

Feature Articles

What Brain Research Can Tell Us about Reading Instruction

Hempenstall, K. (2006). *Learning Difficulties Australia Bulletin*, 38(1), 15-16.

Brain-imaging techniques such as Magnetic Resonance Imaging (MRI) have been shedding light recently on how our brain adapts optimally to the tasks of reading and spelling.

When good readers confront text, they can be seen to rely heavily on separate areas in the left side of the brain. These areas are employed cooperatively to convert letters into sounds, fit the sounds together to make words, and to do so fluently. Flourishing students have learned the letters of the alphabet, the sounds that the letters represent, and how the sounds are blended to build words. In the brain images, the three areas light up quite clearly while such students are reading.

With this capacity, the left brain's parieto-temporal region becomes primed to decode (sound out) words, whether they be known or novel words. Progressively, as the readers see words in print, they start to build a neural model of that word. After they've correctly decoded a word a number of times, their neural model is an exact replica of the printed word. It specifies the way the word is pronounced, the way it's spelled, and what it means. In an accurate neural model, all these features are bonded together.

They clarify and store these new internal representations in the occipito-temporal region. When that word becomes represented in the occipito-temporal region, its recognition subsequently becomes automatic and instant - in about one sixth of a second. This is faster than one can predict the upcoming word. When this process occurs, students begin to display rapid, effortless word recognition rather than the slower sounding out strategy.

It's tempting of course to suggest that children not be taught to sound out because it isn't the way skilled readers are seen to respond to print. However, you can't access the occipito-temporal region without first building up the parieto-temporal region. On average, from 4-14 accurate sounding-outs will create the firm links necessary. For some children, it may take many times that number – not all children have strong phonological skills (a talent for discerning small units of sound). Either a genetic component or an instructional component may be involved in their lack of progress.

Those who struggle to read do not use the same brain regions for reading. Instead, they create an alternative neural pathway, reading mostly with regions on the right side of the brain - areas not well suited for reading. It is purely a compensatory strategy involving the visual centres of the right hemisphere - looking at words as if they were pictures. Little activity is observed in the phonological areas of the left hemisphere where capable readers' activity is dominant. The brains of people who can't sound out words look different - there is less blood flow to the language centres of the brain.

If this sequential developmental process (from sounding out to whole word recognition) does not occur, then children will be forced to employ less rapid and accurate systems such as prediction from context, guessing from pictures, and guessing from the first letter. Up to 40% of children will discover the alphabetic principle for themselves quite readily - regardless of instruction. About 30% will get there, but slowly, and about 20-30% will not achieve it without intensive, appropriate direct teaching.

We now understand that the brain has the quality of plasticity. It responds to experiences that stimulate activity in particular areas of the brain, thereby facilitating the growth of neural connections in and between those active regions. That is why practice makes permanent. Practising productive reading strategies forms and strengthens task-optimal neural connections that enhance subsequent reading development. In the same way, routinely engaging in ineffective strategies similarly builds circuits in the brain not optimal to the task. These routines are not easy to break as students grow older, perhaps because between ages 5 to 10 there's a pruning process that erases the neural cells in the brain that remain under-utilised and unconnected. Forming neural links for language is relatively easy up to about age 6, and achievable though more effortful after that time.

The good news is that certain teaching strategies can alter this pattern of brain activation. A number of recent studies have indicated that about 60 hours of structured intensive daily phonics teaching alters the way the brain responds to print. Less right hemisphere involvement occurs, accompanied by more left hemisphere phonologically-based activity as reading improves. These new MRI images now correspond more closely to the pattern displayed by good readers. Importantly, in a study in 2004, the occipito-temporal region continued to develop 1 year after the intervention had ended. The outcomes included increased fluency, accuracy, and reading comprehension.

A recent MRI study of spelling produced similar outcomes. The brain activity of struggling spellers was discernibly different to that of competent spellers. However, when systematic spelling instruction

was provided, spelling improved and the MRI profiles altered, becoming more like those of good spellers. Beginning with a need for phonological knowledge, the brain of the emergent speller (given adequate practice opportunities) establishes a new organizational pattern known as an autonomous orthographic lexicon. It enables automatic, rapid responses, without the phonological encoding previously necessary. However, English is a morphophonemic language, and expert spelling encompasses a further knowledge form. It involves an understanding of root words, affixes, and how they are assembled. This third interrelated level is morphological. Their intervention was based upon the Direct Instruction program, *Spelling Through Morphographs*.

These interventions require work and practice to achieve such positive outcomes, but many skills are hard won in our lives. Why should we expect these crucial abilities to arrive incidentally?

The brain imaging studies have also shown how difficult and exhausting is the task of reading for struggling students. These students have been shown to use up to five times as much energy as do fluent readers when reading. It is unsurprising then that they do not choose to read, and may become actively resistant to the task. Unfortunately, slow early progress predicts a decline in academic progress generally across their primary and, even more dramatically, in their secondary career, as they increasingly lose access to the curriculum.

The brain imaging research is fascinating, perhaps because it offers a glimpse of what appears to be happening when we teach effectively, and students learn something new. However, we don't actually need this information about which areas of the brain tend to be active when most people engage skilfully or otherwise in a task. We can always assess their competence directly using behavioural assessments, such as with reading tests. Observing changed brain function consequent upon effective instruction can be affirming to the teacher, but really, what did we think was happening during learning? Was it the kidneys we thought we were affecting?

Another interesting brain imaging issue relates to the oft heard comment "All children learn differently". It is difficult to argue with such an assertion, partly because it is difficult to operationalize it. However, it usually presented as though it were self-evidently true, despite a lack of supporting evidence. In similar vein, there is a whole industry devoted to the need to attend to children's learning styles, again a notion lacking in empirical support. Within the broader context of whether humans' uniqueness or commonality truly defines them, it would appear that, at least for literacy skills, competence arises for each of us in much the same manner.

The National Enquiry into the Teaching of Literacy has directed our attention toward the findings of scientific research. These findings that can make a huge difference to the many students for whom the reading task is made unnecessarily difficult, whether the cause is due to brain anomalies (very few) or instructional inadequacy (the vast majority).

At such a time when real reform is possible, it is unfortunate that some politicians and teacher organisations decry both the need for change and the strong evidence upon which the recommendations are based. It is our children's future at stake. Time to move on this.

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