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ABSTRACT

This study compared the rapid word processing abilities of groups of students in college, fourth grade, second grade, and kindergarten to see if there is a developmental pattern in such skill development, and to see if phonics training should emphasize either letters and the orthographic rules that create words or letter clusters (common words) that are learned as perceptual units through reading experience. Subjects indicated whether a target letter appeared in a display consisting of three, four, or five letter words, pseudowords, and nonwords; the target letter was present in half the trials. The pattern of results obtained for the kindergarten students was different from the results for the other age groups; kindergarten pupils showed no different mean response times for words, pseudowords, or nonwords, while all other groups showed ordered response times that increased from words to pseudowords to nonwords. These results are taken as further evidence of the importance of orthographic regularity and phonics in beginning reading instruction. (Discussion following presentation of the paper is included.) (RL)

What Do Children Learn When They Learn to Read?

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What Do Children Learn When They Learn to Read?

Learning to read involves the acquisition of a few skills specific to reading and the use of many other abilities that are common to a variety of cognitive processes. Previously-acquired linguistic and conceptual knowledge relevant for understanding oral language and interpreting visual experience is also necessary for reading. Learning to read largely involves the learning of a new language code that is based primarily on spatial relations rather than on the temporal relations of the speech code. Most children in the primary grades possess the necessary perceptual, linguistic, and conceptual abilities to process some written language. Much of beginning reading instruction is therefore directed towards activities unique to processing the visual code. Beginning students of reading must be taught the left-to-right ordering of the letters and words in the text and their sometimes arbitrary relationships to spoken language. Thus, the teaching of reading is focused mainly on the acquisition of basic visual recognition and decoding skills. The teaching of decoding often involves drills on specific letter-sound correspondences, but teaching methods can differ in the amount of emphasis placed on more general relationships between English orthography and phonology.

The emphasis on the relationship between oral and written language is evident in most if not all beginning reading programs. Training in phonics or decoding to sounds has been a fundamental part of reading instruction for decades (Chall, 1967, this volume; Huey, 1908). This is the case despite the fact that decoding is only one method of recognizing words. Research has indicated that phonemic encoding plays a relatively minor role in rapid word identification and skilled reading (Henderson, in press; Kleiman, 1975;

Massaro, 1975). For the beginning reader, however, phonics has traditionally been taught in order to enable children to decode any unfamiliar printed work into a recognizable approximation of its pronunciation. Yet many common English words are blatant exceptions to letter-sound correspondence rules, making the need for some sight-word recognition inevitable.

A secondary goal, or at least a result, of phonics training is to provide the beginning reader with some knowledge of the regularities of English orthography. Just as English phonology restricts the combinations of phonemes which can follow one another in words, orthographic rules constrain graphemic constructions. Phonics drills which relate regularly-occurring graphemic and phonemic groupings presumably call attention to these regularities and thereby help the beginning reader to become familiar with them as general linguistic rules. Knowledge of English orthography could therefore come to facilitate word recognition regardless of whether or not phonemic encoding is used as a route to comprehension in skilled reading (Venezky & Massaro, this volume).

It is obvious that at least some words are recognized by both skilled and beginning readers while they are reading a passage of text. Rapid word identification is an effective subskill of reading in that it can free attentional demands from decoding to accessing lexical and semantic information about words stored in memory. In fact, when word recognition becomes an automatic process (LaBerge & Samuels, 1974), it might be unnecessary during reading to divert attention from the processing of meaning to the recognition of individual letters and words. Thus we might expect word recognition skills to be related to reading ability. This is apparently true for beginning readers, as some research has shown high correlations between word recognition skills and other measures of reading ability. For skilled readers, such as the average college student, word recognition has become automatic or at least rapid enough such that correlations between word processing skills and reading abilities are low (Perfetti & Lesgold, this volume).

The issue that we wish to raise for the present discussion concerns how rapid word recognition skills develop as children learn to read. That is, does phonics training or other experience with written English foster the development and use of orthographic rules to infer word structure based on preliminary and partial visual analyses? Or are common words and other familiar morphemic units recognized as "wholes" in the same way that single letters are? These are, of course, questions that concern purely perceptual aspects of reading. By limiting our discussion to how single words are recognized we must obviously ignore many other cognitive and linguistic processes that intervene between glimpses of text and comprehension of written language. Further, whether individual letters or whole words are identified as elements of perceptual categories in memory probably depends on the level of information being sought by the reader. Nevertheless, if rapid word recognition is the only important skill unique to reading (as Venezky and Massaro claim), then the study of the development of this skill is important for our understanding of beginning reading. By identifying what adults recognize when they are presented with visual displays containing words, we can discover what to try to teach children to look for in text. And we might also learn about what they see despite our attempts at instruction.

Theories of Word Recognition

Most theories of word recognition begin with a sometimes vague set of elementary features as the initial central representations of visual experience. That is, brightness contours and other information such as the presence of lines, edges, and corners are detected by cells in the visual cortex of the brain. Featural information is briefly held in memory until the input from succeeding eye fixations replaces it. This registration of information is assumed to be precategorical in the sense that its quality is largely independent of the type of display presented, be it a word, a random letter string, or any other combination of features with a similar contour density. Information in preperceptual storage (Massaro, 1975) is then synthesized or categorized with respect to a set of relevant perceptual categories in memory. It is the nature of this categorization process that serves to differentiate among theories of word recognition.

Most adults and first grade children can easily name a letter when it is visually presented alone and in a familiar form. The assumption is that internal categories exist for the letters that are defined in terms of sets of critical features. These categories allow auditory and visual translations of the letter codes if the assignments for visual shapes to certain sounds have been learned. Thus, a visually presented word can be quickly converted to a string of letter names or their phonemic codes by a literate adult. This conversion is an obligatory route to word recognition in some theories, whereas others characterize word recognition as a process similar to letter recognition. That is, when a word is viewed, the features in preperceptual storage could be used to recognize individual letters until the word itself is uniquely determined. Alternatively, units larger than single letters could be recognized directly from their visual features, and word recognition could be a holistic process or one based on recognizing component letter clusters as units. This distinction is clearly illustrated in Neisser's (1967) description of the competing theoretical outlooks as being based on inference or on unitization (see also Henderson, in press; Juola, Taylor, & Choe, in press; Smith & Haviland, 1972; and Smith & Spoehr, 1974).

Inference theories (e.g., Massaro, 1975) base word perception upon the prior recognition of one or more letters. Not all letters need to be identified before the word can be recognized, however. The identification of any letter in an English word limits the possible alternatives for what its neighbors can be. Thus, the identification of a few letters can lead to word recognition by facilitating or eliminating the need for subsequent letter identification. In this way it is clear that word recognition could be accomplished by processing fewer visual features than would be necessary if each letter had to be identified independently. Inferential processes could also operate in decoding. The identification of a few letter sounds could be used to generate the entire phonemic code of the word, on at least a recognizable approximation to its normal sound pattern.

Unitization theories (e.g., Smith, 1971), on the other hand, do not maintain that word recognition is necessarily based on the prior identification of letters or speech sounds. Rather, as the visual features and their respective locations are processed, competing word alternatives are eliminated. In this process, some letters in the word might be identified incidentally, but they do not contribute to word recognition unless the word is not recognizable as a sight-word unit. Hypothesized perceptual units have included letters, words, and familiar letter clusters such as spelling patterns which could all be recognized directly from their visual features (Juola, Taylor, & Choe, in press; Taylor, Miller, & Juola, 1976).

Distinctions between inference and unitization theories are often difficult to make in practice, however. For example, words can sometimes be identified under impoverished visual conditions that would preclude identification of any individual letter (Huey, 1908). This result is often used as evidence that words are perceived as wholes, without depending on prior letter identification processes. However, even if no letter is seen clearly enough to be recognized, the available information might be sufficient to limit the possible alternatives to only a few at each position. The limitations on the letter alternatives could be used in conjunction with knowledge of orthographic structure to identify the word. There are other complications in trying to decide between the theories. For example, advocates of the unitization view often claim that word perception can be based either on letters or on higher-order units depending on what the subject's expectancy or processing strategy is. Thus a letter-by-letter model could be supported by the data from a given experiment involving word displays, if the task can be performed more efficiently by using a letter recognition strategy than by first identifying the overall pattern and then checking to determine what its component letters are (Bjork & Estes, 1973; Estes, 1975; Estes, Bjork, & Skaar, 1974; Massaro, 1973; Thompson & Massaro, 1973, Exp. II). On the other hand, if the task encourages recognizing the entire display, it might appear to be the case that letters are actually seen better when presented in a familiar (word) context than when presented in an unfamiliar string of letters (Juola, Choe, & Leavitt, 1974).

In the next section we review some studies of the perception of words and other letter strings that have been used in the past to support one or another of the theoretical positions. While we do not think that the time has come for a final dispensation with regard to the inference versus unitization issue, we do feel that a model based exclusively on letter identification and orthographic knowledge is inadequate to explain rapid word identification and skilled reading. It remains to be determined if either inference or unitization theories can provide an adequate description of developmental changes in children's word recognition processes as they learn to read.

The Word Superiority Effect

There are many experimental tasks which show advantages for common words over letter strings that are not familiar, orthographically regular, or meaningful in any way. Some of these tasks confound perceptual as well as memory and response processes thereby concealing the source of word advantages (see Henderson, in press; Smith & Spoehr, 1974). It is now generally accepted that Reicher's (1969) procedure eliminated enough of the artifactual causes of word superiority effects to allow the conclusion that a word advantage exists in perceptual recognition processes. Reicher specified two letter alternatives either immediately before or soon after a brief visual display that contained one of the letters. The display types consisted of four-letter words, anagrams of the words, or single letters only. The subjects were more accurate in picking the correct letter alternative when it was included in a word display than when it was included in a nonsense string of letters or presented alone. (Our discussion of the word superiority effect will henceforth be limited to comparisons between the perception of words and the perception of meaningless letter strings.)

Reicher's results appear to support the unitization theory since, when words were displayed, each of the two letter alternatives formed a common word when included in the appropriate display position. The effects of orthographic redundancy should then have been controlled for and eliminated as a possible cause of the word advantage over nonwords. However, Massaro (1975) has argued that redundancy can still play a role in the Reicher task if the subjects attempt to synthesize a word from letter and featural information before the two response alternatives are considered. In this case partial information about the critical letter could be used to assist the synthesis of the actually-presented word on word trials, thus insuring a correct response. On nonword trials, however, this attempted synthesis would fail or arrive at a word that was not actually presented. In most cases the subject would then be left with two alternatives between which to choose, and neither might match any letter that had been identified. Because of the greater potential for failure in the synthesis process on nonword trials, the probability of a correct response would be less than when words were presented.

Recognition experiments similar to Reicher's (1969) have been used to demonstrate that letters are more perceptible when they are included in orthographically regular and pronounceable pseudowords than when they are part of an irregular string (Aderman & Smith, 1971; Baron & Thurston, 1973). One can understand how pseudowords could be more perceptible than irregular nonwords from either an inference or a unitization point of view. Pseudowords could be processed more efficiently because their regular orthographic structure facilitates letter identification. However, pseudowords contain letter clusters which are familiar components of common words, and these units might be recognized directly from their visual features. In either case, the use of redundancy could operate at the featural level, basing identification of the entire display on fewer features than those necessary to identify all of the component letters if they were to be considered separately.

We have reported the results of several experiments designed to test inference and unitization hypotheses in a task like Reicher's. In one study (Juola, Leavitt, & Choe, 1974), the displays included common words and orthographically regular pseudowords. Letter alternatives were specified either in advance or after the display as in Reicher's study. In both conditions, letters were shown to be more perceptible in words than in pseudowords. Although the pseudoword/nonword difference discussed earlier is consistent with either an inference or unitization theory, an additional perceptual advantage for words is consistent only with the unitization view. This is under the assumption that the pseudowords have in fact been equated with the words in terms of orthographic structure. In the absence of any agreed-upon and general set of rules for determining the degree of orthographic regularity in letter strings, this last assumption cannot be validated (Venezky & Massaro, this volume).

It should be noted that there are experiments similar to Reicher's which fail to show word superiority effects. These studies have typically involved practice with a fixed and small set of letter alternatives as well as, sometimes, specific knowledge about the relative position of the critical letter in the display (Bjork & Estes, 1973; Estes, Bjork, & Skaar, 1974; Massaro, 1973; Thompson & Massaro, 1973). We argue that this variant of the Reicher procedure disrupts the normal strategy of attempting to recognize the display before considering the response alternatives. Rather, practice with a specific set of letter alternatives encourages a letter-processing strategy that results in the disuse of orthographic information or perceptual units larger than single letters. For these reasons, we have called experiments using a fixed set of target letters for a series of displays <u>detection</u> tasks to distinguish them from recognition tasks of the Reicher type. Consistent with this dichotomy, Juola, Choe, and Leavitt (1974) demonstrated that the visual similarity between two target letters has no effect on recognition performance, but greater similarity produces poorer performance in detection (see also Thompson & Massaro, 1973).

This discussion of the word superiority effect has been limited to a consideration of data and theories relevant to perceptual recognition tasks. There are a number of other experimental procedures that have also been used to demonstrate advantages for words in perception, and some of these might prove to be more practical in experimental work with children. For instance, a task involving search for a given letter in a display containing several letters can be performed by children who have not yet learned the names of the letters. The use of this type of search task also allows for the study of perceptual processes involved in recognizing the display information and subsequent comparison processes operating between the target letter and the encoded display information after it has been recognized. Finally, this procedure eliminates many of the motivational problems that can arise for subjects (especially children) who are continually confronted with brief displays that are difficult to identify.

In the remainder of this paper we will discuss some earlier results from visual search tasks that have been designed to study developmental processes related to reading ability. We will then consider the data from a study of visual search recently completed in our laboratory. The results are relevant to the issues of how children learn to recognize words rapidly and how they come to process words in memory after they have been recognized.

Visual Search

Visual search tasks are of two general types; one involves large displays or long lists of items that must be searched using several eye fixations (e.g., Neisser, 1963), and the other involves the presentation of a small amount of information to central vision such that it can be processed during a single eye fixation (e.g., Atkinson, Holmgren, & Juola, 1969). Krueger (1970a,b) has shown that a single target letter can be found faster in both kinds of search tasks if words rather than unpronounceable nonwords are used. Krueger concluded from his research that familiar and highly redundant words are encoded more rapidly than irregular nonwords, but subsequent comparison processes are largely the same for the two types of displays. We tested this conclusion directly by presenting visual displays containing from three to five letters that were either common words or orthographically regular and pronounceable pseudowords (Gilford & Juola, 1976). A different target letter was specified on each trial, and it was included in the display on half the trials (positive response required) and it was absent on the other half (negative response required). In this task errors were relatively infrequent and the relevant data are response latencies. Consistent with earlier findings (Atkinson et al., 1969), response times increased linearly with the number of display letters. The slopes of the best-fitting linear equations were equivalent for positive and negative trials, and they were also equal for word and pseudoword displays. However, the overall response time was about 40 milliseconds faster for words than for pseudowords.

In order to interpret these results it is first necessary to develop a model for visual search involving the information available in foveal vision. We assume that when a single target letter is presented, it is held in memory as a visual code. (It is possible, as Townsend and Roos, 1973, have argued, that the target letter is held in either an auditory or a visual form in preparation for subsequent processes which can be based on either type of code. We argue, however, that this type of search task is based on visual codes, and we will support our argument with data that are discussed later.) When the visual display is presented, it is encoded into a form compatible with the target item. The target letter is then exhaustively compared with each of the items in the display before a decision to make a positive or negative response is made. The interpretation that the comparison process is exhaustive is required by the result that response times increase at the same rate for positive and negative trials. A search that terminated with the finding of the target on positive trials would produce a function that increased half as rapidly across display size as that for negative trials (Sternberg, 1966). The interpretation of the overall word-pseudoword difference would be that words are encoded more rapidly than pseudowords, perhaps by being recognized more often as single units. Once encoding is complete, however, the quality of the encoded letter string is equivalent for words and pseudowords. This conclusion is based upon the finding of equivalent slopes of the functions relating mean response times to number of display letters for words and pseudowords. According to the model, these slopes are estimates of the letter comparison times, and their equivalence for words and pseudowords indicate that the comparison process is the same for both types of displays.

The model can be summarized by representing the processes that occur between display onset and response output as a series of independent stages (see Sternberg, 1975). These include display encoding, letter comparison, response decision, and response execution. The overall mean response time is assumed to be equal to the sum of the mean execution times for each of the stages. Note that we are assuming that the comparison stage is the only one affected by the number of display letters. Although we could assume that the encoding process takes longer when a larger number of letters is present in the display, we then would have expected different results. Any process that changes as a function of display size should result in changes in the slope of the function relating response time to the number of display letters. If words tend to be perceived as units and pseudowords as several spelling patterns or individual letters, and if encoding time depends on the number of units being recognized, then the slope should have been less for words than for pseudoword displays. This was not the case in the Gilford and Juola data, and our assumption that encoding time is a constant for from one to about five unrelated letters presented foveally is supported by other arguments (Massaro, 1975; Shiffrin & Gardner, 1972).

In the next section we describe the results of a visual search experiment that was designed to answer several questions. First, the model described above was to be tested using word, pseudoword, and nonword displays. By sampling a wide range of materials that vary in their structural similarity to words as well as in their familiarity, we can more adequately test the inference and unitization theories of word perception. We can also more closely assess whether recognition or visual scanning processes are affected by these variables. Second, these methods were extended to the study of visual search in children at different ages and levels of reading instruction. This allowed us to determine the effects of learning to read on perceptual encoding and letter comparison processes. The aim is to gain more evidence for how words are perceived and how changes that accompany learning to read affect visual processing capabilities and strategies.

A Developmental Study of Visual Search

There are several published studies of visual search performance in children. For example, Krueger, Keen, and Rublevich (1974) compared letter search performance in college students and fourth grade children using displays of six-letter words, pseudowords, and nonwords. Although the adults were about twice as fast overall as the children subjects, both groups showed about the same amount of facilitation for words over pseudowords (about 3%) and for words over nonwords (about 9%). Krueger et al. also found that children with better reading skills tended to search faster, but that reading ability was not related to the relative differences between words, pseudowords, and nonwords. In a similar study, Katz and Wicklund (1972) presented single-letter targets and visual displays of one, two, or four unrelated letters to second and sixth-grade children. They reported that overall search time as well as the increase in search time across display size were both greater for second-grade than for sixth-grade children. They reported no reading-ability effects on search performance and concluded (as Perfetti and Lesgold, this volume, have for adult subjects) that reading ability is related only to visual information processing skills that exceed the span of apprehension.

Our research was designed to extend these results by covarying display size and display regularity within subjects. This procedure should allow us to localize the processing stage or stages affected by differences between words, pseudowords, and nonwords. We also recognize the necessity to investigate word processing skills in younger children, in order to study the changes that occur in word perception as children learn to read. Finally, we want to examine more closely the relationship between reading ability and visual search performance.

Our experiment was carried out using identical sets of materials and procedures for groups of college students, fourth grade, second grade, and kindergarten children. Each group contained 20 individual subjects who were run in two or three separate sessions. The task sequence consisted of a 1.5 second presentation of a single target letter followed by a visual masking field for .5 seconds which was followed by a 3-,4-,or 5-letter display. The display contained the target letter on half the trials. The subjects indicated whether the target was present or absent in the display by pressing either of two response buttons. Both speed and accuracy of responses were emphasized in the instructions. All subjects were run for 270 trials involving one trial for each of the stimuli shown in Table 1.

Insert Table 1 about here

The stimuli were selected from Kučera and Francis (1967) such that (a) all words were among the most frequently-occurring words in English (averaging about 275 occurrences per million words), (b) mean frequency was approximately equated across 3-,4-,and 5-letter words, (c) all words contained one syllable, and (d) no letters were repeated within any word. The pseudowords and nonwords were formed by making pronounceable and unpronounceable anagrams of the words, although for about 11% of the stimuli a single letter in the word had to be changed in order to form an acceptable pseudoword or nonword anagram. The orthographic regularity and pronounceability of the pseudowords was affirmed (and necessary changes made) by five independent judges. They also certified the general unpronounceability of the irregular nonwords.

The stimuli were typed in lower case letters and photoenlarged so that they could be seen clearly and in about their normal reading size when presented in a tachistoscope. (A five-letter word subtended a horizontal visual angle of about 1.5 degrees.) The assignments of target letters to the stimuli were made for two different stimulus sets such that each display was used equally often on positive and negative trials within each group of subjects, and, on positive trials, the target letter appeared about equally often in each serial position of the display. The college student subjects were volunteers who participated in the experiment for course credit in an introductory psychology course at the University of Kansas. The children were recruited from local public schools. At the end of two or three experimental sessions the children were tested with the oral reading part of the Wide Range Achievement Test (WRAT) and were paid $3.00 for their participation.

The results will be presented in two parts, the first is concerned with the overall visual search data and the second is concerned with the effects of display type. Figure 1 presents mean response times for positive and negative responses separately for each group of subjects. Both overall search time and search speed (as measured by the slopes of the best-fitting lines) decrease with age. Further, there is an apparent shift in processing strategy from kindergarten subjects to older subjects. Whereas the slopes of the functions for positive and negative responses are about equal for adults (being about 25 milliseconds per letter and 28 milliseconds per letter, respectively), the positive slope for kindergarten children (172 milliseconds per letter) is about half the negative slope (331 milliseconds per letter). The two-to-one ratio of negative to positive slopes is what would be expected if a self-terminating search process were used. In this case, on the average positive trial only about half of the display letters would need to be scanned before the target would be found and the process terminated. The relatively slow search rate of kindergarten subjects is also consistent with a search strategy based on auditory codes. That is, it is possible that the kindergarten subjects successively named each display letter and made a positive response as soon as this name matched that of the target letter. The results for children in the second and fourth grades were more consistent with the adult data. For these subjects, the comparison process can be more adequately described as a rapid, exhaustive scan of the target letter against all of the display letters before a response is made.

Insert Figure 1 about here

The data in Figure 1 combine mean response times for words, pseudowords, and nonwords. The effects of display type did not interact with the number of display letters. That is, the results replicated and extended our earlier findings (Gilford & Juola, 1976) indicating that the search process is the same for words, regular pseudowords, and irregular nonwords. We conclude that this search process is based on a visual image of the display that does not vary in quality for the various types of letter strings. There were significant differences between the overall response times for the three display types, but these effects did not interact with response type nor with the number of display letters. Therefore, the data were collapsed across all variables except for display type and age, and these results are shown in Table 2.

Insert Table 2 about here

Again, as can be seen in Table 2, the pattern of results obtained for kindergarten subjects was different from that obtained for the other groups of subjects. No significant differences among the mean response times for words, pseudowords, and nonwords were found for kindergarten children. All other groups showed the same ordering of response times with words resulting in faster responses than pseudowords which in turn produced faster response than nonwords. Although the main effect of display type was statistically significant for second grade, fourth grade, and college subjects, the word-pseudoword difference was not significant within any group.

These results stand in apparent contrast to those reported by Gilford and Juola (1976) in which a reliable 40-millisecond advantage for words over pseudowords was found. They used a search task involving similar materials and procedures with two exceptions: (a) The displays were 50% smaller than those used in the present study. The smaller displays were somewhat more difficult to see, and if individual letters had been presented they would have been recognizable only by subjects with normal or better acuity. (b) Only words and pseudowords were presented, thus words occurred on 50% of the trials, versus 33% in the present study. Either or both of these factors could have reduced the magnitude of the word advantage in the data reported in Table 2 by lessening the subjects' reliance on a whole-word processing strategy (see also Aderman & Smith, 1971; Juola, Taylor, & Choe, in press; Manelis, 1974).

The mean error rates across all conditions decreased with age, from 9.9% for kindergarten children to 5.7%, 3.3%, and 2.6% for second grade, fourth grade, and college students, respectively. Although the error percentages showed a slight increase as the number of display letters increase, the type of display (word, pseudoword, or nonword) had no significant effect on the error rate. These results allow the response time data to be interpreted directly, without attempting to account for speed-accuracy tradeoffs within any group of subjects.

Finally, there were no consistent relationships between reading ability as measured by the WRAT and any of the results reported here. A few reliable correlations were found between reading level and overall response time, scanning rate, and word-pseudoword-nonword differences, but the pattern of results was inconsistent across grade levels. Unless we can find another measure of reading skill that leads to a reliable pattern of results, we will be forced to agree with Krueger et al. (1974) and Katz and Wicklund (1972) that word processing skills as measured in visual search tasks are not closely related to reading ability.

Summary and Conclusions

The fact that words are more perceptible than strings of unrelated letters has been demonstrated in many experiments (see reviews by Henderson, in press; Huey, 1908; Juola, Taylor, & Choe, in press; Smith & Spoehr, 1974). Word superiority effects in perception have been interpreted within two theoretical frameworks. One theory assumes that letters are the primary units of recognition, and inferences based on orthographic knowledge enable word and wordlike letter strings to be recognized more efficiently than strings that violate rules of English orthography. A second theory assumes that frequently-occurring letter clusters such as spelling patterns and common words are learned as perceptual units through reading experience. These higher-order units are then capable of being recognized directly from their primitive visual features, without necessitating prior letter identification. Although several recent experiments have been specifically designed to settle the inference versus unitization issue (e.g., Juola, Choe, & Leavitt, 1974; Smith & Haviland, 1972; Thompson & Massaro, 1973), it is unlikely that we will be able to eliminate one or the other of these theories given our present methods. A major difficulty lies in developing a measure of regularity for orthographic structure along which both words and pseudowords can be scaled. In the absence of an adequate measure, word advantages over pseudowords in perception experiments can be accounted for by either theory.

With these theoretical problems in mind, we decided to study the development of word superiority effects by using a letter search task. Finding a given target letter in a visual display containing several letters is a task which can be performed by children who have not yet learned to read. By examining search performance in children in several primary grades, we hoped to learn about changes in visual information processing capabilities that accompany learning to read. If word superiority effects in perception develop due to learning orthographic rules or to internalizing spelling pattern and larger units, then teaching methods could be designed to facilitate the acquisition and use of perceptual strategies typically employed by children in recognizing words.

Our results have shown that children at least as young as those in the second grade can use their knowledge about English words to speed visual search performance. That is, decisions about whether or not a given target letter is present in a three- to five-letter display were made more rapidly for words and orthogrpahically regular pseudowords than for irregular nonwords. The advantage for words and pseudowords over nonwords appears to be localized in recognition processes, since search rates did not differ for the three types of displays. The lack of a significant difference between performance for words and pseudowords would seem to indicate that either inference based on knowledge of English orthography or the use of spelling patterns as perceptual units is the key to the word identification process.

Our results have also shown that major changes in visual search performance accompany learning to read during the first years in which the skill is acquired. In contrast to the second grade and older subject groups, whose search data are more similar than different, the kindergarten children show an entirely different pattern of results. First, their search rates were much slower than those for older children and adults, and could conceivably have been based on auditory encodings of the letters rather than on visual codes. Second, the search process for kindergarten children terminated with the finding of a match with the target letter, whereas subjects in all other groups were apparently more likely to use an exhaustive scanning process. Finally, the kindergarten subjects showed no differences between word, pseudoword, and nonword displays, indicating that they were all processed in an identical letter-by-letter fashion. In contrast, second and fourth grade children and adults showed similar effects for displays with regular spelling patterns versus those that were irregular. That is, all subjects except for those in the kindergarten group responded more rapidly when words or pseudowords were presented than when nonwords were displayed. We conclude that these differences between kindergarten children and those in the second grade and beyond are not due as much to maturation and general learning experience as to specific skills acquired during reading and reading instruction.

The lack of any correlation between reading level and visual search performance is somewhat surprising to us despite the equivocal evidence presented earlier (Katz & Wicklund, 1972; Krueger, Keen, & Rublevich, 1974; Perfetti & Lesgold, this volume). We are not ready to give up on this issue, however, as major changes in visual search performance appear to occur quite rapidly; our data show no effects of orthographic regularity in kindergarten children, yet the complete pattern of results observable in the adult data was also obtained for second grade children. We believe that a closer investigation of the relationship between reading ability and visual search performance should be made at the first grade level--when changes in visual scanning strategies and the use of redundancy in English words should first occur. This approach should be fruitful in using visual search tasks to measure changes in perceptual processes that parallel developments in reading ability.

Finally, we are in general agreement with Venezky and Massaro's (this volume) discussion of the best-kept secret in reading instruction. Phonics training apparently has more long-range benefits than the development of decoding skills. Researchers from Huey (1908) to Kleiman (1975) have argued that as reading skills increase, reliance on phonemic encoding plays a lesser role in word recognition, and the process becomes more dependent on purely visual codes. This is not to deny that phonics training is important as an aid in decoding when visual recognition fails. We also recognize the fact that phonemic or more general auditory codes are important in reading in order to retain and comprehend the information gained from several eye fixations (as Huey and Kleiman have also claimed). Nevertheless, the route to rapid word identification and skilled reading depends on the development of visual processing skills that make use of orthographic regularities or the direct recognition of frequently-occurring letter clusters and words. If this is the major skill unique to reading that is to be learned, then perhaps phonics training should specifically include emphasis on the regularities in English orthography. The materials normally used to teach decoding could then be designed to facilitate acquisition of rapid word recognition skills that are important in reading for comprehension.

Footnotes

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Table 1

List of stimulus materials used in the visual search experiment

WORDS

Three Letter	Four Letter	Five Letter
act	best	board
air	born	break
ask	both	chief
big	come	claim
bit	fear	clear
boy	game	earth
car	girl	faith
cut	gone	field
far	head	forms
few	heat	great
gas	hour	heard
gun	just	horse
hit	king	house
hot	lead	large
how	left	month
job	line	night
key	near	plant
led	pain	quite
low	rate	short
men	rest	shown
nor	rise	sight
old	road	sound
put	shot	south
red	sort	speak

Table 1 (continued)

WORDS

Three Letters	Four Letters	Five Letters
run	step	stage
sat	take	think
sea	town	third
son	true	those
sun	turn	trade
two	west	young

Table 1 (continued)

PSEUDOWORDS

Three Letter	Four Letter	Five Letter
tac	steb	droab
ain	bron	kreab
sak	thob	fiche
gib	moce	chaim
tib	rafe	crale
yob	meag	thare
rac	gril	thaif
tuc	noge	flide
raf	hade	morfs
wef	tane	trage
gos	bour	hearb
nug	pust	harse
dit	gink	bouse
oth	dael	grale
woh	flet	nomth
pob	lein	ginth
yek	rane	glant
eld	naip	tique
wol	taer	trosh
nem	ster	whons
orn	sier	thigs
lod	doar	douns
tup	tosh	nouth
der	tors	skape

Table 1 (continued)

PSEUDOWORDS

Three Letter	Four Letter	Five Letter
nur	spet	geast
tas	tade	thonk
ase	nowt	drith
nos	rute	sothe
nus	trun	drate
wot	mest	yourg

Table 1 (continued)

NONWORDS

Three Letter	Four Letter	Five Letter
tca	tbcs	rbdoa
arw	bnor	krbea
ksa	btoh	dfeih
iug	mcoe	lcmia
itb	rfea	liaec
ymb	gmea	htrae
rco	rlig	tfiah
ctu	ngeo	dleif
rfa	hdea	sfmor
wfe	htea	rtaeg
sga	hrou	rdhea
ugn	jtus	hrsoe
hti	ngki	hseou
hto	dlea	rgeal
hwo	ftel	tnomh
bjo	lnei	tgihn
kse	nrea	tpaln
lde	aipn	qteiu
wlo	rtca	rsoht
cim	rtcs	mwohs
nro	rsic	htigs
ldo	rdoa	dsuon
ptu	htos	htsuo
rde	otsr	ksacp

Table 1 (continued)

NONWORDS

Three Letter	Four Letter	Five Letter
nru	tpes	gsact
tsa	tkea	tknih
csa	mwot	hdtir
nso	uetr	htsoe
nsu	ntur	tdaer
wto	wtes	ngyou

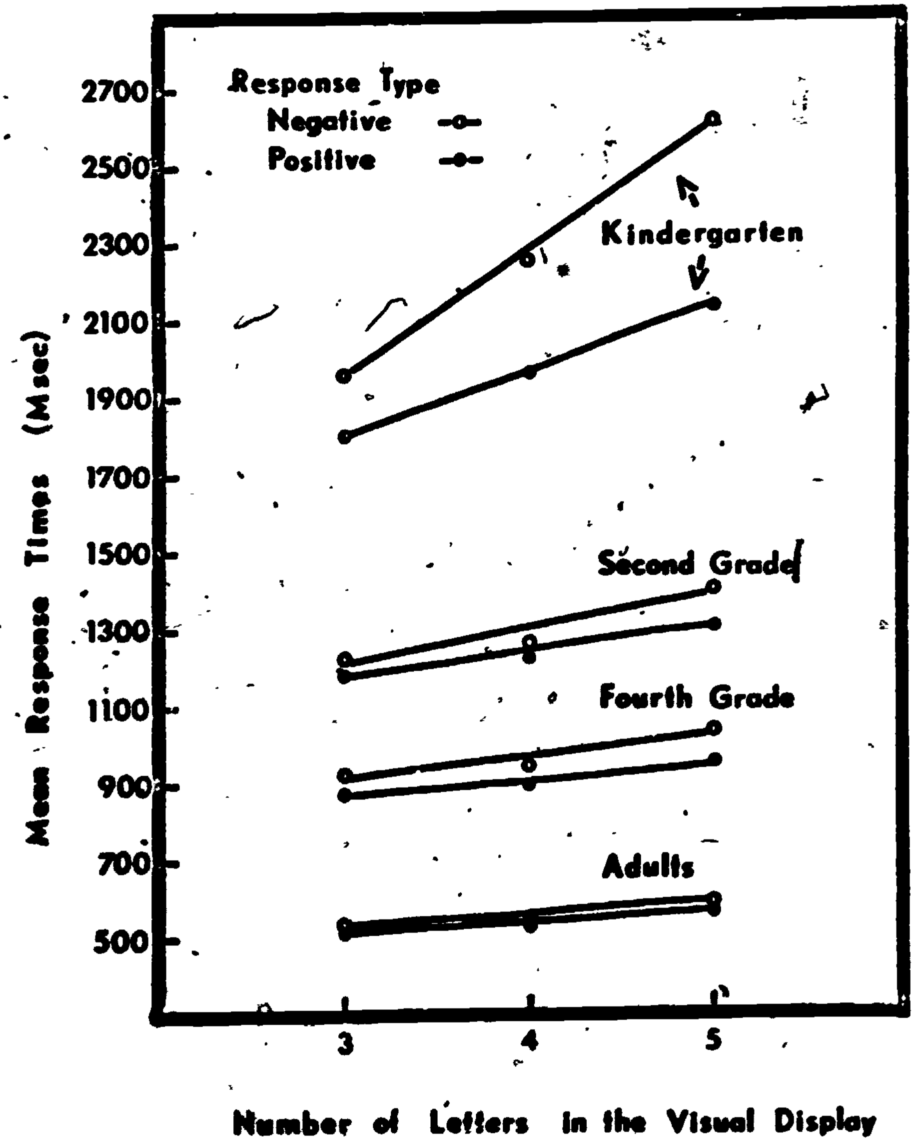
Table 2

Mean response times (in milliseconds) for letter search in visual displays of words, pseudowords, and nonwords

	Display Type		
	Words	Pseudowords	Nonwords
College Students	543	553	568
Fourth Grade Students	933	945	967
Second Grade Students	1,258	1,266	1,301
Kindergarten Students	2,128	2,112	2,104

Figure Caption

Figure 1. Mean response times for positive and negative responses plotted as functions of the number of display letters for kindergarten, second grade, fourth grade, and college students.


Response Type
Negative
Positive
Kindergarten
Second Grade
Fourth Grade
Adults
Mean Response Times (Msec)
2700
2500
2300
2100
1900
1700
1500
1300
1100
900
700
500
3
4
5
Number of Letters in the Visual Display

References

Aderman, D., & Smith, E. E. Expectancy as a determinant of functional units in perceptual recognition. Cognitive Psychology, 1971, 2, 117-129.

Atkinson, R. C., Holmgren, J. E., & Juola, J. F. Processing time as influenced by the number of elements in a visual display. Perception and Psychophysics, 1969, 6, 321-326.

Baron, J., & Thurston, I. An analysis of the word superiority effect. Cognitive Psychology, 1973, 4, 207-228.

Bjork, E. L., & Estes, W. K. Letter identification in relation to linguistic context and masking conditions. Memory and Cognition, 1973, 1, 217-223.

Chall, J. S. Learning to read: The great debate. New York: McGraw-Hill, 1967.

Chall, J. S. The great debate ten years later. This volume.

Estes, W. K. Memory, perception, and decision in letter identification. In R. L. Solso (Ed.), Information processing and cognition: The Loyola Symposium. Potomac, Md.: Erlbaum Associates, 1975.

Estes, W. K., Bjork, E. L., & Skaar, E. Detection of single letters and letters in words with changing vs. unchanging mask characters. Bulletin of the Psychonomic Society, 1974, 3, 201-203.

Gilford, R. M., & Juola, J. F. Familiarity effects on memory search and visual search. Bulletin of the Psychonomic Society, 1976, 7, 142-144.

Henderson, L. Word recognition. In N. S. Sutherland (Ed.), Tutorial essays in experimental psychology. Potomac, Md.: Erlbaum Associates, in press.

Huey, E. B. The psychology and pedagogy of reading. New York: Macmillan, 1908. Reprinted Cambridge, Mass.: MIT Press, 1968.

Juola, J. F., Choe, C. S., & Leavitt, D. D. A reanalysis of the word superiority effect. Paper presented at the meeting of the Psychonomic Society, Boston, 1974.

Juola, J. F., Leavitt, D. D., & Choe, C. S. Letter identification in word, nonword, and single letter displays. Bulletin of the Psychonomic Society, 1974, 4, 278-280.

Juola, J. F., Taylor, G. A., & Choe, C. S. Perceptual processes in reading and word recognition. In A. Whinston and K. Fu (Eds.), Proceedings of the NATO advanced study institute on pattern recognition. Leiden: A. W. Sijthoff, 1976.

Katz, L., & Wicklund, D. A. Letter scanning rate for good and poor readers in grades two and six. Journal of Educational Psychology, 1972, 63, 363-367.

Kleiman, G. M. Speech recoding in reading. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 323-339.

Krueger, L. E. Search time in a redundant visual display. Journal of Experimental Psychology, 1970, 83, 391-399(a).

Krueger, L. E. Visual comparison in a redundant display. Cognitive Psychology, 1970, 1, 341-357(b).

Krueger, L. E., Keen, R. H., & Rublevich, B. Letter search through words and nonwords by adults and fourth-grade children. Journal of Experimental Psychology, 1974, 102, 845-849.

Kučera, H., & Francis, W. N. Computational analysis of present-day American English. Providence, R. I.: Brown University Press, 1967.

LaBerge, D., & Samuels, S. J. Toward a theory of automatic information processing in reading. Cognitive Psychology, 1974, 6, 293-323.

Manelis, L. The effect of meaningfulness in tachistoscopic word recognition. Perception and Psychophysics, 1974, 16, 182-192.

Massaro, D. W. Perception of letters, words, and nonwords. Journal of Experimental Psychology, 1973, 100, 349-353.

Massaro, D. W. Experimental psychology and information processing. Chicago: Rand McNally, 1975.

Neisser, U. Decision-time without reaction-time: Experiments in visual scanning. American Journal of Psychology, 1963, 76, 376-385.

Neisser, U. Cognitive psychology. Englewood Cliffs, N. J.: Prentice-Hall, 1967.

Perfetti, C., & Lesgold, A. Coding and comprehension in skilled reading. This volume.

Reicher, G. M. Perceptual recognition as a function of meaningfulness of stimulus material. Journal of Experimental Psychology, 1969, 81, 275-280.

Shiffrin, R. M., & Gardner, G. T. Visual processing capacity and attentional control. Journal of Experimental Psychology, 1972, 93, 72-82.

Smith, E. E., & Haviland, S. E. Why words are perceived more accurately than nonwords: Inference vs. unitization. Journal of Experimental Psychology, 1972, 92, 59-64.

Smith, E. E., & Spoehr, K. T. The perception of printed English: A theoretical perspective. In Kantowitz, B. H. (Ed.), Human information processing: Tutorials in performance and cognition. Potomac, Md.: Erlbaum Associates, 1974.

Smith, F. Understanding reading. New York: Holt, Rinehart & Winston, 1971.

Sternberg, S. High-speed scanning in human memory. Science, 1966, 153, 652-654.

Sternberg, S. Memory scanning: New findings and current controversies. Quarterly Journal of Experimental Psychology, 1975, 27, 1-32.

Taylor, G. A., Miller, T. J., & Juola, J. F. Isolating the units of word perception. Paper presented at the meeting of the Psychonomic Society, Denver, Colorado, 1975.

Thompson, M. C., & Massaro, D. W. Visual information and redundancy in reading. Journal of Experimental Psychology, 1973, 98, 49-54.

Townsend, J. T., & Roos, R. N. Search reaction time for single targets in multiletter stimuli with brief visual displays. Memory and Cognition, 1973, 1, 319-332.

Venezky, R. L., & Massaro, D. W. History's best-kept secret about reading. This volume.

May 21--P.M.

OPEN DISCUSSION OF JUOLA PRESENTATION

CLAY: Do you have any information on the letter knowledge skills of the kindergarten children? Had they already acquired letter knowledge?

JUOLA: We gave them all the Wide Range Achievement Test. In fact, all of the kindergarten children in our sample were able to name the letters, and I think their mean reading level score on the Wide Range Achievement Test was 1.5. That might be a problem in our sample.

We are saying that second-grade children show as much use of orthographic redundancy, or use of familiar larger units as adults. Our second-grade children test at about the fourth-grade level of reading. So we have all the more reason to use these procedures to work with first-grade, beginning reading children. In fact, we are doing that; we just haven't completed our research.

CLAY: In New Zealand, children go straight into reading words in context, learning their letters in context, so we did find this kindergarten/first-grade difference you would expect to find; however, on my test materials of kindergarten children in the States, I find that they have this letter knowledge before they start the other visual scanning learning.

E. SMITH: You said that the data for the kindergarten kids suggest that they may be using some kind of phonetic or acoustic representation. Have you examined the errors they make? When you give them a target letter that is not contained in the display, for example, are they more likely to say Yes, when the target letter is acoustically similar to something that is in the display?

JUOLA: We do have the trial stimuli and errors, but we haven't analyzed them yet.

I stated that it looked as if auditory comparisons could be going on, due to the fact that the kids are processing displays at about three letters per second. The evidence for auditory comparisons is based on estimates of rates of implicit speech generated in questionable experiments with adults, so I really don't have any outside evidence to support the claim that comparisons could be auditory for kindergarten children and visual for older children. I am certainly comfortable with that interpretation, however.

DANKS: Do you have any explanation for the large difference in the y-intercept for the kindergarten children? They are going to cross at two, and extrapolating down to zero, the negative intercept will be less than the positive.

JUOLA: That is not true. The negative intercept is going to be less than the positive intercept for the kindergarten children, whereas for all other people, if I extrapolated that function, you would find that the intercepts for positive and negative trials would be about the same.

DANKS: Do you have any explanation for that rather large difference?

JUOLA: If you look at the equations for self-terminating versus exhaustive scanning models, you see that some part of the comparison time does go into the positive intercept in the self-terminating model, and it does not in the exhaustive scanning model.

VENEZKY: Jim, how would you account--in the model you are talking about, Ed's model, or anybody else's information-processing model--for what goes on when the alternatives are fixed; that is, in the case where you wipe out the record?

JUOLA: I imagine that when the alternatives are not fixed, you are trying to process the information with respect to existing categories in memory; that is, the categories for letters, spelling patterns, and whole words. If I fix the set of letter alternatives for you and use them for 10, 20, or 30 trials, it might be more efficient to set up new categories specifically for this experiment--categories that depend on only a small number of features--in order to make the critical distinction. It might be more efficient, for example, to say I am going to look for a crossbar in order to distinguish an A from a C. I will only have to detect that single feature to make a distinction between an A and a C; I won't have to process other features that might be involved in deciding whether or not this letter belongs to an existing category in memory. I would say that an effective strategy, when the letter categories are fixed, would be to set up new partial, limited categories, that could be better matched to feature representation than could existing categories of the larger list.

VENEZKY: Do you hypothesize, then, that the matching process could terminate prior to the time the actual letter was identified?

JUOLA: Yes. Essentially, that is why that strategy would be more efficient than one in which you identified the letter and decided whether or not it was the letter you were looking for.

VENEZKY: Could you test that hypothesis by varying the similarity between the two alternatives?

JUOLA: Absolutely. In fact, the data that I showed suggest that. In one case, the alternatives changed from trial to trial; in the other, we held the alternatives constant.

VENEZKY: No, I don't mean that way. Let's say hold them constant, but vary the alternatives.

JUOLA: I want to go back to the earlier experiment, where we showed word advantages when the letter alternatives changed from trial to trial, and no word advantages when alternatives were fixed. We also looked at the similarity of the letter alternatives and found no effect of similarity when the alternatives changed from trial to trial. When the alternatives were fixed, however, we found a very large similarity effect, which would be consistent with that idea.

If you set up feature lists specific to the letter alternatives you are looking for, you would probably have to sample more features to distinguish the similar alternatives from the dissimilar ones. Massaro also reports similarity effects in a task where the alternatives are fixed, and no similarity effects where the alternatives vary.

VENEZKY: That's really remarkable. Think what a low level of control that implies. Something continually bothers me about exhaustive search in the target match. What would happen if the letter string came first and was followed immediately by your target letter?

JUOLA: Do you mean a Sternberg search task?

VENEZKY: Because a resolution can take place first, you eliminate the resolution process, so what gives you the appearance of an exhaustive search? You still think you would end up with curves that would show the amount of search?

JUOLA: I think you are describing the Sternberg search task and an exhaustive scanning process. It sounds counterintuitive; why would a search process continue after a match is found? According to Sternberg, if a search process is faster than a process in which you have to decide whether or not a match is obtained, it is usually more efficient to complete the search process than it is to check for a match after each comparison.

VENEZKY: I suppose the serial position data should confirm this in some way.

JUOLA: Yes.

VENEZKY: Given, though, that there has to be some complexities.

JUOLA: I hope to have the serial position data in the final version of the paper; we don't have them yet.

CALFEE: You showed a graph of slopes for the last study, and you noted that the ratio for the kindergarten children was two-to-one and that the other ratios were not significantly different. What were the ratios, though? My eye picked up some.

JUOLA: They are all bounded between two-to-one and one-to-one, but none of them are perfect. The kindergarten ratio is almost exactly two-to-one. We are averaging across 270 trials, over 2 days for 20 subjects. It is conceivable that we have a few people using one strategy and a lot of people using another strategy.

CALFEE: Suppose that instead of looking at data and testing the hypothesis, you look for the relative support in your data for the hypothesis that it's a two-to-one ratio for all groups, as opposed to a one-to-one ratio for the groups. My eye suggests that the two-to-one ratio might get more support.

JUOLA: For adults the negative slope is 28 msec; the positive slope, 25 msec. That's almost a perfect replication of a study we did at Stanford in 1969, using consonant letter displays. The ratios are very close to one-to-one for adults, and the ratio increases as you go to younger and younger kids, until it's almost exactly two-to-one for kindergarten children.

CALFEE: Is it changing?

JUOLA: Yes, the ratio is getting larger as you work with younger and younger children. Again, I will be looking to see if that's a strategy-type effect; if we do have "self-terminating" children versus "exhaustive scanning" children.

E. SMITH: When Sternberg originally proposed his search task, he argued that when you get exhaustive search, it is likely to be extremely efficient, more efficient than self-terminating search. That fits beautifully with your data. With the kindergarten kids, you only get evidence for self-terminating search when it is slow.

JUOLA: When I ran an experiment at Stanford, I asked each subject, in the debriefing sessions, exactly what he or she was doing. One subject described exactly the two alternatives, the self-terminating search and the exhaustive search. She said, "I use the exhaustive search, because it's faster and easier."

JACKSON: As I sit through this, I am able to conceptualize why there is such a gap between research and practice. If I were a first-grade or kindergarten teacher, I would have a great deal of difficulty understanding what this discussion means in terms of what I am supposed to do with group 1 tomorrow morning. I think it relates to things that Frank Smith talked about yesterday. Maybe we do need to consider the relationship between the researcher and the practitioner. Is there a direct relationship or is there a dichotomy? Are they separate?

JUOLA: I am entirely sympathetic with that statement.

RESNICK: It may be useful to point out that some of these studies will have their greatest value not in telling us what to teach or how to teach, but in describing what happens as children learn to read; in describing the growing attempts to look at changes in word recognition and eventually sentence processing. The next step is to look at those developmental changes in the context of known instructional situations. Different methods of instruction ought to produce, or might produce, different kinds of changes over time; that is, different routes to becoming skilled readers.

So one part of what is going on here is the examination of the effects of instruction rather than the formulation of prescriptions for instructing. The likelihood that something important is happening between kindergarten and second grade to help children acquire at least the fundamentals of learning to read is part of what this is about.

CLAY: I want to respond to Shirley. I asked Isabelle Liberman about development in the visual area rather than in the phonemic segmentation area. I said that if you are going to quote Elkonin, then you might go to some of the Russian developmental psychologists, who have looked at visual scanning developmentally. Isabelle said, "No, kids learn their letters easily."

I am sure many of the disadvantaged children have to go through developmental stages in order to achieve letter identification. I am delighted to hear the emphasis today on the developmental aspects of visual search, which is helpful once children get into more complex components of reading. I agree entirely with the notion that because you put so much emphasis on sound, visual analysis has been almost completely overlooked. I have been working with teachers to help them understand some of this development in the visual area. I think this is very important for the practicing teacher; there is a communication here to be dealt in.

JACKSON: All I am saying is that there isn't that broker relationship, between practitioner and researcher, in the conference.

RESNICK: It takes a little bit of thinking time. It's not a quick turnaround response that does that brokering. That's part of the reason for the several layers of discussants, the immediate discussion that we are having now, the formal discussants tomorrow morning and afternoon, who have had a chance to read the papers and reflect on them, and then that set of four integrative papers. It is a crucial question, and I don't think either my comments or Marie's were attempts to avoid it. We were only trying to suggest some of the ways in which things that may not look directly relevant--and, in fact, don't tell you what to do tomorrow--are part of the effort we need to understand how children can learn to read and, therefore, how we can help them.

E. SMITH: I want to respond to Shirley, too. I agree with you, I think there is a very noticeable gap. I think we should draw a distinction between the theory of reading and the theory of instruction. The talks you heard by Jim, Glenn, and me are exclusively concerned with the theory of reading, but we were asked to see if what we said has any implications for a theory of instruction. While one would naturally guess that a theory of instruction will be related to a theory of reading, I think it is a mistake to think it will be the same theory. Perhaps that's what caused some of us to be thinking we should be talking the exact same lingo, and we are not. You can find plenty of examples of this in other fields. I don't think it is anything to worry about. There is a great difference between the theory of biology and medical practice, and this runs through science completely, and has to.

JACKSON: I agree with that. That's the reason I brought up the comments Frank made yesterday about the dichotomy. I have not seen a focus on the dichotomy, if there is one, between research theory and practice.

VENEZKY: I don't think you should accept what Lauren and Marie said to you. I think you have to accept the kind of research that's talked about here as fundamental research, motivated strictly by a desire to understand how humans carry on a certain process. If, in fact, you are going to [redacted] muffling, and say, "Oh, it might relate this way or that," then your strategy should be to identify real problems in the classroom and go back to research to help you resolve what to do about those problems.

This work is not motivated by problems. We don't really know that there are many problems involved in word recognition, and it may turn out that word recognition is a silly place to think about getting further improvement.

As a scientist, one has to buy the notion that there is a need to understand and that out of that kind of understanding, one can, over time, gain a better sense of security, as he attacks different areas, to those in which he is working. Bell Telephone research laboratory has exactly that attitude. They literally turn their better researchers loose on anything they want, on the assumption that any basic understanding in math, electronics, or computing, because of the fundament understanding it brings, will pay off for Bell, eventually. Bell nvented the transitor, and although there was something like a 15-year gap before the first piece of Bell equipment ever used a transistor, they went right on developing it and trying to find ways to make it better.

I don't think that it's fair for those of us who are interested in basic research to be forced to pretend that we are doing this, because we see this wonderful relationship between our work and reading. As I said before, the minute we start saying that, we make ourselves responsible for identifying real problems and working the other way. I think we get into tremendous problems when we start trying to draw these tenuous relationships. There is a world of difference between fundamental research and what you do in the classroom. I don't think what Frank Smith says comes to that at all. Frank is simply replacing one kind of theory with another, and neither relates to instruction, whether you go to so-called inside-out or outside-in. It's a false dichotomy, also. Everything that is given here that is outside-in has to be a component of any inside-out work. There is no way, in reality, to deal with reading without dealing with the reality of stimuli coming in. In fact, I will show tomorrow precisely how some people build the inside-out component into recognition models.

F. SMITH: It is really unreasonable to expect research by people like Jim and Dave and some of my earlier work to solve problems in the classroom. These are some of the kinds of things I was addressing myself to yesterday. People are working in different domains, and you have to let people who are doing the word recognition studies get on with basic research. You can't ask them to use what they know to resolve schoolroom problems. I think that is one of the aims of this conference, and it's one of the things I wanted to question yesterday.

On the other hand, people who are familiar with classrooms have to try to make sense of what these researchers have to say in light of the way they perceive the problems. In other words, the two endeavors have to be brought together, to the extent they can be, but we shouldn't expect much of an overlap. Although there will be a few occasional interfaces, you can't expect the person with the least knowledge—in this case, the researcher—to solve the problem in the larger area, the school. You wouldn't expect the researcher to go to somebody in the school and say, "Look, I have this whole theoretical problem here, solve it for me, because you are working with kids who are learning to read." These are two entirely different domains. And what is wrong here is the expectation that the researchers ought to be able to bridge the gap.

My second point is that Jim is not giving us a theory of reading. It's a theory of word-recognition, a rather limited theory of word recognition at that. That's fine; we ought to encourage this position. But there are a lot of other things going on in reading. Word-recognition certainly isn't all of reading. On some occasions that may, indeed, be very little of reading.

WHITE: I want to play with Shirley's question a little bit. One question she was asking, apart from asking for a definition of basic research, was: "Why am I sitting here listening to this?" Apart from the fact at basic research goes its way, education goes its way, and the theory of human word reception is not a theory of instruction, her question can be taken at a simple level. She is really saying, "Okay, here is a guy who is telling me some stuff, and what am I supposed to make out of it?" Suppose we take the question down from the highest apologetics and dress it in another way. The basic assumption of this conference is that two worlds are going to meet, so I think it is legitimate for somebody to try to project a path by which those two worlds will come together, unless we want to treat this as one of those exercises in which we all speak and then leave in an existentially closed fashion. I didn't think that the answers to Shirley's question were satisfactory.

RESNICK: Will you address that a little bit tomorrow?

WHITE: Yes, I am going to try to, but now I want to point out that the answer given wasn't really an acceptable one.

GLASER: I want to chastise Venezky and others for not accepting the responsibility for what they say in a research report. You say, "Well, we are just explaining things." On the other hand, Juola does attempt to say: "If this is the skill to be learned, then perhaps phonics training should be revised or replaced with teaching methods that emphasize regularities in English orthography." (Editors Note: This quote is from an earlier draft of the Juola paper. It does not appear in the final version).

VENEZKY: A totally irresponsible statement.

GLASER: Some intelligent teacher is going to pick up your article and say, "Gee, you know, that's interesting. As I teach my kids or as I talk to my publisher about things, that's something I am going to be sensitive to." You can call a physician totally irresponsible when he says, "Gee, you know, someone said that cholesterol has something to do with the circulation of your blood, and maybe I am going to take that seriously and say something to my patients if I read another published study like that." These are reasonably responsible statements, which some intelligent people are going to be sensitive to.

VENEZKY: The only answer that I can give to that is that I am going to make up a new paragraph at the end of every report. It's going to say something like: "Without intelligent consideration of the needs of children, the resources available to an instructor, and the capabilities of the teacher, the contents of this report can be dangerous to instruction."

GLASER: I know nothing that shouldn't be followed by such a statement.

VENEZKY: I think that everyone who is doing fundamental research should be required to do that. It would be better than these gratuitous statements we've heard here.

JACKSON: Let me quote a letter from Lauren: "I am writing to invite your attendance to a series of conferences concerned with the general problem of integrating theoretical research on reading with issues of instructional practice. Despite the profusion of research in reading, we seldom offer strong suggestions for instructional practice. And despite the large number of existing reading programs, few have been analyzed to extract the implicit theories which they represent. In thinking about how best to help in bringing about the integration, it was decided that this purpose could best be served by a series of meetings in which people holding different points of view on reading presented the evidence for their positions, and integrations based on those presentations ...." et cetera, et cetera, et cetera.

That supposedly is the focus of this conference.

VENEZKY: Shirley, I think you have to accept the fact that no relationship is set. Zero relationship is still a relationship. The time when we will see the relationship between very basic research and instructional practice is extremely distant. We should quit pretending the two are so close that we can go immediately into instruction.

JACKSON: Why aren't we saying that?

VENEZKY: Bob seems to have clear evidence that researchers have all been failing over the past two years and getting a little closer to instruction than we should.

JACKSON: Lay it out there on the table.

RESNICK: Wait a minute. You are accepting one point of view with as little behind it as the other one.

F. SMITH: Both can't say that without blowing up this building.

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ROSNER: Given the chance to vote, I would vote with Shirley. But I have to support the other argument with just two simple statements. Number one: Somewhere in that letter, you came across the phrase about the great differences that do exist between research and practice, so you are simply seeing some of the separation between the two fields. Nothing is perfect. Number two: I would bet that the best thing about your making that statement was that you made it. In a cumulative sense, that will change behavior over time.

I don't think it will be here, or at the next conference, where <u>everybody</u> will focus on the practicalities of reading instruction, but I also think it helps, for you to raise that issues. It just isn't practical to look for lucid answers from the basic scientists.

GLASER: You have to understand that basic scientists are trained to be impressed with how much they don't know. That's the only problem they are worried about: "How much don't we know?" Sometimes they get interested in how much we do know and what we might do, but that's a different attitude.

Emphasis on how much we don't know is a very pervasive attitude in psychology and in a lot of the social sciences and economics. My physics friends and biology friends are much less humble; they sometimes teel us what they know.

VENEZKY: As the Frenchman said, when he kissed the cow, "Each and every to his own."

GREGG: I think there is still an answer. We had a whole two-day conference last week, just like one of these, but much more homogeneous, because just the researchers were there. They really ought to have been able to communicate with each other, but at the end of two days, one guy got up and said, "There is a moral to the story: Life is hard."

I really think there is another answer. One of the most difficult problems that we face is trying to make that match between two different kinds of jargons, two different attitudes--as Bob has now pointed out--toward how to use knowledge once it's gained. Some of us are sitting here not even knowing how to communicate with the people that are closest to us about some of the things that we think we know.

JACKSON: I think there is a dichotomy in terms of the attitudes and positions of researchers. Some researchers feel that it's necessary to try to bridge this gap. Other researchers apparently do not feel that this is something that is even worth pursuing.

GLASER: Speaker requested that his comments be deleted.

RESNICK: I am glad the question was raised. If nothing else, in the altercation between some of the more theoretical and clearly practical presentations, we have the beginnings. The fact that you are all willing to sit and listen to each other is perhaps of some interest in itself. I know that politeness plays a great role in that, but it can't explain the whole story, because you didn't have to come.