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ABSTRACT

The reading research and relevant literature examined in this paper focus on the role that "orthographic regularity" plays in word recognition. Orthographic regularities are those features of printed English words that reduce the uncertainty of what letters might be present. The paper considers three theses: rapid word recognition, which is essential for competent reading, depends on internalized (automatic) strategies that use the principle of orthographic regularity; phonics instruction, because of its emphasis on regular letter-sound associations, draws attention to the orthographically regular features of printed English words; and the instructional practice of separating certain irregular words helps the reader avoid generalizing from orthographically irregular sequences. After showing what orthographic regularity is, how it relates to phonics instruction, and the evidence for claiming that it is essential to rapid word recognition, the paper concludes with the assertion that reading instruction must see to it that students acquire an awareness of othographic regularity. The discussion following the presentation of this paper is attached. (RL)

History's Best Kept Secret About Reading

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History's Best Kept Secret About Reading

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From preclassical Greece to the present day, most literates in the Western World have been introduced to reading through letters and sounds. This approach to initial reading, now called phonics, was at the core of the ABC method which dominated reading instruction in Europe and England until well into the 19th century, and the United States until the early 20th century (Smith, 1966). By this method, children learned first the letters with their names and sounds, then various pronounceable (and not so pronounceable) digraphs and trigraphs, then simple words, phrases, and sentences. In The American Primer, for example, a popular introduction to spelling and reading in use at the beginning of the 19th century, children were cycled through items like bu, bo, ob, ub, yb, ic, cc, uc, yc, kni, kno, and knu, before encountering their first real words.

By the early 1900s the ABC method had evolved in the United States into an approach similar to that found in modern phonics program, with deliberate sequencing of letter-sound patterns, separation of pattern words and sight words, and sensible strategies for decoding. The Beacon Phonetic Chart, for example, which was copyrighted in 1912, suggests that letter sounds, not letter names be taught and that blending be done by a process that seems to minimize memory load. There is, so far as we can determine, no major difference between the Beacon Method and the more enlightened (and expensive) phonics program offered in the schools today.

But the introduction to reading via letters and sounds has not been unchallenged, especially in this century. Both silent reading and the whole word approach have had periods of sovereignty in the last 75 years, but phonics is the standard approach today, and is even found in some language experience programs.

1. The Justification for Phonics

But why? Is evidence available to justify this emphasis, or have reading instructors for 2500 years (or more) followed false gods, as a few still claim (cf., F. Smith, 1971)? The standard explanation is that decoding, that is, attaching sounds to letters and then blending the sounds to make a word, serves a number of ends. First, it provides a certain degree of independence for initial readers. Unfamiliar printed words can be translated into phonological forms that may be familiar in the listening lexicon. Without this ability, the child is dependent upon a teacher or other reader to confirm word identifications. Notice that completely predictable letter-sound associations are not essential for this process. With context as an aid, the child can approximate the correct pronunciation of a word, and then adjust it to a phonologically similar word which fits the immediate syntactic and semantic context. This is, in fact, what many beginning readers appear to be doing when they decode in context.

Second, decoding provides an element of self-assurance. Rather than being confronted with an ever-expanding number of arbitrary associations between words and printed symbol strings. as in Chinese, the child sees a more manageable set of letter-sound associations which build a large number of words. In addition, the act of decoding (i.e., successful decoding) is in the early stages of reading both an attention-keeping and a motivating device.

Whether or not these justifications for phonics approaches are supported by anything more than appeals to reason is not our concern at present. We are willing to accept that they are plausible and desirable. If, however, these were the only goals of letter-sound teaching, then the current practice of ending phonics instruction at the end of the third year of reading instruction would be justifiable and we would have little more to say about it. After all, the goal of initial reading instruction is not letter-sound knowledge, but rapid word recognition, which is probably the only major skill unique to reading. It would seem, therefore, that if letter-sound associations are not used by adults in recognizing words--and we think that they are not--then the sooner they are phased out of instruction the better. However, we want to suggest that a letter-sound emphasis in early reading serves another goal, and that validation of this hypothesis could lead to significant changes in both initial and middle-grade reading instruction.

2. Orthographic Regularity and Word Recognition

The overlooked role which letter-sound instruction plays in reading acquisition is in word recognition, but not through the direct application of letter-sound associations. As we will show shortly, there is a rapidly expanding literature that demonstrates a central role for an entity called orthographic regularity in word recognition. By orthographic regularity we mean those features of printed English words which reduce the uncertainty of what letters might be present. Our basic argument is roughly as follows:

1. Rapid word recognition, which is essential for competent reading--oral or silent--depends upon internalized (i.e., automatic) strategies which utilize orthographic regularity.
2. Phonics instruction, because of its emphasis on regular letter-sound associations, draws attention to the orthographically regular features of printed English words. That is, the procedure for analyzing printed words into subunits for pronunciation facilitates acquisition of the patterns which are also orthographically regular.
3. Furthermore, the instructional practice of separating certain (but not all) irregular words, which are learned as wholes, from pattern words, which are learned by analysis-synthesis, helps the reader avoid generalizing from orthographically irregular sequences.

If we can establish these claims, then certain implications for initial and intermediate reading instruction need to be considered. We will delay discussion of these, however, until after we have discussed (1) what orthographic regularity is, (2) how it relates to what is typically taught in phonics instruction, and (3) the evidence for claiming that orthographic regularity is essential to rapid word recognition.

3. Reading Processes

To associate orthographic regularity with word recognition requires that first we describe in some detail the processes involved in word recognition. For purposes of the present discussion we will concentrate on the recognition activities which occur during a single eye fixation in reading. The model for describing these activities or processes, however, is part of a more general information processing model which has been developed and tested over the past few years for describing language processing (Massaro, 1975). Our concern in presenting this model here is not to justify it over other models for word recognition, but to provide a framework from which our hypothesis about word recognition can be explained and tested.

The text in reading is a sequence of letters and spaces which conform to orthographic, syntactic, and semantic constraints defining the written language. The average English reader begins at the top left hand corner of the page and reads each line from left to right. A reader's eye movements are not continuous but occur in a series of short jumps called saccades. The fixation time between eye movements is roughly ten times longer then the movement time itself. An average reading eye movement of one to two degrees requires 20 to 30 msec., whereas fixation time averages one-quarter of a second (Shebilske, 1975; Woodworth, 1938). Initial processing of the visual stimulus must occur during the fixation time between eye movements since the intensity of the light pattern is too weak and the processing time too short during the eye movement itself.

During the eye fixation the light pattern of the letters is transduced by the visual receptors into a feature detection system which places a set of visual features in preperceptual visual storage (cf. Figure 1). The features are described as visual because it is assumed that there is a direct relationship between the stimulus properties of the letters and the information in preperceptual storage. The passive transduction of feature detection contrasts with the active construction of the following processing stages. There is no exact one-to-one relationship between the input and output of the following processing stages since these later stages actively utilize information stored in long-term memory in the sequence of transformations.

Insert Figure 1 About Here

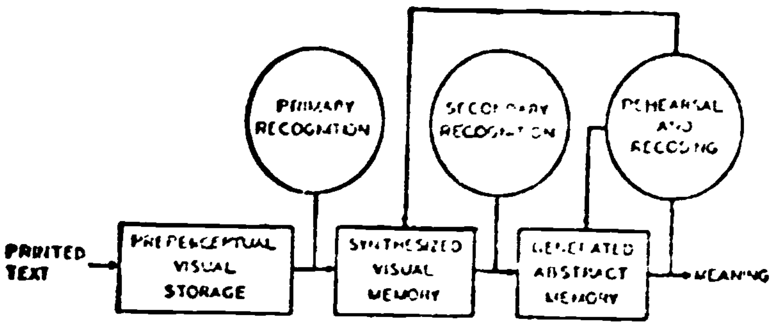
Given the set of visual features in preperceptual visual storage, the primary recognition process attempts to synthesize these isolated features into a sequence of letters and spaces in synthesized visual memory. To do this, the primary recognition process can utilize information held in long-term memory, which for the accomplished reader includes a list of features of each letter of the alphabet along with information about the orthographic structure of the language. The primary recognition process utilizes both visual features and the orthographic structure of the language in its synthesis of the letter strings.

Since there are a limited number of ways that sequences of letters and letter groups can be put together to form English words, the reader's knowledge of this regularity can help resolve the letters in a string that conforms to the language (cf. Massaro, 1975). This knowledge can also help the reader resolve the relative spatial positions of the letters once they are recognized (Estes, Allmeyer, & Reder, 1976).

The primary recognition process operates on a number of letters simultaneously (in parallel). The visual features read out at each spatial location define a set of possible letters for that position.

Flow diagram of processing printed text

Figure 1



The recognition process chooses from this candidate set the letter alternative which has the best correspondence in terms of visual features. However, the selection of a 'best' correspondence can be facilitated by knowledge of orthographic structure. The primary recognition process, therefore, attempts to utilize both the visual information in preperceptual storage and knowledge about the structure of legal letter strings. The interaction of these two sources of information is a critical issue in the analysis of word recognition. We will review the most recent literature on the role of orthographic structure in letter and word recognition in Section 8.

The primary recognition process transmits a sequence of recognized letters to synthesize visual memory. Figure 1 shows how the <u>secondary recognition process</u> transforms this synthesized visual percept into a meaningful form in generated abstract memory. We assume that synthesized visual memory holds a sequence of letters which are operated on by the secondary recognition process which tries to close off the letter string into a meaningful word. The secondary recognition process makes this transformation by finding the best match between the letter string and a word in the long-term lexicon. Each word in the lexicon contains both perceptual and conceptual codes. The concept recognized is the one whose perceptual code gives the best match and the one most likely to occur in that at particular context.

The structure-generated abstract memory corresponds to the short-term or working memory of most information processing models. In our model, this memory is common to both speech perception and reading.

Recoding and rehearsal processes build and maintain semantic and syntactic structures at the level of generated abstract memory. It is also possible to go from meaning to a visual or auditory percept in our model. The recoding operation can transform the meaning of a concept into its surface structure and auditory or visual form.

In this model, the role of orthographic structure in word recognition is concentrated in the primary recognition process and serves to facilitate both the recognition of individual letters and the resolution of relative spatial positions. We might view the utilization of orthographic structure for letter resolution in the following manner:

> For letter strings which are not spelled like English words, orthographic structure probably plays no role. Letters are resolved individually based only on their visual features, which are carefully evaluated in the primary recognition process. For letter strings which are spelled like words, however, less visual information needs to be processed than in the non-word case, because the constraints of English orthography aid the reader in deciding what might be present. If we imagine visual information arriving over time, with the more gross features being available before the more detailed features (Massaro and Schmuller, 1975), then the reader can, by successive sampling, terminate visual processing when sufficient information is available for each letter decision. If, for example, an initial th- has been re-

solved in a letter string, and the features available for the next letter match either c or e, the reader might accept e without waiting for further visual information, since initial thc- is irregular while initial the- is not.[1]

To test the validity of this model, we must first define what orthographic regularity is, which is the topic of the next section.

4. Defining Orthographic Regularity

A page of printed English looks quite different from a page of printed Hebrew or a page of printed Finnish, even to a person who understands none of these languages. English and Hebrew have no overlap in symbol repertoires, while English and Finnish have a large, but not 100% overlap. (Finnish uses the letters c, f, q, w, x, and z only in a small number of loan words, while English has no equivalent for Finnish ä and ö.) Needless to say, experienced readers of Hebrew texts expect Hebrew letters, readers of Finnish texts expect Finnish letters, and readers of English texts expect English letters.

In addition to these differences in symbol repertoires, we presume that readers are aware of other characteristics of their written language. Shown below are several sentences from Finnish and English first grade readers in which all non-blanks have been replaced by X's. Because of the difference in average word length between English and Finnish, the identification of the English sample is obvious.

Sample A

XXXXX XX XXXXXXXXXX XXXXXXXX.

XX XX XXXX XXXXXXX XXXXXXXX,

XXXXX XXXXX XX XXXXXX XXXXXX

XXXX.

XXXXX XXXXX XXXXXXXXXXX XXXXXX

Sample B

XXX XXXX XX XX XXX XXXX.

XXX XXXXX XXX XXXXXXXX XXX

XXX.

XXX XXX XXXXXXX XXXX XXXXX

XXXX XXXX XXXX XXXXXX

XXXX.

How refinied this sense of average length is has not been explored, so far as we know. Could the English reader, for example, distinguish English from French and German samples composed as above?

A third language dependent feature of texts is the distribution of word lengths which normally occurs within any text. All natural languages have evolved lexicons which contain two groups of words: a relatively small, closed set of function words which serve primarily (but not entirely) to signal word relationships (i.e., syntax), and an open ended set of content words which serve primarily to signal meanings

(Hockett, 1958). The function words are heavily used, tend to change relatively slowly over time, and tend (according to Zipf, 1935) to be relatively short in phonological and there alphabetic length. The content words, in contrast, vary from short to quite long, change more rapidly over time than the function words, and have a wide distribution of frequencies of occurrence.

Real texts, therefore, are characterized by certain distributions of word lengths, depending upon the manner in which function words are realized in print. (In Hebrew, for example, the definite article, the co-ordinating conjunction 'and', and most prepositions are prefixed to content words, thus reducing the relative number of short, printed words below that of most European languages.)

But the most important characteristics of orthographic regularity for studying word recognition are not those which characterize sequences of words, but those which define the allowable patterns of letters within single words. Two entirely different approaches have been taken so far to describing this regularity. The first method, described as probabilistic, utilizes word tokens sampled from real texts to define probabilities of occurrence for single letters, digrams, trigrams, and so on. From these data, successive approximations to English words are generated. For example, Hirata and Bryden (1971) have generated tables of first and fourth order approximations to English which have been utilized in studies on orthographic regularity by among others Lefton (1973), Lefton, Spragins, and Byrnes (1973), and Lefton and Spragins (1974).

Mason (1975), on the other hand, generated pseudo words from the single-letter frequency counts published by Mayzer and Tresselt (1965). These differed from the Hirata and Bryden (1971) data in that letter position and word length are considered by the former, but not the latter.

The second method, called rule governed, is based upon studies of the English orthography (e.g., Hockett, 1962; Venezky, 1967, 1970). Rules supposedly define which letters or letter sequences are allowed (or not allowed) in which positions or graphemic contexts. Although no comprehensive set of such rules exists, reasonable approximations to rules can be drawn from Venezky (1967), 1970). This approach to defining orthographic regularity has been utilized extensively by Gibson and her colleagues (e.g., Gibson, Osser, and Pick, 1963), and by many others (e.g., Thomas, 1968; Baron, in press) in studies of word recognition.

Since both of these methods for defining orthographic regularity are commonly used in experimental studies, and each implies a different approach to instruction, we will consider each in detail.

5. Probabilistic Approaches

The earliest approaches to generating English pseudowords was suggested by Shannon (1948), and was utilized by Miller, Bruner, and Postman (1954) and by Wallach (1963) in studies of word recall. A zero order approximation to English was generated by selecting each letter for a string randomly, giving equal weight to each letter. A first order approximation resulted from the same procedure, but with the letters weighted by their frequencies of occurrence in English texts. For higher orders, on i-th order approximation was generated by selecting an initial string of length i-1. Then, a sample text was scanned linearly for that string. Once found, the next letter in sequence was added to the string, the first letter dropped (but saved), and the process repeated until a desired length was achieved.

This scheme tends to generate highly regular pseudo words at the higher order approximations, especially if the last letter drawn for each word is always selected from the last position in an English word.[2] Miller, Bruner, and Postman (1954) appear to have used this restriction in generating eight-letter words which were fourth-order approximations to English (e.g., mossiant, oneticul, preveral, favorial, aphyster).

Wallach (1963), however, employed six-letter pseudowords by truncating those published by Miller, Bruner, and Postman (1954), thus occasionally risking non-English endings (e.g., mossia, onetic, everal iorial, aphyst).

Shannon also suggested a parlor game technique for generating pseudowords (Shannon, 1951). The first person constructed a word by adding letters to an initial string. The first letter added was retained, the first letter of the starting string dropped, and the process repeated with another person. Although Shannon (1951) assumed that letter frequencies in the resulting strings would approximate those of English texts, Attneave, 1953 showed that college students often misjudge the relative frequencies of individual letters.

In contrast to these sequential dependency schemes are the correlational approaches which utilize letter and letter string frequency tables to produce pseudowords with controlled bigram and trigram counts.

Anisfeld (1964), for example, suggested that the Gibson, Pick, Osser, and Hammond (1962) results could be explained by differences in summed bigram frequencies based on the Underwood and Schulz (1960) tables. But a later study (Gibson, Shurcliff, and Yonas, 1970) showed that summed bigram and trigram frequencies were not good predictors of recognition scores on pronounceable and unpronounceable pseudowords.

Underwood and Schulz (1960) provides bigram and trigram frequencies of 2,080 words sampled from Thorndike-Lorge (1944), weighted with respect to the frequency of occurrence of the words. These counts are based on overall frequency of occurrence (tokens) rather than word types (the number of different words contributing to the sample), and sum over all possible word lengths and spatial positions. Failure to account for word length provides obvious problems in describing orthographic regularity. For example, the trigram ght occurs relatively often summed over all word lengths but does not occur in three- or four-letter words.

Summed bigram or trigram frequencies without regard for serial position are also inadequate for a description of orthographic regularity.[3] The bigram ck is legal at the end but not at the beginning of a word.

Yet it is unlikely that this difference can be accounted for in summed bigram frequencies, since k:vowel is as likely as vowelic. This allows ckad to be as 'legal' as dack. (Summed trigram frequencies can handle the positional constraints on ck quite well, but of course can't handle positional constraints on trigrams like dge and tch.) The objections to not including word length and sequential position in assigning frequencies to bigrams can be overcome by using the Mayzner and Tresselt (1965) tables, which give bigram frequencies for each word position in words 3-7 letters in length. However, both orthographically regular and orthographically irregular strings can be generated with either high or low bigram counts. Shown in Table 1 are two lists of words with their bigram counts based on Mayzner and Tresselt (1965). Note that although the words in the first column are orthographically regular by the rules given in the next section, they have extremely low bigram counts; similarly, the irregular strings in the second column have relatively high bigram counts. Similar, but less striking demonstrations can be made of pseudowords generated by controlling trigram frequencies.

Insert Table 1 about here

Letter and letter string frequency tables have also been used to generate approximations to English without regard to summed bigram and trigram frequencies. Hirata and Bryden (1971), for example, generated ten-letter strings for orders of approximation to English from zero to four, using the Mayzner and Tresselt (1965) and Mayzner, Tresselt, and Wolin (1965a,b) tables of single letter, bigram, trigram and tetragram frequencies.

Table 1

Bigram Counts for Orthographically

Regular and Irregular Strings[1]

Regular		Irregular	
bipon	17	thrsm	417
slevs	21	thrse	565
slevy	30	sthse	341
eddop	2	eaich	297
enaby	0	whrst	378
dufip	0	hoier	407

[1] Based on Mayzner and Tresselt (1965). The count of 17 for bipon, for example, is the sum of the counts (for 5-letter words) for bi in positions 1-2, ip in positions 2-3, and so on.

The algorithms used for generating these strings did not utilize positional information, but nevertheless guaranteed orthographic regularity for fourth order strings, except for word endings and word beginnings. (Pseudowords like alicentu, and bloustyle, which have non-English endings, occur in the Hirata and Bryden (1971) lists.) Lefton, Spragins, and Bryrnes (1973), among others have used these lists in developmental studies of guessing missing letters in psuedowords.

A totally different probabilistic approach is represented by Mason (1975). The Mayzner and Tresselt (1965) single-letter tables were used to generate words with high and low spatial frequencies. A high spatial frequency count for a word occurs if the letters for that word are in positions in which they are frequently found in words of the same length in texts. For example, one of the highest possible spatial frequency counts for a four-letter string occurs for THET (3794); but nearly as high is an orthographically irregular string, THET (3794); but nearly as an orthographically regular word JUFF has a count of only 371. Thus, if orthographic regularity relates to recognition ease, spatial frequency counts are inadequate for defining it. Mason (1975) found that spatial frequency was a good predictor of letter search speeds in pseudowords; however, her test items confound spatial frequency and orthographically regularity, with the pseudowords high in spatial frequency tending to be orthographically regular, and those low in spatial frequency irregular. Since both regular and irregular pseudowords can be generated with both high and low spatial frequencies, the relative contributions of the two variables to Mason's task can be examined.

6. Rule-Governed Approaches

In contrast to probabilistic approaches, rule-governed approaches are based upon generalizations about the underlying patterns of English orthography, and therefore might generate sequences that do not occur in real words, and might reject some that do. In addition, probabilistic approaches are based upon word tokens while rule-governed approaches are based upon word types. Thus, in rule-governed approaches the actual frequency of occurrence of a word in texts is not considered. This bias appears to be one of convenience rather than overt decision, resulting from the use of word types in the major studies of English orthography. (Some attempts have been made to evaluate the relative contributions of word types and word tokens in the generalization of letter-sound patterns, but the results have been inconclusive (Johnson, 1971; Johnson and Venezky, 1975).)

Restrictions on letter sequences in English words derive from two primary sources: graphemic conventions and phonological constraints. The first source is a 1400-year accumulation of scribal practices, printing conventions, lexicographers' selections, and occasional accident which somehow became codified as part of the present orthographic system. The second source is the phonology of English which by its own constraints on sound sequences places restrictions on letter patterns.

Graphemic Conventions

English graphemic conventions apply primarily to (a) sequences of the same letter, and (b) positions in which letters and letter sequences may occur within words. No letter can be tripled in an English word, and only 16 letters double (geminate). Those that don't include a, h, i, j, k, q, u, w, x and y. Exceptions to this latter constraint are few (excluding proper nouns and recent borrowings); e.g., aardwork, skiing, and trekked. The letter v rarely doubles, but several exceptions are well established in the language; e.g., flivver, savvy, navvy.

Those letters that can double do so only in medial and final word positions. This pattern has about seven exceptions (e.g., llama, eel, oodles, ooze), in addition to technical terms beginning with the combining form oö-, which brings us to the question of how do we establish a pattern or rule. Of the 100,000 or so word entries in common desk dictionaries, perhaps 15-20 begin with geminated letters. Does 99.98% regularity establish a pattern? For the present we will dodge this issue by claiming that the patterns of regularity presented here are only potential patterns, suggested as a basis for psychological studies. Their derivation, however, is based entirely upon either frequency or graphemic conditioning, without precise definition of what frequencies are rule-producing, except that types rather than tokens are counted.

A second constraint on doubled consonants is that they do not (with a few exceptions) occur after vowel digraphs. Thus, a pseudo word like louff would be irregular, or at least more irregular than words like louf and luff. The three geminate replacements tch (chch), dg (gg = /ǰ/), and ck (cc or kk) obey the same rules as geminates: they do not occur initially nor after digraph vowels. Thus tckan, dgerp, heeck, and loutch are irregular.

Some single letters also have positional constraints in English words. Q must always be followed by u; j, u, and v do not occur in word final position; and k does not occur finally after a single-letter vowel. (A few exceptions exist for u, including you and thou, and one for k: trek.) By this restriction pronounceable pseudo words like baj, blou, mek, and sliv are irregular.

Further restrictions can be found for vowel sequences, especially digraph vowels ending in i and y, but these are less consistent than the constraints mentioned above.

Phonological Conventions

Due to a series of sound changes which began during the Old English period, most noun inflectional endings coalesced into what is presumed to have been an unstressed, neutral vowel (/ə/) which was spelled with the letter e. By the time this vowel became silent, other sound changes had lengthened the vowel in a preceding syllable, so that the final e, although unpronounced, became a marker for distinguishing vowel quantity. thus, the pairs mat-mate, cop-cope arose. The consequence of these changes, plus such other conventions such as the use of a suffix s for noun plural and third person singular in the present indicative forms of verbs, is a highly uneven distribution of letters in different word positions. This is further augmented by the frequent use of common prefixes and suffixes as word-forming elements (e.g., -ing, -ed, co-, pre-). This feature, which is summarized by Mayzner and Tresselt (1965) for words with 3-7 letters, reflects both phonological and scribal variables.

A different set of constraints result from the restrictions of sound sequences in English. For example, certain consonant sequences do not occur in word initial position (e.g., ds-), and certain other ones do not occur in word final position (e.g., -sd, -fd, -pg) Whorf (1956, p. 223), has attempted to summarize the phonological structure of English consonant clusters in monosyllabic words. Notice also that while /wh-/ is an illegal phonological sequence for English, wh- is an orthographically regular spelling. The earlier spelling, hw- was reversed by 11th and 12th century scribes to minimize graphic confusions.

Unpronounceable consonant sequences from other languages or from earlier periods in the history of English often retain their original spellings even when the sound sequences are altered to conform to modern English. Spellings like write, psychology, hymn, and lamb are representative of this group. (However, some forms which appear to belong in this group result from scribal pendantry; e.g., ptarmigan, thumb, crumb). To some degree, the consonant sequences in these words are orthographically irregular, but have regular letter-sound correspondences.

Other orthographic constraints based on phonological conventions could be listed, but they are of less importance than the ones described above. One implication of the constraints described above is that different degrees of regularity are possible. For example, flab, kip, and petch are pronounceable and orthographically regular; cootch, lev, and goff are pronounceable, but (mildly) irregular; ckab, baaaf, and lixx are pronounceable (?) but more irregular; and finally, wksliv, tchfole, and xxx are unpronounceable and highly irregular.

7. Orthographic Regularity and Phonics Instruction

If the psychological reality of orthographic regularity is based upon probabalistic data derived from token counts, then phonics instruction is only marginally helpful (at best) in the development of this process. Since letter-sound associations are selected for instruction on the basis of word types and not word tokens, they could even have a negative influence; for example, in the isolation of certain high-frequency words which have irregular correspondences and are therefore taught as sight words. Probabilistic information requires continual exposure to normal texts.

Thus, the tightly controlled vocabularies of the primary readers and the emphasis on phonics instruction on regularly spelled words probably leads to probability generalizations which differ in some instances quite markedly from those published by Mayzner and Tresselt (1965) or Hirata and Bryden (1971).

However, if the psychological reality of orthographic regularity derves from rule-governed information, then the relationship between some of the potential sources of rule-governed orthographic regularity summarized above and phonics patterns becomes important. The units which are typically stressed in phonics programs are the simple (i.e., single-letter) vowel patterns, the digraph vowels (ee, ea, ow, etc.), sequences like wh-, qu-, dge, and tch, the common (and not so common) initial and final consonant clusters, and the common prefixes and suffixes, all of which play a role in rule-governed regularity. What are not introduced overtly are any of the patterns which require the absence of spelling (e.g., the non-doubling of x). Exactly how these might be taught is not clear, however. Constrasting legal with illegal spellings might be counter productive, in that it would reinforce utilization of the rules in processing the irregular strings.

Equal in importance to what patterns are introduced is the manner of introduction, which depends (in the better programs) on inductive rather than deductive reasoning. A spelling like ee is usually introduced along (with its most common pronunciation), and then in a group of words, divided by position. Thus, see, thee, free, and bee might be grouped, then seek, beet, seed, and so on with the ee emphasized by underlining or color.

A second presentation procedure which tends to emphasize orthographic regularity centers on what some phonics programs call phonograms--common vowel-consonant or consonant-vowel sequences that are productive for word building. Thus, early in many programs the -an 'family' is introduced: fan, tan, man, van, and so on. Aside from emphasizing particular letter-sound patterns, this practice also induces a segmentation strategy that may transfer directly to word recognition.

Finally, the isolation of some irregular forms like debt, thou, is, and was, which are taught as sight words, probably reduces the opportunity for generalizing their spellings as regular. But note that many other sight words, which are irregular from a letter-sound view, (what, wash, and from) are not orthographically irregular. What effect this has on the reader's sense of orthographic regularity is not clear. The differences between orthographic regularity and letter-sound regularity should not be overlooked. Orthographically irregular strings like hek, ssilf, and lowtch are pronounceable (and regularly so), while orthographically regular words like triple, colonel, eighth, business, and arced have irregular letter-sound associations.

The point to be stressed here, however, is that a logical phonics program introduces almost all of the orthographic patterns which can be exemplified positively and introduces them by procedures that give overt attention to the relevant spelling units for orthographic regularity.

8. Word Recognition

In this section, we review a number of experiments that involve the recognition of letters, nonwords, and words, and attempt to show what role orthographic regularity played in the recognition processes.[4] By recognition is meant the resolution of the visual information in order to perform the task asked by the experimenter. Given that experimental tasks differ to the extent they require different degrees of resolution on the part of the subject, the number of processes involved in recogniton will vary accordingly. Needless to say, the nature of the task must be accounted for both in the analysis of the results and in the implications that are drawn for theory. It is somewhat disappointing that some researchers have failed to be concerned with the processes operational in tasks such as searching for a target letter in a letter string, reporting component letters, pronouncing a letter string, or determining whether or not a particular letter string is a word. The different levels of processing in these tasks are somewhat clarified by distinguishing between detection, primary recognition, and secondary recognition, as described in the information processing model which was introduced earlier in this paper.

An example of a study that failed to account for the psychological processes in the task is N. F. Johnson (1975). In one experiment, subjects were given a test word every ten sec. and asked to classify it as either equal to or different from a target word. For example, for the target word <u>block</u> the subjects saw a list of five-letter words, and had to classify each word as equal to or different from <u>block</u> by hitting one of two buttons. In the letter target condition, the subject again saw a series of five-letter test words, but now responded whether or not each test word contained a particular target letter. The reaction times were shorter for the target word than for the target letter condition, leading Johnson to conclude that words are identified as whole patterns suppressing the identification of their component letters.

Johnson's results do not show that words are processed as whole patterns when the task of the subject is made apparent. Subjects in the word condition had to decide whether a five-letter string of letters was the same as a five-letter string of letters in memory. Subjects in the letter condition had to decide whether any of 5 letters in the string was the same as the target letter in memory. Accordingly, the critical difference between the two conditions is probably not word or letter targets, but having the same-length or different-length target and test items. Recall that letters in a sequence can be processed in parallel in our model. Accordingly, subjects can make a relatively direct comparison between the target and test words in the target word condition. Johnson chose his words randomly so that there was almost no chance that a different test word would have even one letter in the same position as a letter in the target letter. Subjects in this condition could have adopted a very liberal criterion of sameness. If even one or two test letters were equal to the corresponding target letters, the subject could have initiated a same response before the processing of the test item was complete. Similarly, a difference of one or two letters would have been sufficient to initiate a different response. In the target letter condition, however, the target letter had to be compared to each of the 5 letters in the test word. Therefore, each of the test letters must have been processed sufficiently to determine whether it was the same as or different from the target letter. The subject in this condition could not terminate his processing until he found the target letter or determined that all of the test letters were different from the target letter. The additional processing required in the target letter condition relative to the target word condition can account for the longer reaction times in the target letter condition, even though letters were the unit of analysis in both conditions. Accordingly, Johnson's conclusion that a word is processed as a whole, suppressing recognition of its component letters, was not warranted by his experimental results.

In contrast to Johnson's idea that a word conceals its component letters, a number of investigators have assumed that a target letter would be found more quickly in a word than a random letter string. In general, it is assumed that the time to find a target letter should be an inverse function of the conformity of the letter string to the orthographic structure of the language. The implicit assumption in this research is that the visual resolution of a sequence of letters will occur faster when the letters conform to the orthography of the language than when they don't. Letter search is dependent on letter resolution and. therefore, should mirror the time it takes to resolve letter sequences. Subjects appear to be able to perform a Neisser search task for a given target letter more rapidly if they search through a list of words than if they search through a list of random strings (Krueger, 1970; Novik & Katz, 1971).

Mason (1975) used a target search task to study the contribution of one aspect of orthographic regularity. Good and poor sixth-grade readers searched through six-letter strings for the presence or absence of a target letter. Words and nonwords were used and the nonwords differed in the degree of orthographic structure as defined by spatial frequency. As explained in Section 5, the spatial frequency of a letter in a letter string is the frequency of occurrence of that letter in the same position in words of the same length sampled from common texts. Given this definition, a letter string can be given a summed spatial frequency that represents the sum of the spatial frequencies of all of the letters in the string. Mason tested the idea that search time for a letter should be an inverse function of the summed spatial frequency of the letter string. The implicit model of the letter search task is that the subjects must first recognize the letters in the string and then compare these letters to the target letter. Differences in the search times for a given target letter in different letter strings should reflect differences in the time to recognize the letters of the string. Faster search times in the strings with high spatial frequencies would support the hypothesis that these letters are recognized in a shorter time than the letters in the strings with low spatial frequencies. Mason (Experiment II) found that good readers were faster (on both yes and no trials) on strings with high than with low spatial frequencies. Poor readers showed no difference. The results support the idea that the time to resolve (recognize) the letters in a string is influenced by the likelihood of letters occurring in their most common spatial positions.

Although summed spatial frequency appears to account for the recognition times in Mason's study, we do not believe it is the critical variable that defines orthographic regularity. Consider some of the arrangements of the letters that make up the word PERSON, which has a summed spatial frequency of 1,141. This number is obtained by the total number of occurrences of each of the letters at its spatial position in the 20,000 English words sampled by Mayzner and Tresselt (1965). The string PORNES contains the same letters in different spatial positions and has a count of 1,858. The string ENSRPO has a count of 383. Looking at these nonwords, we see that PORNES is spelled like an English word and should be relatively easy to recognize, whereas ENSRPO violates what we know about English spelling and should be relatively difficult to recognize. However, it is not difficult to find exceptions to the rule. Table 2 lists some letter strings used by Mason whose letters have been rearranged to yield strings with almost equal spatial frequencies, but with differing orthographic regularities. We are currently testing the prediction that the orthographic regularity as defined by graphemic rules and not the summed spatial frequencies will influence recognition times when these variables are covaried in a target search task.

Insert Table 2 About Here

There is a growing research literature that supports the idea that visual recognition of letter strings can be facilitated by orthographic regularity rather than spelling-to-sound regularity or word meaning. Mason (1975) showed that nonwords high in summed spatial frequency gave reaction times as fast as real words. This result collaborates other findings that visual recognition is as good for pseudowords that obey orthographic rules as it is for real words (Baron & Thurston, 1973). Baron (1975) carried out a series of experiments showing that orthographic regularity but not phonemic quality or meaningfulness has an effect on visual information processing tasks. The time taken to decide whether two strings of letters were visually identical was not shorter when the strings were words relative to pseudowords, but was longer when the strings violated orthographic regularity. Homophone word pairs did not require more time in this task than did nonhomophonic words. Meaningfulness did not facilitate search for a target letter in a letter string although orthographic regularity decreased search time. This series of experiments shows that orthographic regularity is the critical variable that facilitates the visual processing of letter recognition, search, and comparison.

In contrast to Baron's (1975) and Baron and Thurston's (1973) findings, Manelis (1974) found significant differences between real words and pseudowords in a Reicher (1969) task. Overall, a letter in a word was reported about 5% more often than a letter in a pseudoword. However, the difference between the words and pseudowords could have been due to differences in orthographic regularity, not wordness per se. Although Manelis found no

Table 2

Letter Strings of Similar Spatial Frequency that Are Either Orthographically Regular or Irregular*

Regular	Irregular
girbed (1721)	grbied (1690)
pirons (1409)	sopinr (1409)
filtes (1750)	flties (1775)
citred (1861)	teried (1886)
hougen (1399)	nhoueg (1409)

*The numbers in parenthesis give the summed spatial frequency for letter strings.

effect of bigram and trigram frequency in a post-hoc analysis, our analysis in Section 5 shows that these measures are not good indexes of regularity. It remains to be seen if our description pseudowords and words in the Manelis study can acc unt for the observed differences.

We believe that there is substantial evidence to argue that word meaning does not influence the initial visual resolution of letter strings (Baron, 1975; Baron & Thurston, 1973; Massaro, 1975). One implication of this is that there is nothing unique in a visual sense about a sequence of letters that spell a word beyond that accounted for by orthographic regularity. The perceptual equivalence between words and pseudowords argues that words do <u>not</u> have superletter features which allow the words to be recognized without resolution of, at least, some of the letters or letter features. Many teachers and psychologists believe that words can be recognized on the basis of overall shape or configuration without resolution of the component letters (Johnson, 1975; Miller, 1972). If words can be recognized as wholes, then orthographic regularity would play a very minor, if any, role in word recognition. If words are recognized on the basis of superletter features, there would be no chance for orthographic regularity to help resolve resolution of the component letters.

But there is now good evidence against the hypothesis that words can be recognized on the basis of superletter features. The most straightforward analysis was performed by Groff (1975). He examined the shapes of high-frequency words taken from school book sources. The shape was defined by drawing a contour around the letters so that, for example, elephant would be 

. Only 20% of the 283 words were represented by a unique shape. The author rightly concludes that the small number of words that can be represented by a unique shape precludes the utilization of this cue for accurate word recognition.

There is also experimental evidence against the idea of word recognition based on superletter features. Thompson and Massaro (1973) and Massaro (1973) found that visual confusability between letters was equivalent to single letter and word presentations. A letter likely to be confused for another letter was just as likely to be confused in single letter and word presentations. If recognition of words involved the utilization of different features than those contained in the component letters, we would have expected different degrees of letter confusability in letter and word presentations.

McClelland (1976) presented four-letter words, pseudowords, or unrelated strings in either the same case or in mixed upper- and lower-case. The letters alternated in letter case in the mixed case condition. The results showed the recognition of a letter was equally disrupted by mixing the cases of letters in words and pseudowords. Mixing letter cases did not disrupt recognition of letters in the unrelated letter strings. If readers utilized whole word shape or configuration cues in word recognition, mixing letter cases should have disrupted recognition of words more than pseudowords. The results support the idea that legal spelling patterns are functional at an intermediate stage of visual recognition and letters alternating in case can disrupt the resolution of these patterns. Given that the unrelated strings did not have legal spelling patterns, alternating letter case did not disrupt processing of the letters.

Baron (in press) asked observers to pronounce regular words and exception words. Regular words were defined as words that obey the rules of spelling-to-sound correspondence in English (cf. Venezky, 1970), whereas exceptions do not follow the rules. The regular words were chosen to be less frequent in the language to eliminate the pronunciation differences between regular words and exceptions. The words were presented in upper, lower, or mixed cases. The idea was that exception words should be more dependent on a whole word mechanism than regular words and that upper case letters are less appropriate for this whole word mechanism. Therefore, if words are recognized as wholes and exceptions more so than regular words, we would expect an interaction between upper and lower case and regular vs. exception words. No interaction was found, however, arguing against the whole word mechanism.

Other evidence against the whole word idea and for orthographic regularity has been recorded by Baron and Brooks (Baron, 1976; Brooks, 1974). They translated real English words into an artificial alphabet and asked subjects to learn the real word responses to the words presented in the artificial alphabet. The same subjects were also asked to learn stimuli that had the stimuli and responses re-paired so that the new alphabet is no longer a useful guide to pronunciation. Figure 2 lists the alphabets and the stimuli and responses used in the experiment. Note that in the orthographic condition, each of the artificial letters corresponds to an English letter. In the paired-associate condition, the stimuli are re-paired with the responses so that the orthographic regularity is lost. If subjects learn to process words as wholes without regard to the orthographic regularity of the letters, then we would expect that the speed of reading the paired-associate stimuli should be the same as reading the orthographic stimuli. If a whole word analysis is used, the orthographic structure is useless. In contrast, if letter processing mediates word processing, we would expect that the orthographic structure would facilitate reading performance.

Insert Figure 2 About Here

Subjects were asked to read aloud lists of 6 items as fast as possible without error. Although the paired-associate list was initially read faster than the orthographic list, the asymptotic reading times of highly practiced subjects were significantly faster for the orthographic than the paired-associate condition. In a second experiment, the component letters were concatenated to form glyphic patterns, making it difficult to recognize the component letters. Even though the glyphic calligraphy was read faster than the words made up of discrete letters, the orthographic patterns were still read faster than the paired-associated patterns at asymptote. Although these results come from a novel paradigm, they support the conclusions of the other research we have reviewed. Words are not recognized as holistic units; letter analysis and the utilization of orthographic structure must mediate their recognition.

9. Summary

There is now sufficient experimental evidence to argue that some kind of orthographic regularity facilitates the perception of letter strings. We have set out to determine the nature of this regularity, and hope to obtain eventually substantial evidence for constructing a model of the reader's knowledge of orthographic regularity.

In concluding, we would like to return to our concern for phonics instruction which we expressed earlier in this paper. If rapid word recognition is essential for competent reading, and if orthographic regularity is important for recognition, then reading instruction must ensure that an awareness of orthographic regularity is acquired. This might occur simply

Stimuli and responses used in Brooks, 1974

Figure 2

	A	E	N	P	S	T
ALPHABET I	⊔	)(	⊓	( )	III	—
ALPHABET II	V	U	Λ	∩	I	∞

STIMULI

LIST I	LIST II
⊓ ⊔ ( ))(	∩ U Λ ∞
⊓ ⊔ ( ) III	∩ U V ∞
III)(⊔ —	I V Λ U
( ) ⊔ III —	∞ V ∩ U
( ) ⊔ ⊓)(	∞ V Λ I
III)(— III	I V ∩ I

RESPONSES

EVEN-NUMBERED SUBJECTS

ORTHOGRAPHIC LIST I	PAIRED-ASSOCIATE LIST II
NAPE	TANS
NAPS	SANE
SEAT	PEAT
PAST	SAPS
PANE	PENT
SETS	TAPE

ODD-NUMBERED SUBJECTS

PAIRED-ASSOCIATE LIST I	ORTHOGRAPHIC LIST II
SEAT	PENT
PANE	PEAT
NAPE	SANE
SETS	TAPE
NAPS	TANS
PAST	SAPS

from exposure to reading, regardless of reading ability. On the other hand, some readers, because of inefficient recognition strategies, might not acquire a sense of orthographic regularity, or might do so only after considerable remedial attention. We suspect that a full sense of orthographic regularity does not develop until at least the middle grades for some readers, and perhaps much later for others. These are, of course, speculations which can be tested experimentally. We are, nevertheless, no longer willing to agree as we once did with Chall's statement:

> "Once the pupil has learned to recognize in print the words he knows (because they are part of his speaking and listening vocabulary), any additional work on decoding is a sheer waste of time."
>
> Chall, 1967, p. 307

FOOTNOTES

[1]We have, however, greatly simplified the recognition processes in this description, leaving out for purposes of explication that complexities of what are probably asynchronous, partially overlapping processes. More detailed explanations of these can be found in Turvey, 1973 and Massaro, 1975.

[2]In the Shannon (1951) system, all 26 letters of the alphabet plus space were used, so positional constraints were guaranteed for second order and higher approximations to English.

[3]Gibson and Levin (1975, pp. 207-211) distinguish between correlation approaches like Underwood and Schulz (1960), and conditional redundancy approaches which consider positional constraints. However, this dichotomy does not apply to yet another approach, the spatial probability approach, which is discussed shortly.

[4]Orthographic regularity should not be confused as it often is with spelling-to-sound regularity. The latter means that there is also a regular (i.e., predictable) association between the spelling of the language and the way it is pronounced. The more regular relationships between spelling and sound have led a number of researchers to postulate that reading a word involves first recoding it to speech at some level and then accessing meaning on the basis of this speech code (Gough, 1972). But it is unlikely that the spelling-to-sound correspondences could facilitate visual processing since the letters would have to be recognized.

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OPEN DISCUSSION OF VENEZKY AND MASSARO PRESENTATION

FREDERIKSEN: It wasn't clear to me what operations you included in these experiments, in which you establish that primary recognition is either at the level of letter sequences that obey rules of English orthography or at the level of code words. If it is at the level of code words, then the lexical access is immediate.

VENEZKY: That's one of the issues that has been dealt with in the literature. The most convincing evidence that it is something more primitive than lexical representation is that in the Reicher-Wheeler task, pseudo-words, that is, words that obey the rules of lexicography operate like real English words.

FREDERIKSEN: Did Reicher do that?

VENEZKY: Reicher did not do that, but I can give you a number of studies that have done that.

FREDERIKSEN: In the same task?

VENEZKY: In the same Reicher task that controls for the guessing.

FREDERIKSEN: And was the result exactly the same?

VENEZKY: It's exactly the same. There are a number of studies.

JUOLA: Of course I can also cite a number of studie_ that show perceptual differences between the best possible pseudo-words and very common, highly-frequent words. I see that as a lack of proper control.

VENEZKY: The problem we have, of course, when we want to compare a pseudo-word to a word, is to equate them in orthographic regularity.

JUOLA: What are your comments on the definition of orthographic regularity in the study that Manelis has done?

VENEZKY: Manelis did not compute trigram and bigram frequencies based on serial positions. He did a post hoc analysis and found no differences.

I think we have evidence that it is definitely not bigram and trigram frequency that describes regularity.

I am not saying that all of the evidence is in on the issue of words versus pseudo-words, but there are a number of studies that have shown no difference between words and pseudo-words that are composed of regular orthographic patterns.

CAMBOURNE: In the beginning, Dick said something about teaching phonics with a kind of "matress" philosophy, that is, using phonics as something to fall back on, just in case you can't recognize the word from other cues. He hinted that the kinds of things you are talking about were somehow different from this kind of "falling back on." I missed how it was different. If the kind of orthographic patterns that you are talking about are to be taught, how is such teaching different from teaching phonics as something to "fall back on?"

VENEZKY: The differences are very small, but they have to be realized. There is a difference between letter-sound regularity, which is what phonics pretends to be about, and orthographic regularity. Maybe the most trivial way to approach this is to think of a word like "business," with a silent "i." It is orthographically regular, that is, the sequences of consonants and vowels are very predictable by what we would call orthographic rules. But, from a letter-sound standpoint, business is a highly irregular word when looked at from the perspective of phonics conventions. We can cite a lot of simple examples like that. Consider, also, function words, like is and was. For historic reasons, we have voiced the final consonants in those words, although not in non-function words. Thus, the s-/z/ correspondence is irregular from a letter-sound standpoint, but w-a-s is an extremely regular graphic form. That is where the two concerns diverge.

RESNICK: We are going to hear in some later papers that children of varying dialects may not show as much difficulty in learning to crack the code in the decoding stages as has often been said. How would you account for that finding?

VENEZKY: That is a very different story. First there is a myth involved in the assumption that there would be a difference in decoding ability between those who speak Midwestern standard speech and those who speak, for instance, an Eastern New England variant. Pronunciation would be different, but letter-sound correspondence learning would be the same. Now, one could find a difference if one assumed that a teacher in a classroom in Eastern New England insisted that students learn dialects that she herself doesn't know.

But in reality, the classroom teacner teaches what she generally speaks. One can take this a little further and talk about what happens in tne ghetto with a white teacher who doesn't speak black English. The reality is that no one is taught perfect letter-sound correspondences, so that most people seem to be at about the same disadvantage, if you want to call it that. I am not sure it is really necessary to say much more than that. We don't really teach children articulation when we teach them letter-sound correspondences. The point is, there isn't a very good basis to predict interference.

RESNICK: Why aren't you arguing that it is the orthographic regularity, rather than the phonological regularity that matters for becoming a fluent reader?

MASSARO: Don't forget that we are talking about something very narrow in a sense, rapid word recognition. We are not making a claim for how much of the total reading process this may account for. Letter correspondences relate to a whole range of other goals such as motivation and self-checking that come into play long before what we are talking about would show up.

So I am not sure that we could really talk, in an intelligent way, about the stage that you are concerned with, apart from its relationship to what we have presented.

GOODMAN: Dick, before you began to argue your case, you said that the only difference between reading and listening is rapid word recognition.

VENEZKY: No. I said that probably the most important skill that is acquired, that is unique to reading, is rapid word recognition. There are clearly other skills needed to read letters, letter-sound recognition, for example.

GOODMAN: In what sense, then, is rapid word recognition unique to reading, and in what sense is it not part of listening? What is different about listening?

VENEZKY: All right. I am talking about visual word recognition.

GOODMAN: But wouldn't it have an acoustic dimension?

VENEZKY: Only if you hypothesize that there is some kind of acoustical mediation between the visual pattern on a page and the contact you make with it, say, in long-term memory, in the lexicon. We are claiming that there is no acoustical mediation. I think I could provide evidence for that claim.

GOODMAN: I guess I am not quite following you, or, if I am, I am finding it hard to believe in what you are saying. You are saying that in speech you can go from sound directly to meaning, but in reading you have to go to acoustical-visual mediation.

VENEZKY: I am not saying that at all. We have to go back to the model.

GOODMAN: Where do the two processes, listening and reading, make rapid word recognition unique? Where do the processes differ?

VENEZKY: They differ up to the point where an item in long-term memory lexicon is identified. Here is a visual pattern, s-t-o-p here; and here is a word in its acoustic form, /stop/. We are assuming, to some degree that you have two independent processes going on, and that in attempts to recognize those items, each process makes a separate reference to a lexicon and says, "Aha, it is the word stop, meaning halt."

GOODMAN: But why isn't there a parallel in listening to what you are calling rapid word recognition in the visual modality?

VENEZKY: Oh, I am sure there is, Ken. But we are talking about reading.

GOODMAN: I keep saying, what is unique about it, then?

VENEZKY: What is unique is that you start with a visual form. Now, you have to get from the visual input to something you can deal with. That's all we are talking about, no magic, no implications for dialect differences, or meaning. All we are saying is that the best evidence available says you are using processes unique to visual perception when you recognize what word you have when you see the letters s-t-o-p. We are saying, furthermore, that there is no phonological mediation up to that point.

Now, there seems to be some evidence that would lead you to believe that once you go to the lexicon to try to determine if the word is "stop," it's almost impossible to separate access to meaning from access to phonological form. The evidence suggests that it is all there, so readily accessible, it's hard to separate the two.

GOODMAN: You have been very careful to limit what you are saying to recognition, and the evidence you are citing is all limited there. I thought Carl was asking before whether you had evidence that the word is the unit that people process. Are you saying that, or are you saying it's possible that it's larger than a word?

MASSARO: Smaller.

GOODMAN: Smaller than a word, never larger?

MASSARO: A study comes to mind, that also answers Jim Juola's question, a study by Lee Brooks, a very complicated study, that demonstrates that you have orthographic and phonological regularity mediating word recognition.

It's a very convincing demonstration, and offers evidence against the sight word method. It suggests that you don't get this automatic translation from word to meaning.

GOODMAN: Yes. But you see, you are arguing within the word, you are saying that the word is the unit. You are citing that in answer to Carl's question--

MASSARO: The answer to his question is that pseudo-words function like words. That is to say a letter string--

GOODMAN: In context, in connected discourse?

MASSARO: We are concerned with the visual resolution of that string. We are trying to determine what the subject is able to report about the visual quality of that string.

GOODMAN: That's what I am asking you. Are you then generalizing and saying that, in reading connected discourse, we don't process any units larger than the word? (Dick gave an example before of the kid concluding that the word was <u>the</u>.)

VENEZKY: There certainly would be units larger than the word.

GOODMAN: But how would you explain the very common miscue of the word substitution a for the, on the basis of your arguing that it's the orthographic regularity that is the pedictor?

VENEZKY: Ken, you know we are talking about very, very primitive stages in recognition.

We are making a very strong claim in relation to our own concerns. We are saying that it's not a psycholinguistic guessing game at all at this stage; the evidence seems clearly to rule that out. There are many things, though, that go on in reading that are far beyond what we are talking about. Ours is a very narrow concern. We would say, in fact, that the more common example is substituting a for the, a definite-indefinite article change. It is very typical of experienced readers, not inexperienced readers. If pressed on that, we would very carefully say that that comes in as a substitution at a semantic level.

GOODMAN: But if it happens, can you explain it? And it does happen very early.

VENEZKY: You are refusing to attend to what we are trying to do. We are trying to lay out a model, a sequence of processes, that would allow us to examine each of these steps. What we would hypothesize is that that kind of substitution has to come in after recognition.

If you don't see that it's "the," you could not, with the high frequency we observed, substitute something so close semantically, that is functional. That cannot be a visual perceptual confusion, and we predict totally separate kinds of--

GOODMAN: This what I am trying to get you to say. You are saying the "a" substitution comes after an identification of "the?"

VENEZKY: Clearly.

GOODMAN: And do all such substitutions result then from first perceiving the word?

VENEZKY: I don't know. But I would be very willing, if you tell me the substitution, to make a prediction. But the important thing here, and the difference in our methodology versus that of others, is that we are conerned with how you verify these things experimentally, not with how you defend a particular position forensically. That's why we present a particular model. The model may be all wrong, but at least it's an organized way of going wrong. It allows us to build a better model, if a better one is needed.

GOODMAN: I was not arguing about what was wrong with your model; I was trying to find out what its limits are, and how it functions in relationship to the whole process.

VENEZKY: In a very limited, very, very primitive way.

MASSARO: I don't know if I would give that strong an answer to your question; I am not sure that we have data available to answer it. We wanted to show that orthographic regularity facilitates perception. The question your are asking is, "Could the syntactic-semantic information in context override both visual information and orthographic regularity?" I don't think we have the answer.

FREDERIKSEN: What are the instructional implications of all of this? I am tempted to say that there are none, in the following sense: You have said nothing at all about an efficient way to make a person learn the rules of English orthography. Now, one could do it at the whole word level, or one could do it by phonics instruction. You have taken no position on what is a desirable way to train a person to recognize words rapidly. Do you wish to draw any instructional implications at all?

VENEZKY: No.

RESNICK: Why not?

MASSARO: We don't claim to know what orthographic regularity is; these are some of the notions we are testing now. There are a number of ways to define regularity in language, and we wanted to isolate exactly what properties would help define it.

FREDERIKSEN: I find all of this very interesting as a psychologist, but from the point of view of instruction, I don't see it as important at all at this point.

VENEZKY: Carl, I said at the beginning it is not clear whether there will ever be a change in instruction. We are dealing with a primitive level of processing. We are saying that if we can show that orthographic regularity of a certain type is essential to word recognition (and furthermore, that good readers in fact gain an appreciation of this, and utilize it), then it would seem clear that we would want to find out whether there is a better method than the one we are using now. The answer may be "no."

You have to know what planning instruction depends upon, the decisions you have to make. Knowing that is a whole new ball game. Ask the people here who have developed reading programs how sure they are that the way they introduce letter-sound correspondence makes any sense at all.

FREDERIKSEN: Would this affect the way that you teach letter-sound correspondences? Has this had any effect on the development of programs?

VENEZKY: Not at this stage. It may be a long time before we reach the point where it will have that effect.

RESNICK: If what you say is true, doesn't it follow that we should continue something like phonics for a longer time, if all you want to do is give students something to fall back on?

FREDERIKSEN: I don't see how that follows.

VENEZKY: It follows in the sense that if phonics succeeds in teaching orthographic regularity, given that we want to go on teaching orthographic regularity, and if phonics was our best method, we would want to go on teaching it. It does not say phonics is the perfect method.

Anybody involved in developing instruction knows you don't hope to develop the perfect method. If you get something that works half the time, you're doing well.

CHALL: If you wanted to teach phonics, up to and beyond third grade, how would you measure, for the average third grade class, the ability to use this orthographic regularity? Have you any tests, or can you suggest tests?

MASSARO: Certainly. Mason was able to show in her study that good readers are helped by the regularity of words, while poor readers are not You could employ the same kind of experimental task to answer your question.

CHALL: You mean I could use existing phonics tests?

VENEZKY: Probably not.

CHALL: Why not?

VENEZKY: Mason took an artificial orthography. Do you want me to pretend I know, or do you want me to know and say I suspect?

CHALL: You started right off saying you don't know.

VENEZKY: No, I don't think you can use existing phonics tests. You can use my tests, but you can't use existing phonics tests.

Existing phonics tests tend to use all real words. That makes it hard to eliminate word recognition from this kind of orthographic regularity. Also, existing phonics tests are not timed.

What Mason did was take special characters from the top row of the typewriter and constrain how they could appear (impose some regularity). She found very large differences among readers. Good readers learned more quickly to utilize that information to find target letters faster than did poor readers. It turns out, unfortunately, that we have a different explanation of the results than she did, but the idea is close to what we would suggest be done.

POSNER: There was a quarrel about whether a word, at your level of analysis, might be recognized better than an orthographically regular string. I was wondering what is riding on your theoretical thinking that the orthographically regular string, which hadn't been seen before, is equivalent to a word? What trouble does it cause you if it turns out not to be equivalent?

MASSARO: The only trouble would be if it led people to interpret the result to mean that words are recognized as wholes on the basis of supraletter features.

POSNER: So is that what you are attempting to avoid?

MASSARO: That's right.

HOLLAND: Speaker requested that his comment be deleted.

VENEZKY: I don't know. Remember our goal is to help children learn orthographic regularity for rapid word recognition. The games that Bloomfield played were really meant for a totally different purpose. I should really mention as an aside that if you can ever get the 1912 edition of the handbook for the Beacon method, you will see that Bloomfield really was fooling a lot of people. The Beacon method is as systematic as, if not more systematic, than Bloomfield ever was. It was not true that the world was chaos, and Bloomfield recrdered it in logical, systematic steps.

STICHT: In talking about reading versus auding, do you see a parallel with orthographical decoding and phonological decoding?

MASSARO: Yes, that would be the parallel.

STICHT: Can you do graphological decoding in speech? That would be "No," right? But you could do phonological decoding in speech. The point you are trying to make then is that graphological decoding is some kind of knowledge that comes from learning about the relative position of letters. It has to do with printed representation. Is that the idea?

VENEZKY: Yes.

STICHT: Then Ken's problem of the miscue is different. I could do miscue analysis in the auding, couldn't I?

VENEZKY: If you look at our model and imagine carefully building the further stages to get all the way up to the end of some kind of reading process, you find various points where you could say people could make mistakes. For example, if they think from context that only a specific word could occur at a certain place, they may not process the visual features very carefully.

STICHT: That could happen in speech, too.

VENEZKY: Sure.

MASSARO: Yes.

STICHT: That's the point that I was trying to get to. That moves you away from the print-speech problem.

The other point is, what do you think of the typical reading specialists' prescription of what wide ranging reading is meant to do? Is that meant to expose people to the various orthographic types of combinations over the long period of time, so that they can abstract those regularities?

VENEZKY: I don't know.

STICHT: Let's offer that as a possibility for how people might learn those combinations. That's, I think, part of your problem in finding the prescription. I think the traditional prescription today is wide ranging reading.

VENEZKY: It is clear that if we are wrong about what type of orthographic regularity makes a difference, i t turns out not to be rule governed (based on types) but probabilistic (based on tokens), then the controlled vocabulary does us no good. Controlled vocabulary carries us away from the kinds of experiences that would build the probabilities that should be gotten from natural text.

LESGOLD: I had trouble finding any evidence, at least in adults, that slower readers or poorer readers differ in their ability to perceive relatively small amounts of language, particularly units up to trigrams. Now, that suggests one of three things: First, poor readers, as adults, may have some other problems; second, there may be something other than at least the lower order orthographic constraints that is the poor reader's problem; or third, I just haven't searched hard enough. But I certainly don't know of any evidence showing that orthographic rule, regularity manipulations, or statistical kinds of manipulations can produce a situation where the poor reader will be slower or less accurate in reporting up through trigrams. Now, in more complicated situations that tend to get beyond the short-term memory span, there are the Jackson and McClelland results and also Buzz Hunt's results with two rows of four letters. But all of those involve something more than the rules for making initial decisions about what is there, and I don't see the differences between good readers and poor readers on that.

VENEZKY: Mason has differences; Katz, Katz, and Wicklund have differences; we have differences on level of sound learning.

CHALL: We have a dissertation on this with trigrams, going from first to fourth grade.

LESGOLD: That is children.

CHALL: Is that wrong?

LESGOLD: I made the definition on the basis of adults.