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Remediation of fluency: Word specific or generalised training effects?

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Abstract. The present study examines whether reading fluency benefits more from repeated reading of a limited set of words or from practicing reading with many different words. A group of 37 reading delayed Dutch children repeatedly read the same 20 words with limited exposure duration, whereas another group of 37 poor readers received the same reading exercises with 400 different words. Results demonstrated that improvements in accuracy and speed of trained words were larger for the repeated reading group than for the children who had only practiced with these words once. No difference in generalisation of effects to untrained neighbour and control words was found between the two conditions. Furthermore, rapid naming skill was unrelated to improvements in reading fluency and transfer effects in both training conditions. Results demonstrate that the practical value of repeated reading lies in its word specific training effects.

Key words: Reading fluency, Generalisation, Repeated reading, Decoding, Rapid naming

Introduction

Although the success of a remediation program is often measured by looking at the gain in reading fluency of trained words, the efficacy can in fact be judged by two characteristics: the word specific training effects and transfer to untrained material (Kraemer, 2003). It can be questioned whether current training programs that focus on improving reading fluency fulfil both criteria. Although it is common practice to examine the transfer of phonological awareness training to general word reading skill (Castles & Coltheart, 2004), for training programs that focus specifically on improving reading fluency it is often neglected to study generalisation effects to untrained material. Even if transfer is examined, this is often done only by studying whether the training effects remain stable when trained words are presented in a different context (e.g., such as a story, Bourassa, Levy, Dowin, & Casey, 1998). A recent review by Chard, Vaughn, and Tyler (2002) illustrates that the main purpose of many experiments is to show that a certain fluency training program leads to higher word specific training effects than another type of remediation. However, one might argue that it is the level of generalisation to untrained material that demonstrates the efficiency and practical value of a remediation technique. First of all, generalisation leads to an increase in reading skill of untrained words without additional effort. Furthermore, higher general word reading skills leave more cognitive resources available for the ultimate purpose of reading: gathering meaning from text. The present experiment addresses the issue of transfer by examining both training effects and generalisation to untrained material after training reading skill with a limited set of words versus training decoding skill with many different words. The subjects will either receive exercises in which 20 words are repeatedly read or training focussed on decoding 400 different words. Generalisation may occur as a result of improved skills in phonological recoding. Additionally, the ability to draw orthographic analogies to untrained words might independently promote transfer (Savage & Stuart, 2001; Wood, 2002). In the latter case, when the orthographic patterns of the trained words are well established in lexical memory, transfer will only occur to words that are orthographic neighbours of the trained words. To investigate the possibility of both mechanisms, transfer to words that are either orthographically similar or dissimilar to the target words will be examined in the present study.

Training programs for reading disabled children that are focussed on gaining fluency are often based on the idea that repetition of words will improve the word specific orthographic representation in the mental lexicon (Chard et al., 2002; Kuhn & Stahl, 2003). The more specified this representation is, the easier it is to read the word fluently (Perfetti & Hart, 2002). Indeed, it has been demonstrated on numerous occasions that repeated reading training increases reading fluency of specific words (Levy, Nicholls, & Kohen, 1993; Meyer & Felton, 1999). However, the practical value of this type of treatment can be higher if transfer of training effects are found. The few experiments that have studied transfer have failed to find substantial generalisation of repeated reading training effects to untrained material (Lemoine, Levy, & Hutchinson, 1993; Young, Bowers, & MacKinnon, 1996; for an overview of repeated reading training studies, see Wolf & Katzir-Cohen, 2001). It appears that repeated reading leads to high levels of fluency for trained words, but has little benefits for general reading skill. Recent research has provided a theoretical framework for the word specific training effect of repeated exposure (Chard et al., 2002; Kuhn & Stahl, 2003). The self-teaching hypothesis put forth by Share (1995; 2004) indicates that every successful decoding event will improve future reading of a particular word. That this effect is the result of decoding instead of pure visual exposure is demonstrated by the fact that minimizing phonologic processing during presentation significantly diminishes the orthographic learning effect (Share, 1999). Furthermore, the self-teaching hypothesis also predicts training effects to be item-based. Thus the repeated reading training effects are expected to be word specific and generalisation to untrained words is therefore unlikely.

Some experimenters claim that once a word has become familiar after extensive practice, the child will be able to draw orthographic analogies to untrained neighbour words (Bowey, Vaughan, & Hansen, 1998; Farrington-Flint, Wood, Canobi, & Faulkner, 2004; Savage & Stuart, 2001; Storkel, 2004; Wood, 2002). Whereas even beginning readers appear to be able to make orthographic analogies, the performance of dyslexic children seems to be somewhat impaired (Humphrey & Hanley, 2004). It is possible that this diminished skill in making orthographic analogies is the result of less specified orthographic representations in dyslexics (Meyler & Breznitz, 2003). It is exactly this low level of orthographic specification that would be remediated by repeated reading of a word. Thus, repeated reading training might provide reading disabled children with the possibility to generate transfer of training effects to neighbour words. Indeed, this is exactly the result found by Reitsma (1997). In this experiment, groups of three neighbour words were read either 4, 8, or 16 times. There appeared to be a linear relationship between number of repetitions and amount of transfer to untrained neighbour words. However, training with neighbour words may have specifically focussed the subjects on orthographic similarities (the recurring rime unit) of the words and therefore may have trained the ability of the subjects to identify that particular rime unit in new words. This effect might not occur when the same word is repeated each time. In conclusion, the question remains whether repeated reading of dissimilar words, as is done in the present experiment, will lead to transfer effects on neighbour words. In order to examine the orthographic transfer effect, the present experiment will evaluate transfer to untrained control words as well as generalisation to untrained orthographic neighbours of the target words.

Even though repeating a small number of words might cause large word specific training effects or maybe even transfer resulting from orthographic analogies, general reading skill might benefit more from training with many different words and thus many different decoding instances, instead of rereading a limited set of words. There are reading remediation studies that have been able to demonstrate transfer to untrained material. These training programs usually focus more on improving the decoding strategy instead of mere repetition of words. For instance, studies in which children practiced with decoding pseudowords with limited presentation durations have demonstrated substantial improvements in reading of untrained words (van den Bosch, van Bon, & Schreuder, 1995; Wentink, van Bon, & Schreuder, 1997). This type of training, which is focussed on speeded decoding of words, may have taught the children a more efficient reading style, which could have promoted improvements in general reading skill. Thus, repeated reading effects might be word specific, but limiting the exposure duration or providing the child with ample decoding opportunities could have a more positive effect on transfer to untrained material. Indeed, specific instruction and training focussed on decoding of words significantly improves the general word reading skills of beginning and disabled readers (Foorman, Breier, & Fletcher, 2003; Hatcher, Hulme, & Snowling, 2004). It could therefore be claimed that repetition of a small set of words is not the most efficient way to remediate reading disabled children, because only a limited number of graphemes in a limited number of contexts will be decoded. Instead, extensive practice in speeded decoding by presenting many different words with limited exposure duration might be the better option to generate transfer effects. To investigate these hypotheses, the current experiment will examine whether speed and accuracy in reading trained and untrained words is most improved by repeated practice with a limited set of words or alternatively by decoding many different words.

One additional factor that could be of influence on transfer effects of fluency training is rapid naming skill. It has been suggested that a subgroup of reading disabled children suffer from a rapid naming deficit which might be the cause of their inability to create multiletter orthographic patterns (Bowers & Wolf, 1993; Wolf et al., 2002). Thus, children with slow naming speed would benefit less from repeated reading training than children without a RAN deficit (Bowers, 1993; Levy, Bourassa, & Horn, 1999). The present study aims to re-examine the influence of RAN skill on increases in reading fluency resulting from reading practice. Because training with many different words would specifically influence the efficiency of converting graphemes into phonemes, it is expected that RAN would be related to effects of this training condition in particular.

In sum, the present experiment will examine the extent of training and transfer effects after repeated reading of a limited set of words or speeded decoding of many different words. It is hypothesised that word specific repeated reading training will lead to substantial training effects and possibly to transfer resulting from orthographic analogies. On the other hand, similar exercises but with many different words are likely to lead to less word specific training effects, but more improvement in general reading skill and thus higher levels of transfer are expected. Finally, rapid naming skill is hypothesised to be predictive of training results, particularly for the group of children who practiced with many different decoding instances.

Method

Participants

Seventy-four Grade 2 students (mean age = 8.3 years, sd = 6 months) were selected from a total population of over 400 children. A subject was included in the study if he or she had a considerable lag in reading level, while IQ was in the normal range. As measured by a Dutch standardised reading test, the final subject group belonged to the 20% poorest readers of their grade (EMT, Brus & Voeten, 1973). Subjects were excluded from the study if a physical or sensory disability could explain the delay in reading level. Due to the relative regular orthography of Dutch, the subjects could be characterised as slow (on average 2 seconds per single syllable high frequency word) but accurate (85–90% correct) readers. The total subject group was randomly divided into two separate groups, while controlling for reading level ($F < 1$). One group ($n = 37$) received word specific repeated reading training, whereas the other group ($n = 37$) practiced reading skills with many different words.

Stimuli

The word specific training was carried out with 20 high frequency words. The target words had a CVCC, CCVC, CCCVC, CVCCC or CCVCC structure. A second list of 20 control words with similar word structures as the target words was used to assess general transfer effects. These control words were not orthographically similar to the target words, which means that they did not share a rime or onset. Furthermore, a third list of 20 neighbour words was constructed by altering one letter in the onset (12 times) or rime (8 times) of the target words in such a way that another existing Dutch word was made (e.g., *bloem* → *bloed*).

In the second condition, 400 different high frequency one syllable words, including the 20 target words from condition 1, were used. The words had a CVCC, CCVC, CCCVC, CVCCC or CCVCC structure. All words were concrete, highly familiar in spoken form and reading age appropriate. To determine training and transfer effects, the same 20 target, control and neighbour words were used as in condition 1. The control and neighbour words were not used during training in either conditions.

Procedure

Before the training started, the children were asked to read the 20 target words, the 20 neighbour words and the 20 control words. The number of errors and reading speed for each list were noted. The same words, but in alternating order, were administered as a posttest after the training. Furthermore, during pretest a RAN task was administered in which the children were required to name 50 digits, pen drawings of objects, and colours (five different items repeated 10 times) as fast as possible.

A computer program was used to present the reading exercises to the subjects. For both conditions, training started with individual instructions by the experimenter and a 10 item practice session. The target words were presented in reading exercises that were based on activating the semantics of the word. Two forms of exercises were administered in alternating fashion. In the first form, a word was presented on screen (e.g., *bird*). After carefully reading the word, the child was required to click the mouse button. The first word disappeared and was replaced by one of the target words (e.g., *egg*). The child had to judge whether the two words were semantically related. In the second exercise form, a question was presented on screen (e.g., *can you drink it?*). After clicking the mouse button, the question disappeared and was replaced by one of the target words (e.g., *water*). The child was required to answer the question. For both exercise forms a response was given by using the mouse cursor to click on either the 'yes' or 'no' button that was displayed on screen. The type of trials and the order of 'yes' and 'no' answers was semi-randomised and balanced in the training sessions to prevent predictability in responding. Accuracy feedback was given each trial in the form of a picture of a smiling or sad looking bear. Furthermore, the target words were presented in the middle of the screen with a limited exposure duration of 350 ms after which they were replaced by a visual mask in the form of non-letter symbols. Exposure duration remained stable during the sessions.

The difference in exercises between the two conditions was whether 20 target words were repeated or whether 400 different target words were used in the exercises. Obviously, the first word or question to appear on screen was modified so as to fit the target word and the required response. Although an attempt was made to keep the exercises as similar as possible, there was a difference in 'prompt' items between the two conditions. However, the main format of semantic training was identical for both conditions.

Each session consisted of 40 items (2 * 20 target words or 40 different words). The children performed a total of 10 sessions, with a frequency of

2–3 sessions per week. Thus, in the repeated reading condition, each target word was repeated 20 times during the entire training. In the other condition the target words were shown only once.

Results

The data on the performance *during* training show that the children become less accurate. Accuracy rates drop from 88 % correct in the first session to 77 % in the last session, $F(1{,}144) = 23.99$, $P < 0.001$, $\eta^2 = 0.14$. However, at the same time the children have improved their Reaction Times (RT) from 4.3 s to 2.1 s, $F(1{,}144) = 99.06$, $P < 0.001$, $\eta^2 = 0.41$. These results suggest that participants trade off accuracy by increasing their speed. This probably is induced by the use of brief and masked presentations of target words during practice. Overall, the repeated reading group performed during training sessions more accurately (6.4%) and faster (279 ms) than the group who practiced with many different words, $F(1{,}801) = 36.38$, $P < 0.001$, $\eta^2 = 0.04$ and $F(1{,}801) = 6.17$, $P < 0.01$, $\eta^2 = 0.01$, respectively. This result already demonstrates the benefits from repeatedly reading the same words during the training.

The mean accuracy and reading times on the pre- and the posttest are presented in Table 1. As is clear from this Table, the target words were already read more accurately and faster than the neighbour and control words at the pretest. Therefore, in order to allow for a more appropriate comparison the difference between pre- and posttest is represented as a proportional difference, i.e. for each individual the absolute difference as a proportion of pretest performance was calculated. These results unambiguously show that only performance on the target words had improved, both in accuracy and in speed, with about 7 and 32 percent, respectively.

A repeated measures analysis of variance with proportional change in accuracy as the dependent variable and Condition (limited versus unlimited) and Type of Word (target, neighbour, or control) as independent factors showed no significant overall effects. Planned comparisons only revealed a significant interaction effect between condition and the contrast between target and neighbour words, $P < 0.05$, $\eta^2 = 0.07$. As is evident from the Table, only in the limited set condition an increase in accuracy appears whereas at the same time a small decrease occurs for neighbour words. The latter may actually be a result of increased familiarity of the very similar target words.

A similar repeated measures analysis was carried out for reading speed. Both the effects of Type of Word and Condition were significant,

Table 1. Mean reading times (seconds per word) and accuracy (proportion correct) of target, neighbour, and control words during pre- and posttest, as well as the proportional improvement between pretest and posttest for both practice conditions.

	Limited set (20 words).					Unlimited set (400 words)				
	Pretest		Posttest		Prop. diff	Pretest		Posttest		Prop. diff
	M	SD	M	SD		M	SD	M	SD	
Reading time										
Target	1.7	0.9	1.2	1.0	31.9	1.6	0.8	1.4	0.6	10.2
Neighbour	2.3	0.8	2.0	1.0	13.8	2.3	0.9	2.0	0.7	11.3
Control	2.3	1.2	1.9	0.9	10.2	2.1	0.9	1.9	0.8	8.3
Accuracy										
Target	90.4	7.8	96.1	5.8	6.9	92.8	6.4	93.7	6.8	1.3
Neighbour	88.1	9.7	86.2	8.8	−1.4	87.0	8.8	87.3	7.6	1.4
Control	87.2	9.7	88.1	8.5	2.1	86.2	9.5	88.2	10.2	2.8

$F\,(1,72) = 7.67$, $P < 0.001$, $\eta^2 = 0.18$, and $F\,(1,72) = 6.67$, $P < 0.001$, $\eta^2 = 0.16$, respectively. Planned contrast analyses showed that only the increase in reading speed of target words in the limited set condition differed significantly from all other conditions.

The RAN data showed that on average, naming time per item for the children was 1.2 s for colours, 1.2 s for objects and 0.8 s for digits. Compared to findings provided by van den Bos, Zijlstra, & lutje Spelberg (2002), the present participants demonstrated slightly lower RAN skill only for naming digits; the average is 0.80 s (sd = 0.16) for the current participants, which differs significantly from the norm average 0.62 s (sd = 0.12), $F\,(1,204) = 71.20$, $P < 0.01$. Furthermore, negative correlations were found between RAN times and reading level at the beginning of the experiment as measured by a Dutch standardised reading test (EMT, Brus & Voeten, 1973; with RAN pictures: $r = -0.26$, $P < 0.03$; RAN colours: $r = -0.30$, $P < 0.01$; and RAN digits: $r = -0.37$, $P < 0.01$). Finally, irrespective of condition, linear regression analysis did not reveal a significant contribution of any RAN task to gains in accuracy or speed after initial reading level was entered. Thus, although there may be a significant correlation between RAN and reading skill, which possibly results from a common speed factor, there does not appear to be a causative relationship between RAN skill and improvements in reading fluency as a result of word specific training.

Discussion

Problems in attaining fluent reading skills in relative regular orthographies, such as Dutch, often amount to difficulties in achieving adequate reading rates, whereas reading errors are generally not the major obstacle. One of the questions then is how to improve the automaticity of single-word reading of impaired readers in Dutch. The present experiment set out to examine whether repeated reading of a limited set of words is more effective in improving reading automaticity and accuracy of trained or untrained words than reading many different words. Results demonstrate that in general the children have improved their reading accuracy and speed after training. This improvement is however limited to the target words, and only for the repeated reading group. In this condition, the reading speed for target words was improved by more than 30 percent in the posttest. Furthermore, transfer to untrained control and neighbour words was not found for either condition.

It seems that providing ample practice in reading many different words has no additional value over repeated reading training of a limited set of words. On the contrary, only the repeated reading training led to significant improvements in reading the target words. As expected according to the self-teaching hypothesis of Share (1995; 2004, see also Logan, 1997), each successful reading event of a specific word improves the future reading of that particular word. Thus, the practical value of repeated reading training seems to lie in its word specific effect. Each repetition of a word engraves the word specific orthographic information into the mental lexicon, thereby enhancing future retrieval. This process of learning about written language may also be the explanation for the often reported frequency effect in single-word reading. Because high frequency words are encountered more often than low frequency words, the former words are generally read more accurate and faster. Furthermore, it has indeed been demonstrated that performance on orthographic processing tasks is related to print exposure after phonological processing has been entered into the equation (Cunningham, Perry, & Stanovich, 2001). Overall, the present results suggest that for reading disabled children repetition in reading the same word is the key to success in learning to read.

Although recent research has demonstrated that children can rely on orthographic analogies during reading, reading disabled children seem to have a specific disability in this area (Humphrey & Hanley, 2004; Savage & Stuart, 2001; Wood, 2002). In normal reading development, drawing orthographic analogies is a particularly efficient skill, because it helps children to read completely new words without elaborate letter-by-letter decoding. In the introduction it was suggested that the inability to draw orthographic analogies might be the result of less specified orthographic representations of words in the mental lexicon. It was hypothesised that repetition of words would improve the orthographic representation of words and consequently enable the disabled readers to draw analogies. The results of the present experiment do not support this hypothesis. It appeared that the inability of the reading disabled children to draw orthographic analogies was uninfluenced by the number of repetitions of the target words. Overall, the results could be interpreted as evidence for the hypothesis that dyslexic children are disabled in their orthographic analogy skills, irrespective of the level of orthographic representations in the mental lexicon. However, further research is necessary to examine the effect of training on transfer to neighbour words. It may be that aiming the child's attention directly at the orthographic similarities in words might lead to larger transfer effects (Reitsma, 1997). Explicit training may be required to be able to use analogies. The idea that focus of instruction can have an influence on level of transfer has some support (Lovett et al., 1994). For instance, Benson, Lovett, and Kroeber (1997) found higher levels of transfer in reading disabled children after reading training combined with explicit instruction on orthography compared to transfer after mere visual presentation of words.

It could be said that the training and transfer effects are difficult to interpret because the three word lists already differed at the start of the experiment: the target words were read faster than the control words, which in turn were read faster than the neighbour words. However, we evaluated training effects by looking at the proportional improvement. Training and transfer effects could only have been enhanced by the initial difference because more room for improvement was present for the control and neighbour words than the target words. Thus, neither the training nor the transfer effect could have been obscured by the initial differences between the word lists. A second factor that could influence the size of training effects is the fact that reading skill of the subjects was already fairly high at pretest. Even though an average reading speed of two seconds per word is indeed slow, many of the subjects in the present study may be more accurately described as poor instead of dyslexic readers. A stronger difference in training and transfer effects between conditions might occur if (older) subjects were selected who suffer from larger delays in reading skill. On the other hand, the present subjects did not perform at ceiling value and could still improve significantly. Similarly, during training the children showed a significant increase in reaction times. The initial reaction times might seem long compared to the pretest reading speed of 2 seconds per word. However, reaction times not only include reading time, but also the time the subjects need to make a semantic decision and the motor reaction time. The children improve their speed because they become more familiar with the demands of the task itself, but also with the semantic properties of the target words. In conclusion, although the present subjects were not severely disabled in reading, a distinct improvement in performance was visible both on the posttest as during training, which makes it unlikely that differences between conditions were obscured by relatively high levels of reading skill at the beginning of the experiment.

A secondary goal of this study was to examine the relationship between rapid naming skill and gains in word reading after repeated reading training. It was expected that children who had slow naming speed benefited less from repetition and would therefore improve less than children with faster RAN performance. The present data do not corroborate the results of Bowers and Wolf (1993). Indeed, it appeared that the children did have a slight naming deficit for numbers, according to available norm data. However, RAN speed was not predictive of training results once initial reading level was taken into account. A specific hypothesis in the introduction predicted that there would be a positive relationship between RAN speed and improvements in reading for the group who trained with many different words. The speeded decoding of many different words was claimed to ameliorate the deficit in automatisation of naming single items (e.g., letters), which is claimed to result in lower RAN scores. Thus, children with low RAN scores should then benefit more from training in decoding with many different words. However, the present study does not confirm the existence of a causative relationship between RAN performance and effects of training either with a limited set of items or practice in decoding many different words. Linear regression analysis did not demonstrate any influence of RAN on training effects after initial reading level was taken into account. Thus, in our sample of young disabled readers of a regular language we were unable to demonstrate a causative influence of rapid naming speed on learning to read fluently.

The present findings are focussed on single word reading and implications for passage reading were not concurrently examined. One may ask whether improvement in word recognition in isolation generalizes to word identification in context. Research has been published in which transfer effects of training words in isolation to reading in context were not automatic at all (e.g., Fleisher, Jenkins, & Pany, 1979–1980; Levy, Abello, & Lysynchuk, 1997). However, Tan and Nicholson (1997) found that poor readers significantly benefit from single-word training by demonstrating better comprehension of passages containing these trained words than untrained children. Maybe, these incongruous findings are related to the level of severity of the reading deficit. Therefore, it remains to be investigated when such transfer effects occur or what conditions are preventing them.

In sum, repeated reading of words is an effective way to improve reading skill of trained words. Decoding many different words may improve skill in applying grapheme-phoneme correspondences and blending, but the present findings suggest that this does not lead to high increases in general reading fluency. In contrast, it seems that it is improved word specific orthographic knowledge that contributes to the development of reading fluency. The present experiment has demonstrated that repetition of material is an effective way to improve word specific reading fluency in reading disabled children.

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