CHAPTER 1

What Is the Science of Reading?

DEFINING OUR TERMS

When somebody asks you, "What's the Science of Reading?," what do you say? Is it a process? A set of strategies? An approach or method? A reading program? A group or organization? In this chapter, I will define the Science of Reading (SOR). Notice that I'm using capital letters. This enables us to differentiate between *a* science of reading as one of several sciences, and *the* Science of Reading as a proper noun or title.

An Emerging Consensus

Moats (2019) defines the SOR as "the emerging consensus from many related disciplines, based on literally thousands of studies, supported by hundreds of millions of research dollars, conducted across the world in many languages." Who could argue with such an important-sounding sentence? But what exactly does she mean here? Let's unpack it.

Consensus

Consensus is a general agreement about things. Within any field or discipline, there are always a variety of consensuses on all sorts of things. The field of reading instruction is no different. In fact, there are emerging and nonemerging consensuses going on all the time on a whole bunch of things. It's not a static, monolithic field.

Emerging Consensus

"Emerge" means to come forth or to arise from something. Why is it that just now a consensus is emerging? The National Council of Teachers of English (NCTE) has been around since 1911. The International Literacy Association (ILA) has been around since 1956. Membership in these organizations over the years has included hundreds of thousands of teachers, researchers, scholars, and educators. One would have thought a consensus about reading instruction would have emerged long before now.

Related Disciplines

Related disciplines are not identified here but may include fields such as psychology, educational psychology, linguistics, cognitive psychology, and neuroscience. These related disciplines provide depth and dimension to our understanding of the reading process and reading instruction. However, just like reading instruction, they are not static or monolithic. At any given time, one can select from a variety of disciplines to support a variety of consensuses within the field of reading instruction.

Literally Thousands of Studies

Of all the "literally thousands of studies," it's a mystery as to why so few of these are put forward to support SOR mandates. It's a mystery as well why Orton–Gillingham, the Wilson Reading System, the Logic of English Foundations series, American Reading Company, and other scripted for-profit products are accepted as research-based, when in fact there is little if any peer-reviewed research to demonstrate these products' (1) ability to improve students' reading achievement, (2) impact on teachers' ability to teach reading, and (3) greater effectiveness when compared to legitimate meaning-based, balanced literacy approaches and methods. These requirements can also be formulated in a checklist, applicable to any product, of what I call the big three research questions:

1. Does it improve students' reading achievement?
2. Does it improve teachers' ability to teach reading?
3. When compared to other similar things, is it more effective?

In these cases, we don't need literally thousands of studies, we need just one or two. There is no doubt that each of the reading products mentioned above has elements within it that can be supported by research. This is true of almost any commercial product. But having research-based components within a product does not make that product research based. That's like saying that since 60%

of my body contains water, I am a lake. I am not a lake. The claim just means that there is research to support certain parts of the product for certain students and things.

Hundreds of Millions of Research Dollars

"Supported by hundreds of millions of research dollars" simply means there's a lot of money involved. In the case of research related to reading instruction, money comes with the expectation of political or economic return (Allington, 2002a; Altwerger, 2005; Aydarova, 2024).

Applied Empirical Research

According to Shanahan (2020), the SOR is a set of applied research studies. "Applied research" means it was conducted in classroom settings. This differs from basic research, which is conducted apart from the context in which it is used or applied. Shanahan also said that "the science of reading should refer to ***all*** empirical studies of any aspect of learning to read, write, and spell in any language" (in Austin & Shanahan, 2024; emphasis in original). Empirical research is based on the observation and measurement of phenomena as directly experienced by the researcher. However, when we apply the U.S. Department of Education (2005) standard to it, we see that the SOR includes only a single type of empirical study. Scientifically based research in education is that which

> is evaluated using experimental or quasi-experimental designs in which individuals, entities, programs, or activities are assigned to different conditions and with appropriate controls to evaluate the effects of the condition of interest, with a preference for random-assignment experiments, or other designs to the extent that those designs contain within-condition or across-condition controls.

This is similar to the standard employed by Shanahan and the National Reading Panel (NRP, 2000):

> To make a determination that any instructional practice could be or should be adopted widely to improve reading achievement requires that the belief, assumption, or claim supporting the practice be causally linked to a particular outcome. The highest standard of evidence for such a claim is the experimental study, in which it is shown that treatment can make such changes and effect such outcomes. Sometimes when it is not feasible to do a randomized experiment, a quasi-experimental study is conducted. This type of study provides a standard of evidence that, while not as high, is acceptable, depending on the study design. (p. 7)

THE DEFINITION

The SOR seems to refer to a general consensus related to the strategies and practices that lead to improved reading outcomes. These strategies and practices have been determined to be effective using experimental or quasi-experimental research and conducted in authentic learning environments. Also, this research has established a causal link between strategies or practices and student outcomes (i.e., reading achievement). Thus, the SOR could be thought of as a process that uses the following standards when making decisions related to reading instruction and policy:

- Strategies and practices lead to improved reading outcomes.
- Strategies and practices are supported by experimental or quasi-experimental research.
- Research establishes causal variables between strategies and practices and improved reading.
- Research has been conducted in an authentic learning environment (the classroom).

That said, the SOR today might best be described as a *movement* that advocates using these standards for making decisions related to reading policy and instruction.

Even though the SOR research standards above represent a very narrow and distorted view of reading research, they might be acceptable if the programs and policies advocated by the SOR were all based on the research standards mentioned above. Instead, we see the words *research-based* on products but seldom see the relevant research. A good example of this is a product like Orton–Gillingham. The Minnesota Department of Education (2025) identified this as one of approved research-based programs that they allow schools to use with struggling readers. There may be research that has shown Orton–Gillingham to be effective for some students in some settings for some purposes, but there is little if any legitimate peer-reviewed research asking the big three research questions identified earlier in this chapter.

UNPACKING ORTON–GILLINGHAM

Orton–Gillingham is an approach to teaching reading that is said to be "multisensory, sequential, incremental, cumulative, individualized, phonics-based, and explicit" (Rippel, 2020). A recent article in *The Reading League Journal* said that "Many of the defining features of the OG [Orton–Gillingham] approach are supported by extensive scientific research, including direct and

explicit instruction with scaffolding, structured and sequential instruction, and diagnostic and prescriptive instruction" (Austin et al., 2023, p. 5). Also, the Orton–Gillingham Academy (2023) describes the Orton–Gillingham approach on its website as "a direct, explicit, multisensory, structured, sequential, diagnostic, and prescriptive way to teach literacy when reading, writing, and spelling do not come easily to individuals, such as those with dyslexia."

Adjectives and Superlatives

If the number of superlative adjectives used to describe a thing determined its effectiveness, then Orton–Gillingham would indeed be very effective. But what exactly do they all mean? Let's unpack it.

Direct Instruction

Direct and explicit instruction is supported by extensive scientific research (Hughes et al., 2017). Almost everyone in the world today would agree that direct instruction is an important part of reading instruction. Whole-language teachers use direct instruction. Balanced literacy teachers use direct instruction.

Direct instruction is a pedagogical strategy consisting of (1) explicit input, (2) modeling or demonstration, (3) guided practice with a gradual release of responsibility (scaffolding), and (4) independent practice (see Chapter 12). Direct instruction is an effective teaching strategy for the initial learning of any kind of skill (Eppley & Dudley-Marling, 2018). It's a strategy that should be in every teacher's teaching toolbox. It's basic teaching 101.

It has never been a question of *if* direct instruction should be used in early reading instruction. It's always been a question of *how* and *how much* direct instruction should be used. For the SOR, the answer has always been "much." For balanced literacy practitioners, it's always been "as much as needed."

Scaffolding

Educational scaffolding is any type of support used with initial learning (Johnson & Graves, 1997). This initial support is followed by a gradual release of teacher responsibility as students become more adept with what's being learned. Scaffolding is part of guided practice used in direct instruction; however, it's also used to provide support with any type of learning. Everybody believes that scaffolding is an important thing. This is not something new or unique. This is not something that needs extensive scientific research to determine its effectiveness. Again, basic teaching 101.

Structured and Sequential Instruction

According to the International Dyslexia Association (IDA, n.d.), structured instruction for reading includes the following six elements:

- Phonology
- Sound–symbol association
- Syllable instruction
- Morphology
- Syntax
- Semantics

Again, you'd get little argument from anybody in the field of literacy that these elements should not be part of initial reading instruction. Also, it's interesting to note that each of the three cueing systems are included here.

Why am I dragging the IDA into the mix here? Because of its strong link to Orton–Gillingham. This organization, originally called the Orton Society, changed its name to the Orton Dyslexia Society in 1982 and to the International Dyslexia Association in 1997. More importantly, in 2014 it came up with the term *structured literacy* from which *structured instruction* is derived. And the IDA said the quiet part out loud by stating that the purpose of the term was to "unify and sell what we do" (Malchow, 2014). In other words, while some in the IDA were surely motivated by good intentions, marketing was always a factor.

According to the IDA (n.d.), structured instruction is "systematic and cumulative." Let's keep unpacking.

Systematic Instruction

"Systematic means that the organization of material follows the logical order of the language" (IDA, n.d.). But what is the logical order of language? Is there an illogical order? According to the IDA (n.d.) the logical order "must begin with the easiest and most basic concepts and progress methodically to more difficult concepts and elements." Again, this is basic teaching 101. Good teachers always start with easy or simple things and progress to more difficult or complex things when students are ready. However, what's easiest and most basic in reading is based on one's experience with language. Reading things that make sense and using words and concepts from children's experiences is much easier than decoding lists of words and nonsense words in isolation and reading decodable books with artificial sentences like "Nan and Pap sat in a pan."

Cumulative Instruction

"Cumulative" means that each new thing builds on the last thing taught. Again, basic teaching 101. Good teachers always make connections to or build

upon previous learning. This is basic constructivist learning theory (Ormrod et al., 2020). This also reflects Bruner's (1966) learning theory, which calls for skills and concepts to be taught in their simplest form first to become a platform for more complex skills and concepts later.

Sequential Instruction

But what about sequential instruction? What's the sequence? And who decided that the sequence was the sequence? Table 1.1 contains a very basic scope-and-sequence chart. Scope-and-sequence charts can be useful in providing a general sense of the kinds of things you might teach early on, as well as the types of letter patterns you might ask students to notice; however, they are not reliable enough to be used in a prescriptive fashion. They should never become a road map to reading instruction. There is no magic sequence. There is no divine order. There is no universal list.

TABLE 1.1. Common Scope-and-Sequence Chart

Consonants (all)	Vowel digraph syllables ee (*feet*), ea (*each*), oo (*boot*), ai (*bait*), ay (*stay*), oa (*boat*), ou (*out*), ow (*cow*), aw (*saw*), au (*taught*), oy (*boy*), oi (*oil*)
Short vowels a, i, o, u, e	Soft c and g c (*ice*), g (*manage*), g (*bridge*)
Long vowels A, I, O, U, E, Y	Long vowel with magic-*e* ending *lake, bike, note, Pete, mute*
Consonant blends (front) sl, st, sp, sn, sc, sw, sk, sm, br, cr, dr, fr, pr, tr, gr, scr, spr, str, cl, fl, pl, bl, gl, spl, tw	More long vowels ie (*chief*), ei (*seize*), ey (*key*), y (*fly*), ie (*pie*), igh (*sigh*), oe (*toe*), ou (*soul*), old (*gold*), oll (*roll*), olt (*bolt*), ue (*true*), ew (*new*), ui (*fruit*), eigh (*eight*), ei (*vein*), ey (*hey*)
Consonant blends (end) st, sk, sp, nd, nt, lt, lk, lf, ld, lp, lm, lb, lc, mp, ct, ft, pt	Silent letters and advanced digraphs sc (*scent*), wr (*wrap*), kn (*knee*), gn (*gnaw*), ign (*sign*), gh (*taught*), ought (*thought*), ph (*phone*), tion (*action*), sion (*mansion*), sion (*vision*), ci (*special*), ti (*patient*), ture (*picture*)
Consonant digraphs and trigraphs sh, ch, tch, th (unvoiced), wh, ck	
Double consonants at end ff, ss, ll, bb, gg, dd, nn, tt, zz, qu, xx	
ng and *nk* patterns ing, ang, ength, ong, ung, ink, ank, unk, onk	

Besides the subskills in Table 1.1, a scope-and-sequence chart might also include (1) sight words from a most frequent words list (Zeno et al., 1995), (2) the 38 most common phonograms to use for large unit phonics (Fry, 1998), and (3) morphemes (Manyak et al., 2018). These would generally be taught from most common to least common.

Compare the basic scope-and-sequence chart in Table 1.1 to some of the categories of things pulled from a five-page scope-and-sequence chart in Table 1.2. The elements here might make sense to an adult with extensive linguistic knowledge, but to children in pre-operational and operational stages of development, they are meaningless. The unscientific thinking behind structured instruction is that if children put all these teeny tiny parts together in the logical order, they'll be able to read. But that's not how human brains work.

In the Appendix to this book you will find a simple phonics checklist containing consonants, short-vowel sounds, long-vowel sounds, beginning blends, and Zeno sight words. There is no magical, predetermined order, but teachers generally start with the consonants and then hit the vowels and beginning blends. There is no research that supports the idea that students need more of this. No research supports the idea that these need to be taught in a specific order. With this checklist, the teacher can document the date taught. The teacher can also have a checklist for each student and document the date when the letter sound or sight word is used successfully in an authentic reading context. This is much more accurate than a standardized test or screening device. And it enables the teacher or parent to focus on what students need.

TABLE 1.2. Road Map to Nothingness

- digraphs
- protector rules
- short-vowel protectors
- accent and schwa
- digraph doubling rules
- 1 + 1 + 1 doubling rule
- *y* ending rule, part 1
- *y* ending rule, part 2
- *y* ending rule, part 3
- magic-*e* syllable
- vowel-*r*
- schwa in a second syllable
- closed syllables
- vowel team syllables
- vowels in vowel–consonant (VC)-*e* words
- position
- vowel–consonant (VC) in open and closed syllables
- *kind–old* rule
- variant plurals
- FLOSS rule
- consonant digraphs
- silent consonants
- vowel team in a vowel team syllable
- voiced /th/ in final *e*-ending rules
- consonant–vowel–consonant words
- syllable division rules
- syllable division VC/CV
- syllable types: closed, consonant-*le,* open, vowel team, silent-*e,* and *r*-controlled (vowel-*r*)
- long-vowel sounds in open syllables

Diagnostic and Prescriptive Instruction

An effective diagnosis of any kind first determines if there is a problem and then identifies the cause of the problem. According to the IDA (n.d.), diagnostic and prescriptive instruction uses "careful and continuous assessment that is both formal and informal."

Everybody agrees that careful and continuous assessment is important. Nobody wants careless and discontinuous assessment. However, a diagnosis for reading focuses on three deficit areas: word recognition, fluency, and comprehension. A diagnostic reading assessment, sometimes called an informal reading inventory, is one of the few types of instruments that addresses all three deficit areas in ways that enable prescription (Johnson, 2021). These are given outside the context of reading instruction.

Diagnostic instruction uses assessment within the context of reading instruction. The proper term for this is *progress monitoring.* This simply means you take small sample measures along the way to determine how the student is doing and the effectiveness of instruction. Effective reading instruction of any kind has always included pragmatic measures used for monitoring students' progress.

Prescriptive instruction is an instructional plan based on the diagnosis. But all struggling readers are not the same. Each has different strengths and deficit areas. Since each deficit area is addressed differently, the instruction prescribed for each student should be different (Johnson, 2021). This points to the importance of a valid diagnostic measure that specifically addresses the three deficit areas: word recognition, fluency, and comprehension.

This is much different from the one-size-fits-all instruction used in Orton–Gillingham and other reading products. In these products the same reading subskills are prescribed in the same order and way to all students. High-ability readers go faster and are a little ahead. Struggling readers go slower and are a little behind. The same prescribed instruction is used with everybody. However, this type of instruction could hardly be said to be prescriptive.

Multisensory Instruction

Multisensory instruction is said to be the magic ingredient in Orton–Gillingham instruction. This simply means visual, auditory, and kinesthetic modalities are used when teaching. In other words, as children are learning, they see things, hear things, and do things. This is nothing new or magical. It's not unique to Orton–Gillingham. It's called multimodal instruction (Aden & Theodotou, 2019; Hassett & Curwood, 2009; Jewitt, 2008; Tang et al., 2014). Elementary teachers have been using various forms of it for years.

The Research

What about the research that "proves" the effectiveness of Orton–Gillingham? Despite the claims of being heavily research based, it simply is not (Compton et al., 2014; ILA, 2016a, 2016b; Layton, 2017; Ritchey & Goeke, 2006; Stahl, 1998). The research used to support the use of Orton–Gillingham often measures students' progress using pseudoreading or nonreading tasks (Lim & Oei, 2015), uses measures of questionable validity (Hill, 2005), does not use a comparison group (Bas, 2008), is derived from unpublished master's or doctoral theses (Blockinger, 2004), is a study put out by organizations that have a vested interest in a certain outcome (Arndt, 2006), or makes claims of superiority without controlling for covariates such as gender, socioeconomic status, ethnicity, verbal IQ, or initial skills (Ritchey & Goeke, 2006).

LAST WORD

The problem with Orton–Gillingham and similar for-profit products (Lindamood-Bell, Wilson Language Training, Barton System, etc.) is that they try to reduce teaching to an algorithm. An algorithm is a formula for solving problems in which you follow a step-by-step set of procedures (with fidelity) to achieve a specific outcome. In other words, by correctly following a prescribed set of steps in the specified order, you will be led to a predefined solution. Algorithms are useful in mathematics and computer science for calculation, data processing, and automatic reasoning. But for teaching of any kind? Not so much. There are too many confounding variables (e.g., students).

Some would have you believe that if the teaching algorithm is followed explicitly, the teacher can be assured that students will learn to read. And if the algorithm does not work, you run them through the algorithm again . . . and again . . . and again. What these algorithmic programs offer is a false sense of certainty. Research to support the long-term effectiveness of these "direct, explicit, multisensory, structured, sequential, diagnostic, and prescriptive" approaches (Orton–Gillingham Academy, 2023) is simply not evident (Compton et al., 2014).