The global and analytic view of word recognition

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18 The global and analytic view of word recognition

Don G. Bouwhuis

It may be that the distinction implied in the title of this paper is already obsolete in present-day reading education. The analytic way of reading entails the process in which all letters of the word are functional in evoking the word and its meaning. In a global way of reading the whole word, rather than its letters, would function as the mediating unit: the letters would hardly play a role. Visual properties of letter combinations, which could be called transgraphemic features, might be operating in such a case. In 1908 Huey called it a time-honoured question whether we read by letters or by words, and he added that much more is involved in reading than the settlement of this query. As it is, any sort of reading education requires some idea as to how reading proceeds, a theory of reading in order to optimize the early phases of reading. Theories of reading have never been very detailed, nor comprehensive. Thus, it comes as no surprise that approaches in reading education at one time reflect the analytic theory and at another time the global theory. Chall (1967) recorded that these periods followed each other at intervals of between 20 and 30 years. At present there are more comprehensive methods of reading education encompassing both aspects, either simultaneously or sequentially. In the Netherlands the most widely-used method of reading education is known as the structure method, combining analytic with global aspects. Only very few schools, usually in small, relatively isolated communities, are still teaching in the global way only.

From the Greek and Roman times theories of reading were analytic in nature. Reading was usually considered to be the isomorphic counterpart of writing, in which one letter was written down after the other, each one representing a part of the sound of the word. There was also the subjective impression that the eye was moving smoothly over the lines of text during reading, taking out each letter sequentially in reconstructing the word and its sound. These notions are primitive in the light of what we know now about information-processing during reading, but insight into the perceptual processes going on during reading only proceeded very gradually.

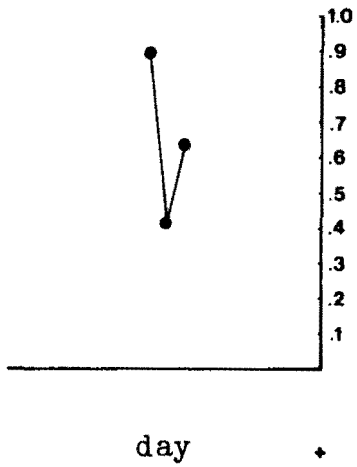
History of reading research

In 1867 the Paris ophthalmologist Javal (1938) discovered that the eyes move in jumps over the lines to be read, rather than proceeding smoothly as had been thought previously. These jumps, *saccades* as Javal called them, are not limited to reading at all, but characterize all our looking behaviour.

In reading the average jump will take 25 milliseconds (ms) while the ensuing fixation pause averages 200 ms, but is quite variable. The size of the *saccade*, or the extent of the jump, is variable as well but the average is 8 letters of normal text at normal reading distance. Both early work (Huey 1908) as well as recent research (Lévy-Schoen and O'Regan 1979) on eye movements show that they are to a great extent autonomous and independent of the linguistic properties of the text. This appears from the observation that most words are not directly looked at and some words are not even fixated. In general the fixation spots are randomly distributed over the letters of the words and may even land on spaces between them.

It was soon established by the research workers that this strongly influenced the way in which words are seen during reading, owing to elementary properties of the human visual system.

Figure 1 Probability of perceiving each one of the three letters of the word 'day' when it is presented left of the fixation point (+) for a period corresponding to a single glance (100 ms)



This is made clear in Figure 1, where the perceptibility of the letters of the word 'day' is indicated, presented at some distance from the fixation point. It is clear that the outward letters are best perceived, especially the one furthest from the fixation point. The letter closest to the fixation point is always perceived second best, while the middle letters can only be distinguished with much more difficulty. This difficulty will increase when the word is longer, or when it is further from the actual fixation point. This picture is reversed for a word presented right of the fixation point. The final letter would be most visible, the first slightly less, followed again by the middle letters. Words in the right visual-field are also somewhat better perceived than those in the left visual-field. Consequently, words look quite different, literally depending on the angle from which they are seen.

These observations present difficulties for a pure global view of word recognition because the same word has a different appearance in different locations of the visual field.

One of the first workers in the field of word recognition was Cattell. He went from the United States to Germany in 1883 to do experiments in Wundt's laboratory in Leipzig for three years. One of the first things he discovered was that a word was recognized as quickly as a single letter (Cattell 1886). Cattell concluded that a word is read as a whole. In fact this finding excluded the possibility that words are recognized by identifying or spelling the letters sequentially. Today we are tempted to say, in derived computer terminology, that letters may also be processed in parallel, or simultaneously. In that case we would also expect Cattell's finding to hold. Cattell further noted that subjects could usually report a maximum of five letters from a meaningless string of letters presented to them for a single fixation pause. But words of up to twelve letters could easily be reported in the same presentation time. He then argued that when you can see a word of, say, twelve letters in a single glance, you could not have seen all letters, but only five of them. This phenomenon would also point to the notion that words are read as a whole. Through the work of researchers such as Averbach and Sperling (1961) we now know that subjects can see many more than five letters in a single glance but are unable to report them all because of memory limitations. That is why present-day theorists assume that if the quickly-seen letters form a word, they are efficiently coded by that word, thus preventing the letters from being forgotten. This cannot be done when the letters form a meaningless arrangement.

A few years later another American, Raymond Dodge came to Germany and worked for two years at the University of Bonn in Erdmann's laboratory. That research showed strong evidence for

whole-word perception in a range of well-designed experiments. However, in several of their experimental tasks the subjects knew the word responses beforehand, making recognition of the word, or in any case its letters, more or less superfluous. Close reading of the complete reports reveals that the subjects, who were the investigators themselves, knew many of the words to be recognized in the trials beforehand. If one knows which word will be presented it is not necessary to see all of its letters to recognize it; and such a phenomenon could aptly be called global perception. Nevertheless, they did not succeed in recognizing 26 very familiar short sentences presented under the same conditions as the words. So, while global reading of words might be possible given sufficient advance information, it did not work for well-known sentences. Meanwhile, other investigators found evidence for the important role of the constituent letters of words and they rejected the findings of Cattell, and of Erdmann and Dodge (1898), opting for whole-word perception. Wundt (1903) and Huey (1908) took more or less opposite views supported by accumulating experimental evidence. Yet the debate was unsettled at the time, since there was insufficient knowledge in general on human information-processing. Nor was the debate to be settled quickly. The study of perceptual processing during reading seemed almost to vanish from the experimental scene for several decades. Only in recent years has reading been attracting fresh interest from investigators in pattern recognition, psycholinguistics, memory and eye movements. At a time when memory factors especially are much better understood than before, it seems now that there is a strong case for analytic perception. Experimental evidence by Estes (1977), Massaro (1975), McClelland and Johnston (1977), and Bouwhuis (1979) points unequivocally to the prime importance of the constituent letters in word recognition.

Recent models of word recognition

An influential model of recognition put forward by Morton (1969) makes clear what kind of processes might operate in word recognition. Morton's so-called logogen model is actually meant to describe a broad range of recognition and listening tasks. The main point to be noted here is that in the model it is assumed that all information regarding the word combines independently and additively. A reader has word knowledge at his disposal and sees strings of letters when he is reading. As has been said before, both letter information and the knowledge that letters form words may be functional in recognizing the word in the sentence. If either of these were lacking we would not recognize the words.

This process is carried a step further in the letter-confusion model by Bouwhuis and Bouma (1979). They assume that when a word is presented to the subject (seen at some place in the visual field) a letter is seen in each of its letter positions. This assumption is reasonable in the case of three-letter words. Which letters will be seen then depends on how distinguishable they are (Figure 1) and their similarity to other letters. On each trial, one of a large number of different letter-strings may be seen, strings made up by the possibly perceived letters. Most of these strings are not real words, but some are. It is supposed that the subject responds with real words only, i.e. the reader employs his word knowledge to select the words from among the meaningless strings and responds with the most likely alternative. On the basis of a large amount of letter-recognition data the model can specify how letters in different positions in a word may be confused with each other. The model is also provided with a vocabulary, thought to be representative of the reader's lexicon, containing some 500 three-letter words. With these data the model can predict which responses may be given by subjects, and in addition how often they will be reported. Testing the model has shown that these predictions closely matched experimentally-obtained responses of subjects (Bouwhuis and Bouma 1979).

Though these results relate to three-letter words only, it has recently been shown that the same model reasonably predicts responses to five-letter words (Baggen 1979). The only alternative quantitative model, propósed by Rumelhart and Siple (1974) is mathematically quite similar to the letter-confusion model. Both models describe word recognition as an analytic process, where elementary visual information about all constituent letters teams up with word knowledge to enable us to recognize the word on the page.

Letters and word knowledge

When we are talking about constituent letters of words, it has to be realized that these have their proper position in the word. This position is of great importance. First (as one can see in Figure 1) from a sensory point of view, the initial and final letters of a word are almost all we can see of a word somewhat removed from the fixation point. But another important aspect can be demonstrated by the following example. In the sentence:

Cany our ead the sew ords

no letter is missing and all are in the right sequence. Typographically it is correct, the number of spaces is correct and even the way the segments are written does not violate English spelling rules. So, why is it so difficult? Apparently something is wrong – all the letters appear in improbable positions. In several experiments it has been shown that the frequency of a letter in a given position in a word to a large degree determines its familiarity. In English, for example, many more words begin with a *c*, *p* or *s* than with *x*, *y* or *z*. A vowel occurs in the middle position of 87.4 per cent of all Dutch three-letter words, but the first letter is a vowel in only 15.4 per cent of the cases. If letters were equiprobable in all positions, the vowels a, e, i, o and u would appear in $^5/_{26}$ (19.2 per cent) of the cases in both the first and the middle positions. The frequency of a letter in a position was shown to be connected with its subjective familiarity in an experiment by Bouwhuis (1979). The general finding can be illustrated as follows. Whenever a word contained a frequent letter in one of its positions, subjects recognized it faster and more accurately. Similar results were obtained in a number of letter-search tasks, devised by Mildred Mason (1975, 1978), also showing that poor readers were not very sensitive to letter-position frequency, but good readers were. From this it appears that it is not just letters which mediate word recognition but rather letters in their position. But the position of letters is a global word aspect, so whole-word properties assist in the recognition of the constituent letters.

Another implication of the importance of letter position is that spelling rules are probably less important for word perception than is sometimes thought (Massaro 1975). It is possible that the effect of spelling regularity is determined by the letter position rather than by abstract rules concerning letter sequences as they occur in the language.

Reading education

The preceding considerations do not give much hint as to how we should teach reading at school. It is clear that letters should be learned, as should where letters belong in a word. It is equally clear that whole words, with their meaning, should be learned to improve word knowledge, which would increase reading efficiency. These are neither new nor unexpected recommendations. It seems probable, however, that early reading of whole words – the pure global way – would generally favour only the prospective good readers, while being less suitable for poorer readers. When poor readers are being taught the whole pattern of a word rather than the detailed components, gross reading errors can result, examples of which are given by Henderson (1977). Of course reading errors typically occur in dyslexic children, who seem to read in a more or less global fashion, which is determined probably by their way of perceptual functioning. Somewhat paradoxic-

ally, spelling ability does not seem to typify good readers. Whereas Frith (1979) found that good readers, as well as poor readers, relied on the visual pattern of letters in their position for reading short sentences, some good readers could be very bad at spelling in writing. Frith (1979) concluded that writing words relies much more on the auditory representation than on the visual, or graphemic representation of words. Both phenomena, reading by graphemic form and writing by phonological form, suggest that phonics is probably not a very effective tool in reading or writing. This was actually the conclusion of the extensive study of Vera Southgate Booth and associates (this volume) on the writing ability of pupils in several age groups and proficiency levels.

Also, it may be desirable to employ somewhat more elaborate letter-shapes than are usually found in children's reading books. The letters printed are frequently large and clear, but lack serifs (the crossbars at the endings). For example, it was shown by Schiepers (1977) that omitting the upper serif of the letter k seriously degraded its recognizability in short presentations to adult readers. Simpler typefaces, like Helvetica or Univers, also contain symmetric pairs, e.g. b,d and q,p, which quite often tend to be reversed by young children. In general, serifed typefaces display much less symmetry, which could counter this tendency. It is generally agreed by typographers that serifed letters will continue to be used in books, newspapers and wherever large quantities of text have to be read. Therefore, it is not entirely clear why children should be confronted with the most simple and schematic letter shapes.

Yet firm recommendations on teaching to read cannot be expected from the present theories of reading, or word recognition. Much more detailed theories of reading are called for, as well as a good deal of supportive experimental evidence, before useful application of research findings can take place. Not only can experimental work be unknowingly repeated as Brooks (1979) has shown, it can often be interpreted in terms of contradictory theories. This can happen more easily when these theories are verbal rather than quantitative, or general rather than detailed. It is probably due more to the inexactitude of the theoretical stands than to their tenets that the global-analytic conflict could thrive for so long. Consequently, what should also be needed is research on the effectiveness of specific reading programmes under sufficiently controlled conditions. By 'sufficiently controlled' is meant that the research should involve larger numbers of students than has been the case, and also that different verbal abilities should be taken into account, as well as the usual safeguards which are employed in research on perception and memory. Follow-up research in the higher age-level

brackets, particularly relevant for poor readers, seems now to be lacking completely. Such research could give valuable information on literacy in adults, as well as provide evidence on the long-term effects of a specific reading programme.

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19 In-service training: a course on aspects of the teaching of reading

Derrick Stock

This paper on in-service training will centre on an eighteen-hour course for teachers in ordinary schools who wish to bring themselves up-to-date on the teaching of reading.

This is the sixth occasion that the course has been run, and it is consistently oversubscribed. Most of the applicants do not teach reading as a subject, but are aware of a situation developing in their schools in which children are failing to develop serious interest in the written word. As a result of this, certain skills, based on reading competence, are adversely affected. The course does not dwell on this, as the reasons may be deeply based in the structure of our present-day society, but rather concentrates on putting forward practical suggestions, based on sound theory, in order to increase teaching efficiency. This in turn would help children to increase their learning capacity and bring about the desired changes. Such an approach needs clear simple objectives, and the course is designed with the following three in mind:

1 It should concentrate on teaching technique. Much of today's knowledge so painstakingly developed in the universities seems to have little effect at classroom level. The best example is in reading itself. Here is a widely-researched subject, supported by plenty of written material, yet few would deny that there is little comparable improvement in reading standards.
2 The knowledge gained on the course should stimulate the course members to pursue their studies even when the course is finished. Course members must go away full of enthusiasm for their new skills and be anxious to apply them in the classroom situation. Without this the course is pointless. It is here that the book list plays an important part because a few selected examples can lead the reader on to more advanced concepts and thus extend the influence of the course still further.
3 The course members must be involved in their own course-programme planning. We present the basic content of the nine sessions to them at the beginning of the course and ask for