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ABSTRACT

Those to whom teachers are accountable--administrators, parents, and the public--seem to be inclined to ignore the findings of more than 20 years of research into the process of efficient and proficient reading in favor of dehumanized instruction that reduces reading to bits and pieces of skills instruction. They cling to the metaphor of mind as machine, an engine built from smaller to increasingly larger parts. To counteract this dangerous, damaging mechanistic metaphor, educators need to develop new metaphors, in particular metaphors that conceptualize reading as a whole-brain process involving interaction and synchronization between the right and left cerebral hemispheres. This metaphor can be supported not merely by inferences from research into the reading process, but by research on hemispheric and whole brain functioning and, indirectly, by various studies of so-called dyslexia. To promote the more efficient teaching of reading, teachers need to (1) advocate and exemplify in their teaching a holistic approach to reading instruction; (2) investigate techniques and technology for promoting the simultaneous, synchronous use of both brain hemispheres; and (3) capitalize upon the popular interest in hemispheric processing to convey to other educators and to administrators, parents, and the public that reading is a whole brain process. (FL)

READING AS A WHOLE-BRAIN PROCESS:

BOTH REALITY AND METAPHOR

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Abstract

Since twenty years of research into the nature of the reading process has not yet managed to capture the attention of those to whom teachers are held accountable, it is proposed that we consider waging the war against ignorance on the metaphorical front: specifically, by capitalizing on the popular interest in brain hemisphere specialization to inform others that reading is a whole brain process involving not only the part-to-whole, "left brain" skills we so typically teach but also the whole-to-part skills often attributed to the right hemisphere. This conclusion is supported not merely by inferences from research into the reading process, but by research on hemispheric and whole brain functioning and, indirectly, by various studies of so-called dyslexia. Recommendations are made for classroom practice, research into brain synchronization and reading, and publicizing the fact that reading is a whole brain process.

READING AS A WHOLE-BRAIN PROCESS:

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Recently a student brought me a computer printout that her third grader had received at school. Splattered with numbers, the printout purported to indicate her son's reading ability. Decoding/phonics skills, 2 out of 4 correct, unmastered; comprehension/literary skills, 2 out of 4 correct, unmastered; and so forth. Then, of course, came the prescription, as if the child suffered from some disease. For decoding/phonics skills: reteaching activity, 333, 353; workbook, 110A; skills practice, 64A; skill charts, 69; reinforcement masters, 12; all as if merely doing the activities would develop the skills that are implicitly assumed to be necessary for reading.

One of the differences that still divides us lies between this kind of teaching/testing practice, on the one hand, and what we know about the process of proficient and efficient reading, on the other. If the preceding reductio ad absurdum occurred in a science fiction novel, we would be superciliously amused. But unfortunately it is occurring in many of our classrooms, at least in the United States. Those to whom teachers are held accountable--administrators, parents, and the public--seem particularly inclined to dehumanize education, reducing it to bits and pieces of skills instruction. It's something like painting by numbers: add green #16 here, green #158 there, brown #39 elsewhere, and you have a tree. Directed by those who think everything must be built up from its smallest parts, we teach children to paint by numbers and to read by sounding out and identifying words, as if the parts bore no relation to one another, as if the whole were not more than the sum of the parts.

But the whole _is_ more than that. With reading, in fact, it is not possible even to identify the parts without reference to the whole (e.g. Smith, 1979). Take, for example, the word _run_. What does it mean? How about the word _hose_? Or the word _store_? Obviously there are many possibilities--one of my desk dictionaries lists over eighty definitions for _run_, for example. However, we don't know which meaning is "correct" until we see the words in sentences like "Margo will _run_ the _store_," "I have a _run_ in my _hose_," "_Store_ the _hose_ over by the dog _run_," "_Hose_ down the _store_ while I _run_ to the laundromat," and so forth. We can name the parts in isolation, maybe--though that's more difficult than naming them in a meaningful context (e.g. Goodman, 1965; Weaver, 1980, Ch. 4). However, we cannot determine what the parts _mean_ until we see them in transaction with one another.

Furthermore, even the whole has no meaning in the absence of a reader; language itself has only "meaning potential," to use Halliday's term (1978). As he and others have pointed out, meaning arises during what Rosenblatt (1978) terms the _transaction_ between reader and text. Though the word symbols are organized into a grammatical and coherent text, together they still have only potential meanings, a partially indeterminate range of possible meanings, until certain meanings are actualized by a specific reader, at a given place and time, and under certain circumstances, whatever those may be. The meaning or meanings that arise during the reading of a text depend in large part upon the reader's schemata, his or her ever-changing organization of knowledge and life experience (e.g. Iran-Nejad and Ortony, 1984), as well as upon the reader's strategies and what the reader is attending to. If the reader's knowledge or experiential background is inadequate, or if the reader is attending primarily to

sounding out letters of words and to identifying words, to the parts, then by exclusively using this "bottom-up" approach he or she may never achieve a coherent sense of the whole. This result is all too possible in classrooms where instruction focuses on skills for sounding out and identifying words, rather than on strategies for getting meaning.

Since increasing numbers of educators are aware that reading is in large part a top-down process, controlled as much by the schemata and strategies of the reader as by the words and sentences of the text, then why have so many teachers adopted primarily a bottom-up, part-by-part skills approach to reading? One reason, of course, is the widespread use of teaching materials that emphasize this approach, namely the basal reading series so popular at least in the States. Another reason was suggested by International Reading Association president John Manning, a year ago (1985): while admitting that the explanation for "skills overkill" is somewhat elusive, he suggested that in part it is because of our acceptance, reluctant or willing, of "the notion that accountability is to be found in numbers, percentile ranks, and grade equivalent scores." The computer printout for my student's son is unfortunately but one example.

Damaging as it is, such a numerical notion of accountability, and of reading itself, constitutes only one symptom of what I think is a pervasive and pernicious metaphor: that of the world as a machine.

Since the time of Descartes over three hundred years ago, Western culture has been dominated by the mechanistic Weltanschauung and metaphor upon which reading skills instruction is based. This world view, this metaphor, has greatly clarified our understanding of the universe, but it has also limited what we are able to perceive, to understand. We have come to see the universe as a great machine: as a clock, in Descartes' day; as

an engine, during the industrial revolution; as an automobile mass-produced part-by-part on the assembly line, in the early twentieth century; and now as a computer, programmed step-by-step. One of the key characteristics of a machine is that it is built up from smaller to increasingly larger parts. Thus in reading, we teach and test the mastery of what seem to be increasingly larger parts: phonics skills, other word analysis skills, and comprehension skills, all as if the sum of such parts would equal the whole, genuine comprehension, and mistakenly assuming that comprehension will be, or should be, the same for everyone. However, the human mind is not a machine, not even a programmable computer, nor is human understanding strictly the result of building from smaller to increasingly larger units.

Thus in education, the implicit metaphor of the mind as machine is dangerous, often disastrous. It encourages us to teach not only as if identifying words will lead to comprehension in reading, but as if mastering rules for punctuation and studying parts of speech and sentences will produce effective writing, and as if memorizing facts in science and social studies will produce understanding of the physical world and of human history and human relations--all of which are demonstrably false.

What, then, can we do to counteract this damaging mechanistic metaphor? I suggest (as does Smith, 1984) that within education we develop more appropriate metaphors to catch the imagination not only of teachers but of the public. I propose one such metaphor: that learning in general, reading in particular, be conceptualized as a whole-brain process involving, if you will, a dance between the right and left cerebral hemispheres (Weaver, 1985). The two hemispheres work in synchronization with one another, each complementing the other.

I shall return to the metaphor concept. Here, I want to explore the

evidence that during efficient and effective reading, such hemispheric complementarity is a reality, not merely a metaphor.

The brain research into left and right hemispheric functioning is still in its infancy. Only recently have investigators turned from the fascinating research on "split brain" patients (those who have had surgically severed the corpus callosum connecting the two hemispheres) and patients with one excised or severely damaged hemisphere to the investigation of people with normally functioning brains. However, the accumulating body of evidence strongly suggests that the left and right hemispheres specialize in rather different functions. In the normal brain of about 90% of right-handed people and about 70% of left-handed people as well (Sinatra & Stahl-Gemake, 1983, p. 4), the left hemisphere apparently engages in sequential, linear, step-by-step processing; it is analytical, focusing on detail, the "parts." The right hemisphere apparently engages in simultaneous, holistic processing; it synthesizes, seeks closure, looks for the gestalt. While the left hemisphere focuses on parts, the right hemisphere seeks the whole that is more than merely the sum of the parts (e.g. Rico, 1983, p. 69; Sinatra & Stahl-Gemake, 1983, p. 62).

Though the left hemisphere is often said to be the locus of linguistic capabilities, this appears in fact to be only partially correct (e.g. Galin, 1979, p. 130; Dennis, 1983, pp. 204-205; see Gazzaniga, 1983, for a contrasting review article downplaying the role of the right hemisphere). Speech production heavily involves the left hemisphere, as does literal comprehension of words and phrases. But the right hemisphere appears to be involved in visual and spatial perception of words and in comprehension, particularly of larger wholes (Bakker, 1979; Zaidel, 1979, p. 82; Searleman, 1977, e.g. p. 514). The latter function of the right hemisphere is strongly

suggested by certain studies of right-hemisphere-damaged individuals. Using primarily their left hemispheres for language processing, such people are often very literal-minded, unable to determine the significance of details in a story, and unable to integrate details into a coherent whole (e.g. Dennis, 1983, pp. 200-201; Kirk, 1983, pp. 269-270; Millar & Whitaker, 1983, pp. 97-98; Wapner, Hamby, & Gardner, 1981; Gardner & Hamby, 1979, as cited by Campbell, 1982, pp. 245-246; Gardner, 1974, pp. 434-435). Thus it looks as if the right hemisphere plays a significant role in what we think of as higher levels of comprehension (Saffran, Bogyo, Schwartz, and Marin, 1980, pp. 398-401). (Luria, 1981, pp. 241-244, describes much the same pattern occurring as a result of frontal lobe damage, but it is impossible to tell whether just the right hemisphere is damaged, just the left, or both.)

One should mention, of course, that there are risks in concluding from studies of split-brain and brain-damaged individuals that the two hemispheres operate similarly in people whose brains are whole and healthy. In an excellent review article, Pappas warns against taking too much stock in "studies of [brain] lateralization whose findings have been inconsistent, fraught with conceptual and methodological difficulties, and still remain controversial" (1983, p. 163).

Despite this warning, however, I find particularly promising some of the studies on hemispheric functioning in normal, healthy brains. For example, studies of blood flow during reading show that "both the right and the left hemispheres become active in much the same manner" in normal brains (Lassen, Ingvar, & Skinhoj, 1978, p. 69), though such studies reveal little about the precise contribution of each hemisphere. A similar pattern is found in studies that map the electrical activity on the surface of the hemispheres: though the left hemisphere is more involved than the right,

clearly widespread areas of both hemispheres are involved in reading (Duffy, Denckla, Bartels, & Sandini, 1980; Duffy, McAnulty, & Schachter, 1984; McKean, 1985; their work, like Luria's and like Lassen et al.'s, suggests that the frontal lobes are heavily involved, in addition to regions in and around Broca's area and Wernicke's area).

In short, a variety of studies involving not only abnormal brains but healthy brains seem to indicate that reading involves a coordination of right and left hemispheric processing (Levy, 1985, pp. 43-44; Kirk, 1983, pp. 259, 270; Luria, 1980, pp. 375, 382). Levy summarizes: "When a person reads a story, the right hemisphere may play a special role in decoding visual information, maintaining an integrated story structure, appreciating humor and emotional content, deriving meaning from past associations and understanding metaphor. At the same time, the left hemisphere plays a special role in understanding syntax, translating written words into their phonetic representations and deriving meaning from complex relations among word concepts and syntax. But there is no activity in which only one hemisphere is involved or to which only one hemisphere makes a contribution (1985, pp. 43-44).

Given the gestalt-seeking proclivities attributed to the right hemisphere, perhaps it comes into play first, initiating the active search for meaning and drawing upon the reader's schemata in that search (at present, this suggestion is mere speculation). But as the act of reading progresses, there is complementary interplay between the two kinds of processing: the linear, element-by-element processing attributed to the left hemisphere, and the simultaneous, pattern-seeking processing attributed to the right.

Notice that I have spoken of the kinds of processing "attributed to"

each hemisphere, for new research repeatedly calls into question the simple dichotomies of the past. Indeed, experts in the field of brain research are cautioning that popularizers of the right-left brain dichotomy have gone beyond what the evidence warrants (Springer & Deutsch, 1985, pp. 7, 239; Calvin, 1983, pp. 102-107). What seems undeniably true, however, is that reading is a whole brain process, <u>somehow</u> involving both hemispheres in simultaneous part-by-part and whole-to-part processing.

The concept of reading as a whole brain process is supported not only by the increasing body of research on hemispheric and whole brain functioning, but indirectly by various studies of "dyslexia," a condition often attributed to those who have severe reading difficulty. One of the unfortunate results of this term "dyslexia" is that so-called dyslexics are often lumped together as if they suffered from a common disease (witness the "prescription" for my student's son). Clearly, however, this characterization of dyslexia is grossly inaccurate: severe reading difficulty is not a disease and, as we shall see, not all who have severe reading difficulty suffer from the same or even similar reading problems. Nevertheless the pernicious term "dyslexia" persists as a way of characterizing severe reading difficulty in people "who are otherwise normal intellectually, emotionally, and medically" (Witelson, 1977, p. 16), those who have severe difficulty in reading even though they have no identifiable physical, psychological, intellectual, or environmental deficits (Karlin, 1980, p. 103). Thus the term "dyslexia" or "specific reading disability" really means that for a typically <u>un</u>specifiable reason, the person so labeled has severe difficulty in reading. As Harris and Hodges point out, the term "dyslexia" has become little more than "a fancy word for a reading problem" (1981, p. 95).

Clearly the causes of severe reading problems could be various, but the concept of "dyslexia" was popularized by Orton, who in 1937 proposed a specific neurological cause, suggesting that "specific reading disabilty" might result from poorly established hemispheric dominance (see Monaghan, 1980, for a more thorough treatment of the history of "dyslexia"). Orton's particular hypothesis is now largely discredited by more recent and more sophisticated research (Malatesha & Aaron, 1982, pp. xx-xxi; Rourke, 1978, pp. 163-164; Witelson, 1977, pp. 18-19), but some neurobiologists still think that reading difficulty may often result from "a functional hemispheric deficit, an abnormal state of cerebral dominance, or disordered interhemispheric integration" (Zaidel, 1979, p. 55); see Hynd and Hynd, 1984, for a summary of some of the more recent studies). Thus whether the cause be neurological or not, many such readers appear to be using predominantly "left-brain" or predominantly "right-brain" strategies rather than an appropriate synchronization of the two.

So far, much of the dyslexia research purports to test reading comprehension by focusing on students' ability to identify single words, a procedure that in my view is patently absurd (Galin, 1979, is a noteworthy exception). Even so, the results suggest lopsided processing in many cases. Of the 107 students labeled dyslexic by Boder (1973), for example, 9% were categorized as "dyseidetic": they had a poor memory for visual gestalts and tended to read analytically, "'by ear,' through a process of phonetic analysis and synthesis, sounding out familiar as well as unfamiliar combinations of letters, rather than by whole-word visual gestalts." These children typically had a much lower sight vocabulary than those in the major group, whole sight vocabulary was itself characterized as "limited" (Boder, 1973, p. 670).

In sharp contrast are the "dysphonetic" children, as Boder calls them. These children read words globally as instantaneous visual gestalts, rather than analytically. Lacking word-analysis skills, they are unable to sound out and blend the letters and syllables of a word. According to Boder, such children tend to read words better in context (as proficient readers all do); also, because of their attention to context and meaning, these readers may substitute a word similar in meaning though dissimilar phonetically: sea for ocean, town for community, or lake for pond (Boder, 1973, pp. 668-670; some of the examples are from other sources). Boder indicates that the largest share of dyslexics in her study, approximately two-thirds, exhibited this pattern; as noted, 9% were dyseidetic, while the remaining 22% revealed both patterns (p. 676). According to Boder, the large percentage of "dysphonetic" dyslexics seems to be typical of other studies as well.

Generally speaking, then, when the left hemisphere predominates, we may get word-for-word reading with little comprehension, or letter-by-letter processing that because of inattention to meaning results in frequent nonwords, such as souts for shouts and ramped for repeated (Weaver, 1980, pp. 8-9, 164-165). Some researchers have called such readers "surface dyslexics," since they attend mainly to the superficial, surface features of the text rather than to meaning (Hynd & Hynd, 1984, pp. 493-494). One suspects that this surface approach may in some cases result from children taking our skills instruction too seriously, from their assuming that reading is merely sounding out and identifying words. On the other hand, when the right hemisphere predominates, we may get renditions that sometimes bear little visual or auditory resemblance to the actual words on the page, such as bird for canary or afraid for heard (Goodman, 1973), the latter in a

context where being afraid made sense (...to see if there was any danger. He <u>heard</u> the...). Such readers may be called "deep dyslexics" because they attend primarily to deep structure, to meaning (see Coltheart, Patterson, & Marshall, 1980, for various articles on "deep dyslexia"). Zaidel (1979) provides evidence that dysphonetic dyslexia corresponds to a left hemispheric deficit, while dyseidetic dyslexia represents a right hemispheric or bilateral deficit. (Fried, 1979, is also relevant. See Sinatra and Stahl-Gemake, 1983, Ch. 2, for a summary of research of dyslexia and hemispheric specialization.)

There is a growing body of evidence, then, that those who have a so-called specific reading disability may often overuse the strategies attributed to one hemisphere while underusing the strategies attributed to the other, and/or such individuals may not adequately integrate the strategies of the two hemispheres during reading (e.g. Aaron, 1982; Zaidel, 1979, pp. 57-58; Oexle & Zenhausern, 1981, pp. 35-36; Leisman & Ashkenazi, 1980).

Indirectly, then, such research involving people with severe reading difficulties supports reading research and hemispheric research in the conclusion that reading is a <u>whole</u> brain process. It involves a complex synchronization of the two cerebral hemispheres and the strategies attributed to them.

It should perhaps be noted that beginning readers tend to focus on one kind of strategy or the other, before they can coordinate the two (e.g. Goodman, 1973). While their initial focus may depend upon genetic or developmental factors, it is clealy affected also by how children are introduced to reading. If children are first expected to learn letters and sounds and to sound out words, they may adopt the part-to-whole strategy

attributed to the left hemisphere. Their reading errors, their "miscues," may be typical of "surface" dyslexics, those readers Boder termed "dyseidetic"; miscues like tuh-huh-ee for the, for example. If, however, children are first encouraged to "read" by turning the pages of a storybook and reciting the story, if they are encouraged to learn various stories, songs, and nursery rhymes, to experience stories until they have virtually memorized them before actually trying to read them, then children may adopt the whole-to-part strategy attributed to the right hemisphere. Their reading miscues may be typical of the "deep" or "dysphonetic" dyslexics: miscues like a for the, for example, or vice versa.

In the United States at least, the educational practice embodied in most basal reading series emphasizes the former approach; perhaps this is why Boder and others have found approximately two-thirds of the so-called dyslexics studied to be "dysphonetic" dyslexics (not to mention the other 22% who exhibited this pattern as well as the dyseidetic pattern). In contrast, psycholinguists and whole language educators emphasize the latter approach, initially focusing on whole-to-part strategies. Thus whole language teachers build upon strategies typical of children who have learned to read "naturally," in the home: the strategies of such children are initially holistic, meaning-oriented, and "right-brained," moving only gradually from a concern for the whole to a concern for smaller and smaller parts. (See Bakker, 1981, for other kinds of evidence that the right hemisphere is involved in early reading.)

Clearly I myself am strongly in the latter camp, advocating an emphasis on meaning first, convinced that meaning-preserving miscues such as those atrributed to the "deep," dysphonetic dyslexic are preferable, usually acceptable without correction, and indeed often a sign that a person is

reading <u>well</u> rather than poorly. In fact, nearly two decades of miscue research have demonstrated that such miscues are typical of proficient and efficient readers (Goodman, 1973, and various more recent sources). But the point here is that children typically begin reading by focusing more on one kind of strategy than the other, either left-hemispheric, due typically to skills instruction, or right-hemispheric, which appears to be the "natural" way for most children (e.g. Cochrane, Cochrane, Scalena, & Buchanan, 1984, pp. 44-45). Profound difficulties arise only when readers <u>persist</u> in such lopsided processing, when reading does not <u>become</u> a whole brain process, literally and not just metaphorically.

This conclusion is reinforced by evidence that learning in general is enhanced when the two hemispheres operate in synchronization; that is, when the peaks and valleys of the brain waves in the two hemispheres coincide (e.g. Cade & Coxhead, 1979; Green & Green, 1977; & Lozanov, 1982; all as reported in Hutchison, 1986). More specifically, learning of various kinds seems to be enhanced when the two hemispheres are synchronized in a highly relaxed state, with the brain producing slow alpha and/or theta waves. When these slow waves are combined with rapid beta waves, both synchronized, the mind is not only relaxed and receptive to learning but also alert and able to focus on a learning task (e.g. Cade, 1979; Hutchison, 1986, e.g. pp. 191-196, 218-220). (However, it must be noted that Sklar, Hanley, & Simmons, 1972, found that during an at-rest state, dyslexic children had more brain activity than normal readers in precisely those two ranges, theta and beta--p.414).

Since learning in general is enhanced when the two brain hemispheres operate in synchronization, it seems reasonable to hypothesize that reading in particular is similarly enhanced by brain synchronization. Indirectly,

then, such studies reinforce the conclusion that can be drawn from reading research, hemispheric research, and research into the nature of so-called "dyslexia": namely, that reading is a whole brain process involving the simultaneous, synchronous use of both hemispheres and complementary kinds of strategies. Though limited to a small group of undifferentiated dyslexics, the EEG study by Sklar, Hanley, & Simmons offers some support for this view (1972, p. 415).

Given, then, the various kinds of evidence that reading is a whole brain process, what can we do, as teachers of reading and as teacher educators, to promote more effective teaching of reading?

1. First, I suggest that we advocate and exemplify in our teaching a holistic approach to the teaching of reading. The so-called "whole language" approach seems ideal, not only because it focuses upon the use of real language for real purposes and draws upon readers' pre-existing schemas, not only because it considers meaning the first and primary goal and thus builds upon children's naturally emerging literacy strategies, but also because it integrates the kinds of strategies popularly if somewhat inaccurately associated with both hemispheres: the linear and "verbal" strategies attributed to the left hemisphere, with the spatial and rhythmic strategies attributed to the right, through music, rhythm and rhyme, creative drama and movement, and art. (See, for example, Fitzgerald, 1984; Held, 1984; and Wagner, 1983). Though it is clearly an overgeneralization to attribute these kinds of processing to the left and right hemispheres exclusively, it is also clear that many and perhaps most children learn most efficiently through such a multi-modal approach.

2. Second, we can investigate techniques and technology for promoting

the simultaneous, synchronous use of both hemispheres. One way we can do this in a clinical setting is with the use of sophisticated EEG (electro-encephalograph) equipment that simultaneously allows for biofeedback training, that is for training in altering a person's own brainwave patterns. One such device is the CAP scan (Computerized Automated Psychophysiological scan). Developed by Charles Strobel of the Institute for Advanced Studies in Behavioral Medicine in Hartford, Connecticut, the CAP scan "instantaneously converts your whole-brain EEG into a multi-color map," displaying it on a TV screen, with each type of brainwave activity represented by a different color (Hutchison, 1986, p. 172). If researchers determine the commonalities among the EEG patterns of large numbers of efficient and effective readers while they are reading, then the EEG patterns of persons with severe reading difficulties could theoretically be compared with these, and the latter individuals could be trained to alter their brainwave patterns appropriately through biofeedback. This in turn might improve their reading ability.

In fact, using a similar BEAM device (for Brain Electrical Activity Mapping), Duffy and his colleagues at the Boston Children's Hospital Medical Center claim to have determined how the EEG patterns of so-called dyslexic readers differ from the EEG patterns of normal readers (Duffy et al., 1980, both references). The particular results of these studies seem open to question, especially since the researchers apparently did not distinguish one type of "dyslexic" from another. Still, the technique itself seems promising, both for characterizing different patterns of brain waves that correlate with different kinds of reading difficulties, and for changing these brainwave patterns. In general, people who first learn to change their brainwave patterns in a clinical setting can learn to change those patterns outside the clinic as well.

In addition to biofeedback, another technique for stimulating brain synchronization is aural entrainment: that is, using a special kind of audio signal that leads the two brain hemispheres to follow in synchronization with the audio signal and with each other. This technique is most effective when used in a clinical setting with stereo headphones, since a different frequency signal is fed into each ear, causing the brain to "hear" the difference between the two; this technique is used to create low-frequency audio signals that otherwise would be inaudible (see Oster, 1973, and Hutchison, 1986, pp. 201-206). This technique of evoking brain synchronization can also be used in a classroom with stereo speakers, though of course somewhat less effectively (Edrington, 1984). Clearly this Hemi-Sync process patented by Robert Monroe bears further investigation by educational researchers and practitioners, including those involved with reading and the teaching of reading. (For more information on the Hemi-Sync process, contact the Monroe Institute of Applied Science, Route 1, Box 175, Faber, VA 22938, U.S.A.)

3. A third thing I suggest we do is that mentioned earlier: namely, work to replace the mechanistic metaphor of reading as a hierarchy of increasingly complex skills with a more appropriate metaphor. We can capitalize upon the popular interest in hemispheric processing (and right hemispheric abilities in particular) to convey to other educators and to administrators, parents, and the public that reading is a <u>whole</u> brain process involving not only the part-to-whole, "left brain" skills we so typically teach but also the whole-to-part skills attributed to the right hemisphere. Let us help people understand that learning to read is not like building a machine but rather like learning to dance, except that one's own brain embodies <u>both</u> partners, the two hemispheres moving in synchronous

rhythm, right and left complementing each other in the organic, ever-changing process of the intellectual dance.

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