

# A Logical Letter–Sound System in Five Phonic Generalizations

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This article introduces a strategy for teaching systematic phonics with a logical system of grapheme–phoneme relationships.

Einstein wrote, “The object of all science...is to co-ordinate our experiences and to bring them into a logical system” (as cited in Hawking, 2007, p. 265). The National Reading Panel promoted the idea of using a logical system for phonics by concluding “that systematic phonics instruction produces significant benefits for students in kindergarten through 6th grade and for children having difficulty learning to read” (National Institute of Child Health and Human Development, 2000, p. 9). The panel also wrote, “The hallmark of a systematic phonics approach or program is that a sequential set of phonics elements is delineated” (p. 8).

For decades, reading researchers unsuccessfully sought to unveil a logical generalized system of delineated letter–sound elements. Johnston (2001) echoed this by stating that phonic generalizations still fail to offer a useful guide to phonics. In just five transparent phonic generalizations, this article ties the strong recommendation of the National Reading Panel for teaching systematic phonics with a logical system of grapheme–phoneme relationships.

## Review of the Literature

Clymer (1963/1996) conducted the first major study of phonic rules, many dating back to their introduction by Noah Webster in late 18th-century editions of his primer, affectionately remembered as “Webster’s blue-backed spellers.” Clymer culled 150 phonic generalizations from “four widely used sets” of primary

readers. In paring these down to a manageable number, he commented that some of the generalizations represented a clutter of “statements with no clear indication as to what was to be done” (p. 183). Of the 150 generalizations, he chose 45 to evaluate against 2,600 words that he drew primarily from four widely used basal readers. Among other parameters, including his requirement of finding at least 20 words from the word list to compare with each generalization, he established the relative reliability for each generalization.

Simply put, from the word list Clymer (1963/1996) identified the ratio of the number of words that conformed to a generalization to the total number of words that applied to it. Of the 45 phonic generalizations, he identified only 18 that met 75% utility. For example, he found that the letter–sound patterns of *kn* in *knife* and *ght* in *night* showed high utility and that their corresponding generalizations reflected this utility. Contemporary reading and linguistic literature replaced the term *utility* with the term *transparency*, as this article reflects.

Furthermore, Clymer’s (1963/1996) research showed that the majority of the generalizations failed to meet the minimum standard that he set for letter–sound utility; within this article, for these and other phonic irregularities, we use the term *unfit* (Pei, 1966). Clymer’s research captivated the interest of other researchers, who replicated the study of the same set of 45 generalizations. Comparing Clymer’s study with five replications, Curry and Geis (1976) reported that, collectively, 20 of the 45 generalizations met the minimum transparency of 75%.

Three comprehensive vowel generalizations, written in assorted variations, created the most intense interest: (1) A single vowel usually has its short sound in a closed syllable and its long sound in an open syllable (e.g., *sup/per* vs. *su/per*); (2) when a word ends

in a final single vowel-consonant-*e*, the first vowel has its long sound, and the *e* is silent; and (3) when two vowels “go a-walking” the first one “does the talking.”

As part of her phonic research, Burmeister (1968) addressed the single-vowel sounds within the closed- and open-syllable generalization. She used the same word list that Hanna, Hanna, Hodges, and Rudorf (1966) used to conduct seminal *phoneme-grapheme* orthographic research for *encoding*. However, Burmeister studied *grapheme-phoneme* correspondence for *decoding*, the opposite process. Although she fell short of identifying the specific sounds of the closed vowels, she found that a single vowel in a closed syllable usually has a short or schwa sound. Unexpectedly, she also found the long vowel sound in less than a third of the open-syllable single vowels. Her research suggests that the letter-sound relationships of open and closed single vowels are more alike than different.

Besides the fact that emergent readers struggle to distinguish between the closed and open syllables, research into this generalization showed uncertainty. Burmeister’s (1968) seminal report and others’ subsequent research, including a report by Greif (1981), presented a compelling case to abandon the open- and closed-syllable generalization. In deference to this strong indictment, the open- and closed-syllable generalization persists in many early reading programs.

Researchers poured even more energy into trying to reconcile letter-sound patterns with the final single vowel-consonant-*e* (VC*e*; Burmeister, 1969; Greif, 1980) and the vowel digraph generalizations (Bailey, 1968; Greif, 1983; Johnston, 2001). Despite numerous attempts, the research showed that, as traditionally stated, neither generalization approached a reasonable transparent threshold. Thus, researchers strongly caution against their use.

As Calfee (1998) and Johnston (2001) noted, as opposed to vowels, the consonants present greater letter-sound predictability and less challenge to emergent readers. Nonetheless, a deep understanding of the letter-sound interrelationships requires an analysis of all of the letters, including the consonants. Clymer (1963/1996) and those who replicated his study analyzed several consonant generalizations that included the following: When *c* is followed by *e* or *i*, the sound of *s* is likely to be heard. When the letter *c* is followed by *o* or *a*, the sound of *k* is likely to be heard. Also, *ch* is usually pronounced as it is

in *kitchen*, *catch*, and *chair*, not like *sh*. These, like a number of other generalizations that Clymer found in use, are clearly of limited utility because of their narrow focus.

From 1977 through 1988, Greif conducted at least 11 grapheme-phoneme studies, all of which showed undependable letter-sound relationships. From these studies he concluded that reading teachers should largely abandon phonic instruction (Greif, 1988). Although Clymer’s (1963/1996) study continued to evoke interest, partly evidenced by its reprinting in 1996 in *The Reading Teacher*, the research into phonic generalizations quieted (Johnston, 2001).

In summary, the generalizations that evolved literally over centuries show little promise of reconciliation with words found in children’s literature. To bring the National Reading Panel’s support for systematic phonics instruction into alignment with a coordinated understanding of systematic letter-sound relationships, the lead author designed the following research.

## Revisiting Letter-Sound Relationships

Rather than revisiting the degree of conformity of letter-sound relationships for existing generalizations, the lead author approached the research as if all letter-sound patterns were unknown. He selected 16,928 words within the Zeno et al. (1995) word list. These words represented those that occurred at least once per million running words in children’s literature, excluding slang, dialectical, contracted, abbreviated, or hyphenated words, and proper nouns. From a computer analysis of these words, which included all possible two-letter combinations as well as many three-, four-, and five-letter patterns, emerged stand-alone letters and letter clusters of *cell* patterns. The term *cell*, originally drawn from biology, means the smallest unit capable of independent functioning. The word *thatch*, for instance, includes three distinct phonic cells as heard in the phonemes /*th*/ /*a*/ /*ch*/. (For these phonemes and throughout this article, the authors used the *American Heritage Dictionary* as the pronunciation guide.)

The study established a benchmark of no less than 75%, but sought at least 90% transparency for each cell. Additionally, if a reoccurrence of a particular phonic cell appeared in a target word, the study

included just the first occurrence. For example, the study included only the first *a* in *banana*. The report also includes the following variant sounds: (1) the syllabic *l* that modifies both the schwa sound as in *pedal* and the long *e* sound for *ea* as in *deal*, (2) the occasional short *i* sound for single vowel *e* as in *pretty*, and (3) the variant sounds for the long *u* as in *super*, *numerous*, and *popular*.

The study included only vowel digraphs with a minimum of 100 occurrences in the word list. (Within this study the term *vowel digraph* includes both traditional vowel pairs as in *see* and diphthongs as in *oil*.)

This 100-word threshold excluded certain vowel digraphs; of these, the 29 words in the 16,928 Zeno et al. (1995) list containing the highly transparent *oy* digraph is the most significant one. (This digraph may be easily taught using the most common one-syllable root words—*boy*, *joy*, *toy*; these words represent 3 of just 11 root words within the 29 words with the *oy* phonic cell.) Nevertheless, of the 16,928 words, the 100-word threshold reasonably encompassed most reoccurring vowel digraphs. The study excluded an analysis of vowel digraphs in triple vowel letter situations—*aye*, *coyote*, *seeing*.

The analysis also excluded inflected root words when a *y* changed to *i* plus a suffix—*cry* to *cries*, and the prefixes in *unable* and *subordinate*. Otherwise, inflections were included in the analysis of the phonic cells. For example, the data shown in Table 1 include the single vowel *a* in *paving*; overall, this and similar inclusions reduced the transparency of the ratios shown in the tables. Similarly, digraph *look-alikes*, as the *ph* in *uphold* and *aw* in *awhile*, were included in vowel and consonant digraph cells; their inclusion decreased the general transparency of the digraphs. Moreover, the letter *y* was studied as a single consonant when it started a word—*yam*, *yak*, *yes*—and studied as a single vowel when it ended a word—*by*, *defy*, *happy*. The 174 occurrences of the medial single *y*, which varied as a consonant and a vowel, were not studied. Finally, consistent with

previous letter–sound research, the study excluded *r*-controlled single vowels (*Vr*), final vowel-*re* (*-Vre*), and vowel digraph-*r* (*VVr*) patterns (*bar*, *bare*, *bear*).

The potentially useful term *phonogram* lacks a cohesive definition (Johnston 2001; Pei, 1966). The online freedictionary.org reflects this lack of coherence by defining phonogram as “any written symbol standing for a sound, syllable, morpheme, or word” (March 1, 2010). Arguably, if this lack of specificity defines single letters, digraphs, and word families alike, then the term becomes essentially meaningless. Accordingly, this article limits the meaning of phonogram to patterns of vowel and consonant combinations. This includes three distinct categories of phonograms: (1) *signal* phonograms, such as the *cy* phonogram that *signals* a soft *c*—*cycle*, *cyst*; (2) *word family* phonograms—*fight*, *light*, *night*; and (3) *syllabic* phonograms, which form a stand-alone syllable—*caution*, *massive*, *football*. This useful distinction of the term helps delineate the letters and letter combinations as (1) single vowel and single consonant letters, (2) final single vowel-consonant-*e* (*-VCe*), (3) vowel and consonant di/trigraphs, and (4) a mixture of vowels and consonants in phonograms.

A methodical dissection of the letter–sound relationships led to the identification of 104 cells shown in Tables 1 through 5. These 104 cells include 54 *basic* transparent cells, 39 transparent *phonograms*, and 11 *unfit* cells. The top row of the tables lists the basic cells. Of these, the tables show 38 basic transparent cells, such as shown for the basic cells represented by *gene*, *hay*, and *taught*, that stand alone without subordinate phonograms or unfit cells. On the other hand, 16 of the transparent basic cells include transparent phonograms, such as the phonograms for the consonant *g*—*gem*, *magic*, *gym*. Furthermore, the tables show 11 unfit cells. Two of the unfit cells, *io* and *ou*, included transparent phonograms—*mansion*, *hound*, *famous*, *house/louse*.

Only one of the unfit cells occurred repeatedly—the single vowel *o*, which appeared 3,054 times within the word list. Due to the frequent occurrence of the unfit single vowel *o*, the senior author tested its letter–sound correspondence within one-syllable words. Excluding words that end in *o*, two similar sounds represent the single vowel *o*—/o/ as in *ox*, *box*, *log*; and /aw/ as in *dog*, *hog*, *log*—in 165 of 200 one-syllable words (83% transparency), except the phonograms in the letter patterns *old* (*mold*; 14/14



**Table 1**  
**Single Vowels; Exclude R-Controlled Vowels and the 3,054 Instances of the Unfit Single Vowel O**

a	e	i	u	y
<ul style="list-style-type: none"> <li>■ <b>cat</b>: 3,703/4,059 (Include the short a sound in <i>about</i> and the syllabic l sound in <i>pedal</i>.)</li> <li>■ <b>ball</b>: 51/52 (one-syllable roots)</li> <li>■ <b>nation</b>: 341/349</li> <li>■ <b>wa</b>: 119 unfit words</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>pen</b>: 4,002/4,494 (Include the short i sound in <i>pretty</i> and the schwa sound in <i>kettle</i>.)</li> <li>■ <b>edge</b>: 308/318 (ends words, except -VCe)</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>pig</b>: 5,011/5,552 (Include the schwa sound in <i>pupil</i>.)</li> <li>■ <b>night</b>: 101/101</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>bug</b>: 1,343/1,421 (Include the schwa sound in <i>mucus</i>.)</li> <li>■ <b>ruby</b>: 440/509 (This u-consonant-vowel pattern includes the u sounds in <i>numerous</i> and <i>popular</i>; it excludes the prefixes <i>un</i> and <i>sub</i>.)</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>kitty</b>: 1,304/1,321</li> <li>■ <b>fly</b>: 14/14 (one syllable)</li> <li>■ <b>defy</b>: 14/18</li> </ul>

Note. **Bold and italics** identify the phonic cell under consideration—*nation*. *Italics only* include a signal letter(s) that is not a part of the sound—consider the letters *by* that signal the long u sound in *ruby*. This table includes 16,632/18,208 discrete transparent cells: 91% transparent.

**Table 2**  
**Final Vowel-Consonant-e (-VCe); Exclude R-Controlled -VRe**

a-Consonant-e	e-Consonant-e	i-Consonant-e	o-Consonant-e	u-Consonant-e
<ul style="list-style-type: none"> <li>■ <b>cake</b>: 131/138</li> <li>■ <b>face/palace</b>: 23/24</li> <li>■ <b>cage/cabbage</b>: 61/62</li> <li>■ <b>gate/chocolate</b>: 134/134</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>gene</b>: 22/23</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>bike</b>: 189/206</li> <li>■ <b>ice/office</b>: 26/27</li> <li>■ <b>massive</b>: 32/32</li> <li>■ <b>captive</b>: 92/92</li> <li>■ <b>-ile</b>: 29 unfit words</li> <li>■ <b>-ine</b>: 66 unfit words</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>bone</b>: 112/127</li> <li>■ <b>handsome</b>: 9/10</li> <li>■ <b>-ove</b>: 15 unfit words</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>use/dune</b>: 75/79</li> </ul>

Note. **Bold and italics** identify the phonic cell under consideration—*captive*. A slash (/) shows distinct phonemes for a particular phonic cell—*face/palace*. This table includes 906/954 discrete transparent cells: 95% transparent.

**Table 3**  
**Vowel Digraphs That Occurred 100 Times or More; Exclude R-Controlled Vowel Digraphs and the 215 Instances of the Unfit IA Digraph**

ai	au	ay	ea	ee	ie
<ul style="list-style-type: none"> <li>■ <b>nail</b>: 294/331</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>auto</b>: 108/120</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>hay</b>: 123/125</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>tea/head</b>: 583/638 (Include syllabic l as in <i>real</i>.)</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>bee</b>: 324/327</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>chief</b>: 76/80 (excludes y to ie + suffix)</li> <li>■ <b>pie</b>: 12/12 (1 syllable)</li> <li>■ <b>diet</b>: 15/18</li> <li>■ <b>ien</b>: 74 unfit words</li> </ul>
io	oa	oi	oo	ou	ow
<ul style="list-style-type: none"> <li>■ <b>io</b>: 117 unfit words</li> <li>■ <b>mansion</b>: 771/818</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>soap</b>: 113/127</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>oil</b>: 113/127</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>moon</b>: 185/198</li> <li>■ <b>foot</b>: 17/17</li> <li>■ <b>book</b>: 42/43</li> <li>■ <b>ood</b>: 61 unfit words</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>ou</b>: 80 unfit words</li> <li>■ <b>hound</b>: 128/139</li> <li>■ <b>famous</b>: 47/48</li> <li>■ <b>house/louse</b>: 32/32</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>mow/town</b>: 213/216</li> </ul>

Note. **Bold and italics** identify the phonic cell under consideration—*bee*. A slash (/) shows distinct phonemes for a particular phonic cell—*tea/head*. This table includes 3,182/3,403 discrete transparent cells: 94% transparent.

**Table 4**  
Single Consonants

b	c	d	f	g	h	j
<ul style="list-style-type: none"> <li>■ <b>bib</b>: 1,901/1,939</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>cat</b>: 2,828/2,832</li> <li>■ <b>cent</b>: 240/243</li> <li>■ <b>city</b>: 244/263</li> <li>■ <b>cycle</b>: 61/61</li> <li>■ <b>special</b>: 37/37</li> <li>■ <b>musician</b>: 12/12</li> <li>■ <b>precious</b>: 13/13</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>dad</b>: 3,113/3,151</li> <li>■ <b>added/fixe<b>d</b></b>: 1,947/1,947</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>fan</b>: 1,631/1,633</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>gag</b>: 942/989</li> <li>■ <b>gem</b>: 285/315</li> <li>■ <b>magic</b>: 135/161</li> <li>■ <b>gym</b>: 29/31</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>hat</b>: 693/736</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>jug</b>: 198/199</li> </ul>
k	l	m	n	p	qu	r
<ul style="list-style-type: none"> <li>■ <b>kick</b>: 715/715</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>lip</b>: 5,441/5,481</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>mom</b>: 2,934/2,934</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>nun</b>: 5,503/5,513</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>pop</b>: 3,220/3,234</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>queen/liquor</b>: 203/203</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>rat</b>: 7,855/7,857</li> </ul>
s	t	v	w	x	y	z
<ul style="list-style-type: none"> <li>■ <b>see/easy</b>: 7,598/7,648</li> <li>■ <b>pension/vision</b>: 121/121</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>tot</b>: 5,600/5,644</li> <li>■ <b>partial</b>: 35/36</li> <li>■ <b>turn/nature</b>: 296/296</li> <li>■ <b>station</b>: 629/643</li> <li>■ <b>cautious</b>: 7/7</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>vet</b>: 1,401/1,401</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>wet</b>: 583/592</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>tax/exit</b>: 352/360</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>yak</b>: 55/55</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>zoo</b>: 240/243</li> </ul>

Note. **Bold and italics** identify the phonic cell under consideration—**hat**. A slash (/) shows distinct phonemes for a particular phonic cell—**see/easy**. *Italics only* include a signal letter(s) that is not a part of the sound—consider the letter y that signals the soft g in **gym**. This table includes 57,542/59,990 discrete transparent cells: 99% transparent.

**Table 5**  
Consonant Di/trigraphs

ch	ck	dg	gh	ght	gn	kn
<ul style="list-style-type: none"> <li>■ <b>chin/chemist</b>: 468/480</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>dick</b>: 333/333</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>judge</b>: 55/55</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>gh</b>: 66 unfit words</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>taught</b>: 144/145</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>sign</b>: 9/9 word endings</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>knit</b>: 31/31</li> </ul>
ng	ph	sh	tch	th	wh	wr
<ul style="list-style-type: none"> <li>■ <b>hang/change</b>: 1,742/1,773</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>phone</b>: 133/141</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>ship</b>: 488/490</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>match</b>: 89/89</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>thin/this</b>: 487/496</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>which</b>: 83/86</li> <li>■ <b>who</b>: 4/4</li> <li>■ <b>whole</b>: 5/5</li> </ul>	<ul style="list-style-type: none"> <li>■ <b>wreck</b>: 52/53</li> </ul>

Note. **Bold and italics** identify the phonic cell under consideration—**phone**. A slash (/) shows distinct phonemes for a particular phonic cell—**thin/this**. This table includes 4,123/4,190 discrete transparent cells: 99% transparent.

words), *olt* (*colt*; 6/6 words), and *oll* (*roll*; 11/13 words), and *r*-controlled vowels. (Notably, the traditional short *o* sound—*ox*, *box*, *log*—represented the first or second preferred pronunciation for all but 3 of the 165 transparent words.)

Collectively, the other 10 unfit cells appeared in just 842 words; these 10 cells included one single vowel cell—*wa*; three -VCe cells—*ile*, *ine*, *ove*; three basic vowel digraphs—*ia*, *io*, *ou*; two vowel digraph letter combinations—*ien*, *ood*; and one consonant digraph—*gh*. Conversely, the three transparent categories of vowels combined showed a ratio of 20,720/22,565 separate transparent basic cells and phonograms for 92% transparency; the basic and phonogram consonant cells combined revealed a ratio of 61,665/62,180 cells for 99% transparency. Of the 93 transparent cells, only 1—the *fy* in *defy*—fell below 80% transparency to 78%; 9 cells fell between 80% and 89% transparency; and 83 of the cells met or exceeded the stringent goal of 90% transparency.

The report systematically organized the basic cells, phonograms, and unfit cells into one of the following five general categories: (1) single vowels—*cat* or *cut*; (2) vowels in final single vowel-consonant-*e* (-VCe) pattern—*bate* or *bite*; (3) vowel digraphs—*sea* or *see*; (4) single consonants—*cat* or *cut*; and (5) consonant di/trigraphs—*thick*, *wretch*. At first, these five categories seemed too straightforward. However, a deeper look into letter–sound relationships showed that patterns of triple vowels as in *beauty* occur infrequently. For example, including the three juxtaposed vowels in the phonograms in *precious* and *cautious*, no triple vowel pattern occurred at least 50 times in the list of 16,928 words. Similarly, aside from consonant trigraphs in *night* and *match*, the letter–sound relationships of triple single consonants typically broke into two or three distinct letter–sound combinations—*lit-tle*, *cost-ly*. Quadruple vowel or consonant combinations—*viewing*, *earthly*—occurred infrequently and showed limited applicability for beginning or remedial readers. In short, these five basic patterns, coupled with their phonograms and excluded unfit cells, robustly systematize the letter–sound relationships into a logical arrangement.

## Five Phonic Generalizations

Written in basic, phonogram, and unfit clauses, each of the following generalizations summarizes one

of the five tables. For easy reference, the basic cell keywords from the tables follow the generalizations:

1. Single vowels usually have their short<sup>1</sup> (or schwa<sup>2</sup>) sound; except the phonograms in **ball** (one-syllable roots), **nation**, **edge** (no sound), **night**, **ruby** (open-syllable *u*), **fly** (one-syllable words), and **defy**; exclude unfit single vowel **o**, **wa**, and *r*-controlled vowels.  
(<sup>1</sup>*cat*, *pet*, *pig*, *bug*, *happy*; <sup>2</sup>*about*, *kettle*, *pupil*, *mucus*)
2. Final single vowel-consonant-*e* (-VCe) patterns usually have a long first vowel and a silent final *e*<sup>1</sup>; except the phonograms for the long sound or short *i* sound in **ace/palace**, **age/cabbage**, **ate/chocolate**, or **ice/office**, and the sounds in the phonograms in **massive**, **captive**, or **hand-some**; exclude the unfit patterns in **-ile**, **-ine**, **-ove**, and -vowel-*r-e*.  
(<sup>1</sup>*bake*, *eke*, *bike*, *home*, *cute*)
3. Vowel digraphs usually have one sound<sup>1</sup> or one of two sounds; <sup>2</sup> except the phonograms in **pie** (ends one-syllable word), **diet**; **mansion**; **foot**, **book**; **hound**, **famous**, or **house/louse**; exclude the unfit digraphs **ia**, **io**, and **ou**; the unfit letter patterns **ien** and **ood**; and *r*-controlled digraphs.  
(<sup>1</sup>*naïl*, *auto*, *hay*, *bee*, *chief*, *soap*, *oil*, *moon*; <sup>2</sup>*tea/head*, *row/cow*)
4. Single consonants usually have one<sup>1</sup> or one of two sounds; <sup>2</sup> except the phonograms in **cent**, **city**, **cycle**, **special**, **musician**, **precious**; **add-ed/fix-ed**; **gem**, **magic**, **gym**; **pension/vision**; **turn/nature**, **partial**, **station**, and **cautious**.  
(<sup>1</sup>*bib*, *cat*, *dad*, *fat*, *gut*, *hit*, *jet*, *kit*, *lit*, *my*, *nap*, *pat*, *rut*, *tub*, *vet*, *wet*, *yak*, *zoo*; <sup>2</sup>*see/easy*, *queen/liquor*, *tax/exit*)
5. Consonant di/trigraphs usually have one<sup>1</sup> or one of two sounds<sup>2</sup>; except the phonogram root words **who** and **whole**; exclude the unfit digraph **gh**.  
(<sup>1</sup>*dick*, *taught*, *judge*, *sign* (word ending), *knit*, *phone*, *ship*, *match*, *which*, *wreck*; <sup>2</sup>*chin/chemical*, *hang/change*, *thin/this*)

Johnston (2001) rightly commented that “simplistic broad generalizations do not capture the complexity of English orthography, yet when they are refined and stated in more specific ways there is the danger that they will become clumsy and complex”

and thus “incomprehensible for the young readers who might try to apply them” (p. 140). Agreeing, we intentionally wrote the previous generalizations in distinct clauses—the basic, the phonogram, and the unfit clauses—that enables the presentation of the five basic clauses as follows:

1. Single vowels usually have their short sound.
2. Final single vowel-consonant-*e* (-VC*e*) patterns usually have a long first vowel and a silent final *e*.
3. Vowel digraphs usually have one or one of two sounds.
4. Single consonants usually have one or one of two sounds.
5. Consonant di/trigraphs usually have one or one of two sounds.

Since these clauses are reasonably easy to memorize and to apply, they form a good starting point for teaching beginning readers to break the code. Because it rarely appears in model one-syllable words, the short vowel clause excludes the schwa sound, which we briefly address later in this article. As explained, while the single vowel *o* is largely unfit, one-syllable single consonant-vowel-consonant (CVC) words may be included within the basic single vowel generalization as usually having either one of two sounds—*ox/hog*.

Rather than memorizing and applying the transparent phonogram clause in the generalizations, teach the phonograms embedded within model words. These include the following 7 single vowel, 7 -VC*e*, 8 vowel digraph, 15 single consonant, and 2 consonant di/trigraph phonograms:

1. Single vowel phonograms: **all** (one-syllable roots), **nation**, **edge** (no sound), **night**, **ruby** (open-syllable *u*), **fly** (one-syllable words), and **defy**
2. Single final vowel-consonant-*e* (-VC*e*) phonograms: **ace/palace**, **age/cabbage**, **ate/chocolate**, **ice/office**, **massive**, **captive**, **handsome**
3. Vowel digraph phonograms: **pie** (ends one-syllable word), **diet**; **mansion**; **foot**, **book**; **hound**, **famous**, **house/louse**
4. Single consonant phonograms: **cent**, **city**, **cycle**, **special**, **musician**, **precious**; **added/fixed**; **gem**, **magic**, **gym**; **pension/vision**; **turn/nature**, **partial**, **station**, **cautious**

5. Consonant di/trigraph phonograms: root words **who** and **whole**

Like the phonogram clauses, the *unfit* clauses are not for memorization per se. Rather, they purposely add to the comprehensive description of the nuances of English orthography, which must be understood to adequately grasp, and appreciate, the logical system of letter–sound relationships. The 11 cells in the unfit clauses include 1 single vowel cell and 1 single vowel phonogram, 3 -VC*e* cells, 3 vowel digraph cells, 2 vowel digraph phonograms, and 1 consonant digraph as follows:

1. Unfit single vowel: **o**
2. Unfit single vowel phonogram: **wa**
3. Unfit -VC*e* phonograms: **-ile**, **-ine**, **-ove**
4. Unfit vowel digraphs: **ia**, **io**, **ou**
5. Unfit vowel digraph phonograms: **ien**, **ood**
6. Unfit consonant digraph: **gh**

Separated, the basic, phonogram, and unfit clauses exhibit easy dissection of the letter–sound relationships and offer straightforward insights into their logical system. Furthermore, the present study affirms that the -VC*e* generalization may be modified and used. On the other hand, this research supports the total elimination of the open- and closed-syllable and two-vowels-go-a-walking generalizations. Finally, as the tables show, the basic, phonogram, and unfit cells form a logical orthographic decoding system.

## Using Automaticity to Teach the Phonic Cells

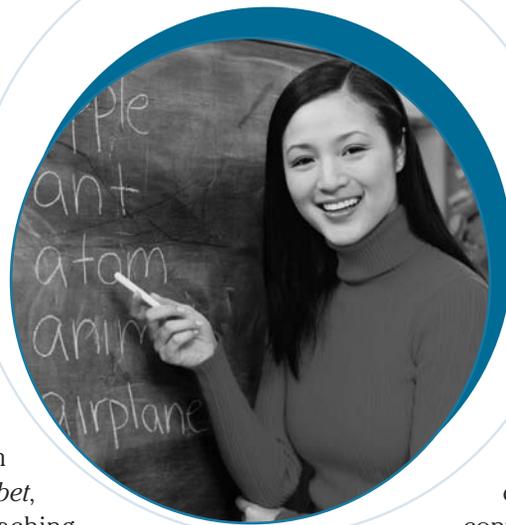
In this section, we briefly discuss one of many possible approaches for teaching the phonic cells to emergent and remedial readers. The teaching suggestions that we describe are not new as such; what is new is that we built our recommendations upon the logical system of transparent letter–sound relationships. This delineates the fundamental distinction that we propose. Without this distinction, our suggestions would pale in significance.

Explicitly teach emergent readers letter–sound relationships. Begin by teaching and applying the basic portion of the generalizations. Teach students to automatically read the transparent short vowels

in model CVC one-syllable words—*at, bat, cat, fat; it, bit, fit, hit; up, cup, pup*, and so forth. Initially present these in pattern words or word families (rhyming clusters); this promotes rapid learning of the embedded phonic cells. As students develop skill, mix the vowels with CVC onset words as well—*bat, bet, bit*. Use similar strategies for teaching CVCe cells—*bake, lake, make*; CVV cells—*pea, sea, tea*; CCVC cells—*chill, chin, chip*; and CVCC cells—*catch, match, patch*. (As used in this article, CC represents any double or triple consonant combination, whether consonant clusters—*must/scream*—or di/trigraphs—*chill/catch*.)

As mentioned, do not ask students to memorize the phonogram clause of the generalizations. Rather, when ready, introduce students to *selected* model phonogram word families—*ball, call, fall; tight, light, sight; hound, mound, pound; book, hook, look*. To read increasingly difficult connected text with automaticity, students must instantly decode the greater share of the transparent phonograms. A few of the phonograms, although essential for instant phonogram recognition in advanced text, are rarely found in beginning reading literature and are thus of questionable merit for explicitly teaching to emergent readers. These, in particular, include the selected phonograms in *special, musician, precious, partial, and cautious*. Learning to blend the other 88 transparent basic and phonogram cells with automaticity is very doable for most students.

Furthermore, as students move from learning to decode to independent reading, they automatically decode many of the phonograms without explicit instruction. Clearly, proficient readers decode basic single letters and di/trigraphs as easily as they decipher phonograms and other complex letter patterns. For instance, with the same ease in decoding the *c*'s represented in the single consonant and in the trigraph in the word *catch*, a skilled reader decodes the more complex *c*'s embedded in the low-frequency phonograms in *technician* or *crucial*. As emergent readers develop into proficient readers, most will require little help to decode the transparent phonic patterns, including those in low-frequency cells.



Students who begin to read with automaticity in connected text usually require little explicit teaching of words containing the 11 unfit cells and other words that lack transparent letter–sound combinations. This may come with little surprise understanding that, aside from the *r*-controlled vowels and single vowel *o*,

the unfit cells occur relatively infrequently and knowing that some of these cells conform to the letter–sound patterns of the basic transparent cells. For example, the letter combination *-ove* is transparent in *cove* and *wove* but is unfit in *love* and *move*. Thus, the incidence of unfit cells is significantly less than the data suggests; this effectually improves the overall transparency of the language.

Similarly, introduce the *r*-controlled *Vr*, *-Vre*, and *VVr* patterns, beginning with sample one-syllable words. Interestingly, although the *r*-controlled single vowels occurred frequently in the word list, relatively few words follow *-Vre* or *VVr* letter patterns. Specifically, aside from the 135 instances of the letter combination *ear*, no *-Vre* or *VVr* combination appeared more than 70 times in the Zeno et al. (1995) word list. Regardless, based on student need, teach words with unpredictable phonic cells by making individualized class lists of unfit words and review these words with students, teaching context clues, highlighting morphemic analysis, and reinforcing other word attack strategies.

As students develop automaticity in reading the basic and phonogram cells in sample words and in connected text, teach them to automatically read phonetically transparent two-syllable (*tummy, picnic*), three-syllable (*animal, pajamas*), and four-syllable (*invitation, celebration*) words. Automatic syllabication correlates with increased ability to read text with more challenging readability. Finally, although we rarely need to explicitly stress it when we teach decoding, the schwa sound may be introduced as the sound heard in the unstressed syllable for the single vowels in *about, kettle, pupil, and mucus*.

In comparison to introducing phonic cells one by one to emergent readers, we recommend identifying remedial readers' gaps of understanding of the phonic cells and then teaching to these miscues.

Thus, identify the transparent basic and phonogram cells that each student fails to automatically blend with other phonic cells in model words. For each of the basic vowel words, create two to three model (1) one-syllable CVC words—*cat*, *fat*, *bat*; (2) one-syllable -VCe words—*sane*, *pane*, *vane*; and (3) one-syllable CVVC words—*fail*, *hail*, *rail*. Create another list of basic one-syllable consonant di/trigraph CCVC words—*chill*, *chin*, *chip*, and CVCC words—*catch*, *match*, *patch*.

With these lists, test students' knowledge of each of the transparent basic and phonogram cells. Present students with the sample words in a randomly ordered list. Ask the students to read words in a normal speaking rate; log the miscues. Using the miscues as the starting point, individualize *daily* automaticity instruction by asking students to read sets of pattern words for each of the miscued phonic cells. As students master one list, introduce a new list of pattern words. Simultaneously teach two to four lists to help students practice particularly troublesome lists while they continue to learn new lists. Some of these model word lists may be short. For example, the phonogram *ation* in the Zeno et al. (1995) list appeared just twice in two-syllable transparent root words—*nation*, *station*. Finally, introduce remedial readers to syllabication practice of two-, three-, and four-syllable words as described previously, including phonograms within these model words, such as the phonogram *ation* in *celebration*.

Combine explicit teaching of the basic and phonogram cells with daily reading in connected text for both emergent and remedial students. Provide students with access to books and other reading material, promoting automaticity at all times using text with an appropriate readability. The reading material may include a variety of programs and resources, such as pattern books, Accelerated Reader materials, DIBELS passages, choral reading, Sustained Silent Reading, and Drop Everything and Read. As needed, use repeated readings to help students overcome arduous decoding and to promote habits of even reading (Deeney, 2010; Samuels, 1988; Staudt, 2009). The research in Tables 1 through 5 clearly shows a high letter–sound transparency for the basic cells and phonograms. Reading connected text helps students to learn and reinforce these letter–sound patterns with little direct instruction. As they master automatic reading in connected text, students will rely

less upon explicit instruction and more on implicit learning of new phonic cells.

## Summary

The logical system of letter–sound relationships presented in this article reflects the outcome of a methodical analysis of letters and letter combinations within 16,928 words found in children's literature. The grapheme–phoneme combinations, isolated in phonic cells, systematically fit within one of five comprehensive letter–sound categories that we packaged into five relatively simple but comprehensive generalizations. Within these, the transparency for the sum of the ratios in the basic and phonogram cells range from 91% to 99%.

Overall, the 54 basic cells, 39 phonograms, and 11 unfit cells unveil a coordinated system of single graphemes, basic -VCe patterns, di/trigraphs, and phonograms. Teachers empowered with this logical science of decoding orthography may powerfully teach the streamlined phonic cells.

Finally, it is clear that breaking the code is not an end—it is one essential step to proficient reading and to a lifetime pursuit of improving reading comprehension. Ultimately, mastery of reading automaticity lures the reader into the incredible world of print.

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