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Reading and the Brain

Toward a New Definition of a Balanced Approach to Reading

by

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Balanced Reading and the Brain

Today it seems that nearly everyone is extolling the advantages of a "balanced" reading program. In fact, I don't believe I have heard any pleas for an "unbalanced" reading program in quite some time.

But I'm not always sure what constitutes a balanced reading program. For many educators, a balanced program is any approach that falls in the middle ground between the poles of "whole language" and "direct phonics instruction."

I would like to argue that a successful reading program cannot be balanced between these two extremes but must stand on its own. I believe that we can gain some insight into what constitutes a balanced program by looking at how the brain functions while we read. Recent research on the brain suggests that when we read, our brains are actually performing several different functions simultaneously. A "balanced" reading program should contribute to children's development of all of these functions by:

- Teaching children to recognize *patterns* in text, such as patterns of letters and words, relationships between letter patterns and sounds, and more complex patterns such as paragraph structure or an author's style.
- Helping children become *strategic* readers who know what to look for in a text, and how to do it—whether it's knowing to look for a particular pattern of letters, the antecedent of a pronoun, or an author's point of view.
- Fostering children's *interest* in reading, so that they value the importance of reading and are motivated to learn.

How do we learn this from research on the brain? In this paper, I will briefly explain some of the methods that researchers currently use to study the brain. Then, I will review some recent findings from this research and their practical implications for reading instruction in the classroom. Finally, I will show how the same conclusions are supported by educational research on reading as well.

Research on Learning in the Brain

Recent findings on the brain have come from new imaging techniques that allow us to study the living, working brain in ways that X-rays and CAT scans would never allow. The new techniques, with names like PET scans and MRI scans, allow us not only to measure the anatomy of the brain but also to "see" it functioning.

PET scans produce images of the working brain that reveal what parts of the brain are highly active and what parts are not. The more active a region is, the more glucose it metabolizes—creating a "hot spot" of energy consumption. Those active hot spots show up as more brightly colored on a PET scan.

The PET scan on the left below (Figure 1) illustrates the activity of a nervous system while a person is hearing words. Several hot spots show up in a pattern that is located mainly within the temporal lobe of the outer layer, or cortex of the brain. These hot spots form a pattern, or network, of brain processors that are involved in the task of hearing words.

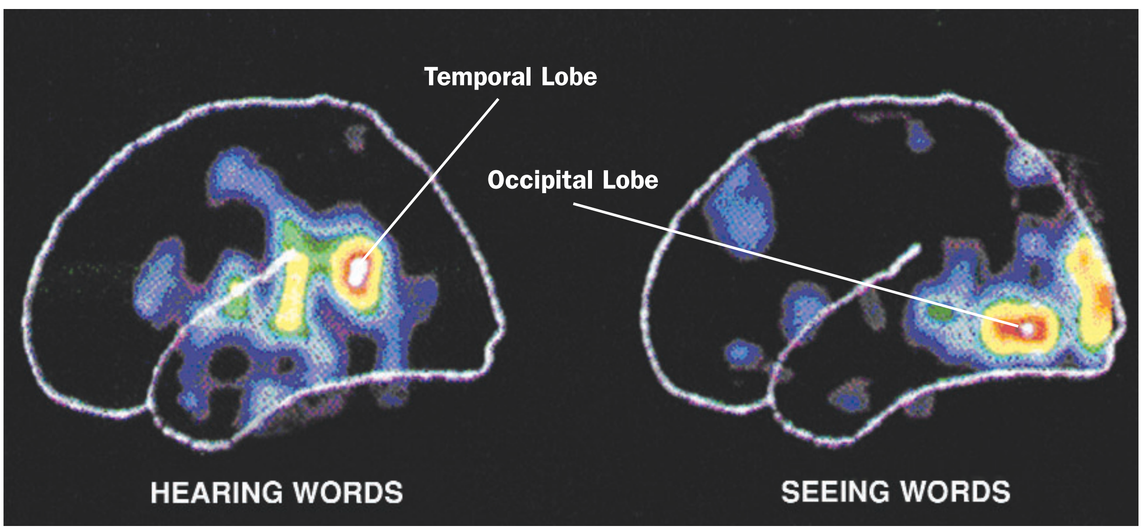

Figure 1

The PET scan on the right shows the areas that burn the most glucose when the nervous system is seeing words. This time the areas of greatest "burn" are in the occipital lobe, distinctly different from the area that is most active during hearing. The two images show that the network of processors for seeing words is different from the network for hearing words.

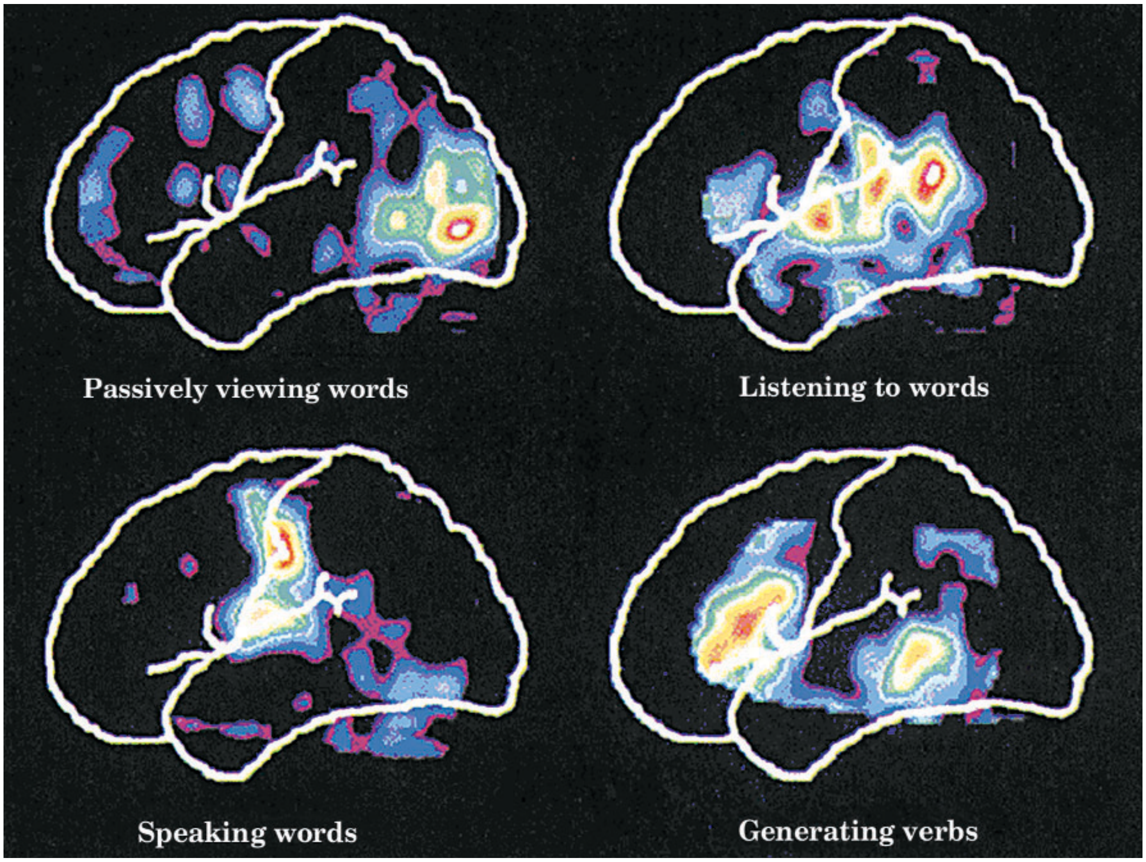

Figure 2

The images above (Figure 2) show brain activity during more specific tasks. Three broad generalizations are clear from the recent research using these kinds of images. First, different types of mental tasks are associated with different patterns of activity in the cortex. For example, the pattern of activity for hearing words is quite different from the pattern for seeing them. Second, the cortex does not contain a single "language" center that governs all of our language use. Rather, any language-related task is accomplished by many different regions of the cortex working together, with each region contributing its own particular function. Third, not everyone shows the same pattern of brain activity, even if they are doing the same task. Brain activity varies, depending on a number of factors such as age, sex, reading level, and motivation, among others.

Distributed Learning in the Brain

As I have noted, in any learning opportunity, many different regions of the brain may be involved. For example, when we learn to recognize an object, its color is processed in a different part of the brain than its shape. A third processor learns where the object is in space and yet another learns its path of motion. All of these processors operate in parallel, each contributing only a small part to learning about the object. Our "knowledge" of the object is an amalgam of many different kinds of knowing, each specialized in a different part of the brain. When we learn to read, even more wondrous and complicated kinds of learning must take place. We shall turn to only a few general points about how we come to learn and know. Then we shall return to reading.

To make things clearer, I shall organize a lot of the separate processors in the brain into the three large systems that have been described by neuropsychologists from Luria (1973) to Cytowic (1996). Broadly speaking, one system recognizes patterns, one generates patterns, and the third determines which of the patterns are important to us. At all stages of learning, all three systems are crucial. Successful teaching requires attention to all three of these interconnected systems. A brief outline of these will follow.

Recognition Systems: Spotting Patterns

Most of the back half of the brain's cortex is devoted to recognizing patterns. Pattern-recognition systems make it possible to identify visual, auditory, and olfactory stimuli—to know that a particular stimulus pattern is a book, your dog's bark, the smell of burning leaves. In reading, pattern recognition systems are essential for identifying basic patterns such as letters and words, the relationship between letter patterns and sound (phonics), or even more complex patterns such as paragraph structure or an author's style.

Obviously, reading depends on the recognition systems. The ability of the brain to quickly recognize the visual pattern of a letter or a word, the syntax of a sentence, or the pattern of meaning in a paragraph is critical to learning to read (for a recent review, see Shaywitz and Shaywitz, 2004). But it is not enough. More of the brain is required in order to make meaning from text.

Strategic Systems: Thinking, Searching, and Planning

Figure 3

The anterior part of the brain (the frontal lobes) comprises the networks responsible for knowing how to do things—holding and moving a pencil, riding a bicycle, speaking, reading a book, planning a trip, writing a narrative, and so on. Actions, skills, and plans are highly patterned activities, requiring the strategic brain systems responsible for generating patterns. Strategic systems are critical for all learning tasks, working in tandem with recognition systems to learn to read, compute, write, solve problems, plan and execute compositions, and complete projects.

These strategic systems are important even in knowing how to see.

Although you may not have noticed it, your eyes probably did not just stare at the picture (Figure 3)—they investigated the picture "strategically." With the help of infrared cameras, we can record these strategies at work. Figure 4 shows some recordings of eye movements as subjects examined the same exact picture. Note how different they are.

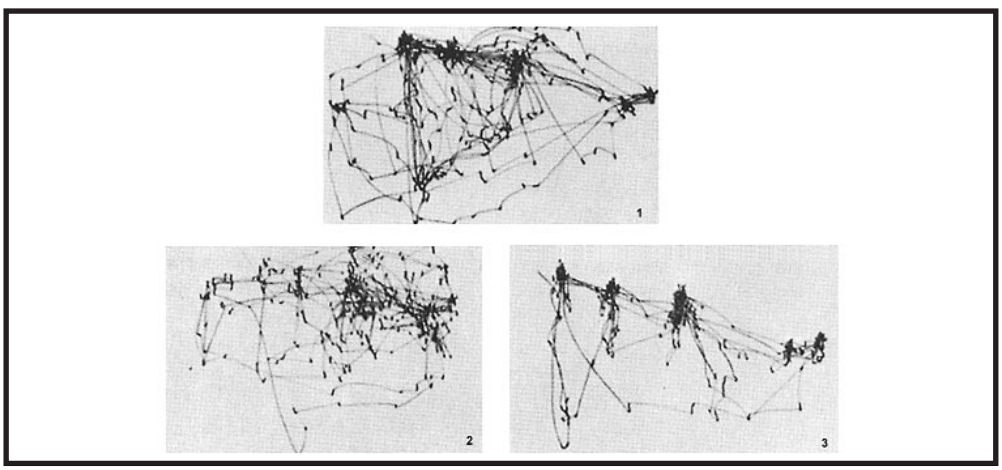

Figure 4

What makes the eye-movement patterns in Figure 4, all of which are from viewing the same picture, so different? The answer is that they were taken from records of different questions. In each case, the subject was given a question like the following: What is happening here? What is the relationship among the people here? What time of day is it? What has been happening prior to the picture? For any normal individual, the different questions lead to very different patterns of eye movements, the outward sign of very different strategies. The capacity to direct one's eyes strategically in this way, like other strategical systems, is located in the frontal lobes.

Frontal systems are also critical in learning how to read. (For a neuro-image of part of the frontal systems involved in reading, see Shaywitz and Shaywitz, 2004.) Much of reading is not just recognizing patterns in text, but knowing how to look for patterns: knowing how to look at the letters, knowing how to "sound out" an unfamiliar word, knowing how to look for the antecedent of a pronoun, or knowing how to look for an author's point of view. These are all critical, but they are not enough.

The Affective Systems: Interest and Motivation

At the core of the brain lie the networks responsible for emotion and affect (the extended limbic system). Neither recognizing nor generating patterns, these networks determine whether the patterns we perceive matter to us, and help us decide which actions and strategies to pursue.

What is important to us varies a great deal over time and depends on our present status, our history, our expectations, and many features of what we call our personality. For individuals who have low blood sugar, food becomes very important, and patterns in the environment that signal food (like a big upright white metal box, a.k.a. a refrigerator) attract their attention and effort. Directly after eating, the same stimulus is considerably less attractive.

As another example, consider novelty. Among mammals like us, there is a preference for attending to things that are novel. Something that is changed in our environment (an unfamiliar smell is detected in our bedroom, a picture is out of place on the mantle, a filling has fallen out of our tooth) draws our attention. We investigate or become alarmed. Such a preference obviously has survival value—attending persistently to things that have not changed would be particularly ineffective. Exaggerated affective reactions to novelty, however, can be disabling.

The affective systems, like strategic and recognition systems, have their own ways of learning and knowing. Clinicians have shown, for example, that amnesiacs may be totally unable to recognize a person or object and yet be able to react appropriately to their affective significance. The patient may be fearful of a doctor who has given him or her a vaccination, for example, even though the patient has no conscious recollection of ever having seen the doctor before.

In summary, as a result of the effective operation of the affective systems, we are able to prioritize goals, develop preferences, build confidence, persist in the face of difficulty, and care about learning. Damage to the limbic system can impair the ability to establish priorities, to select what we value or want, to focus attention, or to prioritize actions. Thus, we now know that physiological as well as experiential factors contribute to individual variation in confidence, persistence, concentration, and other affective factors.

These affective factors are also critical in learning to read. Children who feel that reading is important learn to read. Even children who have severe learning disabilities learn to read when they feel that reading is important (Fink, 1998). Children who don't think reading is important often don't learn to read, or don't learn to read well. Based on factors such as their history of success and failure, the frequency with which their parents read to them, and the degree to which books are an important part of their home, children either come to value reading or come to avoid it.

The Integrated Systems

In reality, all three of the systems described above—recognition, strategic, and affective—work together, in parallel. Each contributes an essential kind of knowing that is central to what we call intelligence. And each is crucial to one of the most demanding outcomes of our intelligence—our ability to read.

Here is a summary of a number of experiments on reading adapted from Cabeza and Nyberg (1997). The images in Figure 5 highlight regions of the brain that have been shown to be hot spots when an individual is reading words.

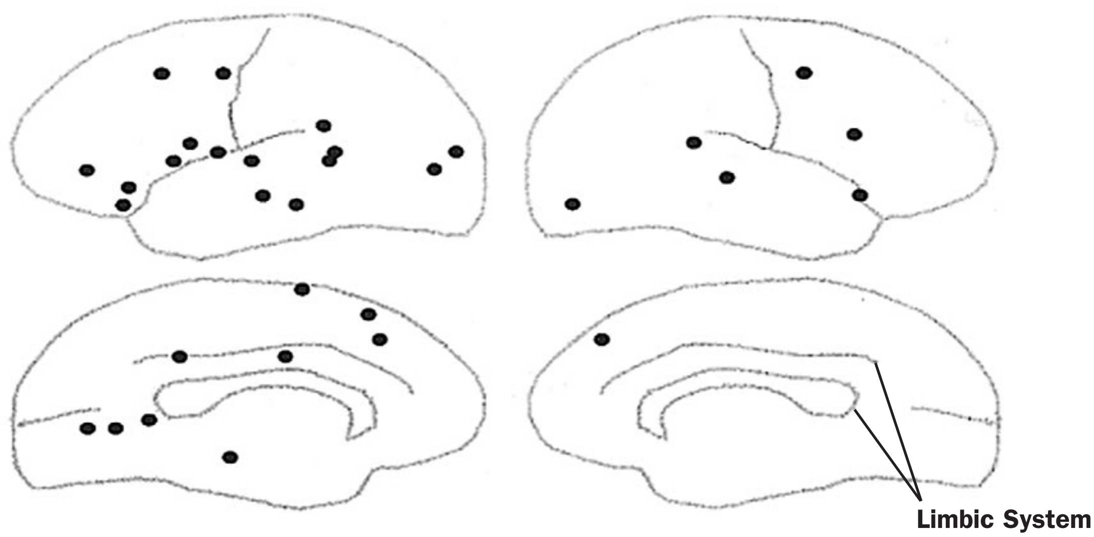

Figure 5. Adapted from Cabeza & Nyberg, 1997.

As you can see from the top two figures, there are hot spots of glucose metabolism not only in the visual-and-auditory recognition cortex (the posterior recognition systems) but in frontal regions as well. Reading involves not only recognizing patterns in print but also using strategies for sounding out words and constructing meaning from them. The bottom images show the central structures related to the limbic system, and it is clear that these affective structures are also involved in successful reading.

Links to Reading Research

The three systems I have outlined may seem familiar to you. In the recent National Research Council Report, "Preventing Reading Failure in Children," for example, the authors describe "three potential stumbling blocks" that can present obstacles.

> The first obstacle, which arises at the outset of reading acquisition, is difficulty understanding and using the alphabetic principle—the idea that written spellings systematically represent spoken words. It is hard to comprehend connected text if word recognition is inaccurate or laborious. The second obstacle is a failure to transfer the comprehension skills of spoken language to reading and to acquire new strategies that may be specifically needed for reading. The third obstacle to reading will magnify the first two: the absence or loss of an initial motivation to read or failure to develop a mature appreciation of the rewards of reading.

The remarkable resemblance to the three "systems" described in the brain is not coincidental. Both of these perspectives emphasize that there are not just two aspects of teaching reading that need our attention; there are three. Students may fail because we fail in teaching them three important things: to recognize the patterns of the written code, to adopt successful strategies for obtaining meaning, and to see the purpose for reading in their own lives. Failure to address any of them results in a program of reading that lacks balance and a program of reading that is likely to fail. In summary, a balanced approach to reading:

- **Emphasizes and practices the common patterns in text.** Teachers might encourage beginning readers to look for recurring patterns of letters or prompt more advanced readers to look for the sequence of events in a story.
- **Models and scaffolds specific strategies for getting sounds and meaning from text.** Teachers can encourage children to "sound out" unfamiliar words or build on children's existing background knowledge to make a new text easier to understand.
- **Provides rich and meaningful texts that engage every child in the importance and joy of reading.** Teachers can select books about topics that match their students' interests or encourage purposeful reading in which students read to find specific pieces of information that they need.

Balanced reading instruction does more than address just one or two skills. It engages all of the many cognitive and affective processes that contribute to effective reading. In other words, balanced reading instruction "lights up" the whole brain—and it turns children on to reading.

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IMAGES

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529 Fourteenth Street N.W.
Washington, D.C. 20045-1938

Figure 3
Title: Eye Movements and Vision
Author: Yarbus, Alfred L.
Year: 1967
Publisher: Plenum Press
City: New York

Figure 4
Title: Eye Movements and Vision
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Figure 5
Adapted from Cabeza, R. & Nyberg, L. (1997). *Journal of Cognitive Neuroscience,* 9, 1. 1–26.

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In 1984, **David H. Rose, EdD**, helped to found CAST (Center for Applied Special Technology) with a vision of expanding opportunities for students through the innovative development and application of technology. Dr. Rose specializes in developmental neuropsychology and in the universal design of learning technologies that will impact learning for the diverse students found in today's classrooms.

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SCHOLASTIC
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Scholastic Inc.
557 Broadway
New York, NY 10012

ISBN 0-439-74220-X

Resource Link
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SAM Keyword: Rose