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ABSTRACT

Using 17, 211 words drawn from the word list compiled for the Stanford Spelling Study (1963) and drawing upon the "American Heritage Dictionary of the American Language" as the pronunciation reference, a researcher approached the language as if little was known about its letter-sound relationships and examined by computer the letter-sound correspondence for all single and paired combinations--a, b, c...aa, ab, ac.... He also examined many three, four, and five-letter clusters and phonograms; if a word contained multiple occurrences of a letter or letter combination, he studied the first occurrence only. All juxtaposed single vowel and consonant combinations that looked like a pair or digraph were counted with the vowel pair or consonant digraph. As he proceeded, he began to find "stand-alone" phonic units and placed these in tables of "phonic cells." Within each phonic cell, he included a ratio of words conforming to the sound(s) to the total number of words identified for that cell. Eventually, all but a handful of the letters and letter clusters fit into a cell. Findings are shown in 3 vowel tables (Tables 1-3) and in 3 consonant tables (Tables 4-6). In summary, the predictable "cells" for the three vowel tables show a collective predictability of 93%, while the consonant tables exceed 99% in letter-sound predictability. This understanding of letter-sound relationships can be applied to students who struggle with decoding; this simple approach to successfully teaching reading fluency can be used with struggling readers from primary-age students to illiterate adults. (NKA)

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LETTER-SOUND RELATIONSHIPS OF PHONIC CELLS

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LETTER-SOUND RELATIONSHIPS OF PHONIC CELLS

Dr. Louis Gates

I struggled with a feeling of failure when "Barry", one of my eighth grade students in my rookie year of teaching, completed the year as I received him—an illiterate. Print was seemingly as foreign to him as hieroglyphics are to all but ancient scholars. Without the ability to decode, he could not use his bright, conceptual mind to interact with print. By June, the intervention attempts that Barry and I tried seemed to only blacken his cloud of illiteracy.

Discouraged, I eased my guilt by attending graduate school in hopes that reading books and articles about decoding and spending time with a community of reading scholars would give me the insights to breaking the code that I sought. Among many reports that I read, Burmeister (1968) discovered the following:

- Every single vowel means a syllable (accept final consonant-*l*-*e*, exclude other final *e* [939/942 words or 99.7% efficient]).
- A single vowel in an open syllable has a long sound (omit final syllable of a word ending in consonant + y [68/217 words or *only* 31% efficient]).
- A single vowel in a closed syllable has a short or a schwa sound (consider final consonant-*l*-*e* to be final consonant *e*-*l*, and, therefore, a closed syllable [641/660 words or 98% efficient]).
- Every vowel combination means a syllable (454/536 words or 84.5% efficient).

While many authors supported the unsubstantiated idea of teaching the open/closed syllable concepts—that usually a single vowel ending a syllable has a long sound, otherwise it usually has a short or the schwa sound—Burmeister's research implied that the open/closed syllable concept was of limited usefulness for determining the sounds of single vowels. Her research also hinted at the possibility that the sounds of open and closed single vowel letters might be more similar than different. Her article further suggested that vowel pairs usually cling together within syllables. All of this in mind, a major step remained: to locate reliable research that showed consistent letter-sound relationships of vowels and consonants—the very building blocks of syllables. I poured over letter-sound relationship studies for reliable clues. Incredulously, I discovered that fundamental letter-sound research was spotty and inconclusive.

LETTER-SOUND CELLS

Using 17, 211 words drawn from the word list compiled for the Stanford Spelling Study (1963), and drawing upon the *American Heritage Dictionary of the American Language* as the pronunciation reference, I approached the language as if little was known about its letter-sound

relationships. With a computer, I examined the letter-sound correspondence for all single and paired combinations--*a, b, c... aa, ab, ac...* I also examined many three, four and five-letter clusters and phonograms (n*ight*, ac*tion*). If, however, a word contained multiple occurrences of a letter or letter combination, I studied the first occurrence only. For example, only the first *m* in *mom* and the first *ch* in *ch*urch were studied. Also, all juxtaposed single vowel and consonant combinations that looked like a pair or digraph were counted with the vowel pair or consonant digraph. While this lowered the letter-sound correspondence for these units slightly, it gave a truer picture of how the emergent reader would approach text. As I proceeded, I began to find "stand-alone" phonic units and placed these in tables of "phonic cells". Within each phonic cell, I included a ratio of words conforming to the sound(s) to the total number of words identified for that cell. Eventually, all but a handful of the letters and letter clusters fit into a cell in one of the following tables of vowels or consonants:

VOWEL TABLES (excepting *r*-controlled vowels):

- Table 1: Single Vowels.(except *i* replacing *y*, e.g., happiness; also except the V in inflected in –VC*e* words, i.e., b*a*king);
- Table 2: Vowel Pairs (i.e., b*oa*t, f*ee*t; the study was also limited to vowel pairs occurring at least 50 times in the word list); and
- Table 3: -Vowel-Consonant-*e* word endings, -VC*e* (i.e., c*ame*, b*one*).

CONSONANT TABLES:

- Table 4: Single Consonants (*bed*, z*oo*m);
- Table 5: Consonant Digraphs and Trigraphs (*ch*urch, wi*tch*); and
- Table 6: Consonant Phonograms (pre*cious*, vi*sion*, ac*tion*, and ambi*tious*).

SUMMARY OF THE RESEARCH

Tables 1 through 6 show my findings. With the major exceptions of the *r*-controlled vowels and the unpredictable *o*, the letter-sound relationships of the single vowel cells (Table 1) are highly consistent—that is they show significant phoneme-grapheme phonic fitness. Of the 14 cells, 2 are unpredictable; the other 12 are 93% predictable (19663/21131 units). This data also reinforced the idea of the limited usefulness of the open/closed syllable concept. Furthermore, the few open syllables found in phonograms are easily decoded (e.g., inform*ation*) as is the open *u* easily identified in *u*-consonant-vowel combinations (s*u*per or d*u*ty). This is noteworthy because it means that the single vowels in open and closed syllables are more alike than they are different. From a practical standpoint, this finding means that one can often "slur" the consonant letters between syllables with little attention to the syllable breaks themselves—a task that simplifies the decoding process.

The 16 vowel pairs are likewise relatively simple to understand (Table 2). Of the 25 cells, 5 are irregular; the other 20 are 94% predictable (3255/3459 units). As an aside, these cells reinforce the folly of teaching the oft-quoted generalization, "When two vowels go a-walking, the first one does the talking!"

Examination of the third major set of vowel situations, the final single vowel-consonant-e, -VC*e* (Table 3), shows few surprises to a mature reader. Of the 15 cells, 3 are unpredictable; the other 12 are 94% predictable (1916/2030 units). The data shows that the first vowel is long and the final *e* is silent in the first column only. However, the mature reader knows, almost intuitively, about the variance that is shown in the phonograms found in Columns B through F. These include the "*a*" (men*ace*, carn*age*, and separ*ate*), "*i*" (mal*ice*, abra*sive*, suppor*tive*, *-ile* [irregular]), and *-ine* [irregular]) and the "*o*" phonogram cells (lone*some*, *-ove* [irregular]). Of interest, by shifting the focus from umbrella generalizations to the individual rows of cells, sensible patterns emerge for single vowel, adjacent vowel and –VC*e* units.

The data found in the three consonant tables (Tables 4, 5, and 6) are straightforward and simple to understand. Of the 28 single consonant cells, only *g* followed by *e* or *i* is less than 90% predictable; aside from *gh*, the consonant di/trigraph cells are at least 92% predictable; and, the four consonant phonograms range from 98 to 100% predictability. Interestingly, the trigraph *ght* (ni*ght*) is highly predictable and it occurs more frequently than its *gh* digraph companion, which is the only unpredictable cell in the three consonant tables. Also noteworthy, is that one major sound is heard for *wh* when the roots and inflections of *who* and *whole* are placed in a separate cell. Finally, the four consonant phonograms (pre*cious*, ac*tion*, pen*sion*/vi*sion*, and ambi*tious*) are known to mature readers and are relatively simple to teach to emerging readers in the upper primary grades.

In summary, the predictable "cells" for the three vowel tables show an amazing collective predictability of 93% (24834/26620 cells) while the consonant tables exceed an astonishing 99% letter-sound predictability (60114/60745 cells). Although some letter or letter combinations remain unpredictable, most of the cells are clearly phonetically fit. Also, it is notable that only through the study of the interaction of the vowels, consonants, phonograms and morphemes was it possible to discover the interesting array and phonic consistency of the cells.

APPLICATION

Armed with the understanding of the letter-sound relationships, I apply this to help students who struggle with decoding. Typically, I begin working with students, like Barry, who have some sense of the letter-sound relationships, but who continue to struggle after two or more years of good classroom instruction. An efficient approach is to test students' knowledge of the phonic cells to find their learning gaps, then have them practice until they can fluently read sample word lists containing the troublesome cells. I usually begin teaching problem vowel units because they tend to be the most difficult for students. Students practice the lists until they can fluently read sample word lists containing the challenging cells. The ideal list presents students with rhyming (or, as appropriate, alliterative) clusters of one syllable sample words that exclude consonant blends: *bat, cat, fat; bay, day, pay; bake, lake, cake*. This "perfect" set of words is, of course, impossible to develop for some sample word lists, such as lists for the consonant phonograms. Nevertheless, reducing the "letter clutter" for either the vowel or consonant sample word lists helps students focus on the troublesome phonic cells. As their learning gaps are filled, I introduce students to simple two syllable words (*kitty, muddy*) and progress to more complex polysyllable words (*reluctance, inattentive*). In short, I now intentionally clutter the learning.

From the beginning, I monitor students' fluency as they read from trade books that are selected according to each student's instructional reading level. This important strategy helps students apply the knowledge learned in the cells, learn nonphonetic units, and promotes fluency. Generally, as students learn to blend the cells into the polysyllabic words and apply this to trade books, they make rapid progress in their fluency and automaticity of unit recognition.

I have been able to use this very simple approach to successfully teach reading fluency to struggling readers from primary-age students to illiterate adults. Although I will always regret that I did not help Barry break his illiteracy barrier, I know that I can now help students like Barry break the code. To this end, I am grateful.

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Table 1
SINGLE VOWELS

Excepting (1) *r*-controlled vowels; (2) *I* replacing *y*, e.g., happiness; and (3) the V in –VC*e* upon inflection e.g., b*a*king)

VOWEL	COLUMN A	COLUMN B	COLUMN C	COLUMN D
a	*1.0* cat, about 4054/4515 90%	*1.1* ball (one syllable roots) 38/39 97%	*1.2* nation 431/442 98%	*1.3* {wa} 76 variable words
e	*2.0* pen, pretty, happen* 4975/5389 92%	*2.1* dance (except -VCe, -CLe)* 571/586 97%		
i	*3.0* big, animal 5653/5959 95%	*3.1* night 78/80 98%		
o	*4.0* {o} 3562 variable words			
u	*5.0* cup, supply* 1468/1549 95%	*5.1* music, numerous, popular (u-C-v)* 724/882 82%		
-y (Word Endings)	*6.0* happy* 1593/1608 99%	*6.1* by (one syllable word)* 17/17 100%	*6.2* defy 61/65 94%	

*Cell 2.0 excludes final e. Cell 2.1 has no sound and it excludes -Vowel-Consonant-e (-VCe) and –Consonant-Le (-CL*e*). Cell 5.0 excludes the *u*-consonant-vowel pattern -*u*CV; this pattern is in 5.1. Cell 6.0 includes two or more syllable words ending in y; 6.1 includes one-syllable words ending in y.

Table 2
VOWEL PAIRS

Excepting *r*-controlled vowels

PAIR	COLUMN A	COLUMN B	COLUMN C	COLUMN D
Ai	*13.0* fail 227/262 87%			
Au	*15.0* autumn 154/169 91%			
ay	*16.0* day 121/123 98%			
ea	*21.0* beat, real, head 465/507 92%			
ee	*22.0* see 257/263 98%			
ia	*31.0* {ia} 248 variable words	*31.1* special 54/56 96%	*31.2* deviate, opiate 36/37 97%	
ie	*32.0* brief 73/82 89%	*32.1* tie (1 syllable word) 11/11 100%	*32.2* diet 14/15 93%	*32.3* {ien} 82 variable words
io	*34.0* {io} 83 variable words	*34.1* action 938/982 96%		
oa	*41.0* boat 98/111 88%			
oi	*43.0* join 99/108 92%			
oo	*44.0* moon 174/186 94%	*44.1* foot (root word) 17/17 100%	*44.2* book 33/34 97%	*44.3* {ood} 69 variable words
ou	*45.0* {ou} 219 variable words	*45.1* count 103/109 94%	*45.2* famous (word ending) 145/146 99%	*45.3* douse, rouse 43/44 98%
ow	*47.0* blow, town 193/197 98 %			

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Table 3
FINAL SINGLE Vowel-Consonant-e (-VCe)
Excepting *r*-controlled vowels

-VCe	COLUMN A	COLUMN B	COLUMN C	COLUMN D	COLUMN E	COLUMN F
-aCe	*100.0* base 223/230 97%	*100.1* pace, palace 36/37 97%	*100.2* page, average 105/114 92%	*100.3* date, private 448/448 100%		
-eCe	*200.0* these 58/68 85%					
-iCe	*300.0* like 391/442 93%	*300.1* nice, notice 52/55 95%	*300.2* massive 51/51 100%	*300.3* native 131/131 100%	*300.4* {-ile} 59 variable words	*300.5* {-ine} 118 variable words
-oCe	*400.0* hole 219/243 90%	*400.1* handsome 22/23 96%	*400.2* {-ove} 24 variable words			
-uCe	*500.0* use, rule 180/188 96%					

Of the vowel units in Tables 1-3, thirteen show two or more cells per row. After working with these cells, I found cell identification is simplified by assigning a number from 1 to 7 to each vowel *a, e, i, o, u, y,* and *w* respectively. Furthermore, all of the vowel cells in the Single Vowel Table are coded with one digit numbers; the cells in the Vowel Pair Table are coded with two digit numbers; and three digit codes are assigned to cells in the –VC*e* Table. These numbers are followed by .0, .1, .2, .3 in their respective Columns A, B, C, D. For example, the single vowel row for the letter *a* is coded 1.0 through 1.3 in columns A through D (Table 1); cells for the *oo* row are coded 44.0 through 44.3 (Table 2); and, cells in the *–aCe* row are coded 100.0 through 100.3 in their respective columns (Table 3). With a little practice, the practitioner may find this code as helpful as I did.

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Table 4
SINGLE CONSONANTS

CONSONANT	COLUMN A	COLUMN B	COLUMN C	COLUMN D
B	bib 2246/2280 99%			
C	cup 3344/3349 99%	special 63/69 91%	cent, city, icy 1299/1311 99%	
D	dad 3562/3636 98%			
F	fan 1755/1758 99%			
G	gag 1049/1056 99%	gem 373/422 88%	magic 156/187 83%	energy 82/82 100%
H	hit 724/786 92%			
J	jug 233/233 100%			
K	kick 621/621 100%			
L	lull 5791/5825 99%			
M	mom 1343/1343 100%			
N	nun 6496/6503 99%			
P	pop 3267/3296 99%			
Qu	queen, liquor 258/258 100%			
R	roar 8320/8323 99%			
S	see, easy 5375/5453 99%			
T	tot 6402/6458 99%	initial* 44/48 92%	tum, nature 370/370 100%	
V	valve 1476/1476 100%			
W	with 529/540 98%			
X	tax, example 644/654 98%			
Y (Word Beginnings)	yes 53/54 98%			
Z	zoo 255/267 96%			

The t has the sound heard in initiate; however, the sound if ia varies in the tia phonogram.

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Table 5 CONSONANT DIGRAPHS and TRIGRAPHS		
PAIR/TRIPLET	COLUMN A	COLUMN B
Ch	church, ache 528/568 93%	
Ck	back 296/297 99%	
Dg	judge 57/57 100%	
Gh	{gh} 50 variable words	night 128/128 100%
-gn	sign (word ending) 18/18 100%	
Kn	knit 35/38 92 %	
Ng	hang, change 550/583 94%	
Ph	phone 229/230 99%	
Sh	ship 403/404 99%	
Tch	hatch 63/64 98 %	
Th	thin, this 552/561 98%	
Wh	which 91/93 98%	who, whole & inflections 14 words
Wr	wrap 49/49 100%	

Table 6 CONSONANT PHONOGRAMS	
PHONOGRAM	EXAMPLE COLUMN
cious	precious 40/40 100%
sion	pension, vision 136/136 100%
tion	action 772/784 98%
tious	ambitious 23/23 100%

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