

In recommending that literacy professionals build a whole-class community that emphasizes important concepts and builds background knowledge, IRA recognizes the brain's need for enrichment, inquiry and challenge in a communal setting. Kowalik and Olsen (2002) found that the typical classroom contains 90% teacher-directed instruction involving secondhand and symbolic activities such as reading and mathematical computation, and 10% involving hands-on learning. They recommend that the teacher restructure and enrich the environment through: (a) field trips; (b) immersion and simulation activities in the real world; (c) hands-on representation of real world items; and (d) guest speakers, mentors, and adult experts who interact with children. Typical strategies that can build background knowledge and concepts include brainstorming, graphic organizers, KWL charts, reciprocal teaching. To build a community atmosphere teachers plan celebrations in the classroom, parents as reading partners, community demonstrations, performances, guest speakers, group projects and cooperative learning activities. Such community activities minimize the element of competitiveness and threat, boost student self-esteem and enhance the idea that working towards a common goal as a team is the way of the workplace. In a low-stress environment students are encouraged to ask for and give help to others as well as to share in celebrations. A learning community is built on the strengths and needs of everyone.

Practice #7: Work with students in small groups while other students read and write about what they have read.

By working with students in an arrangement of short-term, and flexibly-arrayed sub-groups within the whole class, the teacher provides temporary "mini-environments" for immediate feedback which can enhance literacy learning. As Jensen (1998) stated, "the brain is exquisitely designed to operate on feedback…our whole brain is self-referencing. It decides what to do based on what has just been done" (p. 33). He suggested that, as a general rule, students should receive some form of feedback once every half hour. Feedback may come from the teachers, other adults, or fellow students, but it is most effective when it is prompt, specific, multi-modal and comes from differing people, including oneself.

Whether a teacher organizes children by ability, interest, or short term needs, the small group setting allows for more effective immediate assessment of students and informs the teacher's immediate instructional decisions. In addition, feedback given in a small group reduces student uncertainty and

anxiety as compared to that given in a large group structure. Small groups provide a learning-safe environment where individuals feel more valued and cared for, as well as an ideal venue for constructive criticism (Caine & Caine, 1993; Wolfe, 2001; Kowalik, 2001). A flexible grouping structure maximizes feedback opportunities for all students.

Teachers often find it necessary to re-teach or provide focused instruction for a small group of learners while the others are engaged in other literacy activities. Thus, short-term, specific grouping strategies enable the teacher to capitalize on what Sousa (2001) calls the Primacy-Recency Effect. The brain's attentional structures tend to divide any lesson activity into three phases. Sousa calls these "prime-time 1," "prime-time 2", and "downtime." Prime-time one is approximately 50% of the activity, prime-time 2, the final 20% of the activity, and downtime, the middle 30% of the activity. While others are getting individual practice during down-time, the teacher can give provide explicit guided practice to those students who need it or who are not ready to work independently. This additional teacher-supported time enables students to re-enter the whole class during prime-time 2, the summary or closure phase of the lesson.

Another benefit of arranging for small group instruction is that it affords all students opportunities to engage in more independent literacy activities. Thus, students are able to exercise a certain degree of choice and control over their own learning. By providing access to structures within the classroom such as writing centers, differentiated readings, journaling activities, or enrichment project centers, teachers are fostering the brain-compatible concepts of individuality and independence.

Practice #8: Give students plenty of time to read in class.

In suggesting that effective literacy practitioners provide time for reading, IRA is telling us independent reading time is an important component to fostering literacy. Brain research has offered three perspectives on the benefits of reading time: (1) allowing learners to exercise control over their own learning; (2) permitting students to discover and explore their own interests and learning strengths; and (3) allowing teachers to observe and learn from and about students.

Caine and Caine (1991) suggested that, when a teacher provides an element of choice or "orchestrated immersion" in the reading experience, the learner's natural curiosity state, or relaxed alertness, is activated. During such orchestrated activities as reading time, a condition of "orderliness," or mutually valued behaviors is practiced by all students in a communal setting (Caine & Caine, 1991, p. 141). Jensen (1995) noted that providing freedom of choice in an activity enriches the learning environment. As students are given the opportunity to exercise control over their learning, the classroom becomes a safe haven for discovery and pursuit of new challenge. Furthermore, Jensen (1995) has called choice the key to motivation. When students feel empowered to select and read what is meaningful to them, they will be more likely to take risks to explore and exercise their intellectual curiosity. This, in turn, can help to develop individual expertise through immersion. Dickmann and Stanford-Blair (2002) stated that classroom conditions which remove stress and the locus of control from the teacher, and transfer it to the student, are more likely to induce behavioral change in the learner. Finally, Erlauer (2003, p. 59) summarized the benefits of providing choice: "content relevance is increased, their [students'] interest is heightened, stress is reduced, learning styles and ability levels are better accounted for, and both motivation and effort are enhanced."

In addition to promoting long term behavior and motivational change, allowing reading time accomplishes another benefit derived from research on the brain: the opportunity to support individual differences. Tomlinson (1999) described the differentiated classroom as one that has a wide range of

activities providing for individual learning. Such an environment respects students as unique learners with different strengths and multiple intelligences. Armstrong suggested (2003) that reading time can also be used to help students explore their specific strengths and intelligences: "Books can involve much more than just words; increasingly, non-traditional books that combine words with tactile, physical or kinesthetic possibilities are being published" (Armstrong, 2003, p. 35). For example, a student whose basic strengths involve bodily and kinesthetic abilities might enjoy a book on jumping rope rhymes or modeling with clay. These books exemplify a direct relationship between reading and doing since they often come packaged with jump ropes or modeling clay. Similarly, a student whose strength is in visual-spatial intelligence might enjoy a pop-up book on dinosaurs or a wordless book. Armstrong recommends that the teacher develop a library of varied literacy materials to help students integrate visual information in different ways consistent with such multiple intelligences.

Finally, reading time provides opportunities for teachers to observe and conference with individual students, to learn from the students and about them. As the teacher circulates, he or she is modeling active listening, showing empathy, discussing individual interests, or utilizing this personalized feedback session to suggest other books for the reader. These strategies help the teacher build and foster a community of readers. Lyons (2003) pointed out that teachers familiar with students' interests and concerns are more likely to create a safe, caring and supportive learning climate. Since emotional factors are at the heart of learning, she recommends that teachers know what engages students and how to use those interests to engage children's emotions as well as minds (Lyons, 2003).

Practice #9: Give students direct instruction in decoding and comprehension strategies that promote independent reading, balanced with guided instruction and independent learning.

The IRA's suggestion for balancing different structures for learning recognizes the importance of combining direct instruction in decoding and comprehension strategies with guided, monitored practice and independent rehearsal opportunities. Current research about the brain's attention cycles, memory making, and varied learning styles support the notion of balancing direct and guided instruction with practice on the road to achieving independence in reading and learning.

Jensen pointed out that attentional cycles of learners continually alternate between focused and diffused attention. He stated: "the brain does poorly at continuous high-level attention. In fact, genuine 'external' attention can be sustained at a high and constant level for only a short time, generally 10 minutes or less" (Jensen, 1997, p. 45). Much of what the learner is receiving during focused attention needs processing time which is an internal process in the learning brain. Thus, after each explicit teaching experience, the learner needs time for the learning to imprint or solidify through small group discussion, guided practice, or individual reflection and writing. Jensen cautioned: "Processing time depends on the difficulty of the material and the background of the learner" (Jensen, p. 47). Applying this notion and Sousa's primacy-recency effect noted earlier, the teacher can make use of the alternating attentional cycles through explicit teaching, followed with student-centered guided instruction and practice, and finally, closure activities.

Sprenger's (1999) work on the different memory pathways also supports the need for balancing learning structures. According to Sprenger, there are five distinct memory processes or pathways in the brain: semantic, episodic, emotional, automatic, and procedural. Semantic memory is information derived from words, and includes most classroom instruction, especially from lectures and textbooks. Of

all the memory pathways, it is the most difficult to access because it requires the most imprinting or repetition. "It [semantic] memory has to be stimulated by associations, comparisons and similarities. Because "semantic memory can fail us in many ways," (Sprenger, p. 51) it must be supported by repetition and activities to permit connections with other memory lanes. When students read, write, discuss or reflect, they are taking time to transfer and imprint this information in long-term memory. Similarly, Marzano, Pickering and Pollock (2001) concluded that: (1) mastering a skill takes a fair amount of focused practice; (2) while practicing, students should adapt and shape what they learned through discussion or structured reflection; and (3) the teacher should design "focused practice" assignments, especially when students are practicing a complex, multi-step skill or process.

A third brain-based rationale for flexible learning structures comes from research into individual learning styles and preferences. According to Sousa (2001), approximately 46% of students are visual learners who process information first through visual means; 35% of learners are primarily kinesthetic or tactile learners; and 19% of learners are primarily auditory learners. Sousa concluded that teachers need to address these differences by utilizing varied teaching styles including explicit direct teaching and modeling a behavior or complex skill, providing adequate time for reflection and processing activities that address the child's preferred learning style. Informal, classroom based assessment can reveal a need to adjust time for student processing or to provide additional explicit teaching.

A classroom is a cross section of learners whose brains operate in unique ways. Striking a balance means that the teacher needs to provide a variety of structures to maximize memory-making. It does not, however, mean that equal time needs to be given to direct instruction and guided and independent practice. The teacher may determine that a specific comprehension or decoding strategy needs to be made explicit to the entire class, a small group of students, or even an individual student. Direct strategy instruction is then followed by guided and independent practice. Ongoing assessment informs the flow of these stages and teachers should re-group flexibly based on learner feedback. Then, the teacher can provide opportunities for application in authentic literacy contexts or provide additional explicit instruction if necessary as he or she monitors each individual student's progress.

Practice #10: Use a variety of assessment techniques to inform instruction.

Despite today's emphasis on standards and formal high-stakes testing, most educators agree that multi-layered assessment is a better reflection of students' authentic performances and abilities. Brain-based research generally supports the IRA's view about using multiple assessments to: (a) satisfy the learning brain's need for specific and on-going feedback; (b) provide appropriate assessment practices to reduce stress; and (c) respect individual differences by providing a range of assessments for all learners.

The body and the brain are designed to operate on feedback, thus appropriate assessment has to be specific and ongoing. Jensen (1995) stated that feedback informs and directs our efforts, helps us set goals and helps us plan. The most effective feedback is specific, immediate and comes from more than one source (e.g., peers and teacher). Erlauer (2003) recommended that informal observation by the teacher be part of his or her own feedback loop. To Erlauer, informal observation can yield valuable information about what students know, how students work with one another, and how well they are applying new concepts. These data, in turn, should inform instruction. Similarly, Tileston (2002) characterized assessment as a multi-layered, continuous process that is part of instruction, not separate from it, having been introduced just before or simultaneously with the material.

Using a variety of assessment techniques, as suggested by the IRA, has an additional brain-related advantage: it reduces the negative effects of stress associated with high-stakes testing, a form of

assessment typically used by school systems. Caine and Caine (1991) stated such school assessment practice is fundamentally incompatible with how the brain learns and can actually induce a feeling of stress-induced helplessness called cognitive downshifting. In reviewing considerable literature on the negative effects of stress on student achievement, Jensen (1995) suggested that the assessment system is one variable of stress that the teacher should try to control as much as possible. Thus, he recommends that teachers reduce stress which emanates from threats in and outside of class, threats from other students, and threats from the teacher him/herself. To address the issue of stress as it relates to assessment, Jensen suggests: (a) the creation of rubrics to help a student know what is expected of him or her; (b) the elimination of surprise quizzes or tests as punishments; and (c) the implementation of multiple forms of assessment including projects and demonstrations. Sprenger (2002) pointed out that matching the form of assessment to the educational objective builds a sense of predictability that helps students feel more in control and less anxious. For example, an appropriate method of assessing a student's ability to communicate effectively in oral speaking would be to have students create a speech. However, before doing the project, the teacher should immerse them in models of good speeches, and then engage them in creating a rubric to describe the characteristics of a good speech. Chappuis and Stiggins (2002) recommended that the teacher help students to envision the goal or end product at the onset of instruction. In this manner, the student knows what is expected of him and the assessment becomes another learning experience rather than a stressful judgment day. Also, Schenk (2002) suggested that assessments must be closely linked to the practice and rehearsal done in the classroom because of the complex nature of memory pathways. To Schenk, assessment should parallel how a subject is taught. Therefore, pen and paper tests might suffice for simple skills or facts. However, demonstration or performance-based assessment would be more appropriate to complex tasks or projects.

Armstrong (1994) referred to Gardner's multiple intelligences to suggest that there are multiple ways to teach students, as well as to assess them. MI theory expands the assessment arena to include a wide range of possible contexts within which a student can express competence. He offers seven ways in which students can show their knowledge about specific topics using any one or more of the following intelligences: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal and intrapersonal. Thus, a linguistically oriented learner might give an oral interpretation of a key scene or character from a play or novel, a logic-mathematically oriented learner might present a sequential cause and effect graphic organizer mapping a character's development throughout the novel; a spatial-artistically inclined learner may present a series of sketches showing the rise and fall of the novel's main character. Finally, Armstrong makes a strong case for the development and use of student portfolios. They offer the widest possible opportunity to help students demonstrate, celebrate and reflect upon their unique work. In addition, portfolios can be an effective tool for communicating progress to parents and other members of the learning community.

Putting it All Together

As we close, we would like to take our readers back to those two classrooms we described early in this article. Neither skill and drill nor small group projects alone will effectively meet the needs of learners. Rather than making judgments based on mental snapshots, we hope that teachers will plan and deliver instruction based on the five key areas of alignment between literacy practice and brain research: (1) use of learning cycles and time; (2) uniqueness of memory-making; (3) enrichment in the learning environment; (4) creation of positive challenge and elimination of negative stress; and (5) connection of body and mind. Armed with new information, reflective practice, and an openness to feedback, teachers

will be able apply a balanced approach in their classrooms. In presenting a list of sound literacy instructional practices, the International Reading Association (2000) emphasized that practices, not programs, are the key to balancing your literacy program. These practices are not a curriculum, nor are they a set of quick fixes. However, they "may be used to frame questions that will be useful when considering whether there is a good fit between the program or approach under examination for a particular school or classroom setting" (p. 235).

Somewhere in the intersection of the practitioner's past experience, the needs of students in his or her current class setting, and the information about literacy and the brain, lies a powerful tool for change. We offer the linkage between the IRA's literacy practices and how the brain learns in the hope that literacy practitioners will accept the challenge of becoming classroom researchers and therefore contribute to the growing body of knowledge that places the focus on the learner, not on the curriculum.

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Table 1: The relationship between the IRA's suggested ten best literacy instructional practices and principles of brain-based research

BEST PRACTICES for **literacy instruction**	**Underlying principle (s) of brain-based learning**	**Correlating brain-based research studies**
Teach reading for authentic meaning-making literacy experience.	Memory-making and learning include an emotional component; long term memory is governed by "does it make sense" and "does it have relevance to me?"	LeDoux (1996) Sylwester (1995) Jensen (1998) Sousa (2000)
Use high-quality literature.	Neuron growth and brain cell enrichment are linked to the perception and interpretation of experience including story telling and literature	Caine & Caine (1991) Elias (1997)
Integrate a comprehensive word study/ phonics program into reading and writing instruction.	The brain is a pattern detecting organism which simultaneously stores information in specialized parts of the brain; discrete bits of information are given sense and meaning through contextualized learning activities	Caine & Caine (1991) Gazzaniga (1994) Sousa (2000)
Use multiple texts that link and expand concepts.	The brain is a pattern detecting organism which needs to connect prior learning to new experiences	Caine & Caine (1991) Wolfe (2001)
Balance teacher-led and student-led discussion.	The brain is a social learner; the brain is a novelty seeker	Vygotsky (1978) Sprenger (2000) Wolfe (2001)
Build a whole-class community that emphasizes background information and builds important concepts.	Learning is enhanced in an environment of group inquiry, and intellectual challenge; learning enhanced in an environment of safety, inhibited in an environment of threat	Caine & Caine (1991) Sylwester (1995) Sousa (2002) Erlauer (2003)
Work with students in small groups while other students read and write about what they have read	Immediate feedback in the context of a stress-reduced environment facilitates learning; independent practice and reflection promotes long-term memory	Caine & Caine (1991) Jensen (1998) Sousa (2002)
Give students plenty of time to read in class.	Independent practice alters the neural landscape; independent practice breaks down patterns of negative behaviors and promotes engagement by giving students choice and control over learning	Caine & Caine (1991) Jensen (1995 and 1998) Dickman & Standford-Blair (2000) Erlauer (2003)
Give students direct instruction in decoding and comprehension strategies that promote independent reading. Balance direct instruction, guided instruction and independent learning.	Learning and memory-making take place via multiple memory pathways in the brain; each brain is unique in terms of types of memory pathways and efficiency and speed of the pathways; the brain's window for storing new information balanced by its need for "down time and reflection"	Jensen (1998) Sprenger (1999) Wolfe (2000) Sousa (2002) Erlauer (2003)
Use a variety of assessment techniques to inform instruction.	Authentic, contextualized assessment lowers stress and improves student performance	Campbell (2000) Tileston (2000) Chappuis & Stiggins (2002)