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## Summary

When the technique of word decoding is insufficient, this will impair pupils in about everything that is to be learned at school. In primary education much can be learned, but reading comes first. In its dyslexia report the Health Council of the Netherlands (1995) recommended the setting up of a trajectory of intensive individual remedial teaching within education. This trajectory would serve two purposes. Firstly averting a possibly unfavourable reading development of a significant proportion of the pupils with reading problems. Secondly such a trajectory would contribute to the diagnosing of dyslexia, because it would show the persistence of the reading problem in pupils for whom this was not successful. This recommendation was the reason for the research reported in this thesis.

A two-part programme was developed: remedial teaching directed towards working with texts and an experimental computer-assisted word training programme. With the word training programme four separate studies were carried out. In the introductory chapter, the study is placed within the tradition of practice-based or developmental research, such as that fits within the mission of centres for child study in the Netherlands. The goal is to develop forms of assistance on the basis of scientific knowledge in so far as this is available, within and in cooperation with remedial practice. Use is made of the available scientific knowledge, particularly that of *applied behaviour analyses*, which is used for the setting up of a systematic, protocolled intervention in the normal, daily educational practice, aimed at the 10% non-starters among in the first half of grade 2. The paradigm of developmental psychopathology was chosen as a frame of reference for the developmental nature of dyslexia as a disorder. This paradigm emphasises the complex manner in which aptitude and environmental factors affect each other, resulting in various development trajectories.

The implementation of educational renewal is in keeping with Martens' et al. (1999) observation that there is no reason to assume that the introduction of renewal in a school will be subjected to rules other than the bringing about of a behavioural change in a pupil. For these reasons the applied behaviour analyses therefore also provided the 'language' and the instruments. The description of the process hopefully illustrates that the introduction of a change in the education requires more than just the provision of information and the transfer of knowledge, but is a matter of hard work, much practice and endurance, as is also required of pupils with reading problems.

In chapter 2 the choice for intervention in grade 2 is justified, against the apparent trend to invest in prevention in younger pupils. Offord et al. (1999) call for *an optimal mix of universal, targeted and clinical interventions, the nature of the combination will change as knowledge accumulates and there will always be trade-offs among these three*. This combination of measures is referred to as the continuum of care in which school improvement and care measures are brought together. It is argued that there is a limit to the predictability of reading failure and that there will always, however careful

the preparatory and initial reading education is, be pupils who at the start of grade 2 are non-starters and are dependent on targeted interventions.

Chapter 3 first of all describes the development of remedial teaching according to the protocol. For the interaction between the remedial teacher and the pupil use is made of the *pause, prompt, praise* method, based on applied behaviour analyses. Also for the implementation of this method use is made of this technology of change. Schooling, coaching, observations, logbook and feedback resulted in a high treatment integrity: implementation of the method as this is intended.

It would seem that the first part of the question can be answered positively. Intensive remedial teaching returns a significant proportion, estimated at two out of three of the pupils who could be regarded as potential non-starters, into the group of pupils who in normal primary education can in principle be adequately taught using a standard approach to the curriculum. Although in intervention studies it is frequently found that those with a relatively favourable starting position are also the ones who benefit most from intervention, this was not the case in this study.

Chapter 4.1 relates findings about reading problems and dyslexia to both the orthographic characteristics of various languages and differences in the educational practice. Scientific knowledge from Anglo-Saxon research cannot be applied directly to the Dutch language and education in Dutch and the teaching of the Dutch language. In particular there are differences in the relative importance of phonological deficits versus deficiencies in fluency. For languages with a transparent orthography, such as Dutch, deficiencies in fluency seem to be the most important characteristic for pervasive reading problems. As a consequence the focus of attention will be more on reading speed than on accuracy.

In chapter 4.2 the various reading models are examined for their consequences on (remedial) teaching methods. The essence of dyslexia is defined as a problem of automatization at word level. After the initial reading phase somehow or other a phase follows in which pupils increasingly recognise more words immediately and at a faster rate. The various theoretical perspectives - single, dual or multiple route models - seem, if the technical reading proficiency has passed the first phase of initial reading, at present to have few consequences for the teaching method at this level. With the help of learning theory terminology, the procedure is outlined along which the training of direct word recognition should proceed. The learning process is described in terms of operant conditioning as a form of discrimination learning. The learning procedure followed is derived from the classical conditioning paradigm.

At various places the distinction is made between stimulus and response generalisation. Stimulus generalisation is understood to mean the issuing of an identical response under different stimulus conditions. Applied in the area of technical reading, the ability to read practised words within a new text is an example of this. However, in the area of learning to read, the term generalisation usually means response generalisation, in other words that a pupil can read words which are new for him. In this thesis this was nuanced by stating that response generalisation is also shown in an increased ability to

*learn* to read new words. The degree to which the response times decreased during the course of the training is seen as a measure of sensitivity to instruction. Processing at the subword level seems to be an inherent part of this. The conclusion was drawn that a characteristic for weak readers would seem to be that they are particularly less able to easily and efficiently switch between different levels of processing written material, if the task requires this. Not all processing possibilities seem to be open to the same degree for them, especially not those with which units at the subword level larger than the grapheme can be efficiently processed.

By setting up the word training within the remedial programme as a training experiment, an effort was made to find an answer to the second part of the question as well.

Progress in the training is not made dependent on the occurrence of generalisation, but the training is set up such that more or less generalisation would be visible in the dependent variables, response times and accuracy. With the distinction between stimulus and response generalisation, how response generalisation is implicated in the processing of subword units above the level of the single grapheme is described. In this an operationalisation of the term differential sensitivity to instruction is found, not as the ability to be able to read new words, but as the ability to be able to *learn* to read new words with increasing speed. Pupils appear to differ significantly from each other in this respect and this difference would seem to be related to the outcome of the remedial trajectory, in the sense that pupils with a relatively quick progression in the training, are also predominantly the pupils who at the end of the training period no longer belong to the non-starters, and equally the pupils with a relatively slow progress in the training are predominantly the pupils who at the end of the training period still belong to the weakest 10% on a word reading test according to the national standard.

In four experiments, described in chapter 4.3, different aspects of the word training were varied. Study 1 included practice with the CVCC and CCVC words in sets which corresponded with the consonant cluster. The study used pupils who in the first half of grade 2 belonged to the weakest 10% of readers. A modest generalisation effect could be demonstrated between training sets: a somewhat quicker response and a slightly greater accuracy if two sets were built up from words with the same consonant clusters. The offering of words in the form of a pure block made the reading of these somewhat easier, but the form it was offered in had no effect in either a positive or negative sense, on the degree of generalisation.

There were differences between the pupils in how they responded to the training. Those who were no longer considered to be non-starters at the end of the training period, exhibited on average a more rapid decrease in the response time than the pupils who at the end of the training period still scored as non-starters. The same applied *mutatis mutandis* for the increase in the accuracy. Furthermore, the difference between the two groups in terms of response times increased as the training progressed.

Study 2 was carried out with the weakest 10% of readers in the second half of grade 1. Training was carried out with CVC words. The words in the word sets overlapped in the vowel + consonant. There was generalisation between word sets if these had the

same CV word stems. Offering training words in the form of a pure block affected the response time; the words were read at a considerably faster rate without this affecting the degree of generalisation. The differences between studies 1 and 2 were fairly large, especially with respect to the facilitating effect of offering words in the form of a pure block and with respect to the occurrence of generalisation. It is concluded that the use of pure blocks lowers the level of difficulty of words to be practised and in this sense it is a useful remedial teaching aid. In study 2, there also seems to be processing at subword level on the basis of VC word stem among the relatively weak readers.

In the word training of study 3, CVCC and CCVC words were used as in study 1 and like in study 1 we worked the weakest 10% of readers during the first half-year of grade 2. With respect to the first study an intermediate level of words which overlapped in vowel + consonant cluster was incorporated. Pupils who at the end of the training period no longer needed to be considered as non-starters, had on average slightly lower response times in the first part of this training trajectory than the pupils who on the basis of a word reading test still belonged to the weakest 10%. After the training had switched to the same style as in study 1, the difference between the relatively very weak readers and the relatively less weak readers increased considerably. The difference between both training periods lay in the combination of the consonant cluster with or without a vowel. The relatively less weak readers also responded to the transition with an increase in the average response time, but they recovered again. The weakest readers responded with a much stronger increase in the average response time and also exhibited no recovery. A possible interpretation of this is that the large intraword redundancy during the first sessions also made it possible for the weakest readers to develop a decoding at the subword level.

The pupils in study 3 exhibited differences between each other in their average performance in the word training and in particular in the degree to which they responded to the transition of overlap with or without a vowel. Based on this last aspect of each pupil's individual learning curve, a good prediction of their reading level at the end of the training could be made.

Finally, study 4 was carried out with the weakest 10% of readers in the second half of grade 2. This study was an attempt to reduce the difficulty level of working with words with a consonant cluster such that it was also possible for the weakest readers to practice with these. The pupils were not asked to read words but only to assess whether a certain phonetic form was contained in or was equivalent to a word shown. The phonetic form could be a single consonant, a consonant cluster or an entire word. Various conditions, including the time the letters or words were shown, were systematically varied. The learning effect was established by the training words being read once as a test prior to and after each session. An improvement was measured between the pre-training and post-training test in terms of both accuracy and response time, if in the practice the pupils were focussed on the entire word and, although to a lesser extent and only with an unlimited exposure time, when they worked with a single grapheme/phoneme combination *from* the consonant cluster. If the consonant cluster was used the

learning effect was significantly less. Neither in the pre-test scores nor in a word reading test taken parallel to the training could a response generalisation be demonstrated.

Training with words at the CVC level with corresponding VC word stems appeared to be easier and generalisation occurred, even with the weakest readers. At CVCC level, the weakest readers lagged far less behind the relatively less weak readers if training words not only had the CC-cluster in common but also the vowel.

The results of the various studies seem to suggest that in the development of technical reading the sequence appears to be: from decoding at the grapheme level to direct word recognition to processing at subword level. The consequence of the aforementioned would be that practising at subword level with units larger than the graphemes would not be an intermediate stage between graphemes and the whole word, but follows on from the ability to read the entire word. Exercises at subword level do not *result* in direct recognition of words, but should be *based on* words which can already be recognised as a unit, resulting, if all goes well, in a quicker acquisition of directly recognised new words.

Many theses end with the conclusion that more research is necessary, and that is also the case with this thesis. The results of the entire remedial trajectory justify implementation on a larger scale. The results of the word-training programme will need to be replicated in a follow-up study. The treatment of pupils who emerge as dyslexic from this trajectory, could provide insights into how and to what extent the technical reading ability of these pupils can still be developed. Intervention with these pupils will be focussed on the conditions that can elicit response generalisation. In the Rotterdam Approach to Dyslexia, which started at the end of 2002, these aspects will be realised.

