Comparing Research on How the Brain Learns to Read and Sight Word Instruction

A THESIS

Presented to

The Faculty of the Department of Education

The Colorado College

In partial Fulfillment of the Requirements for the Degree

Masters of Arts in Teaching

By

Laura Berg

July 2017

Abstract

Teaching sight words, particularly the Dolch and Fry lists, is standard practice when teaching beginning and remedial reading. Sight words are singled out for instruction because these high frequency words are necessary for fluent reading; the first 25 words constitute about 33% of the words we read in a text (Fry, 1957), so quick and accurate recognition is important. Many of these words are believed to be phonetically irregular, meaning they do not follow phonic rules, and this has led to the practice of teaching students to read these words "by sight," by memorizing their visual features and not relying on the sounds of the letters. This paper explores a question: should sight words be taught "by sight?" A review of the current theories and recent gains research has made in understanding how the brain learns to read and process words– including studies by Dehaene (2011); Ehri (2003); Farrell, Osenga, and Hunter (2013b) – suggests that it is time to review and reflect on the current standard practices for sight word instruction. Close evaluation reveals that the majority of sight words adhere to phonetic rules. Based on this knowledge, reading experts recommend teaching students to read sight words through letter-sound relationships using phonics-based instruction (Ehri,1998; Farrell, Osenga, & Hunter, 2013b; Dehaene, 2011; Laurita, 1966; Moats, 1999; Shaywitz, 2003).

Keywords: sight words, high frequency words, irregular words, Dolch Word list, Fry's Instant Word list, phonics-based, orthographic mapping, neural word form models, Broca's area, Wernicke's area, Visual Word Form area, left arcuate fasciculus, rote memorization, beginning readers, struggling readers, dyslexic readers.

A general standard of practice in kindergarten, first grade, and remedial instruction is to teach high frequency sight words. Also referred to as high frequency words, or irregular words, these are words that occur most often in text and often do not follow common phonetic patterns. Sight words are especially considered to be of value for new and struggling readers.

Sight words, more accurately termed high frequency words, have been a part of reading instruction since Dr. Edward William Dolch (1936) published "A Basic Sight Word Vocabulary" in the *Elementary School Journal*. Dr. Edward Fry developed his Instant Word list in the 1950s and updated the list again in 1980. Dolch and Fry based their lists on the most common words to appear in children's reading materials (Dolch, 1948, p. 98; Fry, 1957). These high frequency word lists have become classroom standards in reading instruction.

A commonly accepted practice is that sight words are necessary for struggling readers to master, and flash card drill and practice is the typical method of instruction. This instruction relies on visual orthographic memory. Even though sight word instruction is standard in every kindergarten and first grade classroom, there is a paucity of research evaluating the effectiveness of the methods for teaching them. Sight words, as a category, are generally considered non-decodable words. Teachers presume sight words must be learned through memorization since they do not follow phonetic rules. These words are taught almost exclusively through rote memorization, particularly flash card drill and practice. The typical student is capable of learning these words without too much trouble, however, practically every teacher who has instructed new or struggling readers has experienced the difficulty of helping some these students try to learn sight words. For 20 – 30% of students the process of learning these sight words is agonizingly slow, and after all that effort, students' ability to accurately recognize the sight words is unreliable (Dehaene, 2011; Shaywitz, 2003, Ehri et al., 2001). Students still

misread the words. Errors such as reading "was" instead of "saw," or "but" for the word "put," and "for" instead of "from." For struggling readers the experience is frequently tedious, unending, and frustrating. Studies show that impaired readers, and specifically dyslexic students, have weak activation in the Visual Word Form area of the brain, which results in poor visual orthographic memory (McCandliss, Cohen, Dehaene, 2003; Dehaene, Cohen, 2011; Shaywitz et al., 1998). Therefore, the prevalent sight word instructional approach of flash card drill and practice is inherently less effective for these students.

Current theoretical models of how the brain learns to read, investigations into reading processing, and brain imaging studies, have some contemporary reading researchers, Dehaene (2011), Ehri (2003), Farrell (2013b), Osenga (2013b), and Hunter (2013b), suggesting that it is time to reflect and review on what science is revealing about sight words and the best practices for their instruction. Have sight words, their instructional methods, and the content of the sight word lists reached the status of "tradition?" Is their instructional value, and teaching methodology, still valid?

This paper critiques the typical classroom instructional assumptions concerning sight words and presents some intriguing contemporary studies that relate to how the brain learns to read sight words and implications for their instruction. The question is – should *sight words* be taught "by sight?"

The History of Sight Words

In the field of education, word lists are a curriculum tool, providing recommended necessary vocabulary for a given subject. Reading instruction has a history of word lists to guide teachers, providing recommended vocabulary for a subject or words necessary for comprehension. Sight word lists are a classic example. Technically, any word that is stored in

visual memory and can be read automatically, without conscious effort or thought, is considered a sight word (Ehri, 2005). For the purposes of this paper, the term *sight word(s)* is used to refer specifically to words from the Dolch 220 and Fry's Instant Word lists (Appendices A and B). These are the specific words that have become curricular items used religiously in primary classrooms across the nation in efforts to improve reading instruction.

The origination of these particular sight word lists for reading instruction can be traced back to an educational resource published by Edward L. Thorndike, Ph.D., an American professor of Educational Psychology, who studied the learning process and taught at Teachers College, Columbia University (Encyclopedia Brittanica Online, 2005). Thorndike authored *The Teacher's Word Book* in 1921. *The Teacher's Word Book* contains an alphabetical list of the 10,000 words which occurred

> most widely in a count of about 625,000 words from literature for children; about 3,000,000 words from the Bible and English classics; about 300,000 words from elementary-school text books; about 50,000 words from books about cooking, sewing, farming, the trades, and the like; about 90,000 words from the daily newspapers; and about 500,000 words from correspondence. Forty-one different sources were used. (Thorndike, 1921, p. iii)

The 2,500 words with the highest frequency are also listed in the back of the book in order of most occurrences to least. This was not the first word list available for teachers, but Thorndike's list became widely adopted. The purpose of *The Teacher's Word Book* was to help teachers decide which words are important to teach and review based on their frequency in texts. Thorndike suggested this book be used to gauge the relative importance of words in order to make decisions about what words are worthy of instructional time and mastery, and what words

to simply explain quickly then move on to other lesson objectives (Thorndike, 1927, p. iv). Subsequent editions were published, *A Teacher's Word Book of the Twenty Thousand Words Found Most Frequently and Widely in General Reading for Children and Young People*, in 1932, and the final edition, *The Teacher's Word Book of 30,000 Words*, in 1944. Thorndike advised using these lists to help choose the most important words to emphasize during instruction based on the logical premise that words occurring in text more frequently are likely critical to the students' lexical knowledge and should be taught more thoroughly (Thorndike, 1927, p. iv). Learning to recognize these words instantly, or by sight, was not suggested as an objective. Rather, the objective of the Teacher's Word Books was to be a tool for the teachers to use as a vocabulary curriculum resource.

Dolch Sight Words

The concept of *sight words* was first promoted by Edward W. Dolch, Ph.D. A professor of Education at the University of Illinois, Dolch was the author of many academic texts and articles about reading, as well as numerous children's books. A proponent of the Look-Say, whole-word method of reading instruction, which teaches reading through matching spoken words to printed words and memorizing words by their shape, Dolch recommended teaching words by sight in first grade, along with consonant sounds, and to wait until second grade to introduce vowels and phonics instruction (Dolch, 1941). In his text, *Teaching Primary Reading*, Dolch (1941) advises that "to the beginner, 'knowing the words' means sight recognition. The child looks at the word form, and the word sound comes to his mind without his knowing either how or why" (p.196). To begin reading instruction with students, Dolch noted "the most widely used method … is 'learning what the lines say.' … The child has to guess what each line says, or be told by the teacher. He is then expected to repeat the lines from memory while looking at the

words" (Dolch, 1941, p. 84). Dolch further advises to draw the child's attention to the individual words to develop exact matching of sight and sound (Dolch, 1941, p. 84). In his book, *Problems in Reading*, Dolch includes a chapter which explains the processes for helping student obtain a basic sight word vocabulary.

Dolch decided to develop his word list to determine which sight words were of the most value to teach. In order to compile his word list, to guide sight word reading instruction, Dolch examined three different sources of word lists related to beginning reading instruction. These sources were detailed in *Problems With Reading* and included:

1. The Child Study Committee of the International Kindergarten Union (1928). A vocabulary list of 2,596 words found to be known by children in spoken language before entering Grade 1.
2. The Gates list (1926). A list of 1,500 words of use for teaching in Grades K–2.
3. Wheeler and Howell (1930). A list of 453 words found frequently in ten primers and ten first readers published between 1922 and 1929. (Dolch, 1948, p. 98)

After analyzing these word list sources, Dolch identified 220 words that, in his professional judgment, were most valuable for beginning readers based on their utility due to the high frequency they would be encountered in text. In 1936 he published this list of 220 words in the *Elementary School Journal* in the article "*A Basic Sight Word Vocabulary*." (Appendix A) The words selected include articles, prepositions, pronouns, verbs, adverbs, adjectives, and conjunctions but no nouns. He referred to these words as "tool words," and later as "service words," because they occur in all books, regardless of the content, whereas nouns are specific to the content of a book (Dolch, 1948, p. 101). He felt that, "Nouns cannot be of universal use because each noun is tied to special subject matter" (Dolch, 1948, p. 102). Dolch made a

separate list, "*The Dolch Noun List*," of the 95 most high frequency and important nouns for beginning readers (Table B). Dolch was very clear that he recommended not teaching nouns as sight words when he named the list "*95 Nouns Common to the Three Word Lists but Not Recommended for a Basic Sight Vocabulary*" (Dolch, 1948, p.103). Both lists were published in alphabetical order, as shown in appendices A and B. Dolch did not intend for the words on his list to be taught in alphabetical order, or in any other specific sequence. Instead, his objective, similar to Thorndike's, was to provide a tool to help teachers identify which words to teach.

Today, Dolch's *Sight Word List* is still a valuable tool in reading instruction because these 220 words represent over half the words found in printed English text and mastering them is essential to reading fluently (Lee, 2011). The words are generally introduced in order of overall frequency (Appendix C), or by the frequency in which they occur by grade level, with 40 – 50 words taught at each grade (Appendix D). The Dolch Sight Word List is one of the two most widely used word lists in primary and remedial reading instruction.

Fry's Instant Words

The other word list that is widely used today is the *Fry Instant Word List*, created by Edward Fry, Ph.D., a professor at Rutgers University in New Jersey, and author of several texts on reading instruction. Fry promotes a phonics-based approach to reading instruction, but also believes that it is important for beginning readers to master core vocabulary of common, high-frequency words by sight (Fry, 1999). He wanted to help classroom teachers and remedial teachers by giving them a research-based list for sight word instruction (Fry, 1980). Fry (1980) researched and compiled the *Instant Words*, in 1957, a work containing 600 of the most common words in English in roughly rank order based on scientific word counts by Rinsland, Dolch, Thorndike and Lorge, Fitzpatrick, and Faucett (Fry, 1957). The words selected are words that

occur so often in text that the first 25 comprise about 33%, and the first 100 make up about 50% of a typical text, so the importance of recognizing them is evident. He refers to these words as "Instant Words" because in order to read with fluency a student must be able to recognize these words instantly (Fry, 1957). Fry collaborated with Elizabeth Sakiey, in 1979, to update and expand his list, published as the *3000 Instant Words*.

In 1980, Fry simplified and revised the *3000 Instant Words* and published his work as *The New 300 Instant Word List* (Appendix C). This revised list was developed by reviewing and compiling lexical data from The American Heritage Word Frequency Book (Carol, Davies, & Richmond, 1971), which contains approximately 87,000 words ranked by frequency, determined by analyzing roughly 5 million words from sample texts. The text material was gathered from 1,045 books recommended for reading in grades three through nine in the United States (Farrell, Osenga, Hunter, 2016). Fry explains that the first 100 Instant Words and their common variants (meaning words with inflectional suffixes such as s, es, ing, ed, er, est) represent about half of the words we read in a given text; the first 10 Instant Words (the, of, and, a, to, in, is, you, that, it) make up about 24% of words in print; and the *300 Instant Words* make up about 65% of words in a text (Fry, 1980).

Fry wrote that "…beginning readers need to master a basic sight vocabulary of common words . . . such as the 600 Instant Words . . ." (Fry, 1980, p. 284). Fry recommended teaching the Instant Words in order of their frequency, and just a few words at a time, suggesting they be introduced at a rate of about 5 per lesson. He recommended teaching the Instant Words in complement to phonics instruction (Fry, 1997). The Instant Words are organized in groups of 100, with the average student expected to master the first 100 in first grade, the second 100 in second grade, and the third 100 in third grade. Instant Words 400-1,000 are to be learned in

grades four and above. Like the Dolch and Thorndike word lists, Fry's Instant Word List is intended to be a resource to aid the reading teacher's instruction, helping teachers quickly identify words that will be of great utility to the beginning reader. *Fry's Instant Word Lists* are widely used by primary grade teachers.

Currently, both the Dolch and Fry lists are widely used, practically interchangeably, to guide beginning and remedial reading instruction. Despite the different sources used to compile the lists, there are 70 words that are on both the first 100 Dolch and first 100 Fry lists. When the first 100 Dolch Words are combined with the first 100 Fry Instant Words, they form a list of 130 high frequency words. All 220 Dolch Words are included in the 1,000 Fry Instant Words. These words occur so frequently in primary text that their instructional value is obvious and mastering these words is essential to fluent reading. The first 220-300 words from these lists have become a staple of primary reading instruction. As recommended by Dolch and Fry, these sight words are taught to be read "by sight," by instant visual recognition. Dolch and Fry advised instructional methods such as look-say, memorization, flash cards, and repetition through games. Kindergarten, first grade, and second grade classrooms typically have these word lists posted on the wall, and they are practiced daily using the recommended techniques.

The Dolch and Fry sight words are such a staple of reading instruction, particularly for beginning and remedial readers, that there has not been much review of their content or instructional methods. However, the 2015 National Assessment of Educational Progress reports that sixty-four percent of U.S. fourth graders scored below proficient in reading, and an analysis of the Early Childhood Longitudinal Program data indicates that approximately thirty-seven percent of fourth graders are not proficient at reading sight words (The Nation's Report Card, 2015; Reardon, Valentino, & Shores, 2012). Student and teacher frustrations with mastering

sight words, low literacy rates, and recent research on how the brain learns to read, have caused some reading researchers, including Dehaene, Ehri, Farrell, Osenga, and Hunter, to reevaluate this traditional teaching practice. What does the current research say? Should *sight words* be taught "by sight?"

How the Brain Learns to Read

In order to knowledgeably address the question, should we teach reading *sight words* "by sight", we need an understanding of how the brain learns to read, especially how it processes words visually. It is interesting to reflect on the fact that reading is a very recent development for humanity. Reading is not an innate or natural process – the human brain did not evolve the ability to read the way it did for seeing, hearing, speaking, and even language development – though all these skills are involved in the reading process (Dehaene, 2011). Reading is a complex skill that must be learned.

Areas of the Brain

Most reading tasks are processed in the left-side hemisphere of the cerebrum, the largest part of the brain, where high level functions are processed (Dehaene, 2011). The cerebral brain structure has four main regions, segmented by distinct folds in the tissue, referred to as lobes. The first lobe, the frontal lobe, is located in the fore-section of the brain. To give a very generalized description of its function, the frontal lobe primarily houses judgment, intelligence, personality, emotions, body movement, and speech. Broca's area, which controls speech articulation, word forms-semantics, phonological awareness, and phonics-orthographic awareness and is highly engaged when processing words during reading, is located in the lower back of the left frontal lobe, specifically in the left inferior frontal gyrus. The parietal lobe, located in the upper back section of the left hemisphere of the brain, is the neural domain

primarily responsible for the sense of touch, spatial and visual perception, interpreting information from the senses, and interpreting language (See Figure A).

Figure A

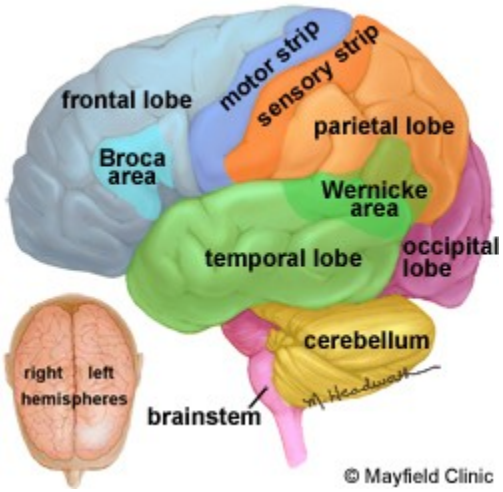


Illustration of the left cerebral hemisphere.

Figure from Mayfield Brain & Spine, 2017; *Anatomy of the brain.*

Retrieved from https://www.mayfieldclinic.com/PE-AnatBrain.htm

The temporal lobe sits under the left frontal and parietal lobes. This neural domain is responsible for memory, hearing, sequencing, organizing, and understanding language. A specialized region, called Wernicke's area, is located in the left parieto-temporal area (the upper posterior part of the left temporal lobe that extends into the parietal lobe). Wernicke's area is an important language comprehension, semantics, and processing center that is actively engaged when analyzing words during reading. The fourth lobe is the occipital, located at the lower back of the brain. The left occipital lobe interprets visual information and houses the Visual Word Form area, in the left occipito-temporal region, a critical area utilized for rapid, skilled reading. Each lobe performs several functions and the lobes operate together in many complex ways, but areas have also

become highly specialized. The brain primarily relies on three specialized regions for the reading process. Two regions, Broca's area and the Wernicke's area, are primarily utilized for processing words and learning to read. The third region, the Visual Word Form area, is used for rapid, "by-sight," reading (See Figure B). Successful reading is dependent on effective communication between the regions (Shaywitz, 2003).

Figure B

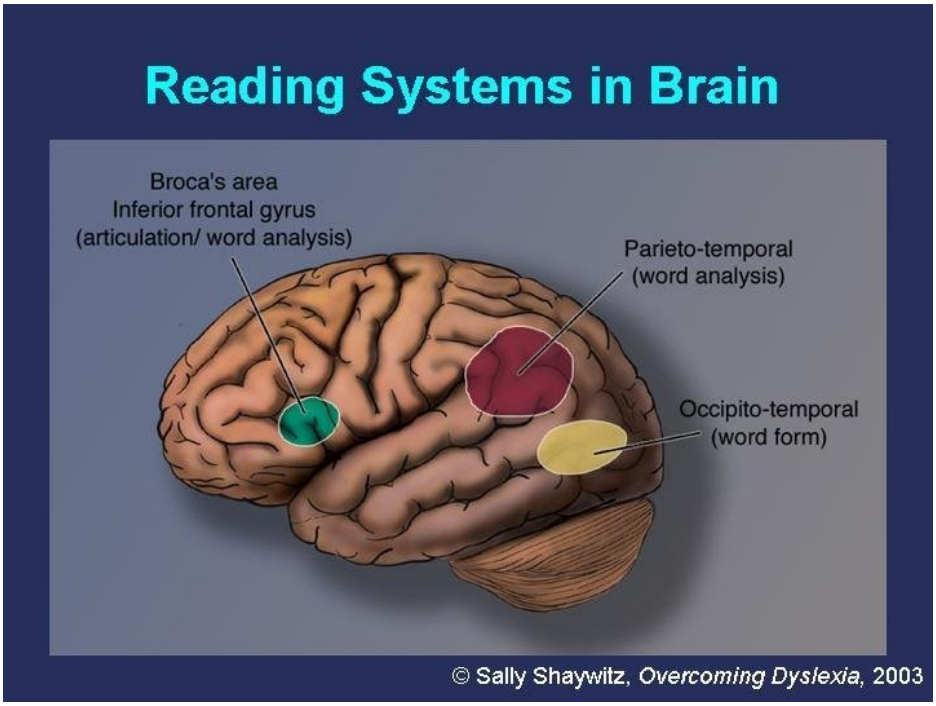


Figure from Sally Shaywitz; *Overcoming Dyslexia: a new and complete science-based program for reading problems at any level – 1st edition.* Knopf/Random House, New York, 2003. Retrieved from Liz Dunoon; *"What is dyslexia?";* August 2014; https://www.dyslexiadaily.com/blog/what-is-dyslexia

The Reading Process in the Brain

People commonly conceptualize reading as a visual process, imagining that the brain sees the printed word then matches it with the correct sound and meaning. This is indeed how reading works – but only after painstaking phonemic analysis and extensive practice. Learning to read follows a predictable developmental process. Initially the typical child will learn a limited number of words by visual-shape recognition, just as people imagine; this type of cue reading is similar to learning to "read" a McDonald's sign. However, reading by relying exclusively on visual cues for each word is ultimately unsuccessful (Ehri, Nunes, Stahl, & Willows, 2001; Ehri, 1987). This strategy is fundamentally limited because "with each new word, the difficulty of finding a unique cue to distinguish it will increase, the child will make an ever-increasing number of errors, and his reading will become more and more halting and confused" (Gough & Hillinger, 1980, p. 183). Studies suggest that children can learn up to approximately 40 words using the visual cue method before they shift to letter-sound mapping strategies (Gough & Hillinger, 1980, p. 183). True reading, being able to recognize a word in any font, in any context, automatically recognizing known words by sight and deciphering unknown words, is accomplished by processing the individual letters in words and the sounds they represent. This skill is based on knowledge of the oral language being read and must be learned.

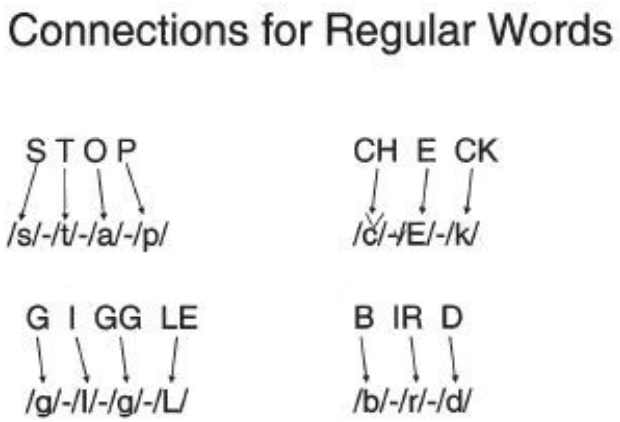
"It is important to note that when children first encounter text, they process it through the right hemisphere, which makes a gestalt or overall picture of the experience" (Preschern, 2017, para. 12). Phonics-based reading instruction changes the structure and functioning of the brain; through increased phonemic awareness, orthographic awareness, and vocabulary enrichment, reading proficiency stimulates structural changes in the brain to develop efficient print processing abilities in the left hemisphere, where the brain's language processing centers are

located (Linkersdörfer et al., 2016). Learning to read actually begins at the phoneme level. Children must first become aware of the fact that words are composed of individual sounds, which researchers refer to as phonemes. Children also need to be exposed to letters and become familiar with the sounds they represent. Once these skills are understood, the child can learn to identify discrete sounds in words and link the sounds to letters. Understanding this alphabetic principle is the beginning of the actual process of reading.

The accepted hypothesis of how the brain learns to read is that the parieto-temporal region of the brain, Wernicke's area, painstakingly analyzes words letter-by-letter, making phonetic associations to sounds and using morphological knowledge to understand a word, creating an orthographic map of the word (See Figure C, Ehri, et al., 2001; Shaywitz, 2003). When beginning readers sound out new words, by sub-vocalizing, whispering, or saying aloud words and letter sounds, they activate Broca's area, located near the front of the brain, in the left inferior frontal gyrus. Broca's area processes the functions of word articulation, which is a multi-sensory coordination of language and oral speech production, word forms and semantics, phonological awareness, and phonics, also known as orthographic awareness (Shaywitz, 2003). It generally takes the parieto-temporal area multiple such encounters with a word to form a secure and accurate orthographic mapping which is linked to a neural word form model; research suggests a typical learner needs to practice a word repeatedly before the brain forms an orthographic map of that word (Ehri, 2005). The neural word form model is a widely dispersed web of information and experiences with the word being read. Some words, like "food" activate vast networks of related information, phonetic knowledge, and understanding. Less familiar words will activate small, shallow, and often inaccurate, networks of understanding (Dehaene, 2011). The orthographic map, with its links to the neural word form model, is then stored in the

left occipito-temporal region, also known as the Visual Word Form area (Shaywitz, 2003, Dehaene, 2011).

Figure C



Representation of orthographic mapping, the capital letter groups on top represent the printed word read, the phonetic symbols between hyphens below represent the sounds of the words stored in memory. The connecting lines illustrate how the printed letters are "mapped" to the sounds.

Figure from Ehri, L. C., Nunes, S. R., Stahl, S. A., & Willows, D. M. (2001). Systematic phonics instruction helps students learn to read: Evidence from the National Reading Panel's meta-analysis. *Review of educational research*, *71*(3), p. 171.

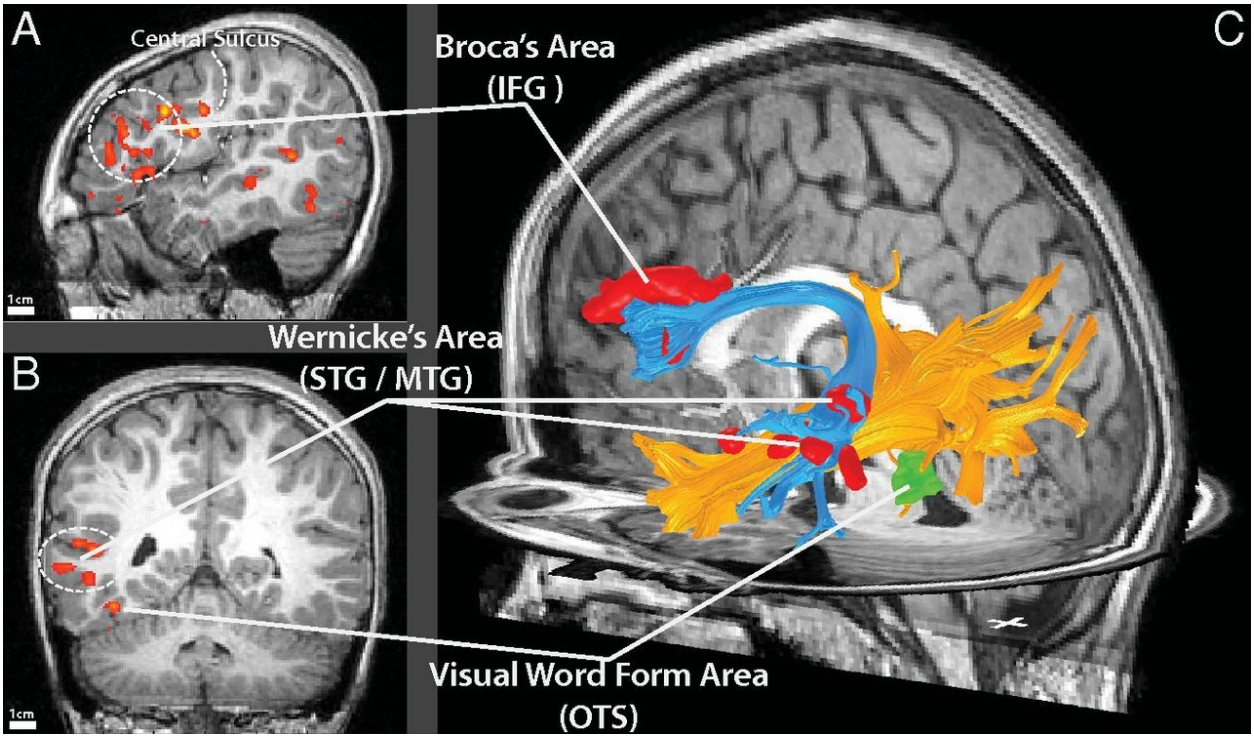
The Visual Word Form Area

The Visual Word Form area is located near the back of the brain, in the left occipito-temporal region where the occipital and temporal lobes merge. This is the part of temporal cortical region that is closest to the parietal-temporal area where words are analyzed and decoded. This localization is consistent across all cultures that read, with all forms of script, whether alphabetic or character-based (Dehaene & Cohen, 2011). As mentioned at the beginning of this discussion, the brain did not evolve to read, so how is there a region of the brain specialized for recognizing print? Researchers hypothesize that the innate functional abilities of this region of the brain, which houses a visual system evolved to respond to the optical stimuli of simple basic shapes – such as T junctions, circles, and intersecting lines – became attuned to learned letters through experience-dependent adaptation (McCandliss, Cohen, Dehaene, 2003; Dehaene, 2011). It is probably not entirely coincidental that many of the alphabets of the world reflect those same primal shapes (Changizi, Zhang, Ye, & Shimojo, 2006). Researchers speculate that we "recycled this ancient capacity by specifically selecting letter shapes that fit with this pre-existing cortical architecture" (Dehaene, 2009, p. 22). New and illiterate pre-readers do not initially exhibit specialization of the Visual Word Form area; however, after direct reading instruction using an explicitly taught phonics-based program, cognitive neuroimaging shows functional changes in the brain and the development of a specialized response to print in the Visual Word Form area (Dehaene, 2011).

The Word Form area is not utilized for learning to read. Letter-by-letter reading, such as done by a beginning reader, an impaired reader, or a normal reader encountering rotated or distorted print, is a function of Wernicke's area and the parieto-temporal region (Dehaene & Cohen, 2011). Through continuous practice of letter-sound relationships, the parietal-temporal system (Wernicke's area) analyzes words in a process called orthographic mapping. Through the

orthographic mapping process the occipito-temporal system (Visual Word Form area) is increasingly incorporated. The orthographic mapping process also generates links to the neural word form model, the network of knowledge associated with the word, which are efficiently retrieved through the Visual Word Form area, eventually resulting in automatic and fluent reading performance (Linkersdorker et al., 2014; Pugh et al., 2001).

Figure D



Yeatman, J. et al. (2012). Development of white matter and reading skills; *Proceedings of the National Academy of Sciences.* Boston Interactive, HighWire Press, Online ISSN 1091-6490. Retrieved from http://www.pnas.org/content/109/44/E3045/F1.expansion.html

Research has identified two primary physical connective pathways in the brains of skilled readers, the arcuate fasiculus (Shown in blue in Figure D. National Academy of Sciences, 2017) and the Inferior Longitudinal Fasciculus (ILF, shown in yellow in Figure D, Yeatman, J. et al. 2012). These structural connections are formed from white brain matter generated by repeated

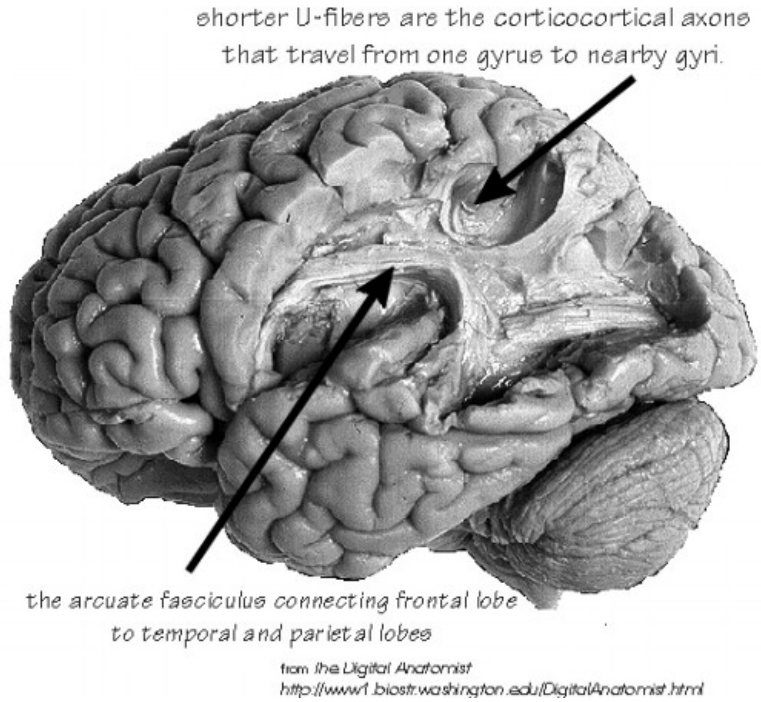
usage of the neuropathways. The arcuate fasiculus connects Broca's area to Wernicke's area, physically linking the phonics-orthographic awareness center with the comprehension processing center. The Visual Word Form area is physically connected to the Broca's and Wernicke's areas by the ILF connective pathway (Preschern, 2017; Kershner, 2016; Zhoa, et al., 2016; Yeatman, J. et al. 2012).

In Figure E, the structural connections of the arcuate fasiculus and the ILF look like pathways linking the different areas of the brain. Brain studies show these pathways become more defined as children grow (Preschern, 2017; Kershner, 2016; Dehaene, 2011).). Learning to read requires a bidirectional dialogue in the brain, between coding for letter strings in the visual regions, and coding the phonological segments of speech in the auditory regions (Dehaene, 2011). These neural pathways are developed and matured through the process of reading, and they become more defined and efficient through usage and practice. The rapidly integrated functions between the reading processing centers of the brain, made possible through the arcuate fasiculus and the Inferior Longitudinal Fasciculus neural pathways, are the biological nexus of skilled reading.

Interestingly, these reading induced changes only occur with a systematic attention to the correspondences between print and speech sounds, also known as phonics-based reading instruction (Dehaene, 2011). Recent brain studies have revealed that the left arcuate fasiculus is underdeveloped in individuals with dyslexia (Kershner, 2016; Dehaene, 2011, Zhao, de Schotten, Altarelli, Dubois, & Ramus, 2016). This physical pathway directly connects Broca's area to Wernicke's area and is crucial for processing high-level phonemic and phonological tasks, indicating the possibility that diminished neural communication pathways are associated with their reading disability (Kershner, 2016). It is unknown if this deficiency is a cause or result of

exhibited reading deficits, but the correlation is clear (Kershner, 2016). Furthermore, intensive remediation that develops reading proficiency has been shown to affect the structure of the brain, stimulating growth of underdeveloped areas in dyslexic students (Linkersdörfer et al., 2014).

Figure E



Interactive Atlases Digital Anatomist Project, Department of Biological Structure, University of Washington. (2000). Arcuate Fasciculus Disection. Retrieved from Preschern, J. (2017). Learning disabilities, brain research guides the way for dyslexia causes and treatment, Speech Language Literacy Lab blog. Retrieved from http://www.sl3lab.com/new-blog/

The Visual Word Form area is uniquely specialized for reading; it identifies words literally by sight. When reading, the eyes scan seven to nine letters at a time, scanning forward and back, with frequent fixations to focus. A beginning reader may fixate up to 224 times per 100 words while examining the letters, bigrams, and morphemes (Rayner, Li, Williams, Cave & Well, 2007). Once the word elements are identified, the orthographic map is assembled and recognized, activating the stored neural word model (Dehaene, 2011). Orthographic mapping of

a word is a component of its neural word form model, which is the formation of the complex web of relationships between a combination of letters, phonic patterns, sound units, and meanings, that is developed as a reader processes a word in print. These connections are retained in memory along with pronunciations, conceptual associations, visual features, and other relevant information and are instantly activated when a word is recognized by the Visual Word Form area, allowing readers to recognize the word by sight (Ehri, 1985; Ehri 2005). Note, however, that the Visual Word Form area is activated by the sight of words and word parts already stored as neural models, words that have previously been analyzed by the parieto-temporal region repeatedly and learned through orthographic mapping and the development of a neural word form model. Reading instruction, guiding the learner to associate letters and phonic patterns to the sounds of words, builds the neural word form models and pathways that make this efficient, visual-route for reading possible. Skilled readers have built a vast wealth of stored neural word form models, enabling them to read rapidly. Functional MRI studies show, while reading, these skilled readers demonstrate the most brain activation in the Visual Word Form area, and less activation in the Wernicke's and Broca's areas of the brain while reading (Shaywitz, 2003).

The Visual Word Form area is structurally and functionally developed through reading instruction. The better the reader, the more they utilize the Visual Word Form area, and as reading skills increase this region of the brain becomes more responsive to written language and less responsive to faces, line drawings, and even print in unfamiliar languages. The Visual Word Form area adapts so completely that it seamlessly integrates script and capitalization, allowing the reader to automatically "recognize a word like radio, RADIO, or *radio*, regardless of its exact font, size, and location" (Dehaene, 2011, p. 21). Some other examples of the site's powerful specializations include the ability to recognize bigram frequency, which are the "statistics of

letter pairings in the participant's language" (Dehaene & Cohen, 2011, p. 256). This region also develops sensitivity to orthographic word units in the reader's language (Dehaene & Cohen, 2011). In addition, the Visual Word Form area seems to "unlearn" mirror invariance; the disregard for object directionality, during reading acquisition, and "distinguishes between words and their mirror images – an indispensable feature given the presence of mirror letters such as b and d in Latin-based alphabets – but remains mirror-invariant for pictures and faces" (Dehaene & Cohen, 2011, p. 256).

Struggling Readers

This model of how the brain learns to read is true for the typical reader. Most beginning readers, approximately 70%-80%, learn these letter-sound connections without too much difficulty, provided they receive effective instruction (Dehaene, 2011; Shaywitz, 2003, Ehri et al., 2001). However, many students will still struggle; it is estimated that 20% of all students are affected by dyslexia (Shaywitz, 2003). Dyslexia is a specific learning disability of neurobiological origin that is thought to be the result of a phonological processing deficit and is characterized by slow, inaccurate reading and difficulties with decoding that are unexpected in relation to the individual's other abilities. Functional MRI studies have shown that the brains of dyslexic and struggling readers do not follow the typical neurological reading process (Shaywitz, 2003; Dehaene, 2011). Dyslexic readers utilize the Visual Word Form area much less than typical readers do (Dehaene & Cohen, 2011; Kershner, 2016; Shaywitz, 2003). "Interestingly, Visual Word Form area specialization fails in dyslexic children, although whether this is a cause or a consequence of the reading deficit remains uncertain…" (Dehaene & Cohen, 2011, p. 259). "Adults with a history of developmental dyslexia demonstrate a reduced tendency to activate the Visual Word Form area, [… this may] reflect the absence of a specialization that accrues over

the course of years of successful reading experience" (McCandliss, Cohen & Dehaene, 2003, p.298). Similar to beginning readers, individuals with dyslexia over-rely on the Broca's area and the parieto-temporal region to read. Dyslexic readers predominantly use letter-by-letter and sub-vocalization techniques and have little access to the automatic, by-sight, recall abilities of the Visual Word Form area (Shaywitz, 2003; Kershner, 2016; Dehaene, 2011). This neural pathway pattern is consistent for dyslexic readers of all ages and languages, even after they become accurate, yet slow, readers (Shaywitz, 2003; Dehaene, 2011; Kershner, 2016). In addition to a great reliance on the Broca's area, dyslexic readers also activate areas on the right side of the brain for reading that normal readers do not utilize. As mentioned in the previous section, another characteristic of dyslexic and struggling readers is that the communication pathways between the reading processing areas of the brain are underdeveloped (Kershner, 2016). The physical structure of the left arcuate fasciculus is smaller than for normal readers. Again, whether this is a cause or result of their disability is unclear. Why the dyslexic brain is unable to properly utilize the Visual Word Form area is not understood, but their widely-distributed, frontal-lobe, compensatory neurological path for the reading process is very inefficient and helps explain why reading is such a laborious process for a dyslexic reader (Shaywitz, 2003; Kershner, 2016).

It is interesting to note that there are two types of poor readers: dyslexic readers, born with the inefficient neurological path for reading, and struggling readers who are born with typical neurological reading pathways that do not function properly, perhaps due to a disadvantaged developmental environment or poor instructional experiences (Ehri, Nunes, Stahl, & Willows, 2001; Shaywitz, 2003). Both of these poor readers are unable to utilize the efficient Visual Word Form area effectively and struggle to read via the labor-intensive combination of

parieto-temporal, atypical right-brain, and Broca's areas. The good news is that with direct, early, multisensory, intensive phonics-based intervention it is possible to re-direct the neurological processes of a struggling reader to utilize the more efficient reading pathways, enhance the development of the left arcuate fasciculus, and remediate the reading difficulties (Ehri, 2014; Birsch, 2011; Dehaene, 2011; Shaywitz, 2003; Ehri et al., 2001; Kershner, 2016). Studies with fMRI images of poor readers have shown that the inefficient dyslexic reading pathway can be re-trained through intensive, direct, explicit, phonics-based, systematic, multisensory reading remediation; these students can be taught to develop and utilize the Word Form area for reading (Shaywitz, 2003; Kershner, 2016; Penolazzi, Spironelli, Vio, & Angrilli, 2010).

Research studies with remediated readers provide evidence that the core problem with dyslexic and struggling readers is the phonologic skill of correlating print to sounds (Shaywitz, 2003; Dehaene, 2011; Ehri et al., 2001; Penolazzi et al., 2010). The studies indicate that, for poor readers, reading "by sight" using the Visual Word Form area of the brain, is difficult and limited unless intensive phonics-based instruction lays the pathway to make it possible (Shaywitz, 2003; Ehri et al., 2001). In order to initiate typical neurological functioning in dyslexic and struggling readers they must be provided direct and explicit instruction in phonics to utilize the typical neurological reading pathways that engage and activate the Visual Word Form area (Shaywitz, 2003; Dehaene, 2011; Ehri et al., 2001; Ehri, 2014).

With repeated use and practice, neural pathways develop in the brain structure to facilitate communication between the three reading centers of the brain, resulting in automatic and fluent reading. Through the processes of creating orthographic maps and developing neural word form models the learner develops the ability to read "by sight." Most readers, with

adequate instruction, learn to read without excessive effort; however, struggling readers, especially those affected by dyslexia, have very poor access to the efficient Visual Word Form area; as a result they are frequently unable to recognize words by sight. Research shows that poor readers' neurological reading pathways can be developed and re-trained through intensive reading instruction that can reshape the brain's reading processing patterns, making it possible for poor readers to utilize the Visual Word Form area more effectively and significantly improve their ability to read (Shaywitz, 2003; Dehaene, 2011; Ehri et al., 2001; Birsch, 2011; Ehri, 2014; Kershner, 2016). With this insight to the brain's neurological pathways of how the brain learns to read, it is time re-examine the original question: should *sight words* be taught "by sight?"

Applying Brain Research to Instructional Practices

Standard reading curriculum programs and instructional practices include sight word instruction, particularly for beginning and remedial readers. Sight words are universally considered to be a valuable component of a complete reading program. The essential elements of an effective reading program include direct, systematic instruction in phonemic awareness, phonics, decoding words, spelling, sight words, vocabulary, comprehension strategies, and fluency training; guided practice of all the aforementioned skills; and enriching language experiences (Shaywitz, 2003, Ehri et al., 2001). Reading programs for beginning and struggling readers typically recommend introducing 5 to 10 sight words a week, allocating one to five minutes for sight word instruction daily. Sight words are singled out for separate instruction from general reading for two reasons: they are words that are extremely useful to know because the first 300 sight words represent about 65% of all written material, and as a group they are considered to be generally phonetically irregular and not decodable (Fry, 1980). For these two reasons, it became standard practice to teach sight words separately and instruct them to be

recognized by their visual features and memorized (Ehri, 2005; Wilson Language Training Corporation, 2006). Sight words are taught to be read "by sight," a "see and read, look - say" approach that utilizes instructional techniques such as flash card memorization, frequent re-reading (in lists, sentences, and text), repeated review and practice through games (flash card go-fish, concentration, and bingo), word search puzzles, songs, building the words with manipulatives, spelling practice, matching, tactile finger writing, and sky writing (KindergartenWorks, n.d.; Wilson Language Training Corporation, 2006; Wilson Language Training, 2013; Pinnell, G. S. & Fountas, I., 2009a; Sightwords, n.d.: Fry, 1984).

An example of current recommended sight word instructional practices is found in the program *Take Flight: A Comprehensive Intervention for Students with Dyslexia*, a researched-based, tier 3 remediation curriculum. This structured, phonics-based approach provides carefully sequenced lessons to guide students to discover discrete relationships between letters, sounds, and word patterns. Each phonetic relationship is explicitly taught using multisensory instructional techniques and linkages. The students are taught to code all new words using phonetic symbols. Controlled phonetic spelling is also taught to reinforce word knowledge structure. These instructional methods are supported by research of how the brain learns to read. For sight word instruction the *Take Flight* program teaches the first 300 words from *Fry's Instant Word List* but *Take Flight's* recommended instruction for these words is very different from the rest of the curriculm. *Take Flight's Instant Word* instruction includes teacher modeling of how to read the words and the student echoing the teacher, without the teacher or student sounding the words out. This process is repeated for four lessons in four different formats: words on flash cards, words in columns, words in rows, and words in phrases and sentences. Teachers are explicitly instructed to not code the words phonetically or allow sounding out. Sky-

writing is permissible. Students are also instructed to practice the word lists at home with a parent using the same procedures. For continuing reinforcement, the words are reviewed again in one or two weeks using the same four day format and procedures; additionally, the instant words are continually incorporated into the controlled text used for the following lessons (Avrit, K., 2013).

The Wilson Reading Program is also research-based and directly teaches the structure of words in a sequential, cumulative system, beginning with phoneme segmentation with emphasis on decoding and spelling word patterns – except for high frequency words. The Wilson Reading Program instructs that high frequency words are to be memorized. The program explains that while some high frequency words are decodable, many are irregular or contain word patterns that have not yet been taught, which is why they are to be recognized by sight using gross motor memory techniques such as skywriting, tactile motor memory through finger writing, and daily flash card review (Wilson Language Training, 2013).

The Pinnell and Fountas program, *Leveled Literacy Intervention*, offers another example of current practices recommended for teaching sight words. Teachers are directed to introduce one or more high-frequency words per lesson using the following techniques – read with students in context, read with students on word cards, play games with the word cards, make the words with magnetic letters, review words using visual matching, practice writing the words quickly in various ways (bigger, smaller, faster) with the goal to write the sight word quickly and automatically – all to promote instant recognition when the word is read (Pinnell & Fountas, 2009a). Interestingly, for teaching regular word patterns – like consonant-vowel-consonant and vowel-consonant-silent e – Pinnell and Fountas emphasize the importance of teaching word patterns and phonograms, then guiding students to look for these patterns, pointing out that

"…readers will struggle if they work on words only as strings of letters. They must learn to make connections between words rather than see each as an isolated unit to be memorized" (Pinnell & Fountas, 2009b, p. 235). The contrast between that advice and the recommendations just above, to instruct high-frequency words with word card repetition and swift re-copying, is interesting.

This contradiction between research validated phonetic reading instruction and recommended memorization practices for teaching sight words is prevalent and widely accepted because it is generally assumed that sight words typically do not follow phonetic rules and are not decodable. All these memorization techniques are widely accepted; all of these techniques are used in highly regarded reading curriculum programs and research-based intervention programs; all these techniques rely on learning sight words using visual properties, often facilitated by mnemonic, auditory, tactile, and kinesthetic activities. It is widely believed that readers memorize "associations between visual features such as the shapes of words and their meanings. This was one justification for the look-say, whole-word method of teaching reading" (Ehri, 2005, p. 170).

However, scientific studies have shown this model is incorrect; research findings suggest that "readers learn sight words by forming connections between letters in spellings and sounds in pronunciations of the words" (Ehri, 2005, p. 170). "The brain uses these connections to bond spellings of the words to their pronunciations and meanings … which functions as a powerful mnemonic" (Ehri, 2005, p. 167). The letter-sound relationships create the orthographic mapping that enables […] the visual route to reading (See Figure C, Ehri, 2005) (Ehri, 2005; Dehaene, 2011; Shaywitz, 2003; Ehri & McCormick, 1998). Research on how the brain learns to read indicates that the Visual Word Form area in the brain allows a person to read by sight through

the activation of the word form models accessed there. These connections and associated meanings are stored in memory to enable the reader to recognize the word (Dehaene, 2011, Ehri & McCormick, 1998). After multiple activations, connections between the letters, sounds, and meanings become firmly bonded, creating an orthographic map linked to a neural word form model which is accessed in the Visual Word Form area where the "sight of the word immediately activates its pronunciation and meaning" (Ehri & Wilce, 1985, p. 6). In addition to using letter-sound connections to encode and store neural word form models, "the process of accessing them in memory is […] phonological in that [letter-sound] connections are rapidly activated to retrieve pronunciations and meanings in memory" (Ehri, 2005, p. 182).

The process of learning to read words so they can be recognized instantly by sight is not dependent on the shape of the word or memorizing the word's visual imprint. Learning to read a word has three phases, first, the reader begins to create an orthographic map of the word by connecting the letter-sound relationships with the meaning and pronunciation of the word using primarily the Broca and Wernicke areas of the brain to process the information. This phase of reading is slow, and at this stage novice readers are prone to confusion between similar words and letter reversal errors. In the second phase, repeated practice, the orthographic mapping becomes securely developed and the neural word form model of the word is linked and refined in the specialized Visual Word Form area. The word is now recognized automatically as a whole unit. The final phase in the process occurs when the word form model is consolidated in memory, allowing the word to be identified and read with increasing speed (Ehri, 1987, p. 8). "[D]uring reading of a single word, millions of hierarchically organized neurons, each tuned to a specific local property (a letter, a bigram, or a morpheme), collectively contribute to visual recognition. This massively parallel architecture explains the speed and robustness of visual

word recognition. Most importantly, for educators and teachers, it creates an illusion of whole-word reading" (Dehaene, 2011, p. 23). Orthographic mapping is a letter-by-letter, sound-by-sound connection and cannot be circumvented to store word form models in the Visual Word Form area. Whenever incorrect or incomplete neural word form models are developed then reading is adversely affected. If the Visual Word Form area has not consolidated a word form model then the reader is still in phase one, using letter-by-letter reading, which is subject to mirror image confusion, sequencing errors, similar-word confusion, and slow word recognition (Ehri, 2005; Dehaene, 2011; Shaywitz, 2003).

The visual recognition, learn by sight, model is not supported by research (Gough & Hillinger, 1980; Barron, 1986; Ehri, 1987;; Ehri & Wilce, 1985; Ehri, 2005; Moats, 2007). Instead, studies show that "instructional procedures which encourage the use of the whole word route, such as look-say, tend to be ineffective in promoting orthographic segmentation, phonemic analysis skills," that are the basis of orthographic mapping (Barron, 1986, p. 113). Instruction that emphasizes memorization of only the visual properties of words is not only counter to what research advises; but it also encourages "guessing" instead of decoding and fosters confusion between words with similar letters (Ehri & Wilce, 1985). Other research indicates that "visual associations are harder to remember than phonetic associations" (Ehri, 1987, p. 21). Some research has even indicated that "instruction in visual processing of words is … a waste of time… because effective visual processing is thought to result from an effective phonetic letter-storage mechanism rather than from direct instruction on the visual properties of words" (Ehri & Wilce, 1985, p. 177). Even worse, these authorities suspect, and some firmly assert, that teaching beginning and struggling readers to read "by sight" is detrimental to their reading development and inhibits their brains from developing efficient reading processes (Ehri, 1991;

Ehri,1998; Farrell, Osenga, & Hunter, 2013b; Dehaene, 2011; Laurita, 1966; Moats, 1999; Shaywitz, 2003). Dr. Stanislas Dehaene, a leading researcher in the field of reading and the brain, explains that "[e]arly research on reading erroneously supported the whole-word approach – and [now] recent research on the brain's reading networks proves it wrong" (Dehaene, 2011, p. 9). Dehaene advises against teaching reading by visual recognition techniques and is a powerful advocate of the phonics approach to reading instruction because of three major points of scientific research evidence that converge to support the grapheme-phoneme model of reading acquisition and development. First, research shows that the reading brain uses letters, groups of letters, and morphemes to recognize words; the theory that words are recognized by their shape or as a whole unit is not supported by the evidence. Second, experiments in which adults were taught to read a pseudo script showed dramatic differences in brain processing and skilled reading. The adults taught with whole-word techniques utilized the inefficient right hemisphere pathways. Only the adults taught using grapheme-phoneme approach activated the Visual Word Form area when processing the pseudo script and were able to decode novel words effectively. Third, a body of reading research experiments, brain studies, and theoretical reading models align with school-based research studies that indicate "the inferiority of the whole-word approach in bringing about fast improvements in reading acquisition" (Dehaene, 2011, p. 26-27).

Considering the above expert opinions, brain studies, the theoretical model of how the brain learns to read, and the research-based instructional practices reviewed, the question can be fully addressed: should *sight words* be taught "by sight?" The answer from researchers, experts, and evidence from studies seems to indicate a resounding, "No!" This discussion now turns to the next logical questions: why are *sight words* still taught "by sight?" Are there any research supported recommendations for how to teach high-frequency words?

Research-based Recommendations for Teaching Sight Words

Research clearly indicates that we should not teach new and struggling readers to read *sight words* "by sight." Unfortunately, sight words are ingrained in our current reading programs and educational practices due to several reasons. Past promotion by experts such as Thorndike, Dolch, and Fry made teaching *sight words* "by sight" the recommended practice. Memorization of sight words has been the standard methodology for so long its efficacy is accepted as fact, despite the lack of research to support it. Now that research evidence clearly indicates that the memorization of sight words should be abandoned, several researchers and education experts are attempting to address the issue of how sight words are taught through educating teachers, publishing research findings, and promoting the phonetic instruction of sight words (Ehri, 1998; Farrell et al., 2013b; Dehaene, 2011; Laurita, 1966; Moats, 1999). National, state, and individual organizations – the National Right to Read Foundation, the Reading Reform Foundation of New York, and the Blend Phonics National Educational Reform Campaign – are campaigning to educate teachers about the negative impact of teaching sight words through memorization and to encourage teaching through phonics-based instructional practices exclusively (The National Right to Read Foundation n.d.; Reading Reform Foundation of New York, n.d.; Blend Phonics Nationwide educational reform campaign, n.d.; The Phonics Page, n.d.). Additionally, a number of educators and organizations are developing and sharing instructional models for teaching sight words phonetically in order to help change the misguided "by sight" teaching practices (Farrell et al., 2013b; Potter, D., n.d.; , Brown,E., n.d.; The National Right to Read Foundation n.d.; Reading Reform Foundation of New York, n.d.).

So, how should *sight words* be taught? The Second Edition of the 20-volume *Oxford English Dictionary* contains 171,476 entries for words currently in use. The Dolch Word List

and Fry's 1,000 Instant Words account for only 1,000 of these words, so how are the other 170,476 words taught? They are effectively taught through research-based, direct instruction in phonics words (Ehri, 1998; Farrell et al., 2013b; Dehaene, 2011; Shaywitz, 2003; Birsch, 2011; Gough & Hillinger, 1980; Moats, 1999; Avrit, 2013; National Reading Panel (US), National Institute of Child Health, & Human Development (US)., 2000). To identify effective, research-based instructional practices, Congress formed the National Reading Panel in 1997 to conduct a meta-analysis of over 100,000 reading studies on how children learn to read. The meta-analysis sought to determine the most effective evidence-based methods of reading instruction. (National Reading Panel, NICHHD 2000). The National Reading Panel's research analysis reveals that the best instructional practices for reading incorporate direct instruction including the following components: specific instruction in phonemic awareness; explicit systematic phonics instruction, guided oral reading, and strategies to enhance comprehension skills (National Reading Panel, NICHHD 2000).

Sight words can, and should, be taught using these same research-based practices as well (Farrell et al., 2013b; Potter, D., n.d.;, Brown,E., n.d.; The National Right to Read Foundation n.d.; Reading Reform Foundation of New York, n.d.). Before beginning instruction it is imperative that students know all the letter names involved (Farrell et al., 2013b). Orthographic mapping is impossible without knowledge of letters. Despite the perception that most sight words are not phonetic, in fact a significant percentage of the Dolch 220 Word List and Fry 300 Instant Words are phonetically regular and decodable. Following are four examples of instructional models for teaching sight words using phonics.

Linda Farrell, M.Ed., and Michael Hunter, M.Ed., authors of the research-based Phonics Boost and Phonics Blitz reading curriculums, literacy consultants, and founders of the online

reading resource site Readsters.com, observe that even though schools adopt systematic phonics-based reading instructional practices, the *sight words* are still taught through memorization techniques (Farrell et al., 2013b, p. 1). Farrell, Osenga, and Hunter (2013b) promote that *sight words* be taught using sound-symbol relationships and therefore they designed an instructional model that organizes these high frequency words by spelling patterns to integrate their instruction into phonics lessons. Farrell, Osenga, and Hunter (2013b, p. 2) recommend not teaching any sight words until students know all the letter names, because students will struggle to learn words that contain letters they cannot even identify. Farrell, Osenga, and Hunter divide the Dolch 220 Word List into two categories, phonetically decodable and irregular. They identify 138 of the Dolch words as having regular phonic patterns, which constitutes 63% of the 220 words on the list (Farrell et al., 2013b, p. 3). Next they restructure the words into three tables of words composed of 17 lists sorted by phonic patterns; the first table contains the 138 words that use standard phonic patterns, a second table contains 45 words that follow less-well known phonic rules, 20% of the total; and a third table contains 37 words that are considered irregular, 17% of the total. Farrell, Osenga, and Hunter provide suggestions for teachers on how to provide instruction for these irregular words, which they call “heart words,” because they have spellings that must be learned by heart. They recommend working with the student to identify the letter(s) in the words that make unexpected sounds, note the irregularity by drawing a small heart above the letter(s), then drawing attention to the regular phonic components of the words (Farrell et al., 2013b). Learning these 37 “heart words” requires some memorization, but it is anchored by phonetic understanding. The other 183 *sight words* are taught using phonics instruction.

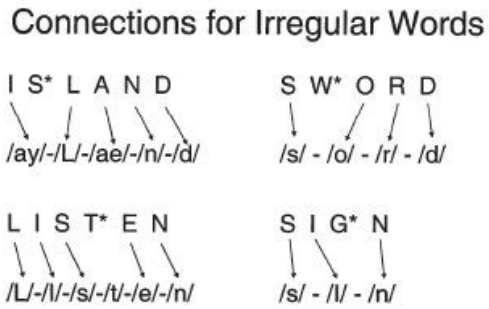
The Phonics Page is another online resource for teachers filled with advice to facilitate phonics-based instruction. This website has information on how to teach *sight words* phonetically. Phonics Page editor, Elizabeth Brown, has combined the 220 Dolch Sight Words and Fry 100 Instant Words, a total of 231 words, then organized them by phonetic patterns, forming 15 lists. The first seven lists contain 157 sight words that are sorted to be taught phonetically; these encompass 68% of the 231 sight words. Lists eight through thirteen contain 69 words that can be taught with instruction of less well-known phonic patterns and rules of English, composing another 30% of the 231 word list. The final two lists contain 5 irregular words that are exceptions, only 2% of the total, to be taught with a combination of memorization and attention to letter sound relationships where possible (Brown, n.d.).

Donald Potter, an educator and founder of the Blend Phonics National Educational Reform Campaign, shares a 25 page booklet, *Blend Phonics* written by Hazel Loring, a master teacher born in 1902, that contains a complete phonics curriculum (Potter, n.d.). Sight words that follow regular phonic patterns are taught within the phonics lessons. To teach irregular sight words, and other phonetically irregular words, Potter suggests writing the phonetic spelling of the word, as it is given in the dictionary, in parentheses following the correct spelling as a strategy to support recognition of the existing letter-sound relationships while identifying the irregularity that must be memorized. For example, Potter suggests writing "said" followed by "(sed)" in parentheses (Potter, n.d.). Outside those irregular exceptions, all other words are taught using a direct, systematic, phonics-based approach.

Many experienced classroom teachers have discovered for themselves that while most of their students manage to learn sight words without too much difficulty, there are 20-30% of the students that struggle. Utilizing good instructional techniques and scaffolding, effective teachers

often do instruct their students to utilize the letter sounds and other phonic clues within sight words to help their students learn to recognize these words. Ehri explains how the brain can use orthographic mapping even for irregular words to link to develop neural word form models. The letter –sound relationships are mapped as usual, with added mental footnotes (*) to remember silent letters or unexpected pronunciation (Ehri, 2005, p. 171). This type of mapping is often informally included in instructional methods by effective teachers, purposefully incorporating this orthographic mapping technique into instruction would be even more effective (Ehri, 2005).

Figure F



Representation of orthographic mapping connections between graphemes in spellings and phonemes in pronunciations to retain irregularly spelled words in memory. The (*) represent mental notes to remember silent letters. The connecting lines illustrate how the printed letters are "mapped" to the sounds.

Figure from Ehri, L. C., Nunes, S. R., Stahl, S. A., & Willows, D. M. (2001). Systematic phonics instruction helps students learn to read: Evidence from the National Reading Panel's meta-analysis. *Review of educational research*, *71*(3), p. 171.

These experts demonstrate that a majority of *sight words* can, and they strongly recommend should, be taught as part of a systematic, phonetic, research-based reading program.

Farrell, Osenga, Hunter (2013b), and Brown (n. d.), identified that between 63-68% of all sight words are phonetically regular, another 20-30% of the sight words will require additional instruction of less common phonic patterns and rules of English, leaving only 2-17% of the sight words in need of phonetically- supported memorization techniques. These few exceptions to the rules do not justify abandoning all sight words to memorization, especially given that research has proven the importance of phonics-based instruction for developing skilled reading. Consider also that the students who are burdened the most by sight words are the struggling readers, the dyslexic and disadvantaged, who have weak reading processing and poor visual memory skills. These students require the most phonetic training of all, and encouraging them to not give their attention to the letter-sound relationships in words undermines the development of their neural processing pathways and Visual Word Form area.

Conclusion

> We need to bury the idea that Dolch words, Fry words, or words from any other high frequency word list need to be taught through memorization. Rather, they should be included in phonics instruction so that, as early as possible, students use spelling patterns to read a greater variety of words than just those on the high frequency lists. (Farrell et al., 2013b, p. 7)

Sight words are incredibly useful; the 300 most frequent words represent approximately 65% of all printed material. Beginning readers and struggling readers need to learn these high utility words, and teachers need to include them in the reading curriculum. However, the traditional practice of teaching *sight words* "by sight" has been refuted by modern research. The brain learns to read using letter-sound relationships. Whole word instruction, the look-say memorization method, may discourage and inhibit the development of orthographic mapping,

strong neural communication pathways, and accurate neural word form models, potentially disabling development of skilled reading, especially for new, struggling, and dyslexic students (Ehri,1998; Ehri, 1991; Farrell, Osenga, & Hunter, 2013b; Dehaene, 2011; Laurita, 1966; Moats, 1999; Shaywitz, 2003). Orthographic patterns are the key to unlocking the brain's powerful Visual Word Form area and the seemingly instantaneous access to accurate word recognition and fluent reading. It is time for instructional practices to catch up with the research: *sight words*, and all reading instruction, should be taught through phonics.

References

Anatomy of the brain. (2017). (Figure A: Illustration. Anatomy of the brain). In *Mayfield Brain & Spine, (brain Figure 3).* Retrieved from https://www.mayfieldclinic.com/PE-AnatBrain.htm

Arcuate fasciculus disection. (2000). *Interactive atlases digital anatomist project, department of biological structure, University of Washington*. Retrieved from http://www9.biostr.washington.edu:80/cgibin/DA/PageMaster?atlas:NeuroSyllabus+ffpathIndex/Syllabus^Chapters/Cerebral_Cortex/ArcuateDiss+2.

Avrit, K. (2013). *Take Flight: A Comprehensive Intervention for Students with Dyslexia; Black Line Master Book.* Texas: Texas Scottish Rite Hospital for Children.

Barron, R. (1986). Word recognition in early reading: A review of the direct and indirect access hypotheses. *Cognition*, 24(1-2), 93-119. doi:10.1016/0010-0277(86)90006-5

Birsch, J. (2011). *Multisensory teaching of basic language skills, (3rd edition)*. Baltimore, Maryland: Paul H. Brookes Publishing Co.

Blend Phonics Nationwide Educational Reform Campaign. (n.d.) Blend Phonics. Retrieved from http://blendphonics.org/

Brown, E. (n. d. a). The Phonics page. *40L.* Retrieved from http://thephonicspage.org/

Brown, E. (n. d. b). Teaching the sight words by sound. *ThePhonicsPage.org.* Retrieved from http://www.thephonicspage.org/On%20Reading/Resources/Sight%20Words%20by%20Sound1.pdf

Carroll, J. B., Davies, P., & Richman, B. (1971). A new academic word list. *Newacademicwordlist.org.* Retrieved from http://www.newacademicwordlist.org

Changizi, M. A., Zhang, Q., Ye, H., & Shimojo, S. (2006). The structures of letters and symbols

throughout human history are selected to match those found in objects in natural scenes. *The American Naturalist, 167(5),* E117-E139. doi: 10.1086/502806

Dehaene, S. (2011). The massive impact of literacy on the brain and its consequences for education. *Human neuroplasticity and education. Pontifical Academy of Sciences*, 117, 19-32. Retrieved from https://pdfs.semanticscholar.org/cff4/56fd014295ce33eec5692e24b832f9d1e7bd.pdf

Dehaene, S., & Cohen, L. (2011). The unique role of the visual word form area in reading. *TRENDS in cognitive sciences*, *15*(6), 254-262. doi: 10.1016/j.tics.2011.04.003

Dolch, E. W. (1936). A basic sight vocabulary. *The Elementary School Journal*, *36*(6), 456-460. Retrieved from http://0-www.jstor.org.tiger.coloradocollege.edu/stable/995914

Dolch, E. W. (1941). *Teaching primary reading.* Champain, Illinois: The Garrard Press

Dolch, E. W. (1948). *Problems in reading.* Champain, Illinois: The Garrard Press

Dolch Sight Words by Frequency. (n. d.). *K12 Reader, reading instruction resources, Dolch word list worksheets and activities*. Retrieved from http://www.k12reader.com/dolch-word-list/

Dolch Sight Words by Frequency. (n. d.). *Mrs. Perkins' Dolch words, Dolch word lists*. Retrieved from http://www.mrsperkins.com/dolch.htm

Edward L. Thorndike. (2005). In *Encyclopedia Britannica online.* Retrieved from https://www.britannica.com/biography/Edward-L-Thorndike

Ehri, L. C. (1987). Learning to read and spell words. *Journal of Reading Behavior*, *19*(1), 5-31. doi: 10.1080/10862968709547585

Ehri L. C. (1991). Chapter 15, Development of the ability to read words. In Barr, R., Kamil, M., Mosenthal, P., & Pearson, P. (1991*). Handbook of reading research (volume 2).* New Jersey: Lawrence Erlbaum Associates.

Ehri L. C. (2003). Systematic Phonics Instruction: Findings of the National Reading Panel.

Ehri, L. C. (2005). Learning to read words: theory, findings, and issues. *Scientific Studies of Reading, 9(2)*, 167-188, doi: 10.1207/s1532799xssr0902_4

Ehri, L. C. (2014) Orthographic Mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning, *Scientific Studies of Reading, 18(1),* 5-21. doi: 10.1080/10888438.2013.819356

Ehri, L. C., & McCormick, S. (1998). Phases of word learning: Implications for instruction with delayed and disabled readers. *Reading & Writing Quarterly: Overcoming Learning Difficulties*, *14*(2), 135-163. doi: 10.1080/1057356980140202

Ehri, L. C., Nunes, S. R., Stahl, S. A., & Willows, D. M. (2001). Systematic phonics instruction helps students learn to read: Evidence from the National Reading Panel's meta-analysis. *Review of educational research*, *71*(3), 393-447. doi: https://doi.org/10.3102/00346543071003393

Ehri, L. C., & Wilce, L. S. (1985). Movement into reading: Is the first stage of printed word learning visual or phonetic?. *Reading Research Quarterly*, 163-179. doi: 10.2307/747753

Farrell, L., Osenga, T., & Hunter, M. (2013a). A new model for teaching high frequency words. *Readsters.com*. Retrieved from http://www.readsters.com/wordpress/wp-content/uploads/2013/03/NewModelForTeachingHFWords.pdf

Farrell, L., Osenga, T. & Hunter, M. (2013b). Comparing the Dolch and Fry high frequency

word lists. *Readsters.com.* Retrieved from http://www.readsters.com/wordpress/wp-content/uploads/2013/03/ComparingDolchAndFryLists.pdf

Fry, E. (1957). Developing a word list for remedial reading. *Elementary English*, *34*, 456-458. Retrieved from http://www.jstor.org/stable/41384648

Fry, E. (1980). The new instant word list. *The Reading Teacher*, 34, 284-289. Retrieved from http://www.jstor.org/stable/20195230

Fry, E. (1999). *How to teach reading.* Westminster, California: Teacher Created Resources, Inc.

Fry, E. (2000). *1000 instant words.* Westminster, CA: Teacher Created Resources.

Fry, E., Polk, J., & Fountoukidis, D. (1984). *The reading teacher's book of lists*. Englewood Cliffs, New Jersey: Prentice Hall.

Gates, A. (1926). *A reading vocabulary for the primary grades.* New York: Bureau of Publications, Teachers College, Columbia University.

Gates, A. (1932). *The improvement of reading, a program of diagnostic and remedial methods*. New York: MacMillan Company.

Gross, C. (n.d.). Inferior temporal cortex. Scholarpedia. Retrieved from http://www.scholarpedia.org/article/Inferior_temporal_cortex

Gough, P.B., & Hillinger, M.L.(1980). Learning to read, an unnatural act. *Bulletin of the Orton Society,* 30: 179-196. doi:10.1007/BF02653717

How many words are there in the English language? (2017). *Oxford living dictionaries, Oxford University Press online*. Retrieved from https://en.oxforddictionaries.com/explore/how-many-words-are-there-in-the-english-language

Kershner, J. R. (2016). Network dynamics in dyslexia: Review and implications for

remediation. *Research in developmental disabilities*, *59*, 24-34. doi:10.1016/j.ridd.2016.07.014

KindergartenWorks. (n.d.). 5 easy mini-lessons to teach sight words. *Kindergartenworks.com Kindergarten Teaching Ideas*. Retrieved from http://www.kindergartenworks.com/kindergarten-teaching-ideas/how-to-teach-sight-words/

Laurita, R. (1966). A Basic Sight Vocabulary-a Help or a Hindrance. *Spelling Progress Bulletin*. Retrieved from http://199.195.144.17/pdf/basicsightvocabulary_laurit.pdf

Lee, B. (2011). *Why sight words are important and when they should be taught.* Retrieved from http://www.learningbooks.net/whydolchwords.html

Linkersdörfer, J., Jurcoane, A., Lindberg, S., Kaiser, J., Hasselhorn, M., Fiebach, C. J., & Lonnemann, J. (2014). The association between gray matter volume and reading proficiency: a longitudinal study of beginning readers. *Journal of cognitive neuroscience*, *27*(2), 308-318. doi: 10.1162/jocn_a_00710

Maurer, U., Blau, V. C., Yoncheva, Y. N., & McCandliss, B. D. (2010) Development of visual expertise for reading: rapid emergence of visual familiarity for an artificial script, *Developmental Neuropsychology, 35(4),* 404-422, doi: 10.1080/87565641.2010.480916

McCandliss, B., Cohen, L., & Dehaene, S. (2003). The visual word form area: expertise for reading in the fusiform gyrus. *Trends in cognitive sciences, 7(7),* 292-299.

Meet Dolch – The Father of Sight Words. (2013). *Sightwordgames.com.* Retrieved from http://www.sightwordsgame.com/sightwords/dolch-list-dolch-word-list-dolch-sight-words-dolch-words-3/

Moats, L. C. (1999). Teaching reading is rocket science: What expert teachers of reading

should know and be able to do. Retrieved from https://eric.ed.gov/?id=ED445323

Moats, L. (2007). Whole-language high jinks. *How to tell when" scientifically-based reading* instruction" isn't. Retrieved from http://www.foundationstutoring.org/wp-content/uploads/2013/10/Whole-Langauge-High-Jinks.pdf

Nation, I.S.P. (2016). *Making and using word lists for language learning and testing.* Amsterdam: John Benjamins Publishing Company.

The Nation's Report Card. (2015). *2015 Mathematics & reading assessments, national achievement level results.* Retrieved from https://www.nationsreportcard.gov/reading_math_2015/#reading/acl?grade=4

The National Right to Read Foundation. (n. d.). PO Box 560, Strasburg, VA 22657, 913-788-6773. www.nrrf.org/explore/

Penolazzi, B., Spironelli, C., Vio, C., & Angrilli, A. (2010). Brain plasticity in developmental dyslexia after phonological treatment: a beta EEG band study. *Behavioural brain research*, *209*(1), 179-182. Retrieved from https://doi.org/10.1016/j.bbr.2010.01.029

Pinnell, G. S., & Fountas, I. (2009a). *Leveled Literacy Intervention Lesson Guide, Volume 1, Green System*. Portsmouth, New Hampshire: Heinemann.

Pinnell, G. S., & Fountas, I. (2009b). *When Readers Struggle, Teaching That Works*. Portsmouth, New Hampshire: Heinemann.

Potter, D. (n. d.). Reading made easy with blend phonics. DonPotter.net. Retrieved from http://www.donpotter.net/education_pages/blend_phonics.html

Preschern, J. (2017a). (Figure E: Image. Arcuate fasciculus). In *Learning disabilities, brain research guides the way for dyslexia causes and treatment, Speech Language Literacy Lab blog, para. 12.* Retrieved from http://www.sl3lab.com/new-blog/

Preschern, J. (2017b). Learning disabilities, brain research guides the way for dyslexia causes and treatment, Speech Language Literacy Lab blog. Retrieved from http://www.sl3lab.com/new-blog/

Rayner, K., Li, X., Williams, C. C., Cave, K. R., & Well, A. D. (2007). Eye movements during information processing tasks: Individual differences and cultural effects. *Vision research*, *47*(21), 2714-2726. doi.org/10.1016/j.visres.2007.05.007

Reading Reform Foundation of New York. (n .d.). 333 West 57th Street, Suite 1L, New York, New York 10019. http://www.readingreformny.org/

Reardon, S., Valentino, R., & Shores, K. (2012) Patterns of literacy among U.S. students. *Literacy challenges for the twenty-first century,* 22, 2, 17-38. Woodrow Wilson School of Public and International Affairs: Princeton University and The Brookings Institution. Retrieved from http://www.futureofchildren.org/sites/futureofchildren/files/media/literacy_challenges_for_the_twenty-first_century_22_02_fulljournal.pdf

Shaywitz, S. (2003a). (Figure B: Illustration. Reading systems in brain.) *Overcoming Dyslexia: a new and complete science-based program for reading problems at any level – 1st edition.* New York: Knopf/Random House. As retrieved from Dunoon, L. (2017). What is dyslexia?. *Dyslexiadaily.com*. para. 12. https://www.dyslexiadaily.com/blog/what-is-dyslexia

Shaywitz, S. (2003b). *Overcoming dyslexia: a new and complete science-based program for reading problems at any level – 1st edition.* New York: Knopf/Random House.

Sightwords. (n. d.). Free resources to teach your child to read. *Sightwords.com*. Retrieved from http://www.sightwords.com/

Thorndike, E. (1927). *The teacher's word book, (second edition).* New York: Teachers College, Columbia University.

University of Illinois Archives. (1992). Edward Dolch. *University of Illinois Archives.* Retrieved from https://archives.library.illinois.edu/archon/?p=digitallibrary/digitalcontent&id=4823

Wilson Language Training Corporation. (2006). Curriculum. *Just Words Overview.* Retrieved from http://www.wilsonlanguage.com/programs/just-words/overview/curriculum/

Wilson Language Training Corporation. (2006). Curriculum. *Wilson Reading System Overview.* Retrieved from http://www.wilsonlanguage.com/programs/wilson-reading-system/overview/curriculum/

Wilson Language Training. (2013). High frequency / sight words. Retrieved from http://www.lakewoodcityschools.org/userfiles/1727/my%20files/high%20frequency%20sight%20words.pdf?id=51784

Yeatman, J. et al. (2012). (Figure D: Image. Development of white matter and reading skills). *Proceedings of the National Academy of Sciences.* Boston Interactive, HighWire Press, Online ISSN 1091-6490. Retrieved from http://www.pnas.org/content/109/44/E3045/F1.expansion.html

Zhao, J., de Schotten, M. T., Altarelli, I., Dubois, J., & Ramus, F. (2016). Altered hemispheric lateralization of white matter pathways in developmental dyslexia: Evidence from spherical deconvolution tractography. *Cortex*, *76*, 51-62. doi.org/10.1016/j.cortex.2015.12.004

Ziegler, J., & Goswami, U. (2005). Reading Acquisition, Developmental Dyslexia, and Skilled Reading Across Languages: A Psycholinguistic Grain Size Theory. *Psychological Bulletin, 131(1),* 3-29. doi.org/10.1037/0033-2909.131.1.3

Appendix A

Dolch 220 List – Alphabetical (Dolch, 1941, p. 205).

a	better	done	get	I	many	out	she	these	wash
about	big	don't	give	if	may	over	show	they	we
after	black	down	go	in	me	own	sing	think	well
again	blue	draw	goes	into	much	pick	sit	this	went
all	both	drink	going	is	must	play	six	those	were
always	bring	eat	good	it	my	please	sleep	three	what
am	brown	eight	got	its	myself	pretty	small	to	when
an	but	every	green	jump	never	pull	so	today	where
and	buy	fall	grow	just	new	put	some	together	which
any	by	far	had	keep	no	ran	soon	too	white
are	call	fast	has	kind	not	read	start	try	who
around	came	find	have	know	now	red	stop	two	why
as	can	first	he	laugh	of	ride	take	under	will
ask	carry	five	help	let	off	right	tell	up	wish
at	clean	fly	her	light	old	round	ten	upon	with
ate	cold	for	here	like	on	run	thank	us	work
away	come	found	him	little	once	said	that	use	would
be	could	four	his	live	one	saw	the	very	write
because	cut	from	hold	long	only	say	their	walk	yellow
been	did	full	hot	look	open	see	them	want	yes
before	do	funny	how	made	or	seven	then	warm	you
best	does	gave	hurt	make	our	shall	there	was	your

Appendix B

Dolch Noun List – Alphabetical (Dolch, 1941, p. 207).

apple	box	Christmas	eye	garden	house	name	robin	stick	water
baby	boy	coat	farm	girl	kitty	nest	Santa	Claus	street
way	back	bread	corn	farmer	good-bye	leg	night	school	sun
wind	ball	brother	cow	father	grass	letter	paper	seed	table
window	bear	cake	day	feet	ground	man	party	sheep	thing
wood	bed	car	dog	fire	hand	men	picture	shoe	time
bell	cat	doll	fish	head	milk	pig	sister	top	bird
chair	door	floor	hill	money	rabbit	snow	toy	birthday	chicken
duck	flower	home	morning	rain	song	tree	boat	children	egg
game	horse	mother	ring	squirrel	watch				

Appendix C

Dolch 220 List by Frequency (Farrell et al., 2013b, p. 10).

1	the	38	then	75	its	112	let	149	must	185	pick
2	to	39	little	76	ride	113	help	150	start	186	hurt
3	and	40	down	77	into	114	make	151	black	187	pull
4	he	41	do	78	just	115	going	152	white	188	cut
5	a	42	can	79	blue	116	sleep	153	ten	189	kind
6	I	43	could	80	red	117	brown	154	does	190	both
7	you	44	when	81	from	118	yellow	155	bring	191	sit
8	it	45	did	82	good	119	five	156	goes	192	which
9	of	46	what	83	any	121	six	157	write	193	fall
10	in	47	so	84	about	120	walk	158	always	194	carry
11	was	48	see	85	around	122	two	159	drink	195	small
12	said	49	not	86	want	123	or	160	once	196	under
13	his	50	were	87	don't	124	before	161	soon	197	read
14	that	51	get	88	how	125	eat	162	made	198	why
15	she	52	them	89	know	126	again	163	run	199	own
16	for	53	like	90	right	127	play	164	gave	200	found
17	on	54	one	91	put	128	who	165	open	201	wash
18	they	55	this	92	too	129	been	166	has	202	show
19	but	56	my	93	got	130	may	167	find	203	hot
20	had	57	would	94	take	131	stop	168	only	204	because
21	at	58	me	95	where	132	off	169	us	205	far
22	him	59	will	96	every	133	never	170	three	206	live
23	with	60	yes	97	pretty	134	seven	171	our	207	draw
24	up	61	big	98	jump	135	eight	172	better	208	clean
25	all	62	went	99	green	136	cold	173	hold	209	grow
26	look	63	are	100	four	137	today	174	buy	210	best
27	is	64	come	101	away	138	fly	175	funny	211	upon
28	her	65	if	102	old	139	myself	176	warm	212	these
29	there	66	now	103	by	140	round	177	ate	213	sing
30	some	67	long	104	their	141	tell	178	full	214	together
31	out	68	no	105	here	142	much	179	those	215	please
32	as	69	came	106	saw	143	keep	180	done	216	thank
33	be	70	ask	107	call	144	give	181	use	217	wish
34	have	71	very	108	after	145	work	182	fast	218	many
35	go	72	an	109	well	146	first	183	say	219	shall
36	we	73	over	110	think	147	try	184	light	220	laugh
37	am	74	your	111	ran	148	new				

Appendix D

Dolch 220 List by Grade (Farrell et al., 2013b, p. 9).

Pre-Primer	**Primer**	**1st Grade**	**2nd Grade**	**3rd Grade**
a	all	after	always	about
look	out	let	or	laugh
and	am	again	around	better
make	please	live	pull	light
away	are	an	because	bring
me	pretty	may	read	long
big	at	any	been	carry
my	ran	of	right	much
blue	ate	as	before	clean
not	ride	old	sing	myself
can	be	ask	best	cut
one	saw	once	sit	never
come	black	by	both	done
play	say	open	sleep	only
down	brown	could	buy	draw
red	she	over	tell	own
find	but	every	call	drink
run	so	put	their	pick
for	came	fly	cold	eight
said	soon	round	these	seven
funny	did	from	does	fall
see	that	some	those	shall
go	do	give	don't	far
the	there	stop	upon	show
help	eat	going	fast	full
three	they	take	us	six
here	four	had	first	got
to	this	thank	use	small
I	get	has	five	grow
two	too	them	very	start
in	good	her	found	hold
up	under	then	wash	ten
is	have	him	gave	hot
we	want	think	which	today
it	he	his	goes	hurt
where	was	walk	why	together
jump	into	how	green	if
yellow	well	were	wish	try
little	like	just	its	keep
you	went	when	work	warm
must	know	would	new	many
what	made	kind	white	write
no	off	now	on	our
who	your	will	with	yes

Appendix E

Fry 300 List by Frequency (Fry, Polk, & Fountoukidis, 1984, p. 22-24).

1	the	21	at	41	there	61	some	81	my
2	of	22	be	42	use	62	her	82	than
3	and	23	this	43	an	63	would	83	first
4	a	24	have	44	each	64	make	84	water
5	to	25	from	45	which	65	like	85	been
6	in	26	or	46	she	66	him	86	call
7	is	27	one	47	do	67	into	87	who
8	you	28	had	48	how	68	time	88	am
9	that	29	by	49	their	69	has	89	its
10	it	30	word	50	if	70	look	90	now
11	he	31	but	51	will	71	two	91	find
12	was	32	not	52	up	72	more	92	long
13	for	33	what	53	other	73	write	93	down
14	on	34	all	54	about	74	go	94	day
15	are	35	were	55	out	75	see	95	did
16	as	36	we	56	many	76	number	96	get
17	with	37	when	57	then	77	no	97	come
18	his	38	your	58	them	78	way	98	made
19	they	39	can	59	these	79	could	99	may
20	I	40	said	60	so	80	people	100	part

101	over	121	name	141	boy	161	such	181	change
102	new	122	good	142	following	162	because	182	off
103	sound	123	sentence	143	came	163	turned	183	play
104	take	124	man	144	want	164	here	184	spell
105	only	125	think	145	show	165	why	185	air
106	little	126	say	146	also	166	ask	186	away
107	work	127	great	147	around	167	went	187	animals
108	know	128	where	148	farm	168	men	188	house
109	place	129	help	149	three	169	read	189	point
110	years	130	through	150	small	170	need	190	page
111	live	131	much	151	set	171	land	191	letter
112	me	132	before	152	put	172	different	192	mother
113	back	133	line	153	end	173	home	193	answer
114	give	134	right	154	does	174	us	194	found
115	most	135	too	155	another	175	move	195	study
116	very	136	means	156	well	176	try	196	still
117	after	137	old	157	large	177	kind	197	learn
118	thing	138	any	158	must	178	hand	198	should
119	our	139	same	159	big	179	picture	199	American
120	just	140	tell	160	even	180	again	200	world

201	high	221	light	241	life	261	sea	281	watch
202	every	222	thought	242	always	262	began	282	far
203	near	223	head	243	those	263	grow	283	Indians
204	add	224	under	244	both	264	took	284	really
205	food	225	story	245	paper	265	river	285	almost
206	between	226	saw	246	together	266	four	286	let
207	own	227	left	247	got	267	carry	287	above
208	below	228	don't	248	group	268	state	288	girl
209	country	229	few	249	often	269	once	289	sometimes
210	plants	230	while	250	run	270	book	290	mountains
211	last	231	along	251	important	271	hear	291	cut
212	school	232	might	252	until	272	stop	292	young
213	father	233	close	253	children	273	without	293	talk
214	keep	234	something	254	side	274	second	294	soon
215	tree	235	seemed	255	feet	275	later	295	list
216	never	236	next	256	car	276	miss	296	song
217	start	237	hard	257	miles	277	idea	297	being
218	city	238	open	258	night	278	enough	298	leave
219	earth	239	example	259	walk	279	eat	299	family
220	eye	240	beginning	260	white	280	face	300	it's

Appendix F

Pre-Reading Words, A New Model for Teaching High Frequency Words, (Farrell et al.., 2013a, p. 2)

Table 1
10 Sight Words for Pre-Readers to Learn

Word	Frequency Rank	
	Dolch	Fry
the	1	1
a	5	4
I	6	20
to	2	5
and	3	3
was	11	12
for	16	13
you	7	8
is	27	7
of	9	2

Appendix G

Flash Words, A New Model for Teaching High Frequency Words, (Farrell et al.., 2013a, p. 3-5)

Table 2A
Flash Words
60 One-Syllable Words with Short Vowel Spelling Patterns
(Numbers in Parentheses Are the Dolch Frequency Ranking)

VC Sorted by vowel spelling	**CVC** Sorted by vowel spelling		**Digraphs** Sorted by digraph	**Blends** Sorted by ending blends, then by beginning blends	**Words Ending in NG and NK** Sorted by ending letters
at (21)	had (20)	hot (203)	that (14)	and (3)	sing (213)
am (37)	can (42)	but (19)	with (23)	just (78)	bring (155)
an (72)	ran (111)	run (163)	then (38)	must (149)	long (67)
it (8)	him (22)	cut (188)	them (52)	fast (182)	thank (216)
in (10)	did (45)	get (51)	this (55)	best (210)	think (110)
if (65)	will* (59)	yes (60)	much (142)	went (62)	drink (159)
on (17)	big (61)	red (80)	pick (185)	ask (70)	
off* (132)	six (120)	well* (109)	wish (217)	its (75)	
up (24)	sit (191)	let (112)	when (44)	jump (98)	
us (169)	not (49)	tell (141)	which (192)	help (113)	
	got (93)	ten (153)		stop (131)	
				black (151)	

*Students easily understand that two consonants at the end of a word spell one sound.

Table 2B
Flash Words
60 One-Syllable Words With R-Controlled, Long, and Other Vowel Spellings
(Numbers in Parentheses Are the Dolch Frequency Ranking)

r-Controlled Vowels Sorted by vowel spelling	CV Long Vowel Sorted by vowel spelling	VCe (silent e) Sorted by vowel spelling	Vowel Teams With Long Vowel Sounds Sorted by vowel sound, then vowel spelling		Vowel Teams With Other Vowel Sounds Sorted by vowel sound, then vowel spelling
for (16)	I (6)	came (69)	play (127)	eat (125)	out (31)
or (123)	he (4)	take (94)	may (130)	read (197)	round (140)
start (150)	she (15)	make (114)	say (183)	clean (208)	found (200)
far (205)	be (33)	made (162)	see (48)	right (90)	down (40)
her (28)	we (36)	gave (164)	green (99)	light (184)	now (66)
first (146)	me (58)	ate (177)	sleep (116)	own (199)	how (88)
hurt (186)	go (35)	like (53)	keep (143)	show (202)	brown (117)
	so (47)	ride (76)	three (170)	grow (209)	look (26)
	no (68)	five (119)			good (82)
	my (56)	white (152)			new (148)
	by (103)				soon (161)
	fly (138)				draw (207)
	try (147)				saw (106)
	why (198)				

Table 2C
Flash Words
17 Two-Syllable Words and 1 Three-Syllable Word
(Numbers in Parentheses Are the Dolch Frequency Ranking)

CVC	"A" Spells Schwa in the First Syllable	Short Vowels and R-Controlled Vowels	Short Vowel and Long Vowel	All Other Two-Syllable Words	Three-Syllable Word Sorted by vowel sound, then vowel spelling
seven* (134)	about* (84)	after (108)	myself (139)	little (39)	every** (96)
upon (211)	around* (85)	never (133)	open* (165)	over (73)	
	away* (101)	better (172)	funny (175)	going (115)	
		under (196)		yellow (118)	
				before (124)	

* These words have a schwa sound in the first or second syllable.
** This word is often pronounced with two syllables, especially in conversation.

Appendix H

Heart Words, A New Model for Teaching High Frequency Words, (Farrell et al.., 2013a, p. 6-7)

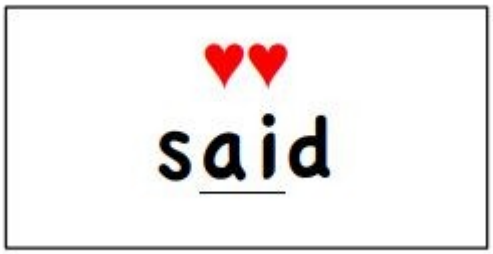
Table 3A
Heart Words
59 Words Grouped by Similar Spelling Patterns
45 Words from the Dolch List and 14 Not on the Dolch List
(Numbers in Parentheses Are the Dolch Frequency Ranking)
(Diamond [♦] indicates word is not on the Dolch List, but fits the spelling pattern)

Unusual Spelling Pattern	High Frequency Words
1. **s** at the end of the word spells /z/	his (13), is (27), as (32), has (166)
2. **v** is followed by **e** because no English word ends in **v**	have (34), give (144), live (206)
3. **o-e** spells short u /ŭ/	some (30), come (64), done (180)
4. **o** spells /o͝o/ (as in *boot*)	to (2), do (41), into (77)
5. rhyming words spelled with the same last four letters	there (29), where (95)
6. **s** spells /z/ in a vce word	those (179), these (212)
7. **all** spells /ŏll/	all (25), call (167), fall (193), small (195), ball♦
8. **oul** spells /o͝o/ (as in *cook*)	could (43), would (57), should♦
9. **e** at the end is after a phonetic r-controlled spelling	were (50), are (63)
10. vcc and cvcc words with **o** spelling long o /ō/	old (102), cold (136), hold (173), both (190)
11. cvcc words with **i** spelling long i /ī/	find (167), kind (189), mind♦
12. words similar in meaning and spelling	one (54), once (160)
13. **a** after **w** sometimes spells short o /ŏ/	want (86), wash (201), watch♦
14. **ue** spells /o͞o/ as in boot	blue (79), glue♦, clue♦, true♦
15. **u** spells /o͝o/ (as in *cook*)	put (91), full (178), pull (187), push♦
16. rhyming words with silent **l**	walk (121), talk♦
17. rhyming words - the letter **a** spells short i or short e (depending on dialect)	any (83), many (218)
18. **oo** at the end of a word spells /o͞o/ (as in *boot*)	too (92), boo♦, moo♦
19. **or** spells /er/	work (145), word♦, world♦
20. **uy** spells long i /ī/	buy (174), guy♦

Table 3B
Heart Words
37 Words that Do Not Fit into Spelling Patterns
(Numbers in Parentheses Are the Dolch Frequency Ranking)

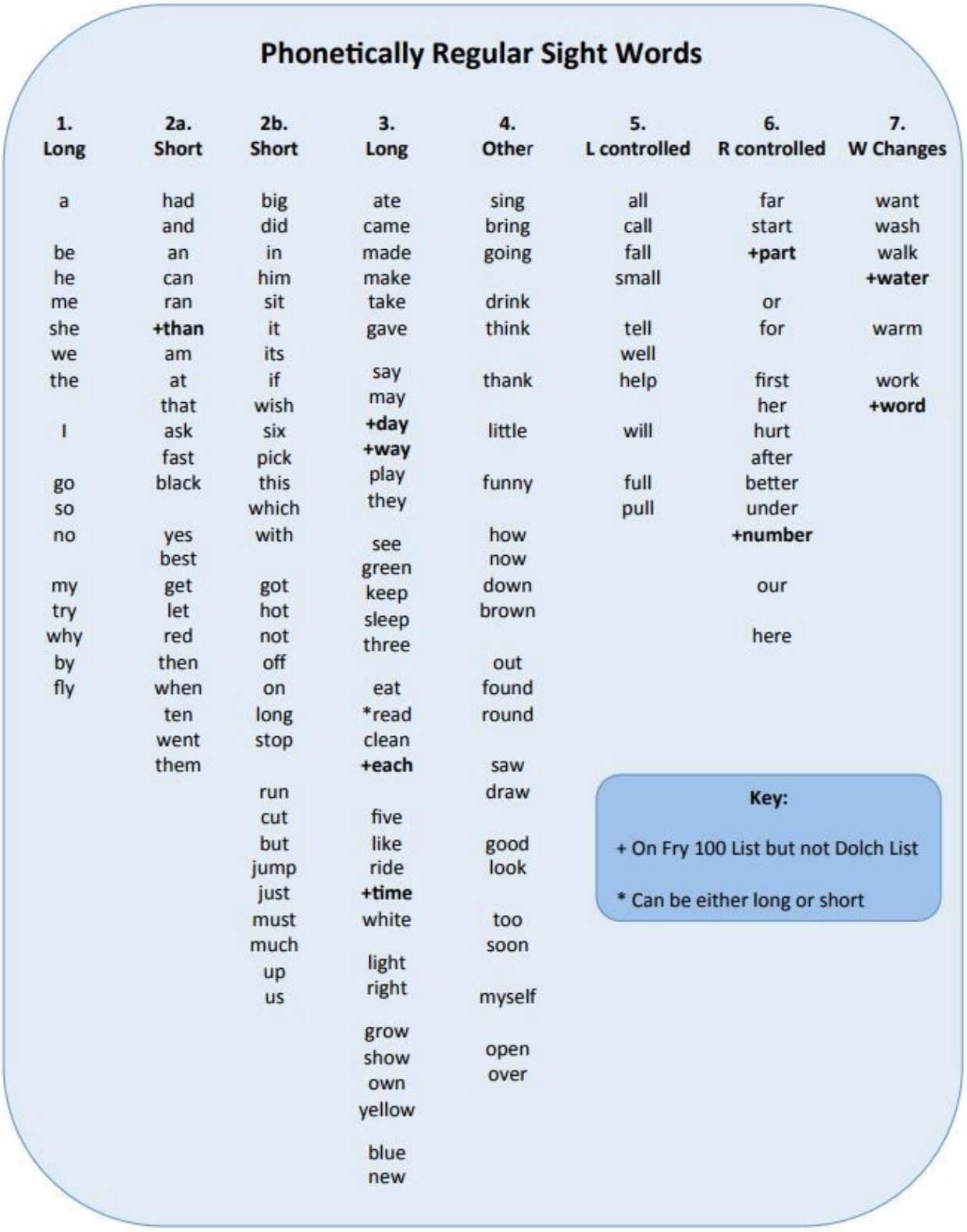
the (1)	very (71)	here (105)	does (154)	use (181)
a (5)	yours (74)	two (122)	goes (156)	carry (194)
of (9)	from (81)	again (126)	write (157)	because (204)
you (7)	don't (87)	who (128)	always (158)	together (214)
was (11)	know (89)	been (129)	only (168)	please (215)
said (12)	pretty (97)	eight (135)	our (171)	shall (219)
they (18)	four (100)	today (137)	warm (176)	laugh (220)
what (46)	their (104)			

Sample Heart Word card for student. (Farrell et al., 2013, p. 7)



Appendix I

Phonetically regular sight words (Brown, n. d. b, p.1)



Phonetically Regular Sight Words

1. Long	2a. Short	2b. Short	3. Long	4. Other	5. L controlled	6. R controlled	7. W Changes
a	had	big	ate	sing	all	far	want
	and	did	came	bring	call	start	wash
be	an	in	made	going	fall	**+part**	walk
he	can	him	make		small		**+water**
me	ran	sit	take	drink		or	
she	**+than**	it	gave	think	tell	for	warm
we	am	its			well		
the	at	if	say	thank	help	first	work
	that	wish	may			her	**+word**
I	ask	six	**+day**	little	will	hurt	
	fast	pick	**+way**			after	
go	black	this	play	funny	full	better	
so		which	they		pull	under	
no	yes	with		how		**+number**	
	best		see	now			
my	get	got	green	down		our	
try	let	hot	keep	brown			
why	red	not	sleep			here	
by	then	off	three	out			
fly	when	on		found			
	ten	long	eat	round			
	went	stop	*read				
	them		clean	saw			
		run	**+each**	draw			
		cut					
		but	five	good			
		jump	like	look			
		just	ride				
		must	**+time**	too			
		much	white	soon			
		up					
		us	light	myself			
			right				
			grow	open			
			show	over			
			own				
			yellow				
			blue				
			new				

Key:

+ On Fry 100 List but not Dolch List

* Can be either long or short

Appendix J

Phonetically regular sight words (Brown, n. d. b, p. 2)

Sight Words Arranged by Phonetic Pattern of Exception

8. Schwa	9. s as z, f as v	10. Vowel Sub	11. Ending v	12. Silent Letters	13. r Exceptions	14. Irregular	15. True Sight
again	as	to	give	would	carry	two	one
about	has	do	*live	know		buy	once
around	always	into		write	four		
away	hers	today	have	eight	your	laugh	
	is	together		who			
come	his				every		
some	goes	because		are			
done	please	been		**+more**	their		
from	these	could		before			
does	those	pretty			there		
what	use	put		**+people**	where		
+other	was	said					
		shall			very		
	of	you					
		kind					
		find					
		old					
		cold					
		hold					
		both					
		any					
		many					
		never					
		seven					
		upon					
		only					
		don't					
		*read					

Key:

+ On Fry 100 List but not Dolch List

* Can be either long or short