DYSLEXIA: A SPECIFIC RECODING DEFICIT?
AN ANALYSIS OF RESPONSE LATENCIES FOR LETTERS AND WORDS IN DYSLECTICS AND IN AVERAGE READERS

H. BOUMA and CH. P. LEGEIN
Institute for Perception Research IPO, P.O. Box 513, Eindhoven, The Netherlands 5612 AZ

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Abstract—Twenty dyslectic and 20 normal readers (11–15 yr) recognized letters and words, both foveally and parafoveally. Correct scores and response latencies were measured. Latencies of correct responses come out longer for the dyslectic group: about 100 msec more for letters and 200 msec more for words, independent of presentation. A simple sequential processing scheme is proposed in which the main source of difficulties for the dyslectics is a delay in their translation of visually recognized items into a speech code. Lower scores then result from the volatile character of visual stores.

1. INTRODUCTION

Poor readers and normal readers are primarily distinguished by their reading abilities. Many research efforts have tried to relate poor reading to poor performance in other tasks, in the hope of finding more basic differences which might have caused the reading problems.

In studies of poor readers, many deficiencies have been reported, both visual and non-visual, such as in the analysis of complex visual configurations [1–3], in the recognition of embedded letters [4], in eye movements [5, 6], in auditory discrimination and blending [7, 8], and in recall [9–12]. Unfortunately, the results are not always in harmony with each other. With other deficiencies probably still around the corner, the fruits seem too many rather than too few and bewilderment rather than understanding seems to have advanced. Notions about a diffuse minimal brain damage or a general maturational lag seem to reflect such absence of coherent theory. The present paper is mainly concerned with specific developmental dyslexia, in which poor word recognition and poor spelling are prominent in the absence of intellectual and emotional handicaps.

This paper will add one more deficiency to the above list in providing evidence that dyslectic readers are slower than average readers in the recognition of letters and words. Contrary to the spirit of general and diffuse theories, in the discussion we shall explore the hypothesis that many diverse deficiencies can be taken to derive from one specific deficiency, i.e. the translation in the brain of visual symbols into speech and vice versa.

In our view, the very specificity of dyslexia, in which the reading of words is so obviously poor in children who otherwise appear quite normal, calls for a specific explanation.

In our Institute, research on normal reading processes started from the consideration that the saccadic nature of eye movements in reading restricts useful vision to the eye pauses. For our research, this has led us to the following division of visual reading processes: (a) the control of eye saccades [13–16]; (b) letter and word recognition from each single eye pause,
both foveally and parafoveally in the reading field [17-23]; and (c) the integration of information as gathered from successive eye pauses [18-20].

As from 1973 we have extended this exploration of visual reading processes to the reading of dyslectic children. We compared the recognition scores of normal and dyslectic children (age group 11-15 yr) for isolated letters, embedded letters, and words, both foveally and parafoveally. We found that both groups of children had equally high scores on isolated letters, indicating that the dyslectic children knew the letter forms. However, on embedded letters and on words dyslectic children scored lower than control children, which suggested that in dyslectic children visual interference effects were more pronounced [4]. The present paper, which deals with response latencies in the recognition of briefly presented isolated letters, embedded letters, and words, both foveally and parafoveally, leads to a somewhat different view. For an initial report, we refer to BOUMA, LÉGEIN and VAN RENS [24].

2. METHODS

Subjects

Twenty weak readers, among whom two girls, had been selected earlier by the staff of a remedial teaching school as to obvious reading difficulties in the absence of intellectual and emotional handicaps. At the time of the experiment, their ages were between 11 and 15 yr and their reading levels according to the Tanghe test [25] were 1-4 yr below normal. An earlier ophthalmological examination had revealed no eye defects.

The control group of 20 normal readers, among whom nine girls, of the same age (11-15 yr) was selected as to average reading level from grades 4-6 of a normal primary school. All 40 subjects had also participated in earlier experiments reported in this journal [4].

Stimuli

There were 23 different lower-case letters (all except x, y, q, which are very infrequent in Dutch) and 48 well known Dutch words. There were three types of stimuli: (1) isolated letters, presented one by one in random order, symbolically indicated as /a/; (2) letters embedded between two letters x at normal typewriter spacing, indicated as /xax/; (3) words, indicated as /wrd/, all of regular spelling and equally distributed over three word lengths (3-4-5 letters). For other details on stimuli, tachistoscope (100 msec) and presentation, we refer to our earlier paper [4].

Presentation

Eccentricity of presentation of the isolated and embedded test letters was at $\varphi = 0^\circ$ (foveal) or at $|\varphi| = 1^\circ$ (parafoveal), either right ($\varphi > 0^\circ$) or left ($\varphi < 0^\circ$) of fixation. One degree visual angle corresponds to four letter positions. Word stimuli were presented such that the word was centred at the fovea ($\varphi = 0^\circ$) or, for parafoveal stimuli, that the letter closest to the fovea was at $|\varphi| = 1^\circ$. For each type of stimulus, parafoveal stimuli were presented randomly right or left of fixation in equal numbers. Each letter stimulus was presented once foveally, once left and once right of fixation. Parafoveal word stimuli were divided into two lists, each list containing each word just once. The words presented left of fixation on one list were presented right of fixation in the other list. In the experiments, the two parafoveal word lists were separated by letter lists and by a foveal word list. Each list started with a few extra stimuli to get the subjects used to the task. Pauses were inserted once or twice in a session.

Responses; voice switch

The subjects responded orally with one letter or one word, directly after stimulus presentation. They were not pressed, in order to let them operate as normally as possible. Responses "illegible", "nothing seen" etc. were allowed. A subject's response operated a voice switch and the time interval between the onset of the stimulus and the triggering of the voice switch was measured electronically. All responses were recorded on tape, together with audible clicks of the microswitch which started each stimulus. Careful evaluation of the sound tracks enabled us to skip latencies unreliable because of heavy breathing, occasional noise from outside, etc. Recent recordings have shown that operation of the voice switch systematically depends on the initial sounds produced, differences being of the order of 30 msec [27]. Consequently, the uncertainty in separate latencies is less than 50 msec.
3. RESULTS*

3.1. Group averages

Correct scores for the foveal and parafoveal stimuli are given in Fig. 1a as averages of the individual results for the two groups of subjects. The results are largely similar to the data gathered from the same subjects a year earlier [4], but the scores are now generally higher. For embedded letters and for words, the better recognition in the right visual field as compared with the left equally confirms our earlier findings and is consistent with earlier literature [27]. In our earlier experiments different stimuli were used left and right of fixation whereas here they were the same.

Response latencies as averaged over the groups are given in Fig. 1b and Table 1. For correct letter recognition, the dyslectic group is slower by some 120 msec both for isolated letters and for embedded letters, and both for foveal and for parafoveal presentation. For correct word recognition, the dyslectic group is slower by some 220 msec both in foveal and in parafoveal presentation. Response latencies of correct responses do not show a significant left-right difference. Average latencies of incorrect responses are generally less reliable because of the smaller number and the greater spread of the data.

Differences between dyslectics and controls for incorrect responses are 220 msec for

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Fig. 1. Fractions of correct recognitions and corresponding latencies averaged for the dyslectic subjects D and the control subjects C for three retinal positions. Recognition concerns isolated letters /a/, embedded letters /xax/ and well-known short words /wrd/.}

*Results explicitly mentioned are statistically significant at least at the 5% level.
Table 1. Group averages of correct scores and response latencies for correct and incorrect responses, together with their between-subjects standard deviations (between brackets). The last column indicates group differences, which depend on type of response rather than on recognition difficulty.

<table>
<thead>
<tr>
<th>Type of Response</th>
<th>Dyslectics</th>
<th>Controls</th>
<th>Dysl.-Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score (%)</td>
<td>Latency (ms)</td>
<td>Score (%)</td>
</tr>
<tr>
<td>Correct responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foveal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/a/</td>
<td>96 (5)</td>
<td>910 (260)</td>
<td>93 (7)</td>
</tr>
<tr>
<td>/xax/</td>
<td>72 (23)</td>
<td>940 (240)</td>
<td>90 (11)</td>
</tr>
<tr>
<td>/wrd/</td>
<td>89 (15)</td>
<td>900 (190)</td>
<td>99 (2)</td>
</tr>
<tr>
<td>Parafoveal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/a/</td>
<td>93 (6)</td>
<td>840 (140)</td>
<td>95 (6)</td>
</tr>
<tr>
<td>/xax/</td>
<td>43 (12)</td>
<td>1040 (120)</td>
<td>54 (15)</td>
</tr>
<tr>
<td>/wrd/</td>
<td>57 (12)</td>
<td>940 (150)</td>
<td>75 (11)</td>
</tr>
<tr>
<td>Incorrect responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parafoveal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/xax/</td>
<td>1380 (230)</td>
<td></td>
<td>1160 (250)</td>
</tr>
<tr>
<td>/wrd/</td>
<td>1240 (250)</td>
<td></td>
<td>1000 (210)</td>
</tr>
</tbody>
</table>
parafoveal embedded letters and 240 msec for parafoveal words. For both groups of subjects, incorrect responses are on average substantially slower than correct responses, the differences being some 300 msec.

As to differences between the types of stimuli, each group reported correct letters and correct words equally fast, whereas correct embedded letters were slower by some 50–200 msec. As expected, correct responses to parafoveal stimuli are somewhat slower than to foveal stimuli, with the exception of isolated letters which are reported about equally fast foveally and parafoveally.

For isolated letters, ceiling effects prevent a possibly more difficult parafoveal recognition from becoming manifest. However, correct response latencies of isolated letters do not differ significantly for foveal and parafoveal presentation. Since the foveal letters came first in the session, we have considered whether the responses to foveal stimuli might perhaps have suffered because the subjects had not yet got used to the task. Two arguments would seem to contradict this: Firstly, each list started with several extra stimuli to get the subjects used to the task, which is indeed an easy one. Secondly, we found no latency differences between the first and second halves of the stimuli for each condition. HAUN [29] found a small effect of eccentricity on recognition latency of isolated letters.

3.2. Certain individual results

Table 1 gives standard deviations of latency distributions of individual averages. These distributions are approximately normal. Generally, the dyslectic subjects differ more among each other than the control subjects. There appears to be overlap between subjects in the dyslectic and the control groups. Distributions of correct response fractions (scores) in Table 1 are generally not normal because of ceiling effects.

3.3. Certain relations between variables

The experiments as described have many variables. Independent variables are type of stimulus (isolated letters, embedded letters, words), retinal location (foveal, parafoveal), and type of subject (dyslectics, normal readers). Dependent variables are type of response (correct, incorrect) and response latency. Conditions for an analysis of variance are not met. We mention here the most noteworthy relations, for which we shall use correlation coefficients as an index.

Relations between correct-recognition scores for different tasks. In correspondence with the earlier results [4], there is for both groups a general, moderately positive relation between correct response fractions for different stimuli and for different retinal positions. For foveal presentations in particular, ceiling effects prevent a useful interpretation of such relations. Generally, the correlation coefficients are of the order of $+0.45$ for the dyslectics and $r = +0.50$ for the controls. Parafoveal embedded letter scores and parafoveal word scores correlate $r = +0.53$ in the dyslectics and $r = +0.61$ in the controls, as compared with $r = +0.44$ (dyslectics) and $r = 0.50$ (controls) in the experiments carried out a year earlier with the same subjects [4]. In summary, there is evidence of a weak common component in correct recognition of embedded letters and of words.

Relations between correct-response latencies for different tasks. Both for the group of dyslectics and for the group of normal readers, there is a general, significantly positive relation between latencies of correct responses for the various tasks. As an example, Fig. 2(a) plots latencies for foveal embedded letters vs foveal words (dyslectics $r = +0.73$, controls
Fig. 2. Correlation diagram for response latencies of embedded letters /xax/ and of words /wrd/, both foveally (2a) and parafoveally (2b).
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Fig. 3. Correlation diagram for response latencies and response scores, both for parafoveal words.

Fig. 4. Relation of response latency for foveal word responses and reading level according to the Tanghe test. Although the correlation coefficient is not significant, it will be seen that there are no quick responders among those with low reading level (<3.5).

\[ r = +0.79 \]. Figure 5(b) gives similar results for parafoveal presentation (dyslectics \( r = +0.61 \), controls \( r = +0.88 \)). In the correlation matrix relating all “correct” latencies, correlation coefficients are \( 0.50 \leq r \leq +0.90 \) for the dyslectics and \( 0.44 \leq r \leq 0.88 \) for the controls. Generally, these relations support the notion of a common component in the speed of responding correctly to visually presented alphabetic material.

*Relations between correct scores and correct response latencies for the same tasks.* The results indicate a relation between correct response fractions and latencies of correct responses in the sense that the higher the correct recognition score, the quicker these correct responses came. Here too, ceiling effects in response scores prevent a useful interpretation
in a number of instances. Figure 3 plots parafoveal word score vs latency of correct responses for each subject (dyslectics $r = -0.49$, controls $r = -0.46$). Thus, to a moderate extent, the quick responders have the higher scores and there is no such thing as a speed-accuracy trade-off, in which the quick responders would have had the lower accuracies. In our Institute, we have recently found many instances in which response latencies of correct responses substantially increased when recognition became more difficult as judged from lower correct scores [30]. The correlations mentioned here, however, concern relations between different subjects carrying out the same task, whereas Bouwhuis et al. [30] were primarily concerned with different tasks carried out by the same subjects.

Relations with the Tanghe reading test. Interestingly, both for the dyslectics and the controls, correlations between correct scores or latencies on the one hand and Tanghe reading level on the other are generally not significantly different from zero, although they are usually in the expected direction (positive for word scores, negative for correct response latencies). Thus, both correct recognition scores and latencies fail to classify as clear determiners of reading level. As can be seen in Fig. 4, there is nevertheless a relation in the sense that all very weak readers (level $\leq 3.5$) come out with long response latencies.

4. DISCUSSION

4.1. Group differences between dyslectics and controls

A number of such differences have been found. Summarized, we corroborated earlier results that dyslectic subjects have lower scores for embedded letters and for words both in foveal and in parafoveal presentation. Scores for isolated letters, however, are equal and close to 100%. Ceiling effects may have prevented a possible underlying difference in recognition difficulty from becoming manifest, but the results again clearly show that our dyslectic children know the letter forms.

As to latencies, the dyslectics are generally slower than the controls to an average value of 120 msec for letter recognitions and 220 msec for word recognitions. It is striking and theoretically important that the difference depends on the type of recognition only and not on the mode of presentation. For words, it does not even depend on the correctness of the response. The particular value of the difference is not so important because it depends on the selection of the widely differing subjects. Generally, incorrect responses take 300-400 msec longer than correct responses in both groups. Such an effect is also well known from experiments with adult subjects in a number of tasks [30]. Perfetti and Hogaboam [31, 32] have reported that in visual word reading and search tasks, poor readers need more time for words, values being not too different from the present ones.

4.2. A simple sequential processing scheme

We shall now try to use the present results for a better understanding of dyslexia as a specific reading weakness. For this purpose, we propose a simple scheme of sequential information processing in overt letter and word recognition. The notion "sequential" is taken to imply a sequence of processes, which, however, may overlap in time, and in which the later ones are dependent on the earlier ones, but not vice versa. Each of these processes takes a certain amount of time, partly to be specified. The scheme is depicted in Fig. 5 and relates to a group of closely connected theories on processes involved in recognition, known as logogen theory [33, 34], multicomponent theory [35] and letter-confusion theory [21-23], to which the reader is referred. The scheme should be considered primarily as an aid for
explaining results, for distinguishing main effects from side effects, and for guiding research into the nature and possible remedy of dyslexia. No claim is made to true independence of stages and even less to full comprehension of the dyslexia syndrome.

We shall discuss the scheme of Fig. 5 first in relation to the present results and next to literature on dyslexia.

The visual quality of the stimulus influences the time needed for visual analysis. Thus, isolated letters need less analysis time than embedded letters and foveal words need less time than parafoveal words. The corresponding differences in response latencies that have been found are therefore attributed to the process of visual analysis.

Latency differences between correct and incorrect recognitions are attributed to the selection phase. In cases of correct recognition, activation of the correct unit will usually have surpassed activation of alternative candidates. Thus, the selection is relatively easy and straightforward. In cases of incorrect recognition, a decision between the activated incorrect unit and at least one other unit (here the correct unit) is required. The latency differences of 300–400 msec between correct and incorrect recognitions are thus attributed to the extra time necessary for selecting between units which visually resemble each other.

The visual-speech recoding phase is proposed as the most likely candidate for the differences between dyslectic and control subjects. The idea is that dyslectic subjects need somewhat more time for recoding a visually recognized letter into its letter name than the control subjects, and even more time for recoding a visual word into its sound (name). The primary reason for attributing this difference to the visual-speech recoding is that the latency difference between dyslectics and controls depends on the item to be recognized (letters vs words), but not on recognition difficulty (isolated vs embedded letters, foveal vs parafoveal). If the time difference were attributed to the visual activation phase, the latency difference between dyslectics and controls would be expected to increase with recognition difficulty.

KLAPP et al. [36], SPOEHR and SMITH [37], and SPOEHR [38] have developed notions of how the recoding from a visual into a speech code may be envisaged. The envisaged influence of
length is well applicable to dyslexic children, who have particular difficulty in dealing with long words.

Finally, it is proposed that the articulation phase is equally developed in dyslectics and controls. The basic evidence for this is that dyslectic children are normal speakers and listeners. In a pilot experiment in which both dyslectic and control children repeated spoken words, which included long and difficult ones, we found no obvious extra delays among the dyslectic subjects. This is in strong contrast to the reading of long words, which dyslectics find particularly difficult [4, 39]. This makes it unlikely that slow speaking is the source of the long latencies in visual letter and word recognition. On the same grounds, a general slowness of dyslectic children in all kinds of recognition seems unsuitable for explaining the specific delays observed in the experiments.

Summarizing this part of the discussion, we propose that dyslectic children’s visual information processing and speaking are just as efficient as those of control children, but their recoding into speech is deficient. Why, then, should their recognition scores be lower? The explanation proposed here takes a lead from the finding that low recognition scores and long latencies tend to go together. Also it is of interest to note that latencies are often as long as 1–2 sec. During this period, the information has to reside somewhere in the visual or the response system. On the assumption that storage of the response as such is possible only after that response has become available internally, the preceding phases of the recognition process should have their own storage facilities. If we take the first storage facility after the retina to retain rather unprocessed visual information for some 0.25 sec, we clearly need other forms of visual storage before the information can be carried to a more lasting response form. These storage facilities are assumed to be volatile, such that each extra delay automatically leads to decreased performance (lower probability of correct responses).

The picture as sketched above is a simplistic one, but it has the advantage of clearly assigning experimental results to possible processing stages and it lends itself to further experimental tests.

In general terms, such an approach has recently been advocated by a number of researchers in the field [40, 41]. A view somewhat similar to the one put forward here has been advocated by JORM [8] (1979), who attributes the primary difficulty to auditory short-term memory problems rather than to “phonemic translation”. However, TORGESSEN [42] has found that lower short-term memory scores are open to easy improvement by training.

It seems relevant to consider briefly the relation between word recognition and letter recognition. The longer latencies for embedded letters as compared with those for words might be taken to suggest that word recognition occurs earlier than recognition of the constituent letters and thus cannot be based on the latter. We think that this conclusion is premature. During actual word recognition, neither an explicit selection between alternative letters nor a recoding of individual letters into their names is necessary. Thus, in our view, word recognition can very well be based on the activation, without selection and recoding, of a number of the word’s constituent letters. For a quantitative theory on this the reader is referred to BOUWHUIS and BOUMA [21–23].

We now turn to word recognition and reading. Correlations of reading level with word recognition scores were positive though small, and with word recognition latency negative though small. Thus, the reading level of the children cannot be deduced from their word recognition in any simple way. On the other hand, in our data a low foveal word score implies a low reading level and a quick foveal word response excludes a low reading level. It seems then that other component skills of reading (see [40]) sometimes make up for shortcomings in word recognition, for example an adapted eye movement strategy, a good concentration, or a better utilization of context. It can be maintained, therefore, that for adequate
reading, word recognition skills are a necessity, in addition to other skills. It should be added
that the simple reading test we used was not designed to reflect the intricacies of the com-
ponent skills; as our insight deepens the need for more sophisticated reading tests increases.

The above discussion has been based on group averages. We wish to stress again that the
distribution of results of dyslectic and control subjects overlap and that there are marked
differences between individual dyslectic subjects. The framework sketched above is clearly
suited for individual results as well.

4.3. Confusing issues in dyslexia research

Unspecific and specific theories. Many authors have noted that the literature on dyslexia
is rather confused, both as to experimental results and to type of theories [2, 41]. A number
of factors contribute to the confusion. A first difficulty is the distinction between poor read-
ing in general and specific developmental dyslexia. Throughout the literature, authors have
been struck by the very specific nature of the reading difficulties of so many subjects, mainly
difficulties of visual word recognition and of spelling, in the absence of any general intel-
lectual, emotional or social handicap. However, in selecting subjects for research purposes,
it is rather difficult to exclude other weak readers, and so it is often difficult to compare
results found by different authors.

A second difficulty resides in the type of explanation. Some authors favour a neurological
explanation (minimal brain damage, dysfunction of the left hemisphere, dysfunction of the
parietal lobe); others prefer a functional explanation (disturbed visual processing, disturbed
phonemic recoding); still others lean towards a developmental explanation (general matura-
tional lag). The types of theories are not mutually exclusive, but the different goals of the
authors and the different degrees in which theoretical notions have been worked out make a
comparison or combination difficult.

Thirdly there is the quite general difference between statistically significant results and
substantial results. Since the difficulty of visual word recognition is quite substantial, weak
but statistically significant correlations cannot be convincing as explanatory factors unless
they are part of a more comprehensive theory.

However, the main difficulty is probably distinguishing between causes and effects. In our
society, printed text is such an important source of information that subjects with poor
reading ability will almost certainly develop a multitude of secondary relative deficits, such
as in knowledge, in perceptual skills, and sometimes in emotional stability. Little imagina-
tion is needed to perceive the development of many weak correlations, but once they have
been found, it is difficult to give any specific explanation of their source. For these reasons,
it seems a relatively safe strategy to direct research efforts to the strong effects themselves or
to closely related effects, and almost without exception these have been found in the field of
visual language material.

In trying to attribute the main difficulty and cause of dyslexia to poor visual-speech
recoding, it remains to explain why in many other tasks certain deficiencies have been
observed. Recently, VELLUTINO [44] has discussed the issue at some length and therefore we
shall only touch upon a few of these questions here.

If there are no primary deficiencies in visual analysis, the relative difficulty of dyslectics
in dealing with complex configurations [1, 2] may then result from having missed a certain
transfer of the skill of visual word analysis to complex visual processing in general, or from
a hidden use of names when carrying out the tasks. Perhaps it is as well to remember that
any children with a primary deficiency in visual analysis will most likely also find it difficult
to analyse printed words. This would give rise to the contention of a positive correlation between the two skills, but would not allow the conclusion that dyslexia is generally caused by problems in visual analysis. VELLUTINO et al. [43, 44] reject the hypothesis of a visual deficiency on the grounds of copying experiments in which dyslectic children performed just as well as controls. This is indeed strong evidence, and it will be interesting to see the approach extended for more complex visual configurations.

Quite different evidence against a primary visual deficiency explanation can be derived from the consistent reports that dyslexia is virtually unknown in Japan [45]. The Kanji symbols, which are adapted from Chinese, directly represent meaning, not mediated by sound. In the two Kana scripts which do represent sound (syllables), there is one-to-one correspondence between sign and sound, much more regular than in most alphabetic languages (see also [46]). Despite the complexity of the visual configurations, Kanji symbols are more easily learned by young children than Kana [47].

In alphabetic languages visual analysis of print is by definition deficient in dyslectic subjects. If we put the primary difficulty in the visual-to-speech recoding phase, the deficient letter and word recognition could be attributed to (a) the disappearance of visual information from volatile visual stores before it can be put into the more stable speech code, and (b) the interference of recoding difficulty with a proper development of internal visual word units. This might be expected to affect mainly long and infrequent words. In the experiments reported here, even the low frequency words were short and well known.

In our view, deviating scanning patterns of the eyes should be considered as secondary to reading difficulties.

Apart from visual deficiencies, auditory deficiencies have also been reported in dyslectics, usually involving an inability to make fine discriminations between phonemes embedded in words [2, 3]. As VALTIN [41] has pointed out, the awareness of phonemes is increased by proper spelling experience, and these auditory deficiencies may therefore be secondary to the spelling difficulties of dyslectics. Along the same lines, WALLACH et al. [48] have found that children who experience no difficulty in discriminating between words with small differences in just one vowel, may well have difficulties in naming the vowels explicitly. Again, if certain primary auditory or speech deficiencies exist, these may lead to reading difficulties [49] and thus inflate general correlation coefficients between the two.

VELLUTINO [44] in his review comes to the conclusion that the cause of dyslexia is either to be found in deficient phonemic recoding, or in deficient general language abilities. We think the latter notion unattractive, since it conflicts with the normal listening and speaking capabilities of dyslectics. Certain secondary language deficiencies may occur, however, inasmuch as they normally develop concurrently with reading. PERFETTI and HOGABOAM [31], too, have advocated a position in which they stress the verbal part of reading difficulty, just as we do.

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**Résumé:**

20 dyslexiques et 20 lecteurs normaux âgés de 11 à 15 ans devaient reconnaître des lettres et des mots en vision à la fois fovéale et parafovéale. On mesurait les scores de réponse correcte et les réponses de latence. Les latences de réponses correctes étaient plus longues pour le groupe dyslexique d'environ 100 msec. pour les lettres et de 200 msec. pour les mots, quelle que soit la présentation.

On propose un schéma de traitement séquentiel simple selon lequel la source principale des difficultés pour les dyslexiques est un retard de la traduction des items reconnus visuellement, en un code verbal. Les scores inférieurs proviennent alors du caractère fugace du store visuel.

**Zusammenfassung:**

20 dyslektische und 20 normale Leser im Alter von 11 bis 15 Jahren erkannten Wörter und Buchstaben foveal und parafoveal. Es wurden die Scores für zutreffende Antworten und die Latenzen der Reaktionen gemessen.

Die Latenzen der korrekten Antworten waren bei der dyslektischen Gruppe länger: etwa 100 msec mehr für Buchstaben und 200 msec mehr für Wörter, unabhängig von der Art der Darbietung.

Ein einfaches Schema der sequentiellen Verarbeitung wird vorgeschlagen, in dem die Hauptursache für die Probleme der dyslektischen Personen eine Verzögerung in der Übertragung visuell erkannter Items in das Sprachsystem ist. Die geringeren Leistungen sind daher die Folge der flüchtigen Natur der visuellen Speicherung.