Straight Talk on the Science of Reading

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The science of reading is getting much public attention (Hanford, 2018; Hanford, 2019). That shouldn't be surprising, since reading is so important. Reading plays a significant role in academic and economic success, civic and social participation, and even in physical health (Shanahan, & Shanahan, 2008). Success in learning to read offers a tremendous opportunity to share the benefits of society. Given that, it makes sense that parents would want their children to have the greatest chance to learn to read well; aligning classroom instruction with the science of reading would seem a wise course toward its accomplishment (Seidenberg, 2017).

But what is the science of reading? What would reading instruction based upon such a science look like? This paper provides answers to those questions.

What Is the Science of Reading?

Any science is an organized body of knowledge on a subject that has been developed through systematic observation and experiment. A science of reading includes everything that science has to tell us about reading – how we read, what we read, why we read, and so on. For instance, through magnetic imaging, research has identified how brains process information when a person is reading a word (D'Mello & Gabrieli, 2015; Wandell & Le, 2017), and eye motion cameras have captured what the eye does during reading (Zhou & Shu, 2017). Such findings are an important part of the science of reading – but they don't provide a complete picture of what is important to consider for reading instruction.

The value of basic research is two-fold. It can provide provocative insights that may result in new ways of thinking about how we should teach reading; innovations that then must be evaluated rigorously prior to any wide implementation. Basic research can also buttress our understanding of existing instructional approaches. It is in this way that the science of reading has been helpful recently. Research has long shown that certain instructional approaches are particularly effective, and basic science investigations are now helping to explain why that is.

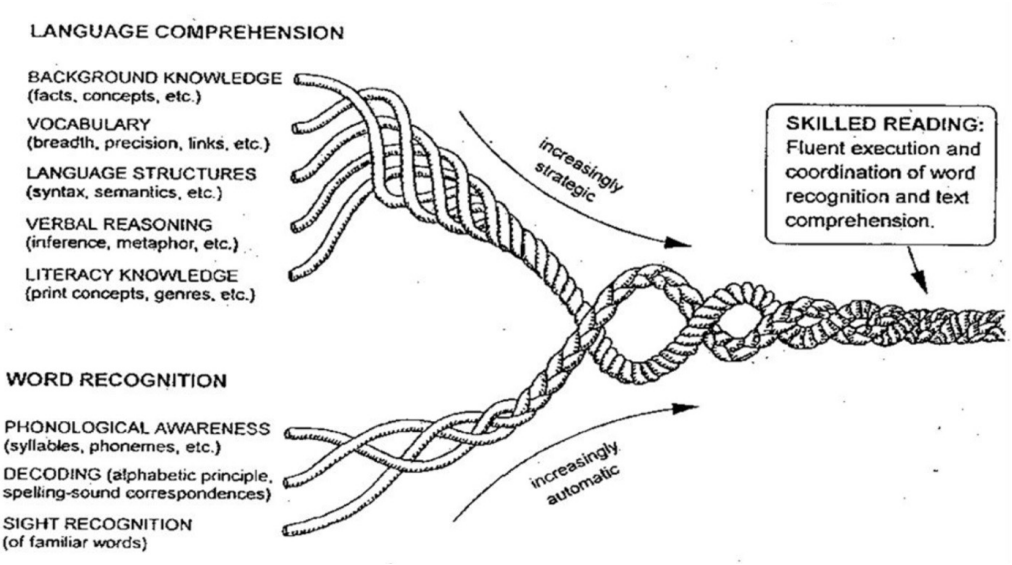
Any instruction that is truly based on the science of reading would require that teaching approaches be evaluated empirically and proven to provide students with clear learning advantages (Shanahan, 2020). If such practices are consistent with basic science findings, all the better. *Wonders* was designed with this science of reading instruction in mind. The content and major instructional approaches of *Wonders* have their basis in an extensive body of rigorously conducted and thoroughly replicated instructional research, and are consistent with the exciting findings that have emerged from recent basic scientific investigation.

What Does Science Say about Reading?

There are many conceptions of reading. They all agree that it is a complex process involving the coordination of several kinds of skills and knowledge, that readers must translate text to language, and that this language then must be understood. Science has done much to identify the skills and knowledge implicated in reading and how they are coordinated.

Hollis Scarborough is a senior scientist at Haskins Laboratory, where she has conducted research on reading for nearly 40 years. She has developed a useful visual representation of skilled reading.

The Many Strands That are Woven into Skilled Reading
(Scarborough, 2001)



In Scarborough's rope, there are two major strands of reading development: word recognition and language comprehension. The entwining of these components is what enables reading.

Scientific study indicates that those two strands – word recognition and language comprehension—differ in important ways. Word recognition requires automaticity; that is, readers must become so proficient in decoding from print to language that they can do it with little conscious attention (Petscher et al., 2020). We have a limited capacity to process information. The more effort required for figuring out words, the fewer cognitive resources that will be available for comprehension. Automaticity in word recognition allows readers to focus on understanding (Castles, Rastle, & Nation, 2018). Comprehension, on the other hand, tends to be more intentional and strategic. Readers make conscious decisions about what to pay attention to and draw upon their knowledge of the world to make sense of the information in a text (Wexler, 2019; Willingham, 2017).

As usefully as Scarborough's rope summarizes the concept of skilled reading, it is important to remember that it is a simplification. There are components of reading not included in the illustration, such as working memory (Cain, 2006). Likewise, the figure is not especially explicit with regard to some of the key mental processes required for reading. For instance, it does not include "orthographic mapping" or "situation model construction," both of which are central to reading (Ehri, 2020; Kilpatrick, 2015; Raudszus, Segers, & Verhoeven, 2019).

Orthographic Mapping: The process by which readers come to store written words in memory through the decoding process.

Situation Model Construction: In cognitive theory, the information expressed in words in a text is referred to as the text model. When readers create mental representation of this information by combining knowledge with text information, that is a situation model.

How Does *Wonders* Address the Science of Reading?

Alignment with Research. The design of *Wonders* is closely aligned with the findings of a substantial body of strong research evidence drawn from educational and cognitive science. *Wonders* provides extensive high-quality support for instruction in phonological awareness, phonics, fluency, vocabulary, and comprehension – guiding instruction in ways consistent with the results reported in randomized control and quasi-experimental studies that have met What Works Clearinghouse standards and that have been replicated multiple times as reported in high-quality meta-analyses.

Reading requires the automatic recognition of words – something accomplished not through rote memorization or from trying to figure words out from context but through the translation of the letters and spelling patterns into language sounds and pronunciations. A substantial body of neurological and cognitive research has shown this to be the case (e.g., Dehaene, 2009; Yonch deva, Wise, & McCandliss, 2015), and there is an extensive compendium of instructional studies showing the effectiveness of phonemic awareness and phonics instruction in supporting this (Bus & van IJzendoorn, 1999; Ehri, Nunes, Stahl, & Willows, 2001; Ehri, Nunes, Willows, Schuster, Yaghoub-Zadeh, & Shanahan, 2001; Fletcher, Savage, & Vaughn, 2020; Foorman et al. 2016; Foorman, Petscher, & Herrera, 2018; Melby-Lervåg, Lyster, & Hulme, 2012; National Early Literacy Panel, 2008; National Reading Panel, 2000). Accordingly, *Wonders* provides research-based teaching of both phonemic awareness and phonics, emphasizing letter-sound correspondences, the decoding of spelling patterns, and orthographic mapping (the process by which readers come to store written words in memory through the decoding process).

Studies also have shown the benefits of teaching students to read fluently (Chard, Vaughn, & Tyler, 2002; Kuhn & Stahl, 2003; Lee & Yoon, 2017; National Reading Panel, 2000; Therrien, 2004). Fluency requires word reading automaticity, but this word recognition must be accomplished repeatedly during the reading of connected text. Fluent reading includes at least some initial comprehension, too, such as the ability to pause appropriately in response to punctuation and meaning. Research shows that guided oral reading with repetition is the most effective way to support the development of fluency. *Wonders* provides opportunities both to teach and practice fluency, and guides teachers to give appropriate feedback to students, to encourage their reliance on orthographic-phonological information during the reading of text.

Automatic word reading and text reading fluency are essential because they enable and support comprehension. *Wonders* supports the development of comprehension ability in three important research-supported ways. First, it builds oral language; second, it builds knowledge; third, it teaches intentional strategies that students can use to focus on meaning.

Reading has its basis in oral language (Brimo, Lund, & Sapp, 2018; Cain, 2003; Deacon & Kieffer, 2018; Foorman et al. 2016; Spencer & Wagner, 2018). There are many aspects of language that play an important role in reading including, most prominently, vocabulary (Bowers, Kirby, & Deacon, 2010; Goodwin & Ahn, 2013), but also syntax (sentence grammar), and cohesion (how ideas are linked to each other across a text). *Wonders* provides considerable amounts of direct instruction and practice of these skills, in both oral and written language.

Research shows that comprehension requires more than knowledge of the words on a page. Readers must connect the printed information in text with the knowledge they possess (Kaldenberg, Watt, & Therrien, 2015; Swanson, Hairrell, Kent, Ciullo, Wanzek, & Vaughn, 2014; Wexler, 2020; Willingham, 2017). Background knowledge – what each of us brings to a text – is used to generate inferences, to clarify ambiguity, and to support working memory. Accordingly, *Wonders* is designed to support sound reading instruction and to ensure that students have the opportunity to increase their knowledge of the natural and social worlds through their reading lessons. *Wonders* provides high-quality texts from social studies, science, and literature throughout the program and encourages the learning of information from these texts through reading, discussion, and writing.

Finally, as previously noted, comprehension is a strategic process. Students must learn to monitor their comprehension and to make appropriate executive decisions about how best to read a text, to focus their attention, or to seek information outside of the text itself (e.g., looking a word up in a dictionary). There are hundreds of studies showing that strategy instruction improves reading comprehension—including the strategies of summarization, self-questioning, using text structure, turning to one's background knowledge, and so on (Bogaerds-Hazenberg, Evers-Vermeul, & Bergh, 2020; Edmonds et al., 2009; Elleman, 2017; Gajria, Jitendra, Sood, & Sacks, 2007; Gersten, Fuchs, Williams, & Baker, 2001; Hall, 2015; Hebert, Bohaty, Nelson, & Brown, 2016; Okkinga et al., 2018; Pyle et al., 2017; Sanders, Losinski, Ennis, White, Teagarden, & Lane, 2019; Sesma, Mahone, Levine, Eason, Cutting, 2009; Shanahan et al., 2010). *Wonders* provides teachers with guidance and support for developing these kinds of cognitive strategies using the approaches found to be most effective by research (Shanahan, et al., 2010).

Wonders is a program that offers comprehensive support for instruction in all these key areas of learning identified by research as essential for reading development. Furthermore, its instructional routines —that is, the ways that these skills are taught—are consistent with the approaches used successfully in research studies to improve reading ability. *Wonders* provides a sequential curriculum and supports and encourages explicit teaching, intensive and well-organized instruction, and differentiation so that all students benefit.

Explicit Instruction. Instructional programs may differ in the degree to which students are expected to discover, infer, or construct new knowledge versus how much direct, explicit sharing of knowledge is provided by teachers. Research has found that the effectiveness of instruction depends heavily upon the degree of explicitness of the teaching. The more explicit the instruction, the more likely it is that students will learn to read (Stuebing, et al., 2008). One review of more than 300 studies concluded: "Learning is enhanced only when the information presented is explicit, logically organized, and clearly sequenced" (Stockard, et al., 2018, p. 502). Both the National Reading Panel (2000) and the National Early Literacy Panel (2008) reported that explicit teaching of various skills and abilities was effective in improving reading achievement.

> ***"The more explicit the instruction, the more likely it is that students will learn to read."***

According to this research, explicit teaching is intentional, with clear goals and well-defined learning outcomes. It is well-planned, as teachers must have a clear conception of what will take place in a lesson if it is to accomplish its goals effectively and efficiently. Explicit teaching is sequential, following a series of steps that explains the purpose or outcome of a lesson, providing modeling of the skill or ability, guided practice with feedback and guidance from the teacher, opportunities for more distant practice, and evaluation to determine success and to allow for reteaching.

Wonders offers lessons with explicit purposes, so that both teachers and students have a clear idea of what they are trying to accomplish, and employs reliable instructional routines that minimize lost time and keep the focus on learning. Teachers are guided to introduce new skills with modeling, a demonstration of how a skill works prior to the students' own attempts. The lessons require that students implement the skills multiple times with close teacher supervision and the possibility of immediate teacher guidance and feedback, and this is followed by additional practice in applying the skills in text reading. Skills and knowledge are revisited for review throughout the program, to ensure that students maintain these skills, and the lessons propose specific language the teachers can use to guarantee accuracy and quality.

Sequential Instruction. The National Reading Panel (2000) in its influential review of research for the U.S. Congress reported on the importance of "systematic" instruction in the teaching of reading. What they meant was that students learned best when their instruction followed a clear and explicit curricular sequence (Stockard et al., 2018). Such an approach ensures that students master easier or higher-value skills early in their progress, prior to confronting either more difficult or less-frequently-used skills. It also allows for the separation of confusable skills and the coordination of instruction across literacy components

(e.g., phonemic awareness, phonics, comprehension), so that students learn to apply their foundational skills in authentic reading and writing activities.

Wonders provides a detailed scope and sequence of reading instruction throughout the grades that is consistent with empirical research and the requirements of state educational standards. This scope and sequence details student learning progressions in phonemic awareness, phonics, fluency, vocabulary, reading comprehension, and writing, allowing teachers to determine what they are going to teach daily, weekly, across units, and through the entire school year. This approach empowers teachers to be in control of their classroom instruction and should ensure smooth progress for most students.

Intensive and Well-Organized Teaching. The amount of instruction that is provided to students has long been known to be an important ingredient in reading success (Farbman, 2015; Foorman, Goldenberg, Carlson, Saunders, & Pollard-Durodola, 2004; Gettinger, 1991). Students who receive more teaching generally outperform those who receive less. Likewise, small group teaching tends to be more intensive than whole class instruction, leading to more learning (Hong & Hong 2009). It is essential that teachers employ clearly and consistently structured lessons that keep the focus on learning (rather than trying to get used to unfamiliar routines).

> ***"Small group teaching tends to be more intensive than whole class instruction, leading to more learning."***

Wonders provides well-structured lesson plans that implement consistent instructional routines based upon lesson features that research has identified as vital for success. These routines are utilized across the program, providing teachers with step-by-step sequences and procedures, language for presenting the instruction, and guidance concerning the lengths of lessons and amounts of time to be devoted to particular activities. Instructional routines include both whole class and small group instruction as well as opportunities for independent practice.

Instruction for All. Some students learn more easily than others. Research has found that higher reading achievement can be accomplished if instruction is differentiated on the basis of student needs (Connor & Morrison, 2016; Connor, Morrison, Fishman, Crowe, Al Otaiba, & Schatschneider, 2013). This differentiation should address what it is that students must be taught as well as the degree of explicitness and intensity of the instruction. Let's face it, if one group of students masters particular phonics skills and another has not, it would make little sense for them to work on the same skills. Some students also have been found to benefit more from explicit teaching and close teacher guidance, while more advanced readers flourish with less guidance and more opportunities for enrichment activities. English learners may require special instructional supports to ensure their success as well (August & Shanahan, 2006; Baker et al., 2014; Gersten et al., 2007).

Wonders provides many opportunities for all students to master reading successfully. The program includes extensive resources for assessing and monitoring student learning, so teachers can be aware of their students' learning needs. *Wonders* includes special resources for English learners in need of oral language support and provides small group lessons and embedded scaffolds to support their learning throughout the program. There are also enrichment materials for gifted learners, and special routines for guiding struggling readers to take on more demanding texts successfully. The program is rich with alternative approaches and diverse delivery methods aimed at supporting all readers.

The science of reading is complex and encompasses a variety of aspects of the reading process, including decoding. As neurologists, cognitive scientists, and other researchers continue to explore the how and why behind learning to read, the science of reading will continue to evolve and give us more insight into "what works" for our students. By adopting curricula that are firmly grounded in the science of reading and that employ high-quality, research-based approaches – like those in Wonders – educators can ensure that the instructional practices they follow in the classroom are proven to support student outcomes.

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