Australian Education Research Organisation

Introduction to the science of reading

The ability to read proficiently is fundamental to a student's success at school and in later life. The science of reading provides the strongest evidence about how young children learn to read. Understanding the cognitive science behind how students learn to read and the research on effective instruction makes it easier for educators to align policy and classroom teaching with evidence.

The science of reading

Cognitive science explains how the brain learns skills that are not innate or 'biologically primary'. Speaking is a biologically primary skill that humans have evolved to learn or 'pick up' naturally, whereas reading, whilst closely associated with speaking, is primarily a cultural invention of the last 6,000 years, which requires repetition and external motivation to be mastered (Geary 2008; Sweller 2008). When a child is taught how to read, neural networks that have evolved to specialise in language and visual recognition are re-purposed for the process of reading and writing (Dehaene 2010; Snow 2021). Reading must be explicitly and systematically taught in a structured way.

The science of reading refers to a body of evidence that encompasses multi-disciplinary knowledge from education, linguistics, cognitive psychology, special education and neuroscience. The science of reading looks at the essential cognitive processes for competent reading and describes how reading develops in both typical and atypical readers. These studies have revealed a great deal about how we learn to read, what goes wrong when students don't learn, and the instructional strategies that facilitate the cognitive processes required for reading (Castles et al 2018; Ehri 2005, 2014; Moats 2020)

Oral language development

Oral language development in the preschool years is the essential foundation of reading development. Oral language development comprises children's ability to use vocabulary and grammatically correct sentences when they speak, as well as receptive language (understanding what others are communicating). Oral language development is considered a biologically primary skill; however, children exposed to more complex oral language in the first 5 years of life will arrive

at school with a wider vocabulary and more comprehensive ability than those who have not been so exposed (Snow 2021). Where children start school with limited oral language, early intervention is essential for ensuring they catch-up with their more experienced peers.

The simple view of reading

The aim of learning to read is comprehension, or the capacity to extract meaning from print. Reading comprehension is largely the function of two broad skill sets, identified in the Simple View of Reading (SVR). These skills are word recognition and language comprehension.

Word recognition

Word recognition includes decoding and the capacity to recognise printed words. Decoding is the ability to identify letter-sound relationships and letter patterns to correctly pronounce what is being read. Decoding begins with early phonological awareness (the ability to identify and manipulate parts of spoken words, for example, to recognise rhyming words, identify syllables and segment a sentence), phonemic awareness (the ability to identify and manipulate individual sounds (phonemes) in spoken words) and phonics (the development of letter-sound knowledge) (Buckingham 2020).

Phonological awareness, phonemic awareness and phonics should be explicitly and directly taught in the early years of school to enable children to accurately sound out printed words. The active sounding out of words using letter-sounds knowledge is referred to as reading through the phonological pathway.

Beginning readers tend to rely on the phonological pathway to read words. Repeated decoding of an individual word over time causes that word to become retained in a reader's long-term memory through a process that is known as orthographic mapping. This allows the reader to recognise the word automatically and read the word without needing to actively sound it out. Automatic recognition of words is called the lexical pathway for reading. It takes deliberate practice for children to build up enough words to read connected text with fluency. Skilled readers will primarily use the lexical pathway; however, they still use the phonological pathway if they come across an unfamiliar word.

Language comprehension

Language comprehension is the ability to derive meaning from spoken and written words. It consists of vocabulary, background knowledge and an understanding of how words are combined to form sentences. By upper primary and secondary school, most readers have been exposed to decoding, but issues with language comprehension commonly create barriers to being able to read at an appropriate level. Many words used in an academic context are not used in everyday speech and, as a result, must be explicitly taught.

The relationship between the 2 components is conceptualised in the Simple View of Reading as:

word recognition x language comprehension = reading comprehension

Importantly, the Simple View of Reading states that reading comprehension is a *product* of word identification ability and language comprehension. If either of these two factors is absent, the student will not demonstrate reading comprehension.

The 5 (or 6) keys to reading

Contemporary evidence identifies five specific sub-skills that are essential to the

acquisition of word recognition and language comprehension. These are referred to as the '5 Big Ideas' or the '5 Keys to Reading' (Five from Five 2020). They are:

- **Phonemic awareness:** the ability to identify and manipulate the individual speech sounds in words called phonemes.
- **Phonics:** knowledge of the relationships between letters and sounds, and the ability to use letter-sound relationships to decode words.
- **Fluency:** the ability to read accurately, quickly, and expressively. Fluent readers can focus on reading for meaning.
- **Vocabulary:** knowledge of the meaning of words in isolation and in context.
- **Comprehension:** the ability to extract and construct meaning from written text.

Recent studies have also included oral language: the ability to understand and use vocabulary and produce sentences. The addition of Oral Language as a foundation for reading gives us a 'Big 6'.

A more complex breakdown of reading is demonstrated in Scarborough's Reading Rope (Scarborough 2001), which illustrates the interconnectedness and interdependence of all the components of learning to read can be found here.

Reading in the secondary school context

The Simple View of Reading and the 5 Keys to Reading can also explain how reading develops for older students. While early primary students tend to require more support in phonemic awareness and basic phonics (and oral language in the early years), secondary students tend to struggle more with fluency, vocabulary and comprehension. These skills are essential for reading to learn, a core aspect of students' success in secondary school. Fluency, vocabulary and comprehension problems can be addressed through reading interventions, as well as the explicit teaching of subject-specific vocabulary and background knowledge. Poor fluency in adolescent readers can also be a function of poor decoding, especially of complex or multi-syllabic words, meaning phonics instruction can still be a core aspect of secondary school reading intervention (Five from Five 2020).

Current issues

Reading is a biologically secondary skill consisting of multiple cognitive functions, which must be taught systematically and through using evidence-based practices. Widespread adoption of reading approaches that lack strong scientific support has contributed to confusion around reading instruction (Bowen and Snow 2017). A good example of this is the 'multi-cueing' (also known as 'three-cueing' and 'searchlights') approach used in early primary to teach novice readers to recognise unfamiliar words not through decoding, but through association with context or 'cues' in the text (Seidenberg, 2017, Snow 2021). The origin of this model is not entirely clear, has not been linked to cognitive science, and the definition of the three cues (syntactic, semantic and grapho-phonic) varies between different versions of the model. As a result, the meaning and use of multi-cueing is open to many interpretations (Seidenberg 2017, Snow 2021). In Australia, approaches to teaching and assessing reading include many that are not supported by the strongest evidence and do not adhere to the science of reading, which is a foundation for reading success.

Conclusion

Learning to read proficiently is critical to a student's entire education and predictive of future education, health and employment outcomes. The 5 specific reading sub-skills of phonemic awareness, phonics, fluency, vocabulary and comprehension should be taught explicitly and systematically so all children become capable readers. Explicit teaching of these important skills is not yet consistently happening in Australian schools. It is important teachers and school leaders are supported to implement this evidence-based approach if all young Australians are to achieve the success in reading they deserve.

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