CHAPTER

7

PRONUNCIATION KNOWLEDGE LEVEL, P_L

A high level of pronunciation knowledge is necessary for high reading achievement. Individuals who have a low pronunciation knowledge for their age are very likely to be low in reading achievement. Pronunciation knowledge, P_L, is therefore a major factor affecting reading achievement. However, a high P_L is not sufficient to guarantee high reading achievement because reading achievement is also affected by two other factors at Echelon 3 in the causal model, namely, verbal knowledge level, V_L, and cognitive speed level, C_s.

The P_L construct is perhaps the most important one in the causal model because (a) it has a very important effect upon reading achievement, and (b) it is the factor that is unique to reading instruction. Without P_L there would be no need for reading instruction, and with P_L there is a major need for instruction in reading. You must understand the P_L construct in order to understand the causes of high and low reading achievement because P_L is at the core of the causal model. Reading educators who ignore P_L or minimize its importance put their students at risk.

In this chapter, the P_L construct will be defined, and then related to other traditional concepts that are similar. Then, tests that can be used to measure P_L will be described. Also, empirical evidence relevant to the existence of P_L will be summarized.

Theoretical Construct

Pronunciation knowledge level, P_L, is the number of words an individual can accurately pronounce out of context, or in a list, when scaled into GE units. One way to conceive of this construct is to (a) consider all of the main entries in a dictionary, (b) determine how many of these words an individual can correctly pronounce, and (c) transform this amount into a GE unit. A word that can be correctly pronounced by an individual is called a pronounceamatized word, so the number of pronounceamatized words scaled into GE units is pronunciation knowledge level, P_L. The lexicon of pronounceamatized words for an individual will be symbolized as "P_LWords," so P_L is also the number of P_LWords scaled into GE units.

The concept of pronounceamatized words, or P_LWords, has many theoretical implications relevant to the P_L construct. The lexicon of pronounceamatized words, or P_LWords, is simply all the printed words that an individual can pronounce correctly. Some of these P_LWords can be pronounced because they are raudamatized words, or A_LWords, and the remainder of the P_LWords can be pronounced correctly because of pure cipher knowledge. All the words that are unknown when listening but can be correctly pronounced using pure cipher knowledge, are in the lexicon of ciphermatized words (c_kWords). This means that P_LWords are composed of A_LWords and c_kWords such that

$$P_L\text{Words} = A_L\text{Words} + c_k\text{Words} \qquad (7\text{-}1)$$

For example, if an individual correctly pronounced 50 words on a word identification test (P_LWords = 50), and 40 of these words were known words, i.e., raudamatized words (A_LWords = 40), then 10 must have been ciphermatized words (c_kWords = 10), because 50 = 40 + 10. When c_kWords are scaled into GE units, they are symbolized as c_k.

It seems likely that when all of P_LWords, A_LWords, and c_kWords are scaled into GE units, then P_L would equal the average of A_L and c_k,

$$P_L = (A_L + c_k)/2 \qquad (7\text{-}2)$$

Those unknown real words that can be correctly pronounced are called ciphermatized words. Pseudowords that can be correctly pronounced are called pseudomatized words. They provide a measure of pure decoding knowledge. This lexicon of pseudomatized words representing pure decoding knowledge can be symbolized as d_kWords. When d_kWords are scaled into GE units, they are symbolized as d_k. Individual differences in d_kWords are likely to be almost perfectly correlated with individual differences in c_kWords, because unknown real words are not substantially different from pronounceable nonwords from the standpoint of the individual. Therefore, when c_kWords and d_kWords are scaled into GE units, they would be equal, that is,

$$c_k = d_k \qquad (7\text{-}3)$$

This also means that if d_k is substituted into equation 7-2 for c_k, then

$$P_L = (A_L + d_k)/2 \qquad (7\text{-}4)$$

That is, the GE score on a word identification test should equal the average of the GE scores from a measure of reading level (or reading vocabulary) and a measure of word attack (or pure decoding knowledge).

Equations 7-2, 7-3, and 7-4 are likely to be valid for beginning and intermediate readers, but may not be valid for advanced readers who have P_L scores greater than 7.9 and who may also have d_k scores greater than 7.9. The measurement of P_L and d_k at 8 and higher becomes questionable, and it has been theorized that P_L is no longer a causal factor for A_L or R_L when P_L is 8 or higher (see Chapter 17).

Given the proliferation of new constructs and symbols, Table 7-1 contains a summary of the new ones introduced in this chapter, plus similar ones introduced in earlier chapters. For example, the V_L construct was introduced in the preceding chapter as being similar to the concept of listening vocabulary, and its corresponding lexicon is audamatized words---symbolized as V_LWords.

Related Concepts

Introduction. The P_L construct has much in common with word identification, cipher knowledge, spelling knowledge, lexical knowledge, decoding, and orthographic knowledge; these conceptual connections will be explained in this section. The P_L construct is not the same as the autonomous or functional lexicons introduced by Perfetti (1991a), but there are some important connections which also will be explained at the end of this section.

Word Identification. The theoretical construct of P_L has been studied by many researchers under the rubric of word identification. For example, word identification tests usually contain many words that vary in difficulty, or frequency of usage, and the individual is asked to pronounce each word on this difficulty-ordered list. Referring to such measures as "word identification tests" may suggest to some that if the individual pronounces the word correctly, then it is a known word that has been identified. Yet, many of the words pronounced correctly on a test designed to measure pronunciation level, P_L, will be words that are not known when reading (not raudamatized) because they are also not known when listening (see Carver, 1993a). For example, few children in the middle grades will know the meaning of the word "rebut" when it is presented in a list of words (out of context), yet most can pronounce it accurately. So, the term "pronunciation level" is much more neutral than "word identification" because it does not suggest that the individual knows the meaning of the words that are accurately pronounced.

The term "word recognition" is another term that is very similar to "word identification"; both suggest that a word known when listening can be correctly pronounced. However, P_L refers to the correct pronunciation of words whether or not their meaning is known when perceived auditorily or visually, that is, P_L refers to the number of words that can be correctly pronounced, whether or not the words are audamatized or raudamatized. The P_L construct refers to a knowledge of word pronunciation that includes both raudamatized words, A_L-Words, and ciphermatized words, c_kWords.

Table 7-1
Rauding Constructs, Their Corresponding Lexicons, and Their Corresponding Traditional Concepts

Constructs	*Corresponding Lexicons*	*Traditional Concepts*
V_L	V_LWords, audamatized words	listening vocabulary
A_L	A_LWords, raudamatized words	pure lexical knowledge, reading vocabulary, automatized lexicon
P_L	P_LWords, pronounceamatized words	word identification knowledge
c_k	c_kWords, ciphermatized words	cipher knowledge
d_k	d_kWords, pseudomatized words	decoding knowledge, pseudoword knowledge

The concept of word identification knowledge is conceptually almost the same as the P_L construct. Word identification knowledge is (a) ordinarily defined empirically as a GE score on a standardized word identification test, and (b) not defined as a theoretical construct. Notice that a fundamental difference between word identification knowledge and pronunciation knowledge is that P_L is defined more precisely as a theoretical construct, that is, the number of real words that an individual can correctly pronounce when scaled into GE units.

Cipher Knowledge. Reading and spelling are both based upon what Gough, Juel, and Griffith (1992) call the "cipher," that is, the somewhat systematic connections between letters and sounds in words. They make a distinction between code learning and cipher learning. For example, learning to associate 007 with James Bond is what they call learning a code whereas learning to associate Kbnft Cpoe with James Bond is what they call learning a cipher because there is a systematic relationship between each letter in Kbnft and each letter in James. Although the connections between letters in words and their sounds are not perfectly systematic, these connections are close enough so that learning them (learning the cipher) is what Gough, Juel, and Griffith call the foundation of reading and spelling. They presented evidence that "beginning readers read and spell in the same way on different occasions; they simply do so inconsistently" (p. 46).

Cipher knowledge is a concept that refers to the somewhat systematic spelling-sound correspondences which helps individuals correctly pronounce difficulty-ordered lists of printed real words, whether the words are known auditorily (audamatized) or unknown (ciphermatized). Cipher knowledge is also helpful for pronouncing pseudowords accurately and for spelling words accurately.

In summary, cipher knowledge is conceptually related to the knowledge represented by P_L, A_L, and d_k. However, pure cipher knowledge, c_k, was defined earlier as the number of ciphermatized words, c_kWords, scaled into GE units.

Spelling Knowledge. The ability to pronounce increasingly difficult words correctly is dependent upon the ability to learn and remember sounds that are associated with letters, whereas the ability to spell increasingly difficult words correctly is dependent upon the ability to learn and remember letters that are associated with sounds. Stated differently, P_L represents the number of words which can be pronounced accurately, and spelling knowledge can be defined as the number of words which can be spelled accurately. The level of spelling knowledge in GE units will be referred to as spelling level, and symbolized as S_L.

As noted earlier, cipher knowledge underlies both S_L and P_L. Vellutino, Scanlon, and Tanzman (1994) have stated that "... word identification, alphabetic mapping, and spelling are closely related skills" (p. 323). Ehri (1997) has recently built a strong case, both theoretically and empirically, that the learning involved in decoding and spelling are almost exactly the same. As noted earlier, Gough, Juel, and Griffith (1992) have presented evidence that words which can be spelled correctly are likely to be pronounced correctly. According to Juel, Griffith, and Gough (1986), "the relationship between word recognition and spelling was shown to be especially strong, because the development of both skills seem to rely on the same knowledge" (p. 243).

P_L not only can be considered as representing a level of pronunciation knowledge, but it may also be considered as representing a level of spelling knowledge, S_L. Given the above definitions of P_L and S_L, the precise relationship can be represented mathematically as follows:

$$S_L = P_L \tag{7-5}$$

In summary, spelling knowledge and pronunciation knowledge have a great deal in common because both depend upon a common knowledge of the cipher. The connection between S_L and P_L is so close that S_L should equal P_L, that is, when spelling knowledge and pronunciation knowledge are both measured in GE units, then S_L equals P_L.

Lexical Knowledge. A knowledge of the meaning of printed words can be defined as lexical knowledge. The connection between lexical knowledge and pronunciation knowledge is that pronunciation knowledge includes lexical knowledge. This means that P_LWords includes words that can be recognized in print because their meaning is known.

Earlier in this chapter, the number of printed words that are raudamatized was symbolized as A_LWords. Therefore, the amount of lexical knowledge an individual has can be measured by A_LWords. This means that pronunciation knowledge includes lexical knowledge, and the lexicon of P_LWords includes the lexicon of A_LWords, as expressed mathematically by Equation 7-1.

Support for Equation 7-1, which holds that P_LWords can be divided into A_LWords and c_kWords, comes from Ehri and Wilce (1987a). They contended that spelling and word recognition are caused by lexical knowledge and cipher knowledge, which is about the same as saying that P_L (word recognition or spelling knowledge) is composed of two parts, A_L (lexical knowledge) and c_k (pure cipher knowledge).

Juel, Griffith, and Gough (1986) also provide support for these connections among lexical, cipher, and pronunciation knowledge. They use the word "decoding" to mean word recognition, and they contend that decoding requires cipher knowledge and specific lexical knowledge. Notice that if decoding knowledge is measured by P_LWords, if specific lexical knowledge is measured by A_LWords, and if cipher knowledge is measured by c_kWords, then these contentions of Juel, Griffith, and Gough are consistent with Equation 7-1. Furthermore, this equation is a quantified translation of their statement that "we posit that both decoding and spelling are composed of (a) the cipher, and (b) knowledge of specific lexical items, or what we call lexical knowledge" (p. 245).

In summary, the connections among pronunciation knowledge, pure lexical knowledge, and pure cipher knowledge are such that the P_LWords equals the A_LWords plus the c_kWords (Equation 7-1), and P_L equals the average of A_L and c_k (Equation 7-2).

Decoding. Decoding is a conventional concept which sometimes refers to the pronunciation of real words, and sometimes refers to the pronunciation of pseudowords. When decoding refers to the ability to pronounce varying numbers of real words, measured in GE units, then that concept is little different from P_LWords, or the P_L construct. When decoding refers to the ability to pronounce pseudowords, then it is little different from d_kWords, or the d_k construct.

The ability to learn and remember how strings of letters are pronounced in real words will help with the ability to pronounce unknown words and pseudowords. This connection between the pronunciation of known words, P_L, and the correct pronunciation of letter strings in unknown words, c_k, and pseudowords, d_k, has been explained by Reitsma (1983) as follows:

> If word recognition memory entails recognition of patterns of letters co-occurring within words, this might also be used for pronouncing a new string of letters by analogy to similarly spelled words; spelling patterns may be generalized to novel examples. (p. 337)

The ability to correctly pronounce increasingly difficult pseudowords accurately has been called "pure decoding ability" by Roth & Beck (1987), and their wording stimulated the naming of the d_k construct as "pure decoding knowledge." The connection between d_k and pronunciation knowledge comes from the close connection between pure cipher knowledge and pure decoding knowledge. As noted earlier, pure cipher knowledge, c_k, should equal pure decoding knowledge, d_k, because unknown real words are likely to be mostly indistinguishable from pseudowords. In this regard, Gough and Juel (1991) have stated that "the child's mastery of the cipher is directly reflected in his ability to pronounce pseudowords" (p. 51). However, pseudowords are usually constructed by researchers and test makers so that there is only one correct pronunciation based upon highly probable sound-symbol correspondences, even though the pseudowords have never been seen before. On the other hand, cipher knowledge is likely to include more knowledge of the spellings of real words which are likely to be pronounced in more than one way when they have never been seen before. Stated differently, a student who has spent more time learning phonics rules may have slightly higher d_k than a person who has spend more time learning to pronounce audamatized words, and a student who has spent more time learning to pronounce audamatized words may have slightly higher c_k than a person who has spent more time learning phonic rules.

In summary, when decoding knowledge is interpreted as meaning the ability to pronounce real words, then it is conceptually similar to pronunciation knowledge, or P_L. However, when decoding knowledge is interpreted as meaning the ability to pronounce pseudowords, then it is called pure decoding knowledge, d_k, and it is conceptually more similar to pure cipher knowledge, c_k, such that d_k equals c_k (in GE units). Finally, the connection between pure decoding knowledge and the P_L construct has been precisely represented by Equation 7-4.

Orthographic Knowledge. The spelling of words in accordance with conventional practices is called orthography, and knowledge of these conventional practices is called orthographic knowledge, or orthographic skill. This knowledge is relevant to pronunciation level, because P_L is so highly related to spelling knowledge (Equation 7-5). In research related to reading, if the researcher pronounces the word and then asks the individual to produce the correct order of letters in the word, then this is usually called "spelling." However, if the researcher provides two or more printed spellings of a word, and then asks the individual to choose the correct spelling (e.g., bote vs. boat), this is more likely to be referred to as research on orthographic knowledge or skill (see Barker, Torgesen, & Wagner, 1992).

Orthographic knowledge or skill can be contrasted with phonological knowledge or skill. Knowing that "bote" and "boat" are both pronounced the same, is phonological knowledge; knowing that "boat" is a meaningful word but "bote" is not, is orthographic knowledge. However, knowing that "boat" is a meaningful word is more likely to come from knowing the word, called lexical knowledge, rather than being an inference made from knowledge about spelling rules. Orthographic knowledge would also refer to (a) knowing that spelling /boat/ with the letter string "bote" would involve putting letters together in a way that does not represent a conventional word, and (b) knowing that the letter string "bote" would not be a correct spelling of a word but it would still follow conventional spelling practices because it is readily pronounceable (see Assink & Kattenberg, 1993).

Orthographic knowledge includes knowing about orthographic redundancies. These are the statistical probabilities associated with the order of letters within words. For example, the letter "u" always follows the letter "q" in a word. Orthographic knowledge is usually associated with what is known about permissible letter patterns in words that is not necessarily taught in school whereas spelling is usually associated with the correct letter patterns for words that is often taught in school. Spelling usually involves explicit learning whereas orthographic knowledge usually involves implicit learning.

There is a major problem with recent research involving orthographic knowledge. Many of the measures used in this research have combined accuracy with rate, so as to measure orthographic skill or orthographic ability. The *accuracy* associated with orthographic skill would likely correlate highly with P_L, or A_L, whereas the *rate* associated with orthographic skill would likely correlate highly with R_L. A combination measure of accuracy and rate for orthographic skill is likely to create an *efficiency* type variable that would correlate highly with E_L. An example of the problem of combining accuracy and rate into one variable comes from the research of Barker, Torgesen, and Wagner (1992) who studied "the role of orthographic processing skills on five different reading tasks." Two of their five tasks were orthographic. For one of these, called orthographic choice, a student was asked to choose the correct spelling from two choices that sounded alike, such as the "bote" vs. "boat" example given earlier. In the other task, called homophone choice, the student read a sentence such as "What can you do with a needle and thread?" Then, "so" and "sew" immediately came up on the computer screen. In each task, latency and the accuracy were both measured. In their results section, it was not made perfectly clear how the variable representing each task was measured, but it is a reasonable assumption that it was an average of accuracy and rate, and was therefore a measure of efficiency. Therefore, it is not helpful to try to relate the results of this research to the P_L construct in the causal model.

Much of the research that has been conducted on orthographic processing has been summarized by Vellutino, Scanlon, and Tanzman (1994) as follows:

> ... we remain skeptical that the measures purported to assess orthographic coding ability and most often used to evaluate this ability, actually are measuring anything more than word identification and spelling ability, along with the assortment of visual and linguistic abilities that underlie word identification and spelling ability. (p. 324)

Translated into the constructs of the causal model, Vellutino, Scanlon, and Tanzman seem to be saying that orthographic coding ability is trivially different from P_L because orthographic coding ability involves word identification knowledge and spelling knowledge.

In conclusion, orthographic knowledge, orthographic coding ability, and orthographic processing skills that can be measured by accuracy of performance seem to be so closely related to spelling knowledge level, S_L, and pronunciation knowledge level, P_L that there is no need to include a separate construct in the causal model devoted to these orthographic skills, knowledges, or abilities.

Autonomous and Functional Lexicons. Perfetti (1991a) has theorized about the acquisition of the word representations that are used during the reading of text, using the concepts of autonomous and functional lexicons. Those concepts will be explained in this subsection after his ideas about word recognition have been presented.

Perfetti contends that it is the quality and quantity of graphemically accessible words that primarily differentiates between skilled and unskilled readers. He states that "learning to read does not involve learning rules but is rather a matter of incrementing a store of graphemically accessible words" (p. 33). By the quality of the representation of words, he means how well the word can be spelled. For example, a student might spell the word "iron" poorly as "irn," so this would not represent high quality representation of the word even though the word may be correctly recognized in the context of a sentence. Thus, a student who can spell "iron" correctly is more likely to be able to recognize the word out of context, and for Perfetti "skilled word recognition is context-free" (p. 34).

Perfetti goes on to distinguish between the autonomous lexicon of individuals and their functional lexicon. The autonomous lexicon was discussed earlier in Chapter 4; it is all the printed words that the individual can rapidly identify out of context, or in a list. The autonomous lexicon is therefore conceptually similar to the lexicon of raudamatized words, A_LWords, as defined earlier in Chapter 4. Notice that for Perfetti, it is the individual words that become "autonomous," whereas it was the children who became "automatic" under automaticity theory (LaBerge & Samuels, 1974). So, this concept of the autonomous lexicon seems to be almost exactly the same as the raudamatized lexicon, which is the number of words that can be processed at th during the execution of the rauding process, A_LWords.

Whereas the autonomous lexicon described by Perfetti cont lation of words that can be rapidly recognized, his "functional lex all the words that can be recognized in context but are *not* in th lexicon. The functional lexicon consists of the words that an i eventually recognize with difficulty in the context of sentences, b damatized. In the causal model, P_L is an indicant of the popula that can be accurately pronounced out of context, P_LWords, and not directly represent either the autonomous or the functional l fined by Perfetti.

In summary, the lexicon of words represented by P_LWords clude Perfetti's autonomous lexicon, or A_LWords, and (b) woul words in Perfetti's functional lexicon.

Relevant Tests

Introduction. In this section, four tests that could be used P_L will be described—Pronunciation Level Test, Wide Range Test-Reading, Wide Range Achievement Test-Spelling, and t Johnson Tests of Achievement—Letter-Word Identification Test tests will be mentioned as additional examples.

Pronunciation Level Test (PLT). The PLT was developed egy that is slightly different from the dictionary approach outline of this chapter (see Carver & Clark, 1998). Instead, each word from every 500 words on the Carroll et al. (1971) list of words ing to frequency of usage in printed school materials. The num this measure is an indicant of P_LWords. The PLT also provides ure of P_L in that it attempts to estimate the total number of word can correctly pronounce, in GE units.

Wide Range Achievement Test—Reading (WRAT-R). Th measure requires individuals to correctly pronounce increas words, and it provides a score in GE units. Therefore, this meas provides a GE score, so it qualifies as an indirect measure of S_L. In the manual for the WRAT, correlations are reported between WRAT-S and WRAT-R (described above) for students at each of ages 9 to 14. These correlations are extremely high, ranging from .88 to .92. When these correlations were corrected for unreliability of the two measures involved, the resulting correlations ranged from a low of .97 at age 13 (AgeGE = 8) to a high of 1.16 at age 14 (AgeGE = 9). The mean of the six correlations was 1.03, which suggests that the correlation between a perfectly reliable measure of pronunciation knowledge and a perfectly reliable measure of spelling knowledge would be perfect, or 1.00. These data also empirically validate spelling knowledge level, S_L, as an indicant of P_L, and provide strong evidence for $S_L = P_L$ (Equation 7-5).

Because this spelling test is also scaled into GE units, it is appropriate to consider the WRAT-S to be an indirect measure of P_L.

The Woodcock-Johnson Tests of Achievement—Letter-Word Identification Test. The items on this test start out with identifying letters but most of the items require that 47 real words be pronounced correctly. This test will be described by comparing it to the Pronunciation Level Test, PLT, described above.

The PLT was developed by sampling 1 word every 500 words, from word frequency rank 1 to word frequency rank 40,000, and the two tests can be compared using these rankings. For the Woodcock-Johnson, (a) 25 of the 47 words on the test were between the ranks of 1 and 2499, (b) 12 were between the ranks of 2,500 and 40,000, and (c) 10 were lower in frequency of usage, that is, ranked above 40,000. Whereas the Woodcock-Johnson has only 12 words covering ranks 2,500 to 40,000, the PLT has 75 words covering this range.

Given the description of items described above, it seems likely that the Woodcock-Johnson would be more discriminating and therefore more reliable for beginning readers, but the PLT would be more discriminating and therefore more reliable for intermediate readers. This means that it is likely that correlations involving the Woodcock-Johnson as an indicator of P_L would provide much lower correlations with other variables in grades 3 through 7, because such correlations would likely be severely attenuated due to lower reliability and therefore lower validity at these grade levels.

Other Tests. There are many standardized tests of word identification that would either be indicants or indirect measures of P_L. The following two will be named to provide more examples: (a) Woodcock Reading Mastery Tests—Word Identification, and (b) Peabody Individual Achievement Test—Reading Recognition.

Summary of Theory

The P_L construct is the number of words that an individual can correctly pronounce—called pronounceamatized words, or P_LWords—scaled into GE units. This construct is trivially different from whatever it is that has traditionally been measured by word identification tests, because these tests require that increasingly difficult (or less frequent) words be correctly pronounced. However, traditional word identification tests ordinarily have not been designed to sample systematically the population of words that can be accurately pronounced. P_L is also highly related to spelling knowledge level, S_L, which is the number of words an individual can spell correctly in GE units, such that $S_L = P_L$ (Equation 7-5). Because the P_L construct is so closely related to S_L, it follows that the P_L construct is also closely related to orthographic knowledge because this kind of knowledge is little different from spelling knowledge.

The lexicon of pronounceamatized words, P_LWords, includes the lexicon of raudamatized words, or A_LWords, plus those unknown words that can be correctly pronounced using pure cipher knowledge, called ciphermatized words, or c_kWords (Equation 7-1). When expressed in GE units, P_L is the average of A_L and c_k (Equation 7-2). Because the number of c_kWords should be almost perfectly related to the number of pseudowords that can be accurately pronounced, called d_kWords, it follows that when both are measured in GE units then d_k equals c_k (Equation 7-3). Therefore, P_L is also the average of A_L and d_k (Equation 7-4). This means that an indicant of A_L (passage comprehension) and an indicant of d_k (word attack) can be used to predict P_L (word identification), using Equation 7-4.

Summary of Evidence

There is evidence that indicants of A_L (passage comprehension) and d_k (word attack) can account for almost all of the reliable variance in P_L (word identification), that is, the relevant multiple correlations involving measures corrected for attenuation are around .95 (from Torgesen, Wagner, Rashotee, Burgess, & Hecht, 1997; from Woodcock, 1973). These data are highly consistent with the theory underlying Equations 7-1, 7-2, 7-3, and 7-4.

There is also evidence for Equation 7-5 that $S_L = P_L$. Measures of word identification and spelling knowledge are generally correlated around .90 or higher when they are corrected for attenuation (Calfee, Lindamood, & Lindamood, 1973). Furthermore, there is strong evidence from factor analytic research that pronunciation knowledge and spelling knowledge are identical factors (Carroll, 1993).

On the other hand, data exist which have been interpreted by Frith (1980) as suggesting that there are individuals who are high in P_L (good readers) and low in S_L (poor spellers), but a close examination of those results may be interpreted as providing no support for these claims. Frith worked with a group of 120 twelve-year-olds, that is, sixth and seventh graders. She selected 10 who were good readers and good spellers (Group A), 10 who were good readers and poor spellers (Group B), and 10 who were poor readers and poor spellers (Group C). She described the tests used to measure reading and spelling, but she did not report the details of the procedures used to select the individuals in each group. She did report the means and SDs of each group on both reading and spelling, and these data seem to undermine her interpretations. Group A and Group B both purportedly contained good readers except the mean for Group A on the indicant of P_L was .8 of an SD higher than the corresponding mean for Group B; this is a large effect size according to Cohen (1977). Therefore, it is misleading to compare these two groups as if they were equally good readers. Similarly, Group B and Group C were both supposedly composed of poor spellers. However, the spelling mean for Group C was .8 of an SD lower than the corresponding mean for Group B; again a large effect size. Therefore, it would be misleading to compare these two groups as if they were equally poor spellers. For example, Frith (1980) states that "Group C who had more nonphonetic misspellings, and hence must be worse at using letter-sound correspondence rules, managed nevertheless to do as well as Group B on the spelling test" (p. 500). In fact, however, Group C did not spell as well as Group B according to her own data. Notice that when Frith selected her group of poor spellers and good readers (Group B), she could not find a control group that was equally good in pronunciation knowledge (Group A), and she could not find a control group that was equally poor in spelling knowledge (Group C). The results that she reported are exactly the results that would be predicted from the contention in this chapter that level of ability to spell words is the same as level of ability to pronounce words, or that S_L is an indirect measure of P_L such that $S_L = P_L$. Therefore, these data may be alternately interpreted as providing strong evidence that word identification tests and spelling tests are both measures of P_L.

Implications

It is not necessary to administer a word-identification test plus a spelling test because the GE scores on both tests will be approximately the same; both types of tests are measuring the P_L construct. Furthermore, it is probably not necessary to administer a word attack type of test, involving pseudowords (indicant of d_k) along with a word identification test (indicant of P_L) and an unspeeded comprehension test (indicant of A_L), because d_k is not independent of

P_L and A_L. That is, P_L is purported to be equal to the average of A_L and d_k, so only two of these three tests need to be administered; the score on the third test can be determined from the scores on the other two tests.

For most students in the lower and middle grades, pronouncing many isolated words accurately and spelling many words accurately represent a level of knowledge that strongly affects reading achievement, or E_L. This knowledge is represented theoretically by the P_L construct. This P_L construct should be taken into account when trying to understand the causes of high and low reading achievement, and when trying to help many poor readers become better readers. Educators who disregard pronunciation knowledge level, P_L, and spelling knowledge level, S_L, are doing their students a disservice, especially those poor readers who are relatively low in P_L and S_L.

Forget Me Nots

Pronunciation knowledge level, P_L, tries to incorporate all of the good ideas that have traditionally been associated with the following concepts: (a) word-identification knowledge, (b) decoding knowledge, (c) spelling knowledge, and (d) orthographic knowledge. These earlier concepts have been upgraded by the P_L construct, which is more precisely defined both from a theoretical and an operational standpoint. Pronunciation level, P_L, is the number of words an individual can correctly pronounce when the words are presented out of context in a list, and then scaled into grade equivalent units; for example, an individual may have a fourth-grade pronunciation level, $P_L = 4$.