Part 1b
More on Both Sides of the Theory - Speech and Print

How the GPC Theoretical Basis of Reading is Derived from Speech
(pp. 1-13) ,

The Theory's Expanded Application

In reading a large volume of variable words in texts.
(pp. 14-23)

When speaking or reading, something deep is going on in the brain that has been very difficult to expose through the confines of behavioral experimentation. Ehri and others have attempted to find out as much as possible about this activity. Her letter/sound bonding theory seeks to link **two major sources of information**, one coming from the partially hidden phonology of speech and the other from a visible alphabetic writing system. This section reports more on what is known about each side of the theory, speech and print, for a deeper understanding of **the role that speech plays in reading words.**

The Second level of the mystery discusses how the theory is applied at a more complicated level.

More on the two sides of the theory

The theory, at the first level, must explain how it works
by using both large sources of information: speech and print.

1.) spoken words, part of nature, acquired very early in human evolution and within a unique social history. Built from the smallest particles of sounds to form words that are spoken and briefly heard, the internal structure is hidden in the human brain and is only partially revealed in a system of "alphabetic" speech sounds. It produces thousands of words from only a limited number of distinct sounds called phonemes.

Phonemes: the smallest particles of speech arranged to form words, from a set number, in order to distinguish one spoken word from another. With training, phonemes can be briefly identified in their natural state, through the ear, and can be approximately symbolized into an alphabetic print system[1]

2.) The **alphabetic print system,** a graphic human invention, developed much, much later than speech. Built so that its smallest units, letters, symbolically match particular phonemes in their hidden natural patterns as permanent, sustainable, and repeatable visual approximations of thousands of words in spoken language. (Due to unique aspects of how the English alphabet represents speech, the term "grapheme" is often used to indicate that the alphabetic units of representation can be more than one letter, like with sh th ch.)

Both sources of information, speech and print, are **linked together**, according to Ehir's theory, to match and interact with each other to make it possible to read words.

From the Side of Speech,

Knowledge Gained, And Dyslexia Understood

"**We read with our eyes, but the starting point for reading is speech**." Mark Seidenberg, 2017 [2.] Speech comes from a storage of words held in the lexicon, or mental dictionary, in memory. In order for a high-speed model for reading words to work in the minds of readers, **the readers must first possess, in memory, a large storage of oral vocabulary as a source to be accessed at the most basic and smallest letter/sound level**.

The Role of Spoken Language in Beginning Reading

Children with better language skills consistently demonstrate better abilities to learn to read than their peers with poor language skills.

> "*We know that vocabulary size and quality are strongly related to early reading achievement. A groundbreaking study by Betty Hart and Todd Risley documented large differences in the amount and variety of adult speech to children and in the types of verbal interactions that took place associated with SES. Children from lower-income families were exposed to fewer utterances and acquired fewer vocabulary words than higher SES children, and they later showed poorer progress in learning to read. Variability in spoken-language acquisition associated with SES is apparent as early as eighteen months of age."* [3.]

The lack of a rich underlying oral vocabulary at an early age is due to either **low language experiences** prior to schooling or **inborn weaknesses in the phonological aspects of speech, now known as developmental dyslexia**. Evidence showing how a reciprocal relationship between speech and print works is well documented, they tend to strengthen each other. A study by Tunmer and Chapman illustrates this relationship. It's entitled, "Does 'Set for Variability' Mediate the Influence of Vocabulary Knowledge on the Development of Word Recognition Skills?". It found that oral vocabulary contributes to the development of word recognition **indirectly** through a variable called "*set for variability",* a term coined by Venesky. In essence, this means that words already in a child's speaking vocabulary are easier to read, especially at the beginning of instruction. According to the authors, "set for variability" works as follows:

> "*Children with poorly developed vocabulary knowledge will have trouble identifying and assigning appropriate meanings to unknown printed words if the corresponding spoken words are not in their listening vocabulary or are only weakly represented phonologically in their mental lexicon (Perfetti, 2007). This, in turn, will limit the development of their decoding skills, as additional spelling-sound relationships can be induced from the stored*

> *orthographic representations of words that have been correctly identified.* ***Vocabulary knowledge should therefore contribute to the development of both decoding skills and real-word recognition***." [4.]

In keeping with Ehri's theory of L/S bonding that enables the reader to access words in storage, if the words in print are not in a memory storage, the L/S bonding has nothing to find and access. The word that is pronounced, if possible, might as well be a non-sense word.

The study of the relationship between **speech and reading is a relatively modern development**. Marilyn Adams stated that,

> *"The discovery and documentation of phonemic awareness (knowledge and skills) is considered the single most powerful advance in the science of pedagogy of reading this century*." (1990) [5.]

A leader in this development from the Haskin Laboratory, Alvin Liberman, emphasizes the need for both sources of information being in play,

" **a theory of speech and a theory of reading/writing are inseparable, and that the validity of the one is measured, in no small part, by its fit to the other**." [6.]

> *"In the course of 30 years or so, the idea that reading words requires phonology has ascending from a minority view to one with such a substantial majority that* ***it now amounts to a conventional wisdom. This sweeping change of opinion can be celebrated as a triumph of reading science."*** [7]

Humans can read because they can speak.

In order to explain this relationship in reading,

an attempt is made to see into or hear the hidden phonological structure of spoken words

The storage of phonological information, contained in spoken words, is the **hidden source** that makes all of the connections with print possible. Oral words are the bundles of alphabetic speech sounds, called phonemes. Buried deep in these bundles, the individual phonemes are difficult to detect, or hear, in a word's pronunciations, especially by a non-reader. This hidden source of knowledge is structured into an oral "**alphabetic phonological** form of words" made up from a limited number of phonemes available within a language.

The phonemes can be thought of as an internal, oral alphabet. Using their limited number as an oral alphabetic base, the bundles of phonemes must be constantly re-arranged, in patterns, to form thousands of words in speech. As described in Part 1a, these patterns are, at times, hard to detect, or to hear by the human ear, inside the words, as they are heard in their pronunciation. They are therefore heard as one acoustic sound per syllable that needs to be decoded into an identifiable spoken word that exist in the listener's oral vocabulary. (see Part II, Brain Imaging)

Spoken language evolved and existed far before a written alphabetic representation of the phonemes was invented. Because print emerged from the innate spoken language systems**, "Writing is not language, but merely a way of recording language by visible marks."** [8.] Prior to the creation of a **printed alphabet**, the uniquely **phonemic "alphabetic structure**" of spoken words evolved over thousands of years for oral communication.

Matching this oral alphabetic structure to an alphabet print, within a given language, was an ingenious way of creating a written language that was more efficient, and easier to read than one that matched meanings of words to single graphic symbols. However, this discovery required an

analysis of spoken language and the discovery of its phonological systematic structure, over time, that was formed from a set number of small bits of spoken sounds. **Little did its inventors know how closely the alphabetic writing would be neurologically linked to the evolved natural neural system that operates speech.** (see Part II)

This alphabetically structured oral language base, that evolved over thousands of years, is necessary for a written alphabetic language. Without a storage of the "alphabetically" structured oral vocabulary, there was nothing for the letters to match to be read. Perfetti refers to the **alphabetic phonological (mental) representation** of English words, i.e. in pronunciation, as a source of knowledge that is built from the set number of 43 phonemes. He emphasizes the importance of this oral knowledge source as a base for learning to read, found in the above account on the "set for variability". Oral vocabulary supplies words to the underlying mental lexicon to be accessed and retrieved for reading by letter matchings, per Ehri's theory. Oral vocabulary involves both quantity (number of words held in storage) and quality (knowing its correct pronunciation and meaning). It has been estimated that a typical pre-literate kindergarten child enters school with an oral vocabulary of some 3000 to 4000 words.

The origin of spoken language is largely unknown. "It is a continuing mystery that will probably never be puzzled together satisfactorily…. There is one thing we are not in the dark about, and that is the role of language in making man (and woman) quintessentially human." [9.] The thinking is that it must have begun to emerged early in the evolutionary process of homo sapiens, 150,000 years ago. **Also, as current thinking goes, there was only one original language, very early, that branched off into thousands of other languages**.

According to John McWhorter's book, **The Power of Babel**, language has always been in constant change. The number of phonemes that make up languages varies from about 100 in some click-using languages of Africa to 43 in English to 13 in Hawai'ian, according to how far early humans had to travel from the origin of language in Africa. (NYT, 4.15.11) McWhorter reports that something unique, in the evolution of humans, occurred 35, 000 years ago that created radical changes that may indicate growth in language development. It is assumed that the capacity to create spoken words from bits and pieces of physically produced oral sounds eventually evolved into an innate capacity by the human species and resulted in a huge advancement in civilization. [10.]

The phonology of words, as part of nature, is privileged over all other levels of language because it provides the "surface interface" (alphabetic phonemes) for the alphabetically written words. The printed representation of words (letters) became a secondary representation of this internal, more primary, human source of language. Because of the innate human abilities for speech, phonemic information becomes a major component of reading in an alphabetic language, which makes it "obligatory", i.e. involuntary, can't be stopped, once learned. Reading can't be done without it. The phonology of speech comes automatically. "**This activation of speech codes occurs almost always because the speech codes are part of the lexical representation**" [11.] (see Part II, New Science of Brain Imaging).

A lengthy research review of this question by Stanovich and Share (1995) concludes:

> "…any plausible model of reading acquisition must assign phonology a leading role. …Studies suggest that the activation of phonological information **is a ubiquitous feature** of skilled word recognition. … It also seemed reasonable to expect **a certain bias toward reliance on sounds, given the extensive experience in the spoken domain up to school entry." [12.]**

Understanding how the matching with print is accomplished requires a "very powerful theory of memory … to explain how readers could read words (instantly) by sight". This can only be done by "showing that **sight word learning is, at root, an alphabetic process, in which spellings of specific words are secured to their alphabetic pronunciations in memory.**" Ehri's GPC theory attempts to accomplish this objective.[13.] **Her theory shows how a written alphabetic language "piggy backs" onto this spoken language, which helps explain how reading can be performed as easy as speech.** The earlier statement, "Humans can read because they can speak", must be qualified to, "Humans can read, **an alphabetic language,** because they can speak".

An instructional implication for WHAT must be learned in order to read well.

This is a question of What not How. The How question will be discussed in Part III.

To gain access (cognitive knowledge) to this oral storage of words from print, readers must learn how the phonemes are internally structured in spoken words, when they are spoken. Because of the way a limited number phonemes construct spoken language, they are considered an internal "alphabet". Readers must know this alphabet of phonemes, which means having a clear knowledge of these sounds. A new reader must learn to hear and distinguish each phoneme in words as they are heard in pronunciations. They must not only be able to hear, they must be able to articulate these phonemes so that particular letters can be articulated to matched particular phonemes. There is a large literature examining how children's level of phonological awareness and facility relates to their success learning to read.

This is the first instructional challenge for beginning readers. It contributes to the "impasse" often experienced by new readers. Awareness does not come easy to most new readers. A level of natural sensitivity to phonemes is low for speech. They are not always pronounced in neatly sequenced units in time, like letters are seen in space. They come fast (at rates of 10 to 20 consonants and vowels per second, see below) and are often partially hidden in seamless streams of speech. As a result of learning to speak, the child develops only a partial knowledge of phonemes, which is sufficient for supporting speech but insufficient for reading. Linking letters and sounds, as defined in Ehri's theory, must start with increased sensitivity, knowledge and detection of the fleeting, briefly heard and partially hidden complex system of sounds in speech in a particular language. (Mysteriously some new readers pick this up very easily with little instruction or realization of what they are doing. See Pt. II)

Ehri's February 2014 **emai**l sums up the importance of the phonemic source for letter/sound relationships .

> *"**Readers need phoneme segmentation skill (???) so they can analyze pronunciations of specific words into their smallest sounds**. ….**They need to apply their GPC knowledge** to connect graphemes in spellings of individual words to phonemes in their pronunciations to bond the spellings to pronunciations and retain them in memory, referred to as **orthographic mapping**. In addition, the pronunciation **or phonological representation of the word** has to be sufficiently precise **in order for the graphemes to link up to the phonemes that they symbolize**. Some imprecision in the pronunciation can be tolerated when readers see the spelling of a word, notice additional or unexpected letters, and alter their pronunciation to conform to the spelling. For example, 'often' pronounced 'offen' may get changed to 'off-ten' when readers see its spelling, or 'magazine' mispronounced as 'maz-a-gine.' ."*
> *(the issue of segmentation of the phonemes will be taken up later, especially in Instructional Implications.)*

Thus, in order for the young reader to learn the intended letter/sound connections that eventually work, mysteriously, almost automatically in identifying words, the child must first be able to **gain knowledge of phonemes and their arrangement (alphabetic structure) in spoken words.** This

knowledge is **not a natural by-product of learning to speak.** Various teaching techniques for, and difficulties with accomplishing phonemic knowledge is discussed in Part III. **The level of knowledge of and skill with phonemes needed for reading goes far beyond what is needed for speech.** Yet, this **required higher level** of knowledge is critical in making a firm link between both sides, speech and print. (see Part II Brain Imaging.) **Weaknesses in the phonological side of the theory is precisely where the learning disability of dyslexia resides, resulting in neurologically rooted word reading difficulties.** [14.]

New brain-image studies, Part II, show that the human **brain does all the work for speech**, in **hearing** the phonemes **in the inner structure** of speech and in **translating** them to **spoken words**, performed automatically, without the speakers' or listeners' knowledge. **A more detailed and pronounced knowledge of phonemes and their structure becomes necessary in reading an alphabetic written language**.

In describing the varying degrees of difficulty in gaining phonological knowledge for reading (especially relevant to dyslexia), Ehri directly cites a landmark essay of Alvin Liberman on the relationship of speech to reading.

> *"Phonological awareness is not a normal by-product of learning to speak. (The reason for this) should lay bare the critical difference between speech and reading/writing, and thus lets us see why the one is so much easier (to learn) than the other… In speech**, phonologic and syntactic processing is not a matter of choice but mandatory.(involuntary)** "*
>
> *"Speech delivers phonological information **at rates of 10 to 20 consonants and vowels per second**. Thus, children who have mastered speech might nevertheless be unaware of the discrete (temporal) segments it conveys." (parenthesis added)*
>
> *"In spite of the complexly encoded nature of the speech signal, **phonological structures** are in fact contained within it. **Those structures must be produced and received by the speaker and listener, whether they know it or not**, for if the structures were not, language **as it has come to be would not exist**. Moreover, it is possible to become aware of those structures, for, **if it were not, alphabetic reading and writing as they have come to be would not exist**. No matter, then, that the speech process itself is fully automatic, hence **unavailable to consciousness as a process**; for the listener, that process must nevertheless produce phonologic representations (phonemes that produce words) of which the listener can be conscious. (can recognize and understand)"* [15.]

The hidden nature of the phonemes, from direct observation, contributes to the mysterious aspects of the speech side of the theory. For reasons cited above, the phonemes are elusive.[16.] Ehri (1979) wrote, "If the light were not so gradual in dawning, the relationship between speech and print might count as one of the most remarkable discoveries of childhood" (p. 63).[17.] (cited, p. 8)

Part **of the problem** of matching alphabetically spelled words to speech is that the oral structure of the phonemes and the represented printed structure don't completely match. The printed words come in neat rows of letters, with spaces in between. The spoken words come in "**bunches of phonemes**". Each phoneme is distinct but not pronounced or articulated in a neat, distinct order.

In spoken syllables of words, the phonemes over-lap and sound, to the untrained ear, like they are one sound. Add to this feature the speed in which they are articulated, they are only detected enough to recognize the words in speech. Representing the neatly lined up printed letters to these bunches of fast sounds takes specific training. If the alphabetic writing system truly represented, or mapped, words as they are spoken, the letters would be piled up on each other and be unreadable - something like this illustration. This makes matching print to speech all the more difficult.

Two ways an alphabet can represent phonemes in spoken words.

Approximate arrangement, but readable — Actual bundles, but unreadable

Stop 

Early in its research development, **before brain-image studies**, the phonological structure and links to letters **could only be inferred** from specially contrived experiments with the reading behavior of children. [18.] Ehri describes the inferences made about how letters access the "deep" jumble of phonemes before brain-image research helped to clarify?

> "*The answer proposed in this chapter is that **access is gained through the acquisition of unobtrusively functional deciphering skills that involve two types of structures, one nested within the other**. The larger structure is lexical (internal) and consists of specific words as units with orthographic, phonological, and semantic **identities**. **Nested within words are structures consisting of graphemes linked to phonemes**.*" [19].

An alphabetic written language, itself, draws increased attention to the phonemes in speech, assisting in their awareness. The detection of phonemes, its causal interrelationship with learning to read, as well as its contribution to advanced reading, have been widely researched within the last 40 years. The Rack research group from the UK, in their 1994 report, opened with this statement.

> "*It is now **almost universally acknowledged** that there is an intimate, and probable causal, connection between children's **early phonological skills and the process of learning to read**. Children's abilities to process the sounds of language analytically seem to be powerful determinants of their later abilities in reading*." [20.]

According to Seidenberg, in his 2017 publication on **the science of reading**, [21.]

> "*For reading scientists the evidence that **the phonological pathway** is used in reading and especially important in beginning reading is about as close to conclusive as research on complex human behavior can get." P. 124*
> *"For reading researchers, the issue was settled in the late twentieth century by several types of findings that converged on the same conclusion: **phonological information is an essential element of skilled reading** in every language and writing system; impairments in the use of **this information** are typical of poor readers and dyslexics….. the use of the phonological pathway is **an essential component of skilled reading**." P. 126*
> *"Researchers disagree about many details – it's science, not the Ten Commandments – but there is **remarkable consensus about the basic theory of how reading works (at the word level**) and the causes of reading successes and failures.*" (Citations were made from five publications since 2001.)

This runs contrary to the prevailing view held by **practicing educators** for most of the history of modern education.

> "Most educators have assumed that reading is purely visual and that phonology is something that poor readers fall back on." [22.] P. 126

Seidenberg concludes that readers rely on phonology to read words because "they have to, **given the deep integration of orthography and phonology in writing systems, in behavior, and in the brain**." He lists the major reasons that support this view. [23.] (p. 266)

- Dependence of a written code on speech
- Writing systems evolved to represent sound and meaning
- Role of phonological phonemic awareness in beginning reading's impact on reading skill
- Positive impact of explicit phonics instruction on reading outcomes
- Impaired representation of phonology associated with poor reading, reading disability; behavior studies and computational models showing causal connection
- Remediation of phonological impairments associated with increases in reading skill

IN CONCLUSION

The mystery is:
Why can humans read so well after instruction?

The solution is speech. Humans read because they can speak. *The only reason humans can learn to read an alphabetic language well is that they have a brain that can decode speech sounds*. The same mechanism in the brain that enables speech, also enables reading. The alphabetic language "piggy backs" onto speech.

This is only true, if letters of the alphabet have been linked up to the phonemes in speech. If the links between letters and phonemes are firm, the brain does for reading what it does for speech. This means that humans read more with their ears than with their eyes. That's what makes it possible and also is what makes teaching necessary. It doesn't happen naturally. It must be taught.

This is a major change in the way reading has been understood for over two thousand years. It is now universally recognized by researchers, but not by educators. They don't read the massive amount of reports on the subject.

So, How does this relate to **teachers**? It generally supports teaching phonics and teaching it in a direct fashion. But only in general, not all the small details can be derived directly from theory. The details of methods still must be verified individually. But the theory has moved the dial over to teaching the alphabetic code directly, evident in the CCSS.

At the beginning, the more explicit and systematic the better (without being ridiculous). This increases the chance for every child to learn to read, even those with dyslexia. The theory helps understand why this general approach works so well. It also debunks other theories in vogue, forever.

Dyslexia
Subsumed within the larger context of the Science of Reading words
What can go wrong and where.

It's important to insert a discussion of dyslexia within the speech side of the theory of reading words because this is where the condition for dyslexia resides. The discussion of the speech side of Ehri's theory provides context and insights for an understanding of the reading disability of dyslexia. This is the kind of dyslexia that is developed from nature, not acquired from some kind of brain injury. An understanding of any kind of dyslexia is derived from an understand of the phonologic basis of reading words, which identifies the source of the problem. An understanding of how words are normally read enables an understanding of what can go wrong within the process that creates dyslexia.

A phonological base for reading words means that any weaknesses with the phonology of language will have serious effects on learning to read words, especially with decoding.

A core phonological theory of reading assumes that the reader has an underlying capacity to cognitively hold, access and retrieve thousands of words in memory for both speech and reading, each having a different trigger or demand for its use, to speak, spell or to read. **In the realm of speech, this underlying ability with phonology exists as a normal human variable, distributed over the general**

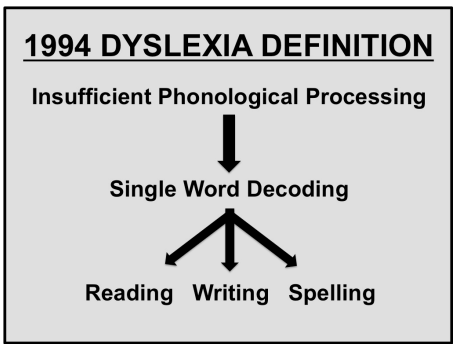
population, from weak, to average, to strong. **The distribution results in a wide variation of skills with both speech and reading. This becomes the root source of dyslexia. The lower "tail" on the left side of the curve, represents a weakness, precisely resulting in a condition that, most notably, causes difficulties in learning to decode words, a major symptom of dyslexia.** [24.]

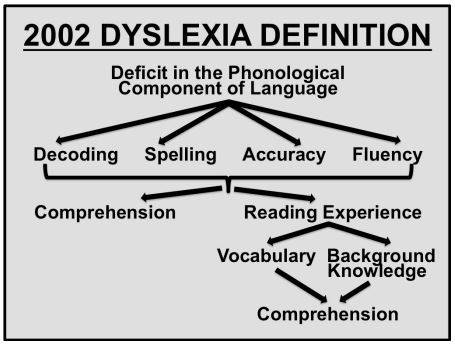
In reading, if firm letter/sound connections have been learned, **however difficult** or by whatever means**, a written alphabetic language enables the reader to tap into the phonological source of oral information in order to attach reading, as a "parasite", onto the mechanism that operates speech, for a free ride**. [25.] This "free ride" is possible, due to the **innate capacity for speech, which is, as noted, greatly varied among humans**. This variation, at the lower end, is the source of weakness for reading words. The level of severity may not be evident in speech, but, because of the added demands for reading, it creates a "bottle-neck" in reading words. In contrast to other cognitive abilities, this weakness is specific and unexpected. It does not correlate well with other language skills related to listening, language comprehension or IQ. It is now known that the specific phonological weakness, if caught early and treated through carefully planned and programmed explicit beginning teaching of decoding skills, can be strengthened to prevent learning difficulties in word recognition, a symptom of dyslexia. (more on this on Parts II and III.)

Phonological weaknesses may also affect a child's ability to put simple ideas into writing, as well as to spell words and write sentences. This weakness has ill effects on short term phonological memory, which has ill effects on decoding, other aspects of reading words and reading for meaning. Slowness in rapid oral response to name objects and symbols is an indicator of dyslexia and affects decoding, reading fluency, following directions, responding to questions and listening comprehension. For example, **"Good readers have been shown to differ from poor readers in the speed and accuracy with which they can orally name colors, numbers, and objects, as well as letters**" [26.]

Behavioral results: Other teaching consequences of dyslexia concern classroom behavior. It can result in anxious, over-active, inattentive behavior, or in the opposite direction, as shy, withdrawn behavior (poor social skills). Difficulties with learning to read, write and spell, frequently result in avoidance and disinterest. A child with dyslexia, or any other cause of learning difficulty, often mistakenly concludes that they are not capable and smart as others. This can result in low self-esteem and additional acting-out behavior in the classroom.

Dyslexia Defined: The results of two reviews, in 1994 and 2002, by the International Dyslexia Association (IDA) is illustrated by the following graphs.





The formal definition of Dyslexia that was adopted illustrates its phonological source and its resulting difficulties with reading words.

> *"Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and / or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction"*

In 2016, this was re-examined by a IDA team of 30 well-known researchers and practitioners. [27.] The leading member, Dr. Jack Fletcher summed up the opinion of the group:

> *"There appears no compelling reason to change the definition of dyslexia. The definition remains meaningful for research and for practice. It includes inclusionary criteria, which is critical. It does not specify operational criteria, which is impossible (i.e., thresholds for severity or eligibility). There should be no equating of dyslexia as a diagnosis and eligibility for special education because there must be a demonstration of educational need."*
> *….This definition has left its mark on research and practice … Figuratively speaking, the research in reading has resulted in a vaccine that, given wide use, should ameliorate most difficulty in learning how to read. The term dyslexia might fade into obsolescence like smallpox, polio, and pertussis. However, if someone didn't identify what polio was, create a cure, and get that cure to the masses, we would still be hearing the term and reading about it every day. If some day, we stopped using the term dyslexia altogether, that might be a good thing! Right now, however, we are at a critical stage of getting the vaccine to the masses.* " (more in Part II and III)

From the Side of Print,

Alphabetic Knowledge Gained

The visual aspect of reading may be an easier source of information to study and learn. The letters can be observed, touched, traced and written, whereas speech is fleeting and partially hidden. It's like the difference between looking at a still photo vs. a video. Identifying letter linkage to the more **elusive phonemes** and **to a full representation and expression of spoken words** is the tricky part. **"Writing is not language, but merely a way of recording language by visible marks."** (see above)

Its Creation: The invention of an alphabetic writing system was clearly an in ingenious creation. But it was not accomplished all at once. It was a long and tedious task, close to 1000 years in development before being use in lengthy documents. Evidence of its first use came from approximately 4000 years ago. [28.] This lengthy development of alphabetic languages, starting with Semitic and Greek languages in the second millennium BC into the first millennium BC. The lengthy development illustrates the difficulty of **1.)** detecting/finding the phonemes in what is heard and **2.)** symbolizing the phonemes and their structure into a complete alphabetic written language.

The consonant sounds, easiest to detect in speech, came first in the Semitic languages, like in ancient Hebrew text. The Greeks added the more allusive vowels and additional consonants in their language and completed the first alphabetic writing system. In his **Republic**, written almost 400 BC, Plato states, "*In learning to read, we were satisfied when we knew the letters of the alphabet*".

This development replaced a widely used logographic writing system, from symbols for whole words, **to** the gradual use of alphabetic symbols for the small pieces of abstracted sounds heard in the pronunciation of words. **This slowly developed and learned linkage meant that reading an alphabetic language has always been primarily rooted in speech, i.e. in the partially hidden, systematic structure of a given number of phonemes within a particular spoken language. Even though the print seems dominant to the reader, reading is not visually rooted in print**. Its source runs deeper, evident from its origin. **In reading, the phonological sound system of phonemes remains primary, and print is secondary, the reverse of what it seems intuitively.**

In an address at the 1998 annual meeting of the *Society of Scientific Studies of Reading*, Alvin Liberman, elaborated on the relationship between speech and reading that help explain how speech and alphabetic writing systems are linked.

> "(*My colleagues, from Haskins Laboratory) appreciated early on that* ***the connection between speech and reading is a two-way street*** *and that one is well advised to* ***look in both directions before proceeding****. "*
>
> *"Thus****, looking first toward speech****, they observed….. that the* ***alphabetic structure*** *of (spoken) words is not to be found at the surface of the acoustic signal but only at a deeper,* ***less accessible level***."

Letters are what are seen at the surface. With learning, they link print to speech and provide the learner access into the deeper sources of spoken language, that exist in nature. By identifying and bonding with a matched phoneme within the structure of spoken words, they enable word reading. Liberman continues.

> ***"Then looking in the other direction toward reading****, …..they saw that mastery of speech does not normally make a child aware that (spoken)* ***words do, in fact, have an (oral) alphabetic structure.*** *….****I promote the notion that only the right theory of speech can provide insight into the process by which a child who speaks is converted to one who also reads***." ….
>
> **And, we read an alphabetic language because we can speak.**
>
> *"The unique discovery underlying the alphabet was neither more nor less than what I have already identified as* ***segmental phonology****, the part of grammar that* ***generates all words by variously combining and permuting a small number of consonants and vowels***.(into words)" [29].

As noted earlier, Liberman ties these two sides together "as a two-way street":

> *"Proper use (of an alphabetic writing system) requires that readers* ***attach the (created) artifacts of the alphabet*** *to the* ***natural (alphabetic) structures*** *of their language, taking care to make the connection at the earliest stage. (****Once this is done****),* ***readers get all the rest of the complex processing for free, courtesy of the biological specialization for language that they own simply by virtue of membership in the human race***."

Quality Visual Knowledge of Letters is still necessary

Charles Perfetti, over the last 25 years, has stressed the need to learn "a high quality of representations" from the printed words in order for this two-way process to work. This is necessary so that printed words can be firmly attached to spoken components stored in memory. This is known as the **Lexical Quality Hypothesis** (LQH).

This hypothesis focuses on the quality of learned print that is required for reading. He asks: "how thoroughly do readers need to learn the details of print in order to read words easily? How trained should the eyes of readers be to notice the details of print?" Perfettti argues ***"that the central theoretical question for a theory of reading acquisition is the development of lexical representation***" [30.] of the sound structure, so that firm connections to components of spoken words can be made. In order

to gain the necessary visual **links** to hidden, internal language, the following questions need to be studied.

> *"How does the child mentally represent printed words at each point of reading development?*
> *How does the child access these representations during encounters with print?*
> *How do word representations and word access change with experience and instructions?*
> *How are words represented in the mind?*
> *What form of knowledge allows word recognition?"*

Thus, word identification is greatly determined by the physical perception of **its letters** (how they are seen), not the word as a whole, Perfetti stated:

> *"**How the letters are used is the central theoretical question of word identification.** While all letters must be perceived, not all need to be "seen" equally. Some get a relatively high level of activation (attention) and others a relatively low level from the word."*
> *"When people read text, the print fills their minds with ideas. **The route to these ideas begins with individual printed words**. Eye movement studies show that when readers read a text, their eyes land on practically every word".* [31].

According to Perfetti, gaining a functional mental representation of words involves the following guidelines for instruction:

1. increased repetition of seeing a word and
2. increased quality of detail, how well it has been seen or how much detail is noticed.

He continues to argue:

> "*that the retrieval of a lexical representation (of a word in memory) is high in quality **'to the extent** that it contains both semantic and phonetic (l/s) information sufficient to recover its memory location'…. Thus a 'name' without meaning and a meaning without a 'name' are both **low quality***." P. 298 [32.]

He then explains the connection between meanings and the decoding of words:

> "Vocabulary (pronunciation and meaning of words) affects decoding because decoding a word whose meaning is known strengthens the connection between the word's **orthographic form** (print) and its meaning. This process helps establish a word-specific representation…. **Simply put, as children decode words, they strengthen their vocabulary knowledge; and as children retrieve their knowledge of a word's meaning while decoding it, they strengthen the identifiability of that word**." [33].

Both sides of the GPC theory, print and speech, complement each other. **Detailed knowledge o**f **letters, sounds and shapes, contribute to strengthening the young reader's sensitivity to and knowledge of the phonemes**. **Letters give the reader something concrete to assist oral memory of spoken words.** Printed letters make reading easier than spelling because it starts with the tangible print to look at, refer to, and start from, to change print to speech. Whereas, spelling starts from the allusive, hidden phonemes in spoken words that are initially hard to isolate in speech and turn them into print form. This helps explain how dyslexia has particular ill effects on spelling.

On the other hand, the skills with phonemes can help to direct visual attention, eye movement, to learn the visual details of words and drive eye movement from letter to letter, left to right, in assisting in the process of attaching letters to the full phonemic form of words. In a recent review, by a group of researchers from the Haskin Laboratories find…

> "Phonological training supported increased sensitivity of the visual word form area (in the brain) to the phonological structure of words." [34.] Pg 227.

Thus, **each source of information, print and speech, interacts and supports the other. "***Phonological and lexical- orthographic abilities are correlated, but each makes a unique contribution to reading achievement. The result is two complementary but overlapping kinds of knowledge that support the reading of words"p. 12.*[35.]

Learning to read an alphabetic written language, itself, forces a certain amount of phonemic awareness and sensitivity **beyond what is needed for speech**. Recall the note in the Introduction about the Chinese scholars not being able to hear individual phonemes in non-alphabetic Chinese. On the phonemic side, articulating the phonemes can assist the eye movement in attending to all visual details of words. (see implications on Part III.)

Perfetti summarizes his view of how both sides of the theory work together.

> "***I need to emphasize that word-form knowledge is also critical in skilled reading****. The development of word reading skill depends on the* ***refinement*** *of word representations* ***by adding spelling knowledge to spoken-word representations****.* ***This refinement*** *produces representations that* ***increase in precision****, knowledge of all the letters of a word, and redundancy, complete letter knowledge and complete phonemic knowledge* ***with connections between the two****.* ***These characteristics allow word reading and meaning retrieval to be rapid and relatively automatic given a familiar printed word***." p. 296 [36.]

"(In order) to secure complete representations of sight words in memory, readers need sufficient familiarity with letter shapes. They need to know how to distinguish the functional (letter) units that typically symbolize phonemes in words. They need to know how to segment pronunciations into constituent phonemes that match up to the (letters) they see in spellings. It is in performing this grapho-phonic (letter/sound) analysis (decoding) for individual words that the spellings of words penetrate and become attached to reader's knowledge of spoken words in a way that links written language to the central mechanism governing spoken language." [37.]

So, the **quality** of visual representation in memory is increased by the number of repetitions made with various practicing routines, up to the point of learning the full detail of a word. As the quality of detail increases from accurate repetition, **accessing a word in memory increases in accuracy**. The question for instruction is: what kind of activities can best provide repetitions and increased quality detail?

The Theory's Expanded Application.

How alphabetic knowledge is applied to reading
a large volume of variable words in texts.
Part 1b (cont.) pp. 13-20

The first explanation of the solution to the mystery focuses mostly on single words or syllables. A deeper look at the phonological basis of reading and how it is represented by an alphabetic print raises questions about the **second, more challenging part of the mystery**. **How can this simple letter/sound alphabetic bonding theory explain how thousands of words are read within the context of meaningful texts, where many are longer and have multiple spelling variations. This goes beyond what is usually taught in the early grades. English is a massive language – more than 450 million words by contemporary estimates – but only 5,000 common words make up 80 percent of a typical school text. It is estimated that, if a detailed analysis is made, there are anywhere from 200 to 500 different letter/sound correspondences in English, where there are unique and varied alternative or non-phonetic spellings. Teaching each correspondence is impractical**. (More on that part later.) First, how does this theory apply at this level. Then consider how is it learned and used? This is both an instructional and a theoretical question, but the theoretical comes first.

The Challenge of English Spellng Varations

In any alphabetic language, especially English, the printed alphabet is not a perfect grapho-phonemic match, even with the more transparent common 55 correspondences that are typically taught in the first two years of instruction. There are sibtlties and nuanses in word pronunciations (nature's wonders and societie's influence) and spellings (human creations). Alphabetic languages are also tranparent or opaque. English is opaque.

> The English writing system is alphabetic. Breaking the code entails figuring out how graphemes represent phonemes. These relationships, though systematic, **are variable** across word spellings. The same letters may symbolize more than one phoneme, and single phonemes may be represented by **alternative graphemes**. The **vowels are especially variable.** This lack of transparency makes it harder for beginners to figure out the system without help. [38.] (NRP 2000 report, Chapter 2, Alphabetics, Part 1, Phonemic awareness)

Some samples:

> "...words that contrast: MINT/PINT, DIES/DIET, and DONE/BONE/GONE; silent letters; letters such as C, G, and Y that each represent two phonemes; homographs like WIND, DOVE, and PERMIT; or one-off words like YACHT and COLONEL. Even THE, the most common word in the language, has two pronunciations, as heard in this Katy Perry lyric: "I've got the eye of the tiger." [39.] (p. 131)

Variations with vowels.

> "For instance, the regularity of grapho-phonemic correspondence for vowels in English is only 48%, compared to 94% for French vowels in one-syllable words.". "The likelihood of choosing the wrong pronunciation in English is much greater because the grapheme /a/ in an English word is pronounced in different ways, even in the most frequently used words such as cat, cake, call, arm, and above." [40.]

Because of spelling, with silent, non-phonetic insertions or wide phonetic variations, English, contrasted to Finnish, Spanish, or French, is considered a "deep" orthography. These variations and inconsistencies present many challenges in explaining how Ehri's theory of reading words applies on a broader scale. It makes the application of the alphabetic principle, described in Ehri's theory, to English especially challenging.

A More Detailed Analysis Helps understand the problem

Two kinds of Regularly spelled words:

1. **Simple,** consistent patters, and **2. advanced**, with some variation but still consistent.

Two kinds of Irregularly spelled words: Unique alterations or non-phonetic spellings,

Words that have letters that do not represent any phonemes or that have letters that represent phonemes unconventionally. Words like "often, island, sword" have a silent, non-functioning letter. The word "is, "his", changes the typical sound for the letter S, as in "this", to a /z/ sound. The word "was" changes the letter a to the /u/, unless a rule is considered for words that start with the wa, as in "water" and "want". Then there is the common word "said" where both the letters a i are changed to the /e/ sound.

Ehri stresses that many English spelling deviations arose for a variety of reasons and from various historical processes. For instance: some spelling variations are due to common, grammatical morpho-graphic reasons (verb tenses), which works beyond the L/S theory. Knowing this requires inserting this information into the application of the L/S theory. [41.] In spite of the many deviations, Gough contends that "Knowledge of English letter-sound rules (common patterns) is necessary to enable the reader to recognize **the majority** of English words." [42.] Does this mean that the majority of English words are regular, or that the common patterns still apply in some way?

A computer analysis of common letter/sound correspondences in the English language by Burmeister (1975) revealed that letter/sound connections are useful, especially for teaching beginers the basic workings of the alphabetic code. She was able to identified a small set of 55 letter-sound correspondences that do apply the most common alphabetic knowledge for about 80% of the language. [43.] Does alphabetic knowledge have any application for the other 20%? In addition, Burmeister "found that many of the traditional phonics rules did not generalize well enough to justify teaching them." (also see Becker, Dixon, & Anderson-Inman, 1980 p.?)

The problem is that even regular letter/sound correspondences that extend beyond the most common 55, but seen less frequently, are so numerous (over 200 by some counts) and complicated that most readers don't know what they are. And words with these more complicated patterns must also be read as well, fast decoding, as the more common 55 patterns.

> "….no one knows what all the pronunciation rules are or how they can be learned…. With (some) kinds of syllables, it is harder to say what the rules are. ……. however they (the rules) are stated, the number of rules is so large that

only a small subset can be taught, surely the bane of every teacher charged with providing phonics instruction. **How the child catches on to the rest is a mystery.**" P. 137 [44.]

Also see, M. Adams, Beginning to Read, (1990) p. 259, Forty-five Phonic Generalizations,

Mark Seidenberg has explained how the phonological base can continue to work beyond the most common patterns by pointing out that the spelling-sound correspondences (spelling rules) are still mostly consistent in English, even if somewhat advanced. From this, he further points out that exceptional variations in spellings exist along a continuum from the most simple and common to the most difficult and unusual. Words can thus be arranged along a continuum of degree of difficulty **for teaching alphabetic knowledge first, before applying it to harder to learn words.** This continuum would include words with unique alterations or non-phonetic spellings, for which he prefers to use the term "quasi-regular" to stress their partial exceptions. This analysis emphasizes **the degree** of exceptional variability, within and beyond the numerous spelling patterns and representations.

".. **few English word spellings are totally arbitrary** in the sense that they contain no letters that conform to English letter-sound spelling conventions. Most spellings that are considered irregular are only partially so. For example, *island* and *sword* each contain only one irregular letter. All the other letters correspond to sounds in the word's pronunciation. In using memory processes to read these words, **readers are more apt to take advantage of any available systematic relations** than to ignore them and rote memorize the entire form." P.111-12 [45.]

Even many exceptions have some reason or a phonological context, thus the spellings of the exceptions over-lap with the phonological basis of English words.

"Exceptions are not arbitrary (thus needing to be memorized); they overlap with the regulars. An exception such as *pint* shares structure with 'rule-governed' forms such as *pant* and *pine*. Dual-mechanism theories (memorization/decoding) miss **these partial regularities**. … **The system …..is quasi-regular**: There are different degrees of consistency in the mapping from spelling to sound. These range from rule-like (e.g. initial b is always pronounced /b/) to **more complex contingencies**. The child might learn that -ave is pronounced as in *gave* except in the context of h-, or that the gh in –ght is usually silent but not in *draught,* and so on."
(Question: Is there a rule for the sound for the ea vowel diagraph? lead vs bread or read vs. read?)

Seidenberg warns against the "misleading" dual-method of teaching reading, in which young readers are taught two kinds of word recognition, by decoding and by memorization), that is applied to the exceptional words and even promoted among some researchers.

"For years, research and teaching have been driven by the intuition **that two types of knowledge** are involved: Rules are used to pronounce "regular" words such as *gave* and *save*, whereas exceptions such as *have* are memorized (as outlaws). (Colbeart, et al. 2001).

This would amount to teaching two methods for reading English words: phonologically based cipher reading for regularly spelled words and rote memorization for words with problematic spellings. (more on this in Part III, Instructional Implications from theory.)
(Also considered in Part II, Brain Images, noting that each uses different areas of the brain.)

Ehri also questioned "whether the memory process is a rote process", even for "quasi-regular" words. She points out that…"Rote memory is used to learn relationships that are arbitrary and unsystematic.". Very few English words are that arbitrary. She sees the use of systematic letter-sound relations, applying her theory, as a foundation, for reading both regular and irregular words, equally efficiently.

"Consider the huge number of words that mature readers are able to recognize by sight. Consider their ability to look at a spelling and access that particular word in memory instantly while bypassing thousands of other words.

"Consider that words are read by sight after only a few exposures to the word, and that readers remain able to read words by sight even when the words are read infrequently." p.117 [46.]

How is this more advanced reading explained? Even at this stage in learning, something more powerful seems to be at play beyond strict memorization.

Seidenberg describes how his computerized model has shown how quasi-regular words are eventually learned and read with the powerful use of learned alphabetic knowledge, **which amounts to an extended, more advanced use of Ehri's theory**.

> "(Computer) models (like Ehri's theory) can learn to perform the pronunciation task accurately for thousands of words. The model represents both rule-governed cases and exceptions -– *mint-pint, gave-have, bone, done*, and all the rest – **contrary to the intuition that two mechanisms are necessary**. …. As a result, performance on any given word is affected **by knowledge of other words**. For example, training on *save* and *gate* …. help in performance on *gave*."
> "**According to this theory**, mastering spelling-sound correspondences is a statistical learning problem. … **'Rule-governed' forms and 'exceptions' represent points on a continuum of spelling-sound consistency."** [47].

Thus, a large part of the solution of knowing how alphabetic knowledge applies to a broader assortment of words **is determined by the kind of instructional plan used that, after establishing a firm alphabetic (phonics) base, then applies it to the partially regularly spelled words using the continuum principle**. (see Pt. III) This is where theory and practice over-lap. **If a carefully planned sequence of words that includes a gradual degree of the continuum of quasi-regular words, with spelling complications and variation, the phonological theory continues to be applicable beyond the most common 55 patterns.** Alphabetic knowledge continues to be a base that **gradually requires more advanced applications**. It is not practical to expect teaching all the individual advanced correspondence found in the English language. So how are they learned so well?

In summary, learning the alphabetically decodable words with the 55 most common correspondences works as a base…

1. in learning new and unusual correspondences that still work phonetically; or
2. in reading partial alphabetically decodable of quasi-regular words as cues for the real word; or
3. in reading words with patterns similar to other known words with common rules.

For example: as noted earlier, kindergarteners can learn at least 40 letter/sound correspondences, (almost all the English phonemes), for as many as 400 word samples; First graders can learn as many as 50 correspondences (covering a large majority of words), for as many as 2000 samples; and finally, 90 correspondences that are taught in most phonics-based programs, which still only covers a small portion of the total possible correspondences, perhaps as many as 500, that exist in modern English. How does the L/S bonding theory become so highly applicable in meeting the larger challenge in English writing, when most advanced correspondences are not individually taught? [48].

Word Frequency, another analysis that helps explain how the challenge is met.

The above analysis of letter/sound correspondences provides help in explaining how readers apply the letter/sound theory to words on a larger scale. An analysis of word frequency, or how often certain words show up in printed material, **adds an additional layer to this explanation.** [49]. Both kinds of analysis helps bring down the daunting teaching task to a practical level by providing guidence for instructional plans and a major part of the explanation for how alphabetic knowledge can meet the unique challenges in teaching reading the English language.

Word Frequency

An analysis of word frequency has shown that…from a sample of 5 million words : 50% came from the most common 100 words; 25% came from the next 900 common words, 15% came from the less common 4000 words, and 10% came from the least common 80,000.

Each kind of analysis, spelling and frequency, comes from a different classification of words that partially overlap. Words can be both regular and infrequent, or irregular and frequent. The 100 most common words fall into both categories, spellings and frequency. Of the 100, 78 are regular, 22 are both partially regular and frequent. **Some of the 80% of all words** that are spelled with common correspondences may also be in the least-frequent 20% class.

However, most of the 10% words that appear least often, that come from the largest pool of 80,000 different words, are complicated, longer, carry more meaning and less likely to be completely composed of the most common correspondences. The most frequent words are usually more functional, with less meaning bearring. Gough points all of this out and further points out that reading the 10% less frequent words are just as critical as all the rest because they often carry more meaning and are less predictable. They must be read as well as all the others. [50.]

Gough attempts an explanation.
"To become a skilled reader the child must master (internalize) this cipher." (use of alphabetic knowledge)… "The influence of knowledge of the cipher will vary inversely with word familiarity, **the less familiar a word, the more important the cipher will be."** … "To read ordinary text, children must be able to identify unfamiliar words."
"In real text, most words are unpredictable." (from the context.) "Words that are predictable (from context) tend to be short and common, **whereas words that are unpredictable (from context) tend to be long and uncommon."** [51.] Gough: pps 38-39 (Reading Acquisition)

For Gough, the more difficult challenges are with words of unusual spellings, such as: *listen or said*, or in the "many orthographically ambiguous words like *bead* and *bread* and *steak* and *area*", that appear in texts **at varying frequencies**. Gough asserts that **words with problematic spellings require additional knowledge of these unique spellings**. Ehri also writes about the need for the new reader to become increasingly knowledgeable about **orthographic variations** in the English language, **in combination with applying the letter/sound principle.** However, for Gough, "(**Some) Specific lexical knowledge** must be added to **the cipher** to achieve both skilled reading and spelling." Without being able to explain exactly how cipher reading works, he still "..holds, however, **that the cipher is the foundation for both** (reading and spelling) **skills**." **The most problematic words are read by means of the cipher with additional "as needed" word knowledge**, and they are still read, **without detailed analysis**, quickly and easily, by the accomplished reader, even with additional, and necessary, knowledge of unique spelling variations.

Evidence shows that good readers do not, normally, slow down for less frequent or less predictable and more difficult words. "Consider that words are read by sight after only a few exposures to the word, and that readers remain able to read words by sight even when the words are read infrequently" Reading comprehension requires that there be relatively little fluctuation in speed, unless the content is dense in meaning and needs extra thought. Because the less frequent words usually carry more weight and key meanings in a context , they rarely can be guessed from context. To be a competent reader, one must be able to

read all kinds and levels of word complexities, automatically, as cipher words, as part of an "obligatory speech activation". How is this action finally accomplished.

How are all of the kinds of spelling patterns, basic and advanced, and words frequencies, within a connected text, learned and read equally well, within a relatively short learning period of two to three years? Combining an analytic knowledge of the most common L/S correspondences with a word frequency analysis does help find the answer. In both cases, the instructional plan plays a critical role in explaining how the alphabetic principle can continue to apply in a more advanced way. However, given all of this analysis and instructional planning, meeting this large challenge is still daunting. Is learning the alphabetic knowledge, at a more advanced level, able to meet this challenge?
A team of prominent researchers attempt to explain how this is done.

> "Beyond these rudimentary beginnings, progress in learning to read is fueled by several factors that center on increasingly adaptive use of the alphabetic principle and the establishment of orthographic patterns that are associated with pronunciations. Successful learners apply their primitive understanding of the alphabetic principle to their encounters with words, which are turned into opportunities to apply and extend their alphabetic knowledge."
> (Research on) "*functional phonological skill….* Suggests that the main learning mechanism available to the child is *phonological recoding*, recoding of spellings into pronunciations. A model of how this mechanism works comes from Share (1995),[52.] who emphasized the role of self-teaching in learning to read words."
> "The importance of a phonological-recoding mechanism, therefore, goes beyond its role in learning decoding rules. In addition, the application, even the imperfect application, of this mechanism helps the child learn specific word forms. Models such as Share's self-teaching model emphasize the child's acquisition of individual word representations, rather than stages of development. … Texts that contain a high proportion of familiar words will be read well, and the occasional low-frequency word provides an opportunity for phonological self-teaching. Because the child will face many low-frequency words over time, the phonological-recoding mechanism is a very powerful, indeed essential, mechanism throughout reading development, not merely for beginners." [53.]

All things considered, is this enough? Ehri is somewhat vague on just how far her theory goes in explaining these challenges at this level of advanced word reading. She acknowledges that readers, at the most efficient and accurate level of expertise, employ a dominant alphabetic way of reading all kinds of words, regularly or irregularly spelled, from simple to complicated. The strongest evidence for this is a skillful reader's ability to read phonetically spelled non-sense words, where meaning and context are not available cues. Yet, Ehri acknowledged the need for more research on this aspect of her theory. She does not exactly know "what kind of words readers should be able to handle" phonetically by cipher reading or **by some other means**.

> "English words vary in number of letters, number of syllables, and letter-sound regularity. Readers may be able to use the cipher in learning to read short, regularly spelled, mono-syllabic words by sight, but they may regress to phonetic cues (decoding) in processing multisyllabic words or even to logographic cues in processing (memorizing) words with spellings that defy their letter-sound knowledge." P. 137
>
> "Learning to read these words by sight may require knowing **higher order spelling regularities** and how these patterns **are connected systematically to subunits in pronunciations or in meanings. More research is needed on how readers learn to read various kinds of words by sight and whether the concept of cipher sight word reading is useful in explaining how readers learn to read longer and more complex words**." [54.]

Is there still something missing in these explanations? What about the high volume of words, not frequently seen, yet, needing to be read well? Does Gough's less specific concept of cipher reading, and Ehri's vagueness, imply something more at play, related to speech, as described above?

Gough's concept of added word knowledge to "cipher reading" may put the final touch on this part of the mystery. It, at least, points out that there is more to the explanation of advanced reading than just applying the bonded L/S with added nuances or advances. He acknowledges that good readers have very good decoding (ciphering) skills, evidenced by their skills with **pronounceable** pseudo-words. Reading pseudo-words is the best test of decoding skills because their translation from print to sounds cannot be assisted by familiarity, meaning or context.

However, early on, in Gough's chapter, "Word Recognition", in the 1984 Handbook of Reading Research, he "reluctantly admitted that the decoding view was inadequate". [55.] (Ehri, 1998 SSR also cited this.) Although the evidence of these skills, by good readers, is not denied, Gough, as well as Ehri, does not believe that these same decoding skills, even with advanced learning, continue to be used in the same way by cipher readers. For him, and Ehri, "cipher reading, re-conceptualizes sight-word" reading, described above and in Part Ia. Good reading transforms to something more instant and more phonetically complicated, beyond the "primitive" skills first learned in beginning reading. Although Ehri attempts an explanation for this, seen in the above description, some ambiguity regarding the full letter/sound explanation remains with both Gough and Ehri. Thus, even with specifications, for both, **cipher reading still contains some mystery, especially applied to the larger volume and increased complexity of words**. Where does this mystery come from?

Gough's term, "cipher reading", as a metaphor, implies something more. He calls attention to the immensity and complexity of the task of reading words in English, with the nuances from spoken language that alphabetic writing systems contain. He states, "(To read) with any degree of skill, (children) must internalize the cipher" for "there is only one way to read well and this is with the aid of the cipher", which seems to be an advanced, and somewhat mysterious, application of alphabetic knowledge, letters and phonemes. He acknowledges that this is no small task. "The orthographic cipher of English is complex." … "An alphabetic orthography is based on a system of rules". … "if children could internalize this system (learn the system), they would have a way of tranforming the novel into the familiar, and they could decode the message." (automatically?) The metaphoric nature of cipher reading is seen in these statements. The term "cipher reading", as a metaphor, clearly implies **something more** than the **sum** of the parts analyzed above. [56.]

As a metaphor, the term, cipher reading, suggests **an added dimension in reading words in a text, beyond Ehri's more specific L/S bonding sight-word reading explanation.** As a metaphor, the term attempts to account for the advanced, complicated, and even problematic nature of rapidly reading the English alphabetic system, which can only approximate spoken language. He points out that the phonetic letter/sound correspondences learned, especially at the early stages, are only primitive forms of reading. The cipher "does not consist of the rules taught consciously in phonics". (the 55 most common corespondences?) "The rules of phonics are explicit, few in number, and slow. In contrast the rules of the cipher are implicit, very numerous, and very fast." "**We are intrigued by the suggestion that what the child has internalized are not rules at all…**"

Yet, with all of these complications, "cipher readers" eventually, through instruction, experience and practice, are able to navigate and read with relative ease, especially with comprehension. Gough "found that children **who have the cipher** (evidenced by their skills with psuedo-words) **learn to read and spell new exception words faster and more accurately than children who do not**." Given the vastness of this task, the term "cipher reading" remains purposely vaguely defined by Gough. Without being able to

explain exactly how or what the whole process is, he has used the broader understanding of cipher reading that is based on phonemic awareness (connections to speech), decoding skills, the application of the alphabetic principle, and beyond. **This leaves reading words, as far as Gough is concern, with some mystery**.

> "It appears to us that word-specific knowledge is constructed on a frame built by the regular, systematic correspondences. **In our metephor, knowledge of the cipher is the foundation, and word-specific or lexical knowledge is the superstructure of decoding. And, of course, the cornerstone is phonemic awareness**." [57.]

This view can have problematic instructional implications on how young readers transfer from the "primitive form of decoding" to "cipher" reading. Gough's views on how this learning is acquired, are in conflict with modern instructional research and will be discussed in Part III, Instructional Implications.

There are about 55 letter/sound correspondences, 40+ phonemes and the 26 letters, to provide the "framework" and foundation for thousands of common and less common but regular, systematically spelled words, (approximately 80%), plus all the words that are more or less spelled quasi-regularly that may require careful instructional sequencing for learning as well as additional word-specific or lexical knowledge. Given the complexity, the shear mass of words, regular and varied, found in English, especially with a wide variety of exceptional spellings, the ability to read words in the way the GPC theory suggests, even with Ehri and Seidenberg's specification and Gough's added nuances**, is a daunting task**. **Is the theory adequate for the task? Gough's use of metaphor for cipher reading may indicate that it is not. Ehri's reference to speech, remains promising, but needing more clarity and confirmation.**

Summary and Evaluation of The Research Challenge to Support this Theory

A large research challenge had to be met by researchers to demonstrate how the major distinctions within the theory are explained, in spite of how they may appear, and then show how the levels of difficulty in reading English are met.

Perfetti claims that this challenge has been met. Researchers have…

> "**produced multiple demonstrations that phonology plays a role in identifying a single word, in deciding whether a word fits a semantic category, or even just in deciding whether a letter string is a word. (**p. 154)..Persuasive evidence exists enough to **support what Frost (1998) termed the strong phonological hypothesis: that all word reading requires the engagement of phonological representations." (**p. 155) [58.]

Researchers, as early as the late 1970's, up through the 1990's, including those done by Ehri, have helped to expose the interactive relationships of print to speech that supports the GPC theory. Ehri has made a major contribution to these "multiple demonstrations" in her work by uncovering hidden indicators of what is being done in the epicenter of reading words. Her experiments provided evidence of the phonologic source of sight-word reading, termed "cipher word reading". How Ehri arrives at the GPC theory is explained, with experiments cited, in several of her journal publications and chapters in larger publications. (**Reading Acquisition**, 1992. [59.] and "Eight of Ehri's Experiments" in Extension A)

Seidenberg describes a study by Van Orden using homophones and pseudo-homophones and a study by Charles Perfetti that "illustrate the kinds of research that yielded a clearer picture of phonology, context , and early reading." [60.]

The experiments sought to find: **to what extent** the Grapho-phonic Correspondence (GPC) theory explains the mystery at both the word and extended more complicated level. Demonstrating the phonological activities in normal reading is difficult because it happens fast, and, from the phonemic

side of the GPC theory, is not observable. Without improved exposure through behavioral experimentation, the theory is left to some degree of speculation or intuition about what and how readers read words at the deepest and the most advanced level. Speculation in the past, with little empirical demonstration, has led to numerous faulty theories, with faulty instructional approaches that followed.

Ehri's experiments are most successful in demonstrating how necessary letter/sound connections are in making reading words possible, leaving inferencial evidence in explaining the speed. However, as the volume of words increase, with increased spellings complications and variations, with longer words, less frequent correspondences, and with unque spellings, **it is difficult to see how the letter/sound bonding aspect of the theory, even with added advances, can totally account for rapid reading of the full spectrum and volume of words read in English**.

Some Lingering Questions

Some of the interactions between letters and sounds remain intriguing, almost magical, and left unanswered. In Ehri's first few studies, children were observed having a "natural" knack for connecting some letters to parts of words heard in speech. Children did this to assist in remembering words, even before being taught. How was this accounted for? The Rack group replicated this finding. [61.] Exposing this knack is truly interesting. Ehri even based her concept of the early phases of instruction on the assumption that this knack for partial letter/sound connections would be used to read some words with partial letter/sound connections at the start. [62.] Ehri's reference to the Stroop tests, as a means of experiencing the automatic "pull" in attention to reading words, raised this same issue. [63.] Is this a glimpse of the human brain seeking the hidden phonemes in an alphabetic print, coming from speech? Does it exist in every child equally? [64.] It didn't appear to be so in the experiments. If this innate tendency is available, does it, to some degree, help in learning at the beginning? If so, what are the instructional implications?

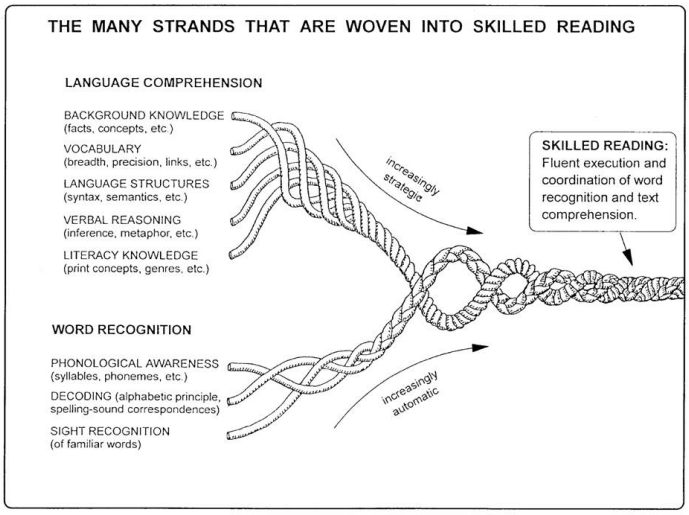
As was noted earlier, the total number of reading vocabulary that must be accumulated, from grade to grade, with a rapid increase of varied letter/sound correspondences, is in the thousands per grade. This level of proficiency, **learned in early grades at an increasing rate**, is difficult to account completely by the GPC theory. It is hard to believe that, with all 200+ correspondences, (or maybe 500?) with the complications and exceptions, all corespondences can be specifically, directly and systematically learned like the first 55 most common can be. At the same time, it is even harder to believe that shear memorization of all words is possible. It is equally hard to believe that the reader has time to think through decoding strategies and analygies that can be applied to this vast number and variety of additional correspondences and words. **Something more seems to be at play that makes Ehri's cipher sight-word reading concept work**.

For Gough, the forces described by Ehri and how they work are uncertain. Recall, "cipher reading" is not always sufficient. Reading words with problematic spellings requires **additional knowledge**. "Specific **lexical knowledge** must be added to the cipher to achieve both skilled reading and spelling." Even with this added knowledge, as needed, cipher reading is still a metaphor, for Gough. **Something more seems to be at play** in making skilled word reading possible and applicable to thousands of words.

Gough's idea gives Ehri's theory an added dimension. However, even this, as he recognizes, is not fully satifactory in explaining how reading words is done so well. **How does the "cipher", plus word**

knowledge, work with the full complicated and extensive tasks of reading thousands of words? Gough believes that a full explanation is unknown. [65]. The task of reading words at the high quality that reading demands, to be learned just over a few years, remains daunting. Thus, even Gough's concept of how cipher reading is used, as a metaphor, needs **something more of an explanation** as well, beyond being a metaphor.

Ehri stated, in her 1998 *Scientific Study of Reading* presidential address, that more is needed in…
"explaining the nature of **the connections that would allow** readers to retrieve from the visual forms on the page specific words in memory while bypassing all other words, including those having almost identical visual forms. The connections had to be systematic, easily learned, quickly activated, capable of handling thousands of words, and unique for each word."



"We (IDA) are thrilled that Dr. Scarborough has granted us permission to display the seminal Reading Rope in our gallery"

BIO on Linnea Ehri

Linnea C. Ehri earned her Ph.D. in educational psychology from the University of California, Berkeley, in 1970 and was a professor at the University of California, Davis, before coming to the Graduate Center in 1991 as a distinguished professor. She has received research awards from the American Educational Research Association (AERA), the National Reading Conference, and the Society for the Scientific Study of Reading (SSSR). From 1998 to 2000 she served on and was the primary writer of Chapter 2, Phonemic Awareness and Phonics, for the **National Reading Panel**, commissioned by the U.S. Congress to report on research-based **methods of teaching reading effectively to elementary students.** She has published more than 130 research papers in books and scholarly journals and has edited two books and served on editorial boards of eleven scientific journals.

Her research has contributed to our **understanding of psychological processes** and sources of difficulty in learning to read and spell. Her studies underscore the importance of beginning readers **acquiring knowledge of the alphabetic** writing system. One major finding is that **readers use their knowledge of grapheme-phoneme connections to retain sight words in memory**. She also has found that l**earning the spellings of words influences readers' conception of sounds in the words and helps them learn and remember new vocabulary**.

Research on Learning to Read and Spell: A Personal-Historical Perspective

Ehri delivered this presidential address at the annual meeting of the Society for the Scientific Study of Reading, March 1997, Chicago. **Ehri** provides a glimpse of her experiences conducting research on word-reading processes in beginning readers for more than 20 years. At the outset, **she proposed a theory that the spellings of individual words become bonded to their pronunciations in memory, and she conducted studies to obtain evidence for this theory**. This led her into various controversies with other researchers over issues such **as** whether phonemic awareness is a cause or consequence of learning to read and **to what extent beginning readers use visual cues or alphabetic cues to read their first words**. The disagreements proving most fruitful were those that spawned additional research. Disputes considered unproductive and even harmful were those involving dogmatic views not open to empirical evidence and maligning appellations intended to implant prejudice. This recounting of her career underscores the value of a systematic line of research as well as intensive discussion with other researchers.

Bio on Mark Seidenberg

Seidenberg has published many scientific articles in fine journals such as Science, Psychological Review, Nature Neuroscience, Language, Psychological Science, and was honored as one of the 250 most-cited researchers in the areas of psychology and psychiatry by those Web of Science citation-counting people. His reading research addresses the nature of skilled reading, how children learn to read, dyslexia, and the brain bases of reading, using the tools of modern cognitive neuroscience: **behavioral experiments**, **computational models**, and **neuroimaging**. His language research addresses what people know when they know a language, how this knowledge is represented in the brain, and how it is acquired and used.

> *I study language and reading, with the goal of understanding how these skills are acquired and used, and the brain circuits that support them. If at all possible, I'd like this research to make it easier for more people to become better readers, and for children who struggle with reading to obtain effective help. The idea is to provide supplementary language experiences early, when the child's plasticity for language is high. We can also use our computational models of reading to predict where dialect differences will interfere with progress, and how experience can be structured to improve performance.*

Here's more about what that means: For many years the study of language was dominating by theoretical linguistics, particularly syntax. More recently, there have been important insights coming from outside of traditional grammatical theory: from computational modeling, from studies of the brain bases of learning and neurodevelopment, from renewed interest in the statistical properties of language.

About Reading

The initial focus was on behavioral studies and the development of neural network models of normal and disordered acquisition. The research has now progressed to identifying anomalies in the development of neural circuits for reading, and how those anomalies interfere with reading and other behavior.

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