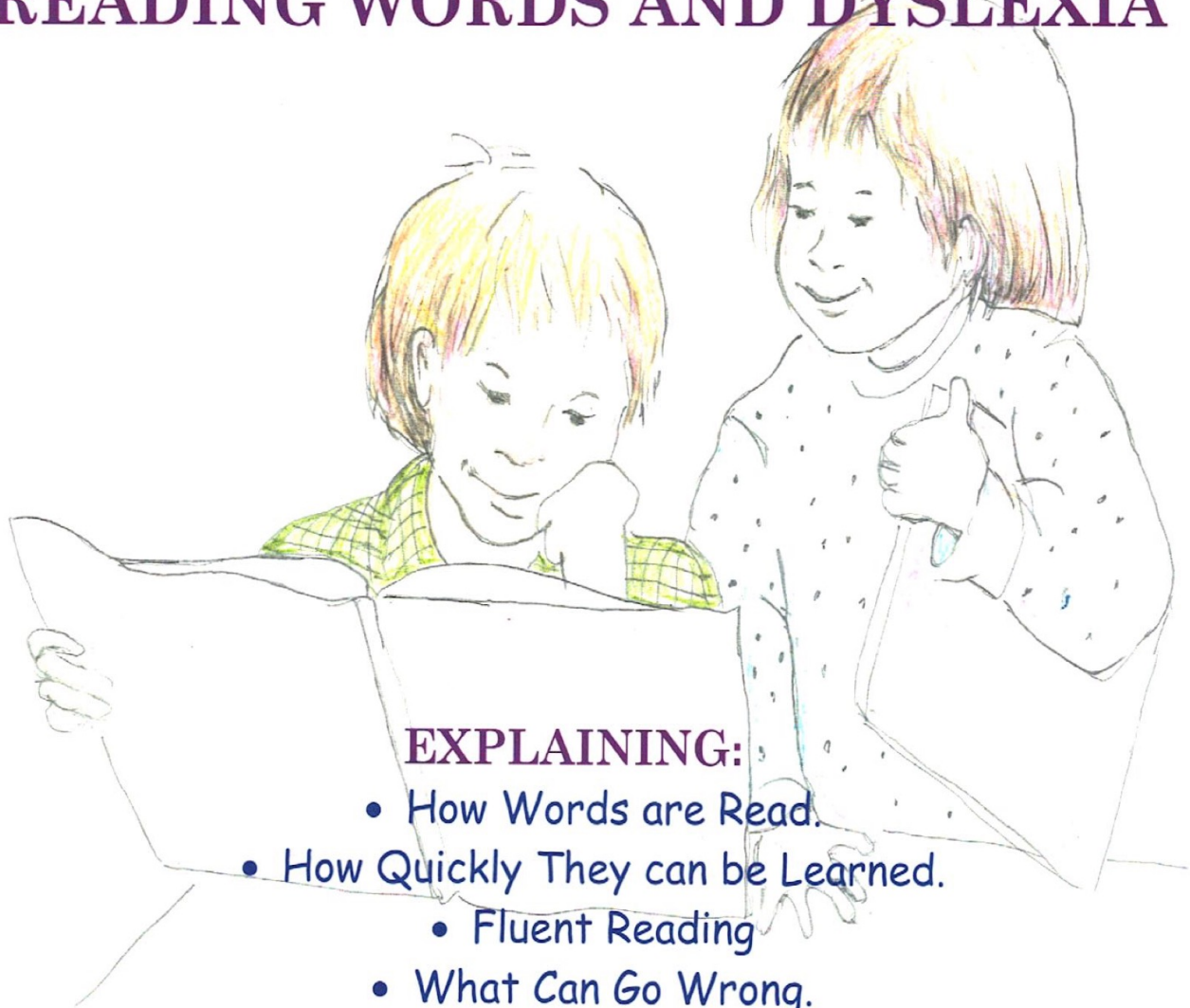


Introduction

# THE SCIENCE OF READING WORDS AND DYSLEXIA



## **EXPLAINING:**

- How Words are Read.
- How Quickly They can be Learned.
  - Fluent Reading
  - What Can Go Wrong.
    - Dyslexia.
- Instructional Implications.

An ODE Approved Study on  
The Understanding and Recognition of Dyslexia

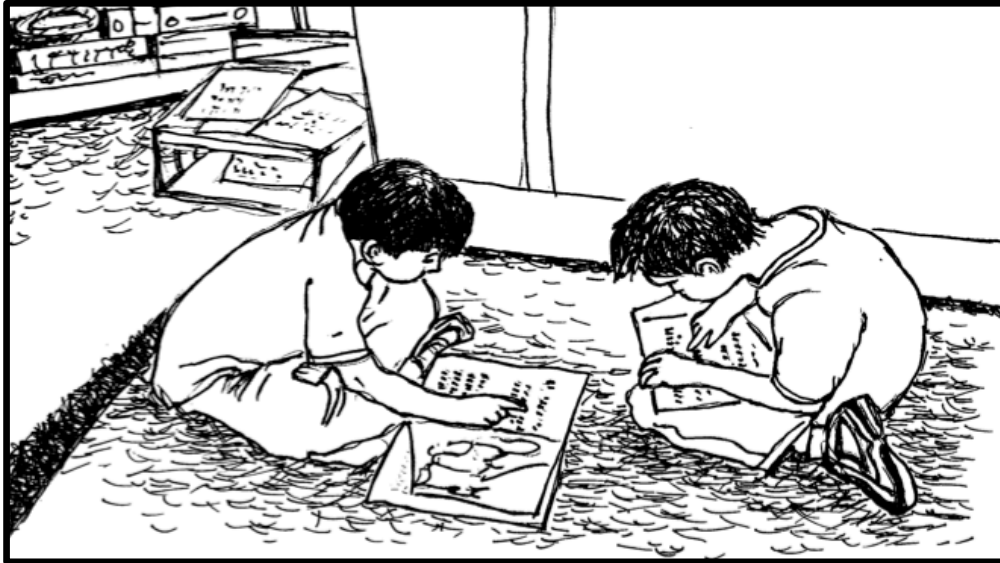
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## INTRODUCTION

# *The Science of Reading Words and How it Relates to Beginning Reading and Dyslexia*

The Mystery and Search for Explanation on  
how readers are able to read words as easily and quickly as they listen to speech.  
Charles Arthur, Instructor (11.1.19)



Speech and reading, once learned, seem to work very much the same.

Without realizing, readers read words as naturally as they hear speech. They may think that they know how they do this, intuitively. But they don't.

Speech is the same. In listening to someone speak, people don't really know how they identify words. They don't notice that they convert the small bits of speech sounds into words, sounds selected from a limited set of only 43 possible. Yet English words are made up of these sounds, just as letters do in print. In fact, in learning to read, it's the letters that call attention to these small bits of sounds in speech that are not paid much attention to. Without an alphabetic writing system, it is not likely that anyone could hear and distinguish individual bits of speech sounds that make up words. But these bits of speech sounds are there.

Speech sounds have evolved in nature and are what makes language possible. Yet, as the words are quickly spoken, the listener pays little attention to these small bits of sound. Attention is given to the whole word. This enables the listener, and speaker, to simultaneously pay attention to the words and their meanings at record speeds. The awareness of speech sounds is not a natural part of speech. For example, it's been reported that Chinese scholars, untrained in reading alphabetic writing, cannot hear, or distinguish the smallest component pieces in their spoken words. Yet, Chinese, like every human language, is systematically made of words from a set number of small sounds. This makes language possible.

In order for reading to be useful, it must, work the same way. In spite of what good readers believe, without noticing, they convert letters to words as they read, rapidly and easily, like in speech. How they are able to do it this as well as in speech, has been a mystery, puzzled over by scholars, for ages.

Linnea Ehri, one of the leading scholars on this, states, ***“One of the great mysteries that has challenged researchers is how people learn to read and comprehend text rapidly and with ease.”***<sup>1</sup>

Scholars have confirmed that reading words quickly and easily is the **hallmark of good reading.**

David Share (1995), states

*“Perhaps the single most distinctive characteristic of skilled reading is the sheer and effortlessness of the word identification process....The ability to instantly and effortlessly recognize the printed word is, in many ways, **the quintessence: sine qua non, of reading skill.**”*<sup>2</sup>.

Kieth Stanovich, (1991)

*“The skill at word recognition is so central to the total reading process that it can serve as a proxy diagnostic for instructional methods ..... lack of skill at recognizing words is always a reasonable predictor of difficulties in developing reading comprehension.”* p. 418<sup>3</sup>.

Phillip Gough (1992)

*“The acquisition of literacy is primarily the acquisition of word recognition skill.”*<sup>4</sup>

Ried Lyon (head of the NIHCD federally funded research projects throughout the 1990s.)

*“The ability to read and comprehend depends upon rapid and automatic recognition and decoding of single words and slow and inaccurate decoding are the best predictors of difficulties in reading comprehension”*<sup>5</sup>.

Ehri gives one reason for why it is so important: *“When children attain reading skill, they learn to (read) in a way that allows their attention to focus on the meaning of the text while the mechanics of reading, including deciphering, operates unobtrusively and out of awareness for the most part”*.<sup>6</sup>

Reading words this well allows for the readers’ attention to be focused on the main point of reading, which is to understand meanings of words and passages, like in speech. Without guaranteeing it, reading words rapidly, easily and accurately is necessary for comprehension.

*“Adequate word recognition ability clearly does not guarantee good comprehension. Nevertheless, while it is possible for adequate word recognition skill to be accompanied by poor comprehension abilities, the converse virtually never occurs.”*p.4<sup>7</sup>

**Here’s the mystery.** How are readers able to learn to read words so fast and accurately, like with speech, and pay little attention to the letters? This is not a question of how to get to this point of reading words, but how it is done once arrived? At the point of reading skillfully, readers read so quickly they don’t realize that they treat letters the same way they treat the small bits of speech sounds, called phonemes. This is true even though letters are more noticeable than the phonemes in speech. Letters can be seen, examined, and touched, whereas the sounds in speech are transient, hard to detect and hear separately, especially by non-readers of an alphabetic language. Paradoxically, it’s the letters that enable readers to read like they hear speech. Finding how this works is the purpose of this study.

Since the early 70s, the research on the search for this explanation has exploded. Reading words is the most heavily researched aspect of reading. Ehri found, early on, that, in tests, skilled readers’ attention is automatically drawn to printed names over the pictured objects even if the names of the objects are incorrect, almost involuntarily. How is this tendency accounted for? What is happening here when readers tend to attend to printed words over pictures? Does this provide a clue? The answer has profound implications for instruction. The hope has been that if this mystery can be solved, and there is a better understanding of reading words, teaching can analytically work backwards to determine instructional improvements - to improve the understanding of how to get to this final level of good reading through instruction.

**The mystery is all the more daunting when considering the full number of words needed to be learned and read in context, a large portion of which have a variety of English spellings.**

**In all of this, children are expected to acquire learning in a relatively short time.**

By the end of first grade, most current reading programs expect an impressive reading vocabulary from children, from approximately 1200 to 1500 words of significant variety. From there, the number of words required is quickly accumulated. In fact, “(word) frequency counts of reading material, prior to Grade 3, reinforce the picture of the young readers continually encountering new words to read.”<sup>8</sup> Some estimates of the number of words grow from 400 in kindergarten, to 2,000 words each following year. Eighth graders are expected to be able to read about 86,000 different words in school materials.<sup>9</sup> These standards may have increased with the new Common Core State Standards. How are children in the early grades able to learn to fluently read so many words within a short time, and do it early with a wide variety of spellings? This is part of the mystery. The explanation must account for this dynamic.

A glimpse of the mystery can be seen as early as kindergarten if it is taught carefully in kindergarten. With carefully planned, special provisions and supports, reading at this level can amount to a reading vocabulary of 400 words with at least 40 letters or letter combinations and close to 60 of the most frequent letter/sound correspondences. This is a high expectation. What crucial learning and human capability, coupled with carefully planned presentation, enables young readers to accomplish this so early?

**The Common Core Standards contain the same rush of high expectations – a daunting task.**

Its expectation comes quickly in first grade. Children must learn to read many words with a mixture of spellings: words containing all letters of the alphabet, including long vowels with silent e, plus the following letter combinations: ee, ea, ai, oa, ou, ar, au, aw, ay, oo, th, sh, wh, ch, ck, eigh, ei, ie, igh, oe, ough, ow, ou, ew, ue, oo, oy, oi, ar, er, ur, or in regular words with up to two and three syllables and with common endings –ed, ing, er, est, ly, and a bunch of common irregular words – all in standard print. This has become a new curriculum norm for first grade reading, yet still not attained by most first-grade readers. When mastered, this level of learning can be applied to 80% of the language. The standard reading rate for **first grade** is typically from 60-90 words a minute of connected texts.

This level of reading in kindergarten and first grade already begins to fit Ehri’s description of rapid and easy reading where young readers begin to pay less and less attention to the letters. How do they do this? Do they start memorizing at this point? The total reading vocabulary expected of **first grade children rapidly increases from there**. Memorizing all of these words does not seem possible. Yet, at some point, all children, in **the early grades**, are expected to read words accurately and quickly. **Aside from concerns about instruction, how is this level of learning possible so early? Then, how are these young readers able to extend this early learning to a vast number of variously spelled English words in text?** Maryanne Wolf, from her neurological studies exclaims that “*learning to read is an almost miraculous story*”. She explains that “*How literate people read words is to understand what we do when we read.*”<sup>10</sup>

**An “inherently intractable” challenge?**

Meeting this early expectation is a daunting task, an amazing challenge for most children. In fact, it can be “inherently intractable”, according to some scholars.<sup>11</sup> Ehri puts it this way.

*“From our findings and those of others, it is clear that learning to process graphemic cues (letters) accurately, automatically, and rapidly is one of the hardest parts of learning to read. It is a part that consumes substantial learning time. It is a skill that clearly separates good readers from poor readers.”<sup>12</sup>*

Here lies a [paradox](#): “How can a skill that feels so easy to the adult be so difficult for the child to acquire?”<sup>13</sup> This contrast puts a fine point on the mystery of how words are read. Learning to read the words is the

most difficult part of learning to read. Perfetti calls it the “bottle-neck” in learning to read. Learning to read does not come naturally like speech. For too many children, this aspect of learning comes with frustration and delay. It is especially hard for those children with a handicapped condition like dyslexia. Reading words is the specific locus of dyslexia.

Fortunately, most of the difficulties can be avoided with good instruction. Ideally, the daunting challenge should be borne by the teacher. The teaching must be skillful and effective so that the child knows nothing of the challenge. To them reading lessons should be fun, something to look forward to.

Yet, “In today’s schools, too many children struggle.”<sup>14</sup> As noted by one prominent researcher, “Scores on standardized reading tests have been nearly flat for decades.”<sup>15</sup> An important relevant question is: **are these difficulties due to the kind of instruction used, sometimes guided by faulty theories? Or, are they due to the nature of the learner and the tasks of learning how to read?** In either case, to be an accomplished reader, reading words accurately and easily is absolutely necessary for good reading, with comprehension.

**Early Theories:** For some theorists, fast and easy word reading, i.e., fluency, was first explained by the simple extension of practice. Putting aside the question of methods, this essentially came as a result of over-learning the decoding process to the point of automaticity, like learning the keyboard on a computer?<sup>16</sup> However, this view left too much unaccounted for by simple practice. What is seen in a five-year old child’s reading is a “special case”, requiring special experiences in order to learn to read. [\*“Learning to read is strikingly different from other sorts of learning.”\*](#)<sup>17</sup> The average college student reads at about 250 words per minute, which could include as many as 500 letter/sound correspondences.<sup>18</sup>

So, a better explanation is needed for reading words easily and quickly, that allows for less and less attention to the letters, without diminishing their importance, that begins to appear very early in a child’s learning, and which rapidly accumulates into a huge number and variety of words. **Linnea Ehri states that all words eventually become “sight words”.**  
**Her theory gives new meaning to the term, “sight words”.**

How much of this “magic” can be known and understood through science? From a scientific point of view, there should be no magic. Some scientists claim that *“Scientific knowledge and technology double every one to two decades, depending on the discipline in which information is measured.”*<sup>19</sup> This definitely has been the case for reading. Reading is among the highest expressions of human intelligence. Understanding this complex skill means understanding something essential about being human. **In order to teach children effectively** and make this essential skill available to as many as possible, **it is important to know how reading works**, once learned. *“...This is why there is a **Science of Reading: to understand this complex skill at levels that intuition cannot easily penetrate.**”*<sup>20</sup> Gaining knowledge of how words are ultimately read, after learning, contributes to the larger understanding of the more complete and “complex act” of reading that reaches beyond what is known intuitively. This knowledge begins with the proposition that ..

**....People can read because they can speak.**

**The solution to the word reading mystery seeks to explain how and why this is true.**

### **A Preview**

**After years of study and experimentation**, Ehri proposed a theory that seeks to describe how the link between speech and print explains rapid word reading. It’s a theory that has held up to scientific investigation and represents a consensus among most researchers. “Researchers disagree about many details, but there is remarkable consensus about the basic theory of how reading (words) works and the causes of reading successes and

failures.”<sup>21</sup> Ehri was part of a large emerging community of cognitive scientists in the 70s and 80s that studied how words are read. Her theory, **Grapheme-Phonemic Connections (GPC)**,<sup>22</sup> with clarifications and elaborations from others, has been further confirmed, clarified and illuminated by brain-image research in the 90s. Ehri’s contribution played a critical role in giving the work on brain-image direction for knowing where to look. (see Part II, The New Science of Brain Imaging.) The unraveling of the mystery required results from both behavioral and neurobiological experiments.

**Instructional implications.** In contrast to the new consensus on the theoretical side, how it can best be applied in instruction does not enjoy such consensus. This is especially true in regard to the role decoding plays, as well as how explicit and systematic instruction should be. These questions can only be finally settled by research on instruction itself. However, a well-founded theoretical framework on how words can be read, when done well, can provide an important foundation that gives direction and a deeper understanding of what instruction is to accomplish. The question here will first be: what is the relationship between theory and research-based practice in teaching skills of reading words? (see Part III, Implications for Instructional Practices.)

### What can a study of the science of reading words do for teachers?

**A science of reading words** can produce a theoretical foundation for teaching. It provides a frame of reference, a clearer understanding of what needs to be learned, and a more knowledgeable perspective, - all of which makes for a more professional teacher. In short, a theory that unravels the mystery of reading words provides teachers with guidance in crafting instruction and a deeper understand of what instruction is trying to accomplish. Lastly, it assists in knowing where, why and how it’s necessary to make adjustments in teaching certain individuals not responding well to core instruction. Possibly one of the most important benefits in this study is in exposing practices based on faulty theories that have evolved over the last century and continue to exist, with ill effects on instruction.

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