

The Relation Between Alphabetic Basics, Word Recognition, and Reading

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One day at the end of a regional inservice, I was approached by some teachers for advice about an 8-year-old boy. The boy had come to their school from Haiti nearly two years earlier. At the time, he knew virtually no English and none of his letters. Since then, the teachers had been working hard to give him one-on-one support with English language development and reading.

For his English language development, their core approach had been centered on reading books aloud to him, actively engaging him throughout. For his reading, they had set out a systematic plan, beginning with the basics. His English was coming nicely, but his reading was not. Even though he had mastered letter recognition, primary letter–sound knowledge, and initial letter segmentation, learning to decode was proving very difficult. In the effort to get him going, the teachers had been staying after school with him four days a week to work on decoding the nonsense words from the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; see dibels.uoregon.edu) materials. And still he was making little progress.

The question addressed in this chapter is whether the teachers' approach toward developing the student's decoding skills was well founded, and why or why not.

From reading the research, the teachers were convinced that the ability to decode was critical for learning to read. They believed that strong decoding would be particularly important for this child as it would enable him to sound out and, through that, to learn new English words through his reading. Research and experience had also taught them that decoding is easier with short, orthographically simple words than with words that are longer or involve more complex spelling conventions. Yet so many of the shortest words in English are irregular.

There are more than 20 different DIBELS nonsense word forms, most containing 50 two- and three-letter items. Within each list, every letter unambiguously corresponds to its most frequently occurring sound, and all primary letter–sound pairs are represented (Camine, Silbert, Kame’enui, & Tarver, 2004). With these thoughts in mind, the DIBELS nonsense word sets seemed to the teachers an opportune resource for developing and practicing the child’s decoding abilities.

These basic premises are right on. Reading with fluency and productive comprehension depends integrally on having acquired deep and ready working knowledge of spelling–sound correspondences (Adams, 1990; Adams, Treiman, & Pressley, 1998). In addition, it is well documented that the decoding of younger and weaker readers is more accurate when they are given short words with simple, regular letter–sound correspondences. Accuracy dwindles with consonant clusters, and still more with complex or inconsistent vowel spellings; with polysyllabic words, all such difficulties are compounded even as issues of syllable division and stress placement are added (Duncan & Seymour, 2003; Laxon, Gallagher, & Masterson, 2002; Rack, Snowling, & Olson, 1992).

In fact, the nonsense word sets in the DIBELS battery were not intended for use in instructing children to decode. Rather, they were intended for use in assessing that ability. Subtests measuring children’s ability to sound out regularly spelled, pronounceable nonwords (also called “nonsense words” or “pseudowords”) are quite common in batteries designed for assessing the needs and progress of developing readers. As examples, lists of decodable nonwords are included in the Word Attack subtest of the Woodcock-Johnson (Woodcock, McGrew, & Mather, 2001), in the nonword section of the Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999), in Roswell, Chall, Curtis, and Kearns’s (2005) Diagnostic Assessments of Reading, in the Gray diagnostic battery (Bryant, Wiederholt, & Bryant, 2004), and in Wechsler’s (2005) Individual Achievement Test.

The motive for including such probes is precisely that nonsense words, because they are not words, will be unfamiliar to readers. After all, if the children have never seen the “words” before, then what are their options? They cannot visually recognize the word as a whole as they have never seen it before; they cannot correct their pronunciation of it based on familiarity or vocabulary matching as they have never heard it before. A nonsense word’s spelling–sound correspondences offer the only basis on which readers can figure out how to pronounce it or check the pronunciation they produce. The rationale, in other words, is that

lists of nonsense words offer “clean” tests of readers’ working knowledge of spelling–sound correspondences and their ability to blend.

Another argument often offered for using lists of nonsense words in tests is that the ability to read them has been shown to correlate strongly with overall reading ability (Bell & Perfetti, 1994; Shankweiler et al., 1999; Swanson, Trainin, Necochea, & Hammill, 2003). As a matter of fact, mature readers can read aloud pseudowords very nearly as quickly as they can read aloud familiar, real words. The difference is measurable in, at most, a few hundredths of a second.

Clearly not even the most skilled reader can possibly sound and blend the separate graphemes of a novel string of letters in so little time. Instead, by every measure and comparison, skilled readers behave as if they *recognize* such well-spelled nonwords. But again, nonwords are not words. They are used in such experiments precisely because no reader is likely to have seen them before. How in the world might people “recognize” a string of letters they’ve never seen? That’s where things begin to get interestingly complicated.

Since the 1970s, researchers have published hundreds upon hundreds of studies directed toward understanding this paradox and its implications with respect to the knowledge and processes underlying reading. The earliest studies exploited the then-new capacity for millisecond timing, using it not only to control durations and sequencing of the materials presented but also to measure the speed of people’s responses depending on their abilities or what they were shown. As examples, differences in response times allow researchers to study the order in which events are processed by the mind, to evaluate the effortfulness or automaticity of processing, and to look for signs of facilitation (faster recognition) or interference (slower recognition) so as to identify how different kinds of information are organized during processing. Over the years, the millisecond timer has been complemented by eye-movement technologies (see Rayner, 1997; Rayner & Pollatsek, 1989), computer simulations (e.g., Seidenberg & McClelland, 1989), and today, an ever-growing array of brain-imaging techniques that enable researchers to locate and trace the flow and interaction of processes involved in word recognition across different areas of the brain. (For a readable and informative overview of the latter, see Dehaene, 2009.)

A conclusion from all this work is that, as it turns out, well-spelled nonsense words truly *are* recognized by skilled readers. This happens in a region of the brain called the *visual word form area* located near the back and bottom of the lower left side (McCandliss, Cohen, & Dehaene,

2003). As its name implies, this little area of the brain is devoted to the visual perception of individual words. It responds to the sight of printed words but, in itself, is indifferent to their sounds or pronunciations, their meanings, their contexts, and even to whether they are actually words. Also as implied by its name, the responsiveness of this area is specific to the *form* or structure of printed words. However, it is not the word's physical form that matters. The visual word form area is indifferent to the size or location or even the fonts or cases of letter strings; for example, it treats *TABLE*, *table*, *Table*, and *tAbLe* as identical (Dehaene et al., 2004). Rather, the responsiveness of the visual word form area is determined by the familiarity of the orthographic structure or spelling of the word in focus. It barely registers scrambled or unpronounceable strings of letters, but it is highly responsive to words and also to well-spelled, pronounceable nonwords (Binder, Medler, Westbury, Liebenthal, & Buchanan, 2006; Bruno, Zumberge, Manis, Lu, & Goldman, 2008; Kronbichler et al., 2007).

For skilled readers, it takes about 150 milliseconds for the letters of a word to get from the eye, through the visual cortex, to their registration in the backmost sector of the visual word form area. Again, at this point, the letters have ceded their shapes to their identities—that is, an **A** is an *À* is an *ɑ*. The visual word form area then progressively reconstructs the spelling of the letter string by combining the visual information it receives with its own knowledge, accrued through past experience, about frequent and allowable pairs or sequences of letters, about the behaviors of vowels versus consonants, about the spellings of syllables that are common to many different words, and even about the spellings of whole words that are extremely familiar to the reader, especially those that are short and irregular. The activity within the visual word form area rolls from back, where the letters gain entry, to front as it works with increasingly large and more complex orthographic constraints (Dehaene, 2009; Maurer, Brem, Bucher, & Brandeis, 2005).

As the reconstructed string of letters approaches the front of the visual word form area, there arises an explosion of activity, spread broadly throughout the linguistic and conceptual areas of the brain. It is through this activity that the word is recognized and interpreted. It is also through the dynamic of this activity that reading becomes productive and fluent. Let us consider this dynamic more closely.

Spelling–Sound Knowledge Connects Print to Language

The recognition of spellings that happens within the visual word form area seems to be the only component of the reading process that belongs exclusively to the domain of print as distinct from the domains of language and thought more generally. In its basic operation, the visual word form area sends the orthography or perceived spelling of each word upward to the phonological processor through the associations that have been established between the letters of the word and its phonemes. As the spelling thus selects the word's pronunciation, the phonological processor in turn relays activation to the many areas of the brain that are involved in generating the word's meanings and in working out its usage and specific significance within the context in which it has been encountered. Thus, the mappings from orthography to phonology—that is, from spelling to pronunciation—are the nexus between seeing and understanding the print on a page (Adams, 1990; Dehaene, 2009; Seidenberg & McClelland, 1989).

Once the printed word has been translated to language, the job is to give it meaning. In this quest, the connectivity of the brain is extensive, serving to relay activity among all experientially related aspects of the reader's knowledge. For example, reading a word such as *stagger*, *limp*, or *tiptoe* activates the motor areas in the brain that are involved in controlling the legs and feet, whereas reading a word such as *chop* or *carve* activates those controlling the hands (Kemmerer, Castillo, Talavage, Patterson, & Wiley, 2008). Whereas understanding a sentence about *eating* activates the areas related to gustatory sensations, understanding a visual description activates areas of the visual cortex (Olivetti Belardinelli et al., 2009; Palmiero et al., 2009). In turn, each of these areas is itself diffusely connected to other related knowledge that is distributed about the brain (Martin, 2007). As Martin and Chao (2001) summarize, “The same regions are active, at least in part, when objects from a category are recognized, named, imagined, and when reading and answering questions about them” (p. 199). One must imagine that this broad, modality-free connectivity is of enormous advantage for young readers and English learners in that much of the understanding required for reading need not be learned *through* language. Even so, when reading, none of this knowledge can be accessed, much less modified or added to, except by means of the words and wordings of a text.

In complement to such connections that recruit all potentially relevant knowledge, there are a number of others devoted to winnowing it down to what matters here and now. As one example, researchers have identified a specific area of the brain that specializes in deciding when the meanings of two words are related (e.g., *couch* and *sofa*, *hunt* and *hunter*, but not *corn* and *corner*) (Devlin, Jamison, Matthews, & Gonnerman, 2004). Another area has been identified as responsible for figuring out the combined meaning of the words comprising sentences (Vandenberghe, Nobre, & Price, 2002). Still another seems devoted to picking out the specific meanings of a word as appropriate to its context (Rodd, Davis, & Johnsrude, 2005). Indeed, it seems that the more scientists look (and devise clever experiments to see), the more the number of specialized areas of the brain they find, all richly interconnected so as to support the process of reading and language comprehension in their interaction.

Again, each of these meaning-construction and disambiguation capabilities resides in the parts of the brain that are devoted to language and thought in general. That is, once developed, they are available for speaking, listening, and writing as well as reading. As educators, however, it is worth bearing in mind that these meaning-construction and disambiguation processes are principally the product of learning that is primarily afforded through experience with written language (Olson, 1994, 2009).

Bidirectionality and Feedback Circuits

The second key to this dynamic is that connections in the brain are bidirectional. That is, when one area activates a second, the second reciprocally sends activation back to the first: The better the match, the stronger the feedback. Getting strong feedback causes the sending node to issue still more activation to an answering node which, in turn, directs more activation back to the sending node. In this way, a feedback loop is created that quickly sets apart the best matches from any others that might initially have attracted activation. Meanwhile, of course, as each receiving node is also sending activation outward and upward to other nodes with which it is connected, the same thing happens at the next level and the next, and so on. In result, the separate, pair-wise activation loops quickly become bound together into an extended and coherent, resonant whole (see Goldinger & Azuma, 2003; Hebb, 1949).

For the skilled reader, the consequence of these self-defining neural circuits is that once the spelling of a familiar word establishes activation

in the visual word form area, its sight, sound, and meaning seem to pop to mind at once. Moreover, the extensiveness of this dynamic ensures that the more familiar and knowledgeable readers are about the words, language, and topic of a text, the richer and more effortless will be their interpretation.

In fact, feedback patterns between any two nodes need not match perfectly to generate resonance. It's just that the resonance they support may be too weak or too diffuse to efficiently single out a winner. Perhaps the child has correctly read most but not all of the letters of the word (see Frith, 1980), perhaps the mapping from spelling to sound is not specific or unique (e.g., "bead" activates both /bēd/ and /bēd/), or perhaps the child's knowledge of the meaning of the word is confused or too sparse to offer key semantic or grammatical links. These sorts of weaknesses in what Perfetti (2007; Perfetti & Hart, 2001, 2002) calls "lexical quality" are characteristic of poorer readers and, as his research demonstrates, they are costly, resulting in sluggish comprehension that may be minimally successful at best.

At the extreme, where the match is critically incomplete, information may diffuse so broadly that it is wholly unhelpful. Further, large mismatches or gaps prohibit resonance altogether. In these cases, when no chain is able to resolve itself, understanding is out of reach. Minimally, the reader will balk, as young readers often do. Where the readers find themselves unable to repair or gloss the problem, they are stuck.

Our teachers' student is stuck. And that brings us to the third key dynamic of the system: It learns.

Learning

The classic Hebbian explanation of learning, named in honor of Donald Hebb's (1949) seminal work, is that when one set of neurons reliably fires with another, the strength of the connection between the two sets grows. In other words, once a reliable, consistent connection is set up, learning will result through repeated encounter. But this raises two questions: First, if the link between A and B is incomplete and, therefore, unreliable or inconsistent, how does it get cleaned up? Second, how does the link get set up in the first place?

Refining the Connections

The role of attention in disambiguating, strengthening, or "cleaning up" learning is axiomatic within the field of cognition and learning, and

examples equally abound in the domain of word recognition. In particular, as the process of decoding words couples the spellings of words with their pronunciations, it pressures alignment between the word's graphemes and its phonemes. Thus, for example, as children learn to decode words that are in their oral vocabularies, the phonemic significance of the words' letters serves to refine their diction (e.g., "one, two, free" becomes "one, two, three"; "bisgetti" becomes "spaghetti").

This sort of phonological restructuring, along with the increases in phonological sensitivity that it brings about, are among the strongest outcomes of learning to read an alphabetic language (Morais, 2003). Because this sort of tightening of a word's identity also sharpens or reduces diffusion of the activation flow, it improves children's ability to access and refine their understanding of the word's meaning.

In keeping with this, Rosenthal and Ehri (2008; see also Ehri & Wilce, 1979) have shown that seeing the spelling of a new word increases children's memory for both its pronunciation and its meaning. In this study, children in second and fifth grades were asked to learn two sets of low-frequency, picturable words. For the second graders, all of the to-be-learned words had consonant-vowel-consonant (CVC) spellings (e.g., *keg*, *sod*, *nib*); for the fifth graders, all were two- or three-syllable words (e.g., *mullock*, *frenulum*). Following research on best practices (Sadoski, 2005), the vocabulary instruction for children in both grades provided pictures and definitions of the words as well as a number of sentences for further supporting their meanings and illustrating their usage. In addition, the children were individually and actively engaged, with feedback, in producing and recalling the words and their meanings throughout the study sessions. The difference of interest was that, for one of the sets of to-be-learned words, the words themselves were printed at the bottom of their picture cards during training and corrective feedback. Importantly, because the words were pronounced by the teacher whenever the cards were shown, the children really had no need to read them; nor were the children asked to read the words or even to look at them. The words were just there. Even so, the results showed that the opportunity to see the printed words while attending to their pronunciations and meanings was of great benefit to all of the children at both ages, resulting in their learning the words' pronunciations and meanings significantly faster and retaining them significantly better. The older children were additionally posttested on their ability to use the words in new cloze sentences. Those who had seen the words fared far better, correctly transferring them to new sentences nearly half again as often.

More recently, Rosenthal and Ehri (2010) have demonstrated that, in reverse, causing children to attend to the pronunciations of printed words that they see also enhances learning. In this study, fifth graders were given brief passages and asked to read them silently. Each passage was about the meaning of a specific word, such as *kerfuffle*; that is, the meaning of the word was the topic of the passage. Within each passage, the target word occurred three times, always underlined. Half of the children were asked to stop and pronounce the underlined word aloud wherever it arose; the other half were asked to place a checkmark next to each occurrence of the underlined word, indicating whether it had appeared earlier in the passage. Through oral retelling of the passages, Rosenthal and Ehri affirmed that the children's comprehension of the passages—and, therefore, of the meanings of the target words—was comparable whether or not they had been required to read the words aloud. However, the children's retention of the words themselves differed markedly, whether measured by spelling, by recall of the word in response to a definition, or by choosing the words' definition in a multiple-choice test. Among the better readers, those in the say-aloud condition showed themselves significantly more able to recall the word in response to the definitional queries; those who had not been required to say the words aloud were slightly less likely to recall the words and, when they did, were much more likely to produce approximate rather than correct pronunciations of them. Among poorer readers, fewer than 40% were able to recall even an approximately acceptable pronunciation of even one of the target words; in contrast, 90% of those who had been required to stop and read the target words aloud succeeded in doing so.

Cleaning up the linkage between orthography and phonology is not just about improving pronunciation. It is about conferring a more distinct identity to the word and, as a result, enabling it to more powerfully, efficiently, and unambiguously direct energy exactly and only to its meaning. This in turn affords resources and focus for strengthening and refining the word's meaning.

Also consistent with the mind's dependence on "good matches" is the fact that meanings and spellings of words with ambiguous or confusing spelling-sound correspondences, such as *imminent*, *eminent*, and *immanent*, are harder to learn (Katz & Frost, 2001). Sometimes phonologically ambiguous spelling-sound correspondences are constrained morphologically. Among older school children, for example, even though *fatter* rhymes with *ladder*, the prominence of *fat* in *fatter* ensures that it will be "heard" and spelled with medial /t/ rather than /d/ (Ehri & Wilce,

1986). Sometimes phonologically ambiguous spelling–sound correspondences can be instructionally corrected. For example, leading children to pronounce schwas as they are spelled (e.g., cho-co-late rather than cho-kə-lət, har-mo-ny rather than har-mə-ny, cor-res-pond rather than cor-rəs-pond, or man-a-tee rather than man-ə-tee) is shown to promote the words’ correct spelling (Drake & Ehri, 1984). (And, after all, the schwa is not really a phoneme, but only a phonotactic consequence of reduced stress.)

On the other hand, English spelling–sound correspondences are notoriously complex and inconsistent. Beyond schwas, there are long and short vowels (both unreliably signaled), digraphs, unruly letter doubling (*pepper* vs. *paper*, *common* vs. *comic*, *demon* vs. *lemon*), silent letters (*comb*, *knit*, *gauge*), and irregular words (*colonel*, *island*). The same letter or spelling may map to several different phonemes (e.g., *cow*, *low*; *get*, *gem*; *read*, *read*) and, worst of all, the same phoneme can be spelled in many, many different ways. For example, Edward Rondthaler, longtime spelling reformer and chairman of the American Literacy Council, lists 18 different spellings for the long /oo/ phoneme: oo (*moon*), ou (*group*), ui (*fruit*), ue (*glue*), ew (*drew*), wo (*two*), u (*flu*), oe (*canoe*), ough (*through*), u...e (*rule*), ieu (*lieu*), oo...e (*loose*), o...e (*lose*), oup (*coup*), ui...e (*bruise*), eu...e (*deuce*), eu (*sleuth*), ous (*rendezvous*), and ou...e (*mousse*) (See American Literacy Council, 2008). Further, whereas the permissible syllables of most languages are limited to CV, CVC, and VC structures, English syllables can (and often do) sport multiple consonant sounds on either side of the vowels (e.g., *sprints*) with the result that, relative to other languages, the permissible syllables in English are far greater in number and phonologically far more complex.

Moreover, just as there is a cost to learning spelling–sound mappings poorly, there is a big cost to the fact that English spelling–sound mappings are so hard to learn. In English-speaking countries, the incidence of dyslexia is far higher and the acquisition of basic literacy skills takes far longer than in countries with more regular or orderly alphabetic systems. (For a review, see Ziegler & Goswami, 2005.) In European countries with highly regular orthographies, such as Germany, Greece, and Finland, nearly all children can read simple one- and two-syllable pseudowords and nearly any real word in their speaking vocabulary by the end of first grade (Seymour, Aro, & Erskine, 2003). In English-speaking countries, it is at least the middle grades before most children reach this level.

Creating the Connections

In short, where the challenge is learning to read English, the amount of attention, time, care, and study required is considerable. But then, all of the difficulties and fixes just discussed are far in the future for our teachers' young student, who is still struggling with the basics. Which takes us back to the question, How does the system get set up in the first place?

"Aha!" astute readers might say to themselves. "The grapheme–phoneme connections are established through the visual word form area!"

Yes, that is essentially what must happen. However, the visual word form area doesn't even exist in prereaders; it develops only gradually through reading growth and experience. Whether our teachers knew it or not, by drilling their young student on phonics, it is the visual word form area that they are seeking to develop. Research tells us that the prerequisites for learning to decode are letter recognition, letter–sound knowledge, and phonemic awareness. Since this child has learned to recognize and sound the individual letters, let us focus on phonemic awareness.

Phonemes are the smallest units of spoken language that make a difference to meaning. For example, the spoken word "rope" comprises three phonemes, /r/ /ō/ /p/, and differs by only one phoneme from such words as *dope*, *road*, *rip*, and *roach*. In principle, phonemes are the sounds that are represented by the letters of an alphabetic language. Again, the mapping between graphemes and phonemes is messy in English, partly because there are fewer letters (26) than there are phonemes (38 to 47, depending on who is counting) and partly because some phonemes (especially the vowels) are variously represented through a number of different letters and combinations of letters. Nevertheless, the principle still holds.

What, then, is phonemic awareness? This is the critical question for our teachers. The National Reading Panel defines phonemic awareness as "the ability to focus on and manipulate phonemes in spoken words" (National Institute of Child Health and Human Development, 2000, p. 2-1), and continues with a list of tasks through which it is commonly practiced or assessed:

- Phoneme isolation—e.g., "Tell me the first sound in *paste*." (/p/)
- Phoneme identity—e.g., "Tell me the sound that is the same in *bike*, *boy*, and *bell*." (/b/)
- Phoneme categorization—e.g., "Which word does not belong? *bus*, *bun*, *rug*?" (*rug*)
- Phoneme blending—e.g., "What word is /s/ /t/ /o/ /p/?" (*stop*)

- Phoneme segmentation—e.g., “How many phonemes are there in *ship*?” (three: /sh/ /i/ /p/)
- Phoneme deletion—e.g., “What is *smile* without the /s/?” (*mile*)

Many educators have adopted this definition of phonemic awareness. Since the National Reading Panel’s charge was to identify scientifically based instructional practices, this is understandable.

But hold it: The National Reading Panel’s task, more specifically, was to determine which instructional practices yielded statistical gains that were robust across soundly designed, peer-reviewed, experimental studies. Given this, it was essential that the panel define phonemic awareness in terms of its quantitative measurement. Yet assessing phonemic awareness is not the same as teaching it. Where the primary task is one of helping children to acquire phonemic awareness, knowing how to test it is not good enough: It is vital to understand what it is at a conceptual level, as well as how it develops.

So, first: How is phonemic awareness defined at that conceptual level? Phonemic awareness is the insight that every spoken word can be conceived as a sequence of phonemes (Adams, Treiman, & Pressley, 1998; Snow, Burns, & Griffin, 1998). Because phonemes are the units of sound represented by the letters of an alphabet, an awareness of phonemes is key to understanding the logic of the alphabetic principle and thus to learning phonics and spelling.

Second, how does phonemic awareness develop? As described earlier, learning is the result of creating new links between established representations in the mind. In decoding, the links are between the spellings of words and the phonological representations of the words. Toward building these links, what are the representations that are available within the mind? On one side are the taught sounds that the letters represent. But what is it on the other side?

Based on a wealth of evidence of many different kinds and sources, science concurs, over and over again, that the representations on the other side are *individual words* (e.g., Adams, 1990; Byrne & Fielding-Barnsley, 1990; Ehri, 1992; Lewkowicz, 1980; Morais, 2003, Murray; 1998; Perfetti, 1992; Seidenberg & McClelland, 1989; Share, 1995; Skjelfjord, 1976; Treiman, 1993).

Children approach the challenge of learning to read with a fairly extensive listening and speaking vocabulary. Necessarily, as part of that vocabulary knowledge, the elementary phonetic and articulatory structure of

individual words and the differences between them must be represented at some level. However, these representations are not conscious but instead are embodied in a precognitive, biologically specialized subsystem that operates automatically (Liberman & Liberman, 1992; Liberman & Mattingly, 1989). This is the gift of human language. In speaking and listening, we do not need to think or expend attention in analyzing or piecing words together, phoneme by phoneme. Instead, a word such as *bag* is heard and pronounced on call as a single, seamless unit.

It is because these processes are automatic and preconscious that we can so swiftly and effortlessly produce and understand spoken language. On the other hand, a basic premise of phonics is that, to learn to read, children need only link the letters to the phonemes. If the phonemes are unavailable to consciousness, then how is this possible?

The answer is that emergent readers must work with the phonological information to which they *can* gain awareness and restructure it to fit the writing system. Whether studied historically across the evolution of literacy or developmentally across its acquisition, evidence attests that people's conscious sensitivity to the phonological structure of their language progresses only gradually to the level of phonemes. That is, people (historically) and children (developmentally) gain awareness of words before syllables, syllables before onsets or rimes, and onsets and rimes before phonemes (Anthony & Lonigan, 2004; Olson, 1994; Treiman, 1993).

Furthermore, sensitivity to phonemes arises only as the consequence of learning an alphabetic writing system. As Murray (1998) expressed it, "To identify a phoneme is to perceive it as the same vocal gesture repeated across different words (i.e., a familiar and recognizable entity)" (p. 462). That is, if the child can recognize that the spoken word "man" begins with the phoneme /m/, he or she can build a new connection, pairing the initial letter of the written word *man* with the initial sound of its pronunciation.

It is through the mappings from the spellings of words to their pronunciations that print becomes bound to the language centers of the brain. For beginning readers, the very process of decoding leaves a trace in memory that connects the letters of a word's spelling with the matching components of its pronunciation. Phonemic sensitivity grows as the same letter maps to and clarifies the "same" sound in many words while, reciprocally, the pronunciation of each word will come to be represented in terms of its phonemes as defined by its spelling. Just as it is easier to hear the initial phoneme of a word, the children's spelling-sound knowledge tends to begin with initial consonants, progressing to final

consonants, medial vowels, and blends (Duncan, Seymour, & Hill, 1997; Treiman, 1993).

Provided that a word is read and understood in context, the activation from the word's spelling will extend through its pronunciation to its meanings and usage. Each time the word is seen, this link will automatically be recalled, thus strengthening and refining the connections that hold it together. Through this process, as the connections between spelling, sound, and meaning become completely and reliably represented and bound together, the word will become readable at a glance; it will become a "sight word." Further, as multiple words reach for the same substrings of letters, the child's knowledge of orthography will progressively expand from single letters to larger spelling patterns.

The most obvious benefit of phonics is that it enables readers to sound out the occasional unknown word they encounter in print. Beyond the beginning stages, however, its most important benefit may be that it leads to decoding automaticity. Decoding automaticity is rooted in the reader's cumulative knowledge of spelling-sound correspondences. Over time, as the product of their cumulative decoding experience, readers progressively refine their phonological sensitivity even as common pronunciations of word parts become tied to common spellings. As this knowledge grows in breadth and depth, it provides a support structure by which nearly every new word is partly learned already, enabling readers to read and spell new words with ease and to retain them distinctly. A side-effect of such knowledge is that it enables them to "recognize" pseudowords.

The Development of the Visual Word Form Area

For mature readers, regardless of the language they speak or the type of writing system they have learned, the location of the visual word form area is the same. It is centered in a region of the cortex that generally specializes in recognizing visual stimuli such as faces and tools that demand foveal viewing and are distinguished by subtle detail. Unlike neighboring areas, however, the visual word form area develops only in the left hemisphere of the brain, rather than bilaterally in both right and left hemispheres. The specific area in which the visual word form area is centered is adjacent to the phonological centers in the brain, which are left-lateralized from birth.

Developmentally, the first sign of specialized activity in the region that will become the visual word form area is a relatively rapid response to letters that arises as children become expert in letter recognition (Maurer et al., 2005). At this early stage, however, the region is still very

immature. Its responsiveness to letters is no stronger in the left hemisphere than in its symmetrically matched region in the right hemisphere. It is only gradually, after nearly two years of reading instruction (and in degree correlated with children's reading growth), that the area begins to show a clear preference for real letters as compared with other letter-like symbols (Maurer et al., 2006). Among on-pace children, it is not until fourth grade that the visual word form area begins to produce adult-like responses to high-frequency words, though even then it shows little generalization to well-spelled pseudowords (McCandliss et al., 2003). In keeping with this, behavioral evidence shows that children's perception of print, including their facility in reading pseudowords, is strongly determined by the specific words with which they are familiar (Booth, Perfetti, & MacWhinney, 1999; Laxon, Masterson, Gallagher, & Pay, 2002; Van den Broeck, Geudens, & van den Bos, 2010). Not until children are about 16 years old does the area's responsiveness to different kinds of tasks and letter strings become mature, though even then it is slower than is normal for adults (Schlaggar & McCandliss, 2007).

Over the primary grades, as the left hemisphere comes to dominate the right hemisphere in visual word perception, accompanying changes are seen in the visual word form area's connections and communications with the language centers of the brain. In the beginning, activity is characterized by slow and effortful letter-to-sound processing. Gradually, as the responsiveness of the visual word form area grows from back to front, both the speed of the system's responses and the complexity of the spelling patterns that gain direct connection to the language centers increase—though again, it is not until adolescence that the full system works in adult-like ways (Sandak, Mencl, Frost, & Pugh, 2004). However, even among mature readers—those who have developed swift responses to frequent spelling patterns whether in words or pseudowords—the responsiveness of the system appears to be firmly anchored on their experience and familiarity with real words that they have learned to read (Bruno et al., 2008).

As described, the changes in the visual word form area's responsiveness and their timing are for children who are developing on pace. Research shows the actual timing of these changes at each stage is correlated, not with age, but with children's reading ability (Maurer et al., 2006; Sandak et al., 2004; Shaywitz et al., 2002). Moreover, the responsiveness of the visual word form area is weak or aberrant in developmental dyslexics and illiterates (Schlaggar & McCandliss, 2007), but has been shown to develop through a similar progression in response to instruction in

decoding, writing, and reading (Brem et al., 2010; James, 2010; Shaywitz et al., 2004; Temple et al., 2003).

Conclusion

Back to our teachers. They were very correct to be reading and discussing literature with the child, for both word recognition and reading comprehension depend on language development. They were also correct that many of the shortest and most frequent words in English tend to be irregularly spelled. (In view of this and as noted in Adams, 2009, teachers are urged to teach the basic function words—for example, *the, of, do*—early, helping children to grasp their usage and to recognize them visually before moving into reading proper.) The teachers were also correct in their belief that helping this child learn to decode accurately and confidently is extremely important toward furthering his language and literacy development.

Where they went awry was in using a test to teach. In this case, the specific problem happened to be that the items in the test were nonwords rather than real, meaningful, knowable words. But think of the many other instances where teachers have endeavored to use assessment methods and materials to teach. In urging teachers to use the findings and products of research, it is critically important that researchers, policy-makers, and teacher educators do a better job of clarifying when and how such findings and products are useful.

Finally and for the sake of clarification, the issue here is not whether words should be taught in context or isolation. Engaging children in reading and writing words in isolation serves to hasten learning of the words' spelling and their recognition. Leading children to read words in meaningful contexts hastens their command of the words' usage and meaning. Both are important to young readers, and equally so. But whatever the teaching or learning activity, it is important to make sure that children see and say the word and understand and think about its meaning in course. The brain does not grow block by block from bottom up. It grows through its own efforts to communicate and find coherence within itself.

Questions for Reflection

1. Research has shown that games and activities for developing children's phonemic sensitivity and awareness have greater impact

when the phoneme is represented by its letter than by, for example, blocks or bingo markers. Based on what you learned from this chapter, why does this make sense?

2. The automaticity of recognizing a word or word part depends on securing strong connections not just between its spelling and pronunciation but also between its spelling/pronunciation and its meaning and usage. For each of the following sets of suffixes, create a set of exercises to help children master the spellings, pronunciations, meanings, and usages of suffixes and real words. (Do not neglect associated spelling issues such as final consonant doubling, dropping final *e*, and changing *y* to *i*.)
 - -ing, -ed
 - -er, -est
 - -ness, -less, -ful
3. Once they have some knowledge of the letters and a basic understanding of the alphabetic principle, encouraging kindergartners and first graders to write using inventive (phonetic) spelling is among the most powerful practices for promoting their reading growth. Thinking about what you learned from this chapter, explain why this is so.
4. It has been shown that word-recognition growth is hastened when the words in children's earliest texts (levels equivalent to the traditional preprimers and primers) are coordinated with their phonics lessons. In what ways may this help young readers both to appreciate and to internalize their phonics lessons? Why?
5. Many basic function words in English pose problems for young readers in two ways. First, these words are poorly distinguished orally ("I want a glass uh milk"). Second, many sport spelling-sound correspondences that are irregular, or at least sophisticated relative to entry-level phonics standards. Because these words arise so frequently (and take on new importance) in written text, it is wise to help students master their spellings and usages before decodable texts are introduced. Following is a list of very frequently occurring words. Invent activities (e.g., language activities, writing activities, rebus texts) through which you could engage kindergartners in using and learning their spellings and usages.

- the, a, an
- of, to, in, for, on, with, at, from, by
- and, or, but, not
- am, is, are, was, were, will, have, has, had, do, does, did
- I, we, you, he, she, they, it
- me, us, you, him, her, them
- my, our, your, her, his, their, its

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