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Brain Science and Reading Instruction

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The past three decades have seen substantial efforts at the national, state, and local levels to improve reading instruction and reading outcomes for students in the United States. These have ranged from the Reading Excellence Act, to the National Reading Panel, to Reading First, to various standards movements, to high stakes testing of students, and higher degrees of teacher accountability. Yet, despite these and other efforts, reading achievement among students in the United States has largely remained unchanged during this period. The National Assessment of Educational Progress reports that the most recent assessment of 12th grade students' achievement in reading (2013) is actually lower than it was in 1992 (U.S. Dept. of Education, 2013). Clearly, we have yet to find the "magic bullet," if there is one, for improving student reading achievement.

One major advance in our understanding of effective reading instruction came at the turn of the century with the advent of the National Reading Panel (2000). The panel was made up of a group of distinguished literacy scholars who were given the task of laying a scientific foundation for effective reading instruction. After reviewing the existing scientific research into reading and reading instruction, the panel identified five critical factors that students must develop competency in and that teachers should emphasize in instruction. These factors were phonological awareness, phonics or word recognition, fluency, vocabulary, and comprehension.

Phonological and phonemic awareness refer to the ability to perceive, segment, blend, and otherwise manipulate sounds, particularly the sounds of language. Research has demonstrated that this competency is required for effective phonics instruction. If students have difficulty in perceiving and manipulating language sounds, they will certainly be challenged when those language sounds become associated with written letters as in phonics. Phonics or word recognition refers to the ability of readers to produce the oral representation of a written word using, primarily, the sound symbol representation of letters and letter combinations. Fluency is the ability to produce the oral representation of written words effortlessly so that readers can direct their attention to the meaning of the text. Fluency also includes the ability to read with appropriate expression that reflects and enhances the meaning of the written text. Like phonics, vocabulary refers to competency with words. However, rather than the ability to "sound out" words, vocabulary deals with the meaning of the oral and written words. Clearly, comprehension is not possible if readers do not know the meaning of words, even if they can sound them out correctly. Finally, comprehension refers to the ability of readers to gain meaning from a written text. Comprehension is the ultimate goal of reading and requires meaning-making effort and strategies on the part of the reader.

During this same period in which the scientific foundation was being laid for reading instruction, advances were being made in our understanding of how the brain works. One of the earliest discoveries was that of the human brain's ability to change itself, or brain plasticity, even beyond the early stages of development. The prevailing scientific view had been that once the critical period of development had passed, infancy to early childhood, the human brain operated within a limited and fixed range of ability. Although changing the brain or learning was clearly possible after the critical stages of development, there were limits. Through a series of studies conducted in the 1990s, neuroscientist Dr. Michael Merzenich and colleagues discovered that our brains had the ability to change in significant ways well beyond early childhood. However, the stimuli (i.e. instruction) that lead to brain changes need to be intentional, intense, focused and repetitive. Early in life, our brains seem to learn effortlessly. Beyond that early period, more intentional effort is required to change the brain.

During this period, neuroscientists, using ever more sophisticated methods, were developing more detailed maps of the brain. That is, they identified specific locations of the brain that were associated with cognitive tasks and competencies. Brain locations and functions were identified for phonological or sound awareness, visual awareness and perception, fluency, vocabulary, and language comprehension.

Reading and Brain Science Meet

We know that there are competencies that need to be mastered in order to become a proficient reader. We also have learned that there are specific areas of the brain that are associated with these competencies. Moreover, we have discovered the brain's ability to change itself in response to intentional stimuli. Do these understandings offer some new approaches for conceptualizing, implementing, and monitoring reading instruction? The answer is, of course, yes.

One of the first approaches came in the areas of phonological awareness and auditory processing. Research indicated that many children with language and reading difficulties had difficulty processing the "fast parts" of speech - common combinations of consonants and vowels that are pronounced quickly (e.g., the plural suffix that distinguishes the word cat from cats). It was the ability of the brain to perceive rapid auditory input that lagged behind other aspects of language use. This resulted in difficulties in distinguishing differences in similar sounds as well as perceiving grammatical prefixes and suffixes in some contexts.

A program was developed that eventually evolved into Fast ForWord®, a program that trains students in sound perception by using technology to initially slow down or enhance the production of the "fast" sounds. Through frequent, repeated, focused and sustained practice with reinforcement, the sound production was gradually modified until it approximated normal speech speed in exercises that emphasized speech perception in words and oral language comprehension. Clinical research indicated that students who were put into such an enhanced auditory processing program made significantly greater progress in speech discrimination, language processing, and grammatical comprehension than students who were placed in a similar program using natural speech production (Tallal, et al., 1996). Similar findings of improved language processing were also reported in a study of special education students.

Fast ForWord and Reading Assistant™

Fast ForWord is a set of 10 comprehensive neuroscience-based oral language and reading programs designed to build the underlying perceptual and cognitive skills that support oral language and reading. The four Language and Literacy series of exercises are designed to build speech perception skills, especially for the rapidly occurring sequences that occur in natural speech, as well as the cognitive skills of memory, attention and processing speed. The six Reading series exercises are more closely aligned with curriculum and targeted to build phonological awareness, phonemic awareness, phonics, reading word recognition, vocabulary, and comprehension for all grade levels, K-12.

Reading Assistant is a technology-oriented reading program that develops reading fluency through repeated and supported reading of authentic texts by students and monitors their progress using speech recognition software. Essentially, students read a text repeatedly after listening to a fluent rendering of the same passage and receive corrective feedback on words they do not know. With such repeated and supported practice, students eventually are able to read the text fluently. Once students are able to read the text independently and proficiently,

they move on to a new text using the same protocol. Repeated readings and assisted reading, where students hear a fluent model of the text while reading it themselves, have been shown to be effective ways to improve reading fluency and reading comprehension (Rasinski, 2010).

Evidence from Brain Science

Applications of fMRI allow researchers to detect changes in brain functioning as a result of an intervention. Temple et al. (2003) found that children identified as dyslexic had substantially lower levels of activation of the left frontal and temporo-parietal portion of the brain, areas typically activated or employed during reading and associated with phonics, reading comprehension and fluency. After a 6-8 week intervention treatment using Fast ForWord, fMRI brain scans demonstrated improvements that approximated normal readers in brain activation in these areas.

Evidence from Students' Reading Achievement

Although examining changes in the way the brain processes linguistic stimuli is encouraging, the real proof for educators and the general public is the extent to which an intervention can affect actual reading outcomes in students. An early clinical study (Temple et al., 2003) of the use of Fast ForWord Language over 6-8 weeks with dyslexic students found that the students made significant and substantial improvements in word reading and passage comprehension. School-based studies, of course, provide even more convincing evidence of the effectiveness of a particular intervention as the intervention is actually implemented in a real school setting with real school personnel. Thomas Gibbs Elementary School in St. Mary Parish implemented Fast ForWord over the course of two years with fourth-grade students. Students' performance on the statewide high-stakes reading achievement increased dramatically, with the percentage of students identified as reading at a Basic or above level increasing from 19% to 81%. During the same period, the statewide average of students identified as Basic or above readers increased from 51% to 69%. Gibbs students went from performing well below the statewide average in reading to substantially above the average in two years.

Although reading interventions are typically viewed as occurring in the elementary grades, it is clear that many students reach high school with significant difficulties in reading, particularly reading fluency, which negatively impacts their performance in all academic areas. Conner High School in Boone County, Kentucky used the Reading Assistant program with 61 ninth- through twelfth-grade students who were performing well below expectations in reading. Students used the Reading Assistant program a total of 37 days, 2-3 days per week over four months. Each instructional session with Reading Assistant lasted 30-40 minutes. Nearly 90% of students made substantial gains in reading comprehension on a standardized test and 33% tested out of the intervention by reaching or exceeding the threshold score on the standardized reading test.

A large-scale, long-term implementation of Fast ForWord interventions in middle and high schools in Texas' Dallas Independent School District had students engage in Fast ForWord instruction for 50 minutes per day for 12 weeks per year, for three years. Average performance on the state-mandated reading test increased over the course of students' use of Fast ForWord. Moreover, while the average performance for students statewide decreased during the study, students using the Fast ForWord intervention, conversely, demonstrated increased reading performance.

Of course, in studies of school implementation of an intervention, it is difficult to tease out the effects of a particular intervention over other instruction that may have impacted student

performance. (Surely, we recognize that any program worth its salt is implemented and extended by knowledgeable and effective teachers and specialists who support, reinforce, motivate, and monitor students' learning.) However, since the general trend in these and other school-based implementations have been positive, where previously the trends were stagnant or negative, it seems reasonable to assume that the gains in reading achievement were at least partially due to the interventions that were implemented.

Conclusions

Albert Einstein was famous for, among other things, defining insanity as doing the same thing over and over and expecting different results. It seems that major educational publishers have been offering the same generic type of reading program for students for years. And the result has been reading achievement that has not substantially changed in 20 years. Perhaps it is time to consider new approaches to reading education and intervention, approaches that tap into informative uses of technology and new understandings about how the human brain works, while at the same time holding on to understandings of the competencies students need to master in order to become fully literate. Fast ForWord and Reading Assistant appear to offer some new ways of thinking about and approaching reading instruction that use technology and understandings of the workings of the brain and brain functions, and that correlate with our understandings of what is important in learning to read. Perhaps it is time to try something new; perhaps it is time for schools to give Fast ForWord and Reading Assistant a try.

References

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