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# Word reading fluency: A transfer appropriate processing account of fluency transfer

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**Abstract.** Word reading fluency, as indexed by the fast and accurate identification of single words, predicts both general reading ability and reading comprehension. This study compared the effects of context training and isolated word training on subsequent measures of word reading fluency. Good and poor readers were given 12 repetitions of two sets of words; 48 new words were learned in each condition. Words were presented in a story during context training and on a computer screen during isolated word training. Target words were read in isolation at test, randomly displayed within a series containing 72 untrained words. Results show that words trained in isolation are remembered longer and read faster when presented in isolation at test compared to words trained in context. Theoretical implications are discussed in relation to transfer appropriate processing.

**Key words:** Contextual facilitation, Reading fluency, Transfer appropriate processing

Traditionally, fluent reading has been characterized as the accurate and swift rendering of a text, coupled with adequate reading comprehension (Levy, Abello, & Lysynchuk, 1997). Recent work has shown that context training is associated with greater fluency improvements than isolated word training. Martin-Chang and Levy (2005) report that children read with greater speed and accuracy when words of a passage are first trained in a story context compared to in isolation. Thus far, the bulk of fluency research has been aimed at understanding reading gains at the text level (Faulkner & Levy, 1994; Levy, Nicholls, & Kohen, 1993; Martin-Chang & Levy, 2005; Rashotte & Torgesen, 1985; Young, Bowers & MacKinnon, 1996). However, there has been a call for a more universal view of fluency, one which also encompasses fluency at the word level (Breznitz & Berman, 2003; Wolf & Katzir-Cohen, 2001). The current study compares the effects of context training and isolated word training on word reading fluency. Our goals were twofold: first, to contribute to the literature on word reading fluency, and second, to guide theory by suggesting a possible mechanism underlying the contextual facilitation effect reported by Martin-Chang and Levy.

Research interest regarding the efficacy of isolated word instruction has spanned several decades (Ehri & Roberts, 1979; Ehri & Wilce, 1980; Johnston, 2000; Samuels, 1967; Singer, Samuels, & Spiroff, 1973). Samuels (1967) first argued that teaching words in isolation increased the resources available for attending to the orthographic components of print. In a training study, he compared the acquisition rates of words presented either in isolation or accompanied by a related illustration. The data showed that children read illustrated words more accurately during training. However, this was not the case at test; once stripped of contextual cues, the children could read more words that had been trained in isolation. In a second experiment, Samuels measured improvements in word acquisition after children had read either illustrated or non-illustrated storybooks. Here again, when poor readers were given books that only contained print they were able to read significantly more words in a subsequent reading test compared to children in the illustrated condition.

Singer et al. (1973) reported similar results when they examined the cumulative effects of pictures and sentences on word acquisition. As the number of extraneous cues associated with words increased, so too did the number of repetitions required to learn them. Consistent with Samuels' findings, Singer et al. concluded that teaching words in isolation resulted in better long-term retention rates compared to learning words in the presence of sentences or illustrations.

In a related set of experiments, Ehri and Roberts (1979) trained students in Grade 1 to read words presented in either context or in isolation. They paired 16 target words with meaningful sentences. In the context training condition, children read both the word and the sentence, whereas in the isolated word condition they only read the target word and the sentence was dictated by the experimenter. Ehri and Roberts concluded that different types of information were conveyed by the two training conditions. Children in the context condition retained more information about the semantic meanings of the words. In contrast, children in the isolated word condition acquired more knowledge about the orthographic characteristics of words, such as information pertaining to how the word was spelled. In addition, children in the isolated word condition learned to read more words in total compared to the children in the context condition. This pattern of results was replicated with a new population of children learning to read function words (Ehri & Wilce, 1980).

Johnston (2000) has also trained children to read words using varying degrees of contextual constraint. She reported that regardless of skill, children read more accurately at test when words were first trained in isolation compared to in sentences. Moreover, the least amount of learning was recorded during passage training, where words were read within meaningful text. Thus, Johnston's findings converge nicely with the view that reading words in context decreases the amount of attention allotted to the orthographic components of print (Samuels, 1967).

However, context training has also been credited with improving reading fluency. For example, it is well accepted that reading speed and accuracy improve as a function of repeatedly reading a passage (Dowhower, 1987; Faulkner & Levy, 1994; Levy, et al., 1993; Rashotte & Torgeson, 1985). Work by Bourassa, Levy, Dowin, and Casey (1998) examined whether the increased fluency gained by repeatedly reading one story would transfer to a second story. They found that novel stories containing trained words were read faster, more accurately, and with greater comprehension than stories containing untrained words. Therefore, it appears that training words in context results in more fluent reading of those words when they are later encountered in a new text. In a second experiment, Bourassa et al. investigated whether the fluency gains accrued by training words in context would transfer to reading words in isolation. They found that words trained in context were read with greater speed and accuracy compared to words that had not been trained. These data suggest that improving fluency in context also results in superior reading when words are removed from the story and read in isolation at a later time.

Why, then, has transfer from context to isolation been reported by Bourassa et al. (1998) but not by Samuels and his colleagues (Samuels, 1967; Singer et al., 1973)? The discrepant findings stem predominantly from the unique research paradigms used by each group. Bourassa and his colleagues were comparing words that had been trained in context to words that had not been trained, on measures of speed and accuracy. Bourassa et al. did not train words out of context. In contrast, Samuels and his colleagues focused on the improvements in reading accuracy that resulted from context training compared to isolated word training. Neither Samuels, nor Singer et al. measured reading speed, or included a control condition to act as a baseline for reading ability. In short, the question of whether one method of training (context or isolated word) contributed to better overall fluency remained largely unanswered.

Recently, Martin-Chang and Levy (2005) conducted a study designed to bridge some of these gaps in the literature. They combined a fluency transfer paradigm similar to Bourassa et al.'s (1998) with a training paradigm that included both context and isolated word conditions (Ehri & Roberts, 1979; Ehri & Wilce, 1980; Johnston, 2000; Samuels, 1967; Singer et al., 1973). Good and poor readers in Grade 4 were taught to read words using two experimental training programs. In the first condition, words were embedded in a meaningful passage (context training), while in the second condition, new words were presented in isolation as part of a computer game (isolated word training). During the transfer phase of the experiment children were asked to read novel passages made up of predominantly: (a) words trained in context, (b) words trained in isolation, or (c) untrained words. Martin-Chang and Levy found that both types of training resulted in significantly faster (all readers) and more accurate (poor readers) reading of novel transfer stories compared to control stories. However, the gains from the training programs were not equivalent; words trained in context were read faster in a new context than words trained in isolation.

This finding was replicated in a second experiment with average readers in Grade 2. Using the same experimental procedure, Martin-Chang and Levy (2005) observed faster and more accurate reading in passages containing trained words (context and isolated word training) compared to those containing untrained words (controls). However, once again the gains produced by context training were more pronounced. Context training resulted in faster, and more accurate, reading of novel transfer passages compared to isolated word training. The evidence reported by Martin-Chang and Levy invites the question of why words trained in context are read faster, and in some cases more accurately, than words trained in isolation. Two explanations have been proposed. The first, known as the contextual superiority hypothesis, revolves around the premise that learning to read in a meaningful context has inherent benefits. In contrast, the transfer appropriate processing (TAP) hypothesis focuses on the congruency between processes employed during training and testing.

The context superiority hypothesis follows the logic of levels-of-processing, as originally proposed by Craik and Lockhart (1972). In their seminal paper, Craik and Lockhart found improved memory for words encoded within a meaningful context (e.g., "cat": is an animal) compared to words encoded based on perceptual attributes (e.g., "cat": rhymes with hat, or "cat": contains the letter a). The term "deep processing" was reserved for words that were encoded based on their semantic meanings, whereas "shallow processing" referred to words that were encoded more perceptually. The contextual superiority hypothesis used here suggests that reading in context is a form of deep processing and will therefore lead to better learning of new words. If this is the case, then words read in context should have an advantage over words learned in isolation, as found in the contextual facilitation effect observed by Martin-Chang and Levy (2005).

The contextual superiority hypothesis gains support from the well documented finding that context facilitates on-line word recognition among inexperienced readers (Archer & Bryant, 2001; Goodman, 1965; Nicholson, 1991), poor readers (Nation & Snowling, 1998; Nicholson, 1991; Perfetti & Roth, 1981; Stanovich, 1980), and fluent readers under impoverished conditions (Perfetti & Roth, 1981; Stanovich & West, 1983). It has been convincingly argued that context aids readers because it takes the urgency out of phonological decoding (Stanovich, 1980). If reading is poor, due to either a lack of skill, experience, or clear data, context increases accuracy by limiting the number of lexical choices that are appropriate given the surrounding syntactic and semantic framework. When this constraining mechanism is combined with even rudimentary phonological knowledge, the result is more proficient reading (Perfetti & Roth, 1981; Stanovich, 1980; Stanovich & Stanovich, 1999; Tunmer & Chapman, 1995, 2002).

The constraining mechanism activated during contextual reading is driven by slow on-line comprehension processing (see Perfetti, 1992; Perfetti & Roth, 1981; Stanovich, 1980; Stanovich & West, 1983). It follows, then, that reading words in context, at least for poor readers (see Faulkner & Levy, 1994), requires more conceptual processing than reading words in isolation. In turn, it could be argued that more conceptual processing leads to "deeper" word representations in memory, and that deeper representations are accessed more fluently during subsequent word reading encounters.

However, a second, and very different interpretation, can also be used to explain increased passage reading fluency after context training, compared with isolated word training. According to TAP, the "best" type of training depends largely on the processes that are required at test. For example, in Martin-Chang and Levy's (2005) experiments, reading always took place in a new story context during the transfer phase. Thus, the processes required during training and test were identical for the context condition. However, this high degree of congruency in the training and transfer phases in the context condition was unparalleled in the isolated word condition. From a TAP perspective, performance in the context condition may have been maximized because common processes were employed during study and test (Rajaram, Srinivas & Roediger, 1998).

The current experiment was conducted in order to contrast the two alternative explanations of the contextual facilitation effect observed by

Martin-Chang and Levy (2005). Good and poor readers in Grade 3 were taught to read words in context and in isolation at phase 1. The target words were subsequently presented in isolation within a series containing both trained words and distractors during phase 2. Presenting the words in isolation at test serves a dual purpose. First, it allows us to contribute to the literature on word reading fluency by clarifying whether words trained in context are disadvantaged when they are stripped of context at test (e.g., Johnston, 2000; Samuels, 1967; Singer et al., 1973), or conversely, whether the reading gains that accrue during context training transfer to isolated word reading (e.g., Bourassa et al., 1998). Second, showing words in isolation at test draws a clear distinction between the contextual superiority hypothesis and the TAP hypothesis with regard to the contextual facilitation effects reported by Martin-Chang and Levy. When target words are read in context during the transfer task, as they were in the experiments performed by Martin-Chang and Levy, the two hypotheses both predict disproportional fluency gains from context training. This is not so, however, when target words are read in isolation during the transfer task. Here, the two theories make opposing predictions about which method of training will lead to the greatest reading improvements. The contextual superiority hypothesis predicts greater word reading fluency will result from context training because of the "deeper" and more meaningful representations formed during training. Deeper representations should result in more fluent reading regardless of whether the words are presented in context or in isolation at test. In contrast, the TAP approach predicts greater fluency gains following isolated word training than after context training; here, greater congruency results from presenting words in isolation during both training and transfer.

## Method

### *Participants*

Forty-eight students in Grade 3 between the ages of 8 and 9 participated in this study. These children were selected from 138 students who were screened in six elementary schools from a local school board. All children with parental consent were tested with the reading subtest of the Wide Range Achievement Test – 3rd Edition (WRAT3; Wilkinson, 1993).

The effects of context are often contingent on reader skill (Stanovich, 1980). Good readers rarely use context to aid word recognition under normal reading conditions (e.g., Allington, 1978; Nicholson, 1991; Perfetti & Roth, 1981); in contrast, effects of contextual facilitation are commonly reported in poor readers (e.g., Allington, 1978; Archer & Bryant, 2001; Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003; Nicholson, 1991; Perfetti & Roth, 1981). Consequently, an age matched design with readers of different ability was used to examine interactions between reader skill and method of training.

The good reader group consisted of 24 students (13 males and 11 females). The average age for this group was 8 years and 4 months (ranging from 97 to 108 months). The mean standard score on the WRAT3 for the good readers was 116.96 (SD = 6.83, range = 110–129). The poor reader group also contained 24 students (10 males and 14 females) whose standard scores on the WRAT3 were lower than 90. The mean score for the poor readers was 86.71 (SD = 2.96, range = 77–90). The average age for this group was 8 years and 6 months (ranging from 96 to 108 months).

*Design and materials*

The critical difference between the current experiment and those carried out previously occurred during the transfer task at phase 2. In the experiments by Martin-Chang and Levy (2005) children were trained to read words in both context and in isolation at phase 1 and transfer took place within a new story context in phase 2. The goal here was to replicate the training conditions used by Martin-Chang and Levy, but to have the transfer task involve reading the words in a new list in phase 2. For a list to be "new" it needed to contain a substantial number of untrained words. To meet these material requirements, distractor words were added to the target sets at test. There were two types of distractors: *control words* contained no trained components and acted as baseline measures of reading, *generalization words* were new exemplars from old word families (words that rhymed with trained words) and acted as a measure of generalization to new orthographic neighbors of trained words. However, it is important to note that our main focus was in the transfer of word reading fluency. That is, we were interested in whether the reading fluency established during training would transfer to reading those words in a different context, in this case, reading the *trained* words in a *new* list. Specifically, we asked whether one type of training (context/isolated word) would lead to heightened fluency transfer when rereading trained words during a subsequent encounter.

A within-subject design was employed where each participant received both isolated word and context training. The training conditions contained different items, so the child learned new words in each condition. Three mutually exclusive lists were created (A, B, & C; see Appendix). Each list was comprised of 12 exemplars from eight word families (e.g., ‘‘ain’’ word family: slain, drain, grain, brain, train, pain, stain, vain, main, chain, plain, gain). Words were considered to be from the same word family if they shared an orthographic rime unit (final letters of a word including the last vowel). These lists were then divided in half to form two sets. Each set contained six different instances from the eight word families, resulting in 48 words in total (e.g. Set A1: slain, drain, grain, brain, train, pain, etc. Set A2: stain, vain, main, chain, plain, etc.). The sets containing different exemplars from the same eight word families were used to create the target words and distractor words. Distractor words coming from the same word families also acted as a measure of generalization to orthographic neighbors. All sets were balanced for word frequency (Thorndike & Lorge, 1952). In addition to the training words and the generalization words, a list of new control words with no systematic orthographic overlap with trained words acted as a baseline measure of reading during each transfer task.

A corresponding training story was written for each of the six word sets (see Appendix for an example). The training stories contained two repetitions of each target word, resulting in 96 ($48 \times 2$) target words per story. The stories contained a number of contextual words that were necessary to create plausible children’s tales; however the children only read the 96 target words. Target words were printed in red ink to make them clearly distinguishable from the contextual words. All of the training stories were 686 words long and were analyzed by the Flesch-Kincaid formula to be at a Grade 3.0 level of difficulty.

By the end of the experiment each participant had been tested on one list of words following context training, one list of words following isolated word training, and one list of words that received no training. The material sets were counterbalanced so that lists A, B, and C were used equally often for context, isolated word, and control conditions, and within those lists, Sets 1 and 2 were used equally often for training and generalization.

In sum, the words were always read in isolation during transfer. What varied was the method of training in phase 1. The fact that all of the words were read in isolation at phase 2 ensures that differences in reading speed and accuracy observed at test are reflections of the word’s training history (context or isolation). In the *isolated word condition*, the target words were trained individually, while in the *context condition*, the target words were trained in context. In the *control condition*, the words received no training.

*Procedures*

All children were tested individually in a quiet room of their school. They received training for approximately 15–20 min a day. Each training condition took place over 2 days (phase 1), with the transfer task occurring on the third day (phase 2). The training conditions were scheduled during two consecutive weeks. The order of training was counterbalanced over all participants.

During isolated word training, the children completed six list repetitions a day, for 2 days, resulting in a total of 12 repetitions for every target word. The 48 words were randomized for each presentation. The target words appeared individually in the center of a computer screen. The experimenter sat beside the participant and controlled the presentation of each item. A maximum of 1.5 s was allotted for each word to be read aloud into a microphone. The word automatically left the screen either when the voice key was activated via the microphone, or 1.5 s elapsed. If the child accurately read the word, no feedback was given and the experimenter recorded the item as "correct". If, however, the child misread the word or failed to respond within 1.5 s, the experimenter provided the correct pronunciation and scored the item as "incorrect". In those cases when the voice key was activated by something other than the child's voice, the trial was recorded as a "spoil". The children were asked to make the words "disappear" from the screen as quickly as possible without making any mistakes. The computer program automatically recorded the time between the appearance of the word and the activation of the voice key. The number of correctly read items was summed for the accuracy measures for each trial. The mean response times reported below reflect only the words read correctly.

In the context training condition, a shared reading paradigm was used so that the target words could be embedded in an age-appropriate story while equating the number of critical responses in the two training conditions. This procedure helped equate task difficulty in the two experimental conditions because in each case, the children read only the designated target words. The shared reading paradigm also ensured that readers of all skill had access to the same amount of contextual information surrounding the target words.

In phase 1, training stories were read three times a day (two word repetitions per story) for 2 days, resulting in 12 repetitions of each target word. The experimenter read the stories at a constant pace however the child was encouraged to read the target words as fast as possible without making any mistakes. If the child misread a word, or failed to make a correct response within 1.5 s (as estimated by a trained experimenter) the correct pronunciation was provided and the word was recorded as an error. Accuracy was recorded as the number of target words (out of 96) that the child read correctly. Response time was measured as the time it took for the child and the experimenter to read the entire story from beginning to end.

During phase 2 of both training conditions, the children were asked to read 120 individual words from a computer screen. The transfer task contained 48 trained words and 72 new words. The new items were divided into 48 words that contained trained orthographic rime units (generalization words), and 24 items that did not (control words: 24 new control words appeared in each training condition resulting in 48 control words in total). In order to ensure that the children felt comfortable using the microphone and voice key, a 4-item practice session was repeated until the children could use it without difficulty. No words from any part of the experiment were included in the practice session.

The children were asked to read the words as quickly and as accurately as possible in phase 2. They were not explicitly told that a subset of the words had been practiced on the previous 2 days. The transfer task in phase 2 was very similar to the isolated word training condition in phase 1. Words appeared individually in the center of a computer screen and remained there until the child read the word into a microphone or until 3 s of time had elapsed. A computer program automatically recorded the time between the appearance of the word and the activation of the voice key via the microphone. The experimenter controlled the presentation of the words and recorded each trial as "correct", "incorrect", or "spoiled". However, unlike training, no corrective feedback was given during the transfer phase and the response cut-off time was increased to 3 s. The time criterion was increased to reduce the chances of low accuracy scores being caused by overly stringent time constraints.

## Results

### *Training phase*

The analyses reported below were conducted using combined list repetitions. Pairs of lists (1 and 2, 3 and 4, etc.) were amalgamated so that one combined isolated word trial contained the same number ($2\times48$) of target words as one context trial. The combined accuracy scores were calculated by summing the number of correct responses across the two list repetitions. The reading speed scores were calculated by taking the mean of the reading times for the correct responses across the two list repetitions.

*Reading accuracy*

The mean accuracy scores for context training and isolated word training are presented in Figure 1. As depicted in Figure 1, good readers were more accurate than poor readers, and both good and poor readers were more accurate during context training compared to isolated word training. A 2×2×6 mixed analysis of variance (ANOVA) where the between-subject factor was group (good and poor) and the within-subject factors were condition (isolated word and context) and trial (1 through 6), confirmed these observations with main effects of group, $F(1,46) = 27.91$, $MSE = 36{,}880$, $p < 0.001$, condition, $F(1,46) = 36.87$, $MSE = 5310.77$, $p < 0.001$, and trials, $F(5,230) = 116.68$, $MSE = 2160.77$, $p < 0.001$. The Condition×Group interaction was significant, $F(1,46) = 24.2$, $MSE = 3485.92$, $p < 0.001$, as was the Trials×Group interaction, $F(5,230) = 62.4$, $MSE = 1155.66$, $p < 0.001$. However, these results should be interpreted with caution because they could result from the fact that the good readers were very near to ceiling. Neither the Condition×Trials interaction ($F(5,230) = 1.01$, $p =$ n.s.), nor the Condition×Trials×Group interaction ($F(5,230) = 0.974$, $p =$ n.s.), approached significance.

As can be seen in Figure 1, the good readers had very high accuracy scores throughout the duration of training[1]. Therefore, to rule out ceiling effects, a 2(condition: context, isolated word)×6(trial: 1–6) within factor

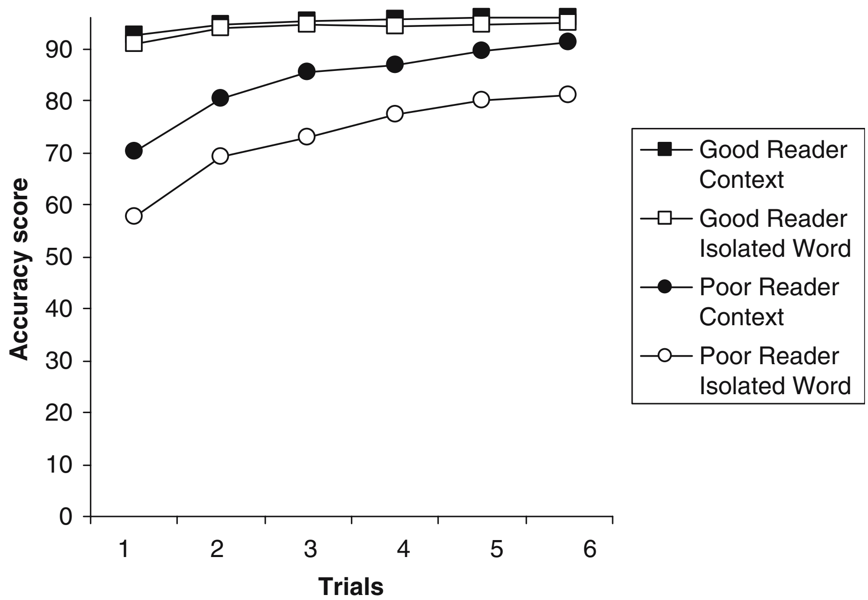


*Figure 1*. Mean accuracy scores (out of 96) over training as a function of condition and group.

ANOVA was conducted on the good readers alone. The ANOVA confirmed main effects of condition, $F(1,23) = 9.832$, MSE = 95.68, $p < 0.005$, and trial, $F(5,115) = 16.38$, MSE = 83.48, $p < 0.001$, showing that the good readers were reliably more accurate when reading in context, and that they made small, but significant, gains over training. The Condition×Trials interaction was not significant, $F(5,115) = 0.411$, $p =$ n.s., indicating that the effects of training were consistent over trials in both conditions.

*Reading speed*

The mean reading times for context and isolated word training are presented in Table 1. During the context condition, the reading time measure reflected how long it took for the experimenter and the child to read a training story, in contrast, during the isolated word condition, the reading time reflected how quickly students could read individual words. Therefore, two separate ANOVAs were carried out for each training condition. In both cases, good readers were faster than poor readers, and mean reading times decreased as training progressed. For context training, a 2×6 mixed ANOVA was conducted where the between-subject factor was group (good and poor) and the within-subject factor was trial (1 through 6). The ANOVA confirmed these observations with main effects for group, $F(1,46) = 15.54$, MSE = 23,8970.89,

*Table 1.* Mean reading times (in seconds) over training (standard deviations in parenthesis).

| | Good readers | Poor readers |
|---|---|---|
| Isolated word | | |
| 1 | 0.71 (0.11) | 0.93 (0.12) |
| 2 | 0.68 (0.09) | 0.88 (0.13) |
| 3 | 0.68 (0.08) | 0.87 (0.13) |
| 4 | 0.67 (0.09) | 0.86 (0.14) |
| 5 | 0.67 (0.08) | 0.85 (0.14) |
| 6 | 0.66 (0.08) | 0.834 (0.16) |
| Context | | |
| 1 | 294.96 (41.94) | 394.17 (86.78) |
| 2 | 277.13 (39.93) | 346.33 (78.13) |
| 3 | 267.40 (33.35) | 316.21 (60.28) |
| 4 | 260.00 (34.27) | 307.92 (64.16) |
| 5 | 244.78 (38.84) | 290.20 (49.42) |
| 6 | 246.58 (30.58) | 281.67 (47.67) |

$p < 0.001$, and trial, $F(5,230) = 129.75$, $MSE = 43{,}889.81$, $p < 0.001$. In addition, the Group×trial interaction was significant, $F(5,230) = 19.09$, $MSE = 6460.6$, $p < 0.001$.

For isolated word training an ANOVA was conducted where the between-subject factor was group (good and poor) and the within-subject factor was trial (1 through 6). The ANOVA found significant main effects of group, $F(1,46) = 37.91$, $MSE = 2.66$, $p < 0.001$, and of trial, $F(5,230) = 15.37$, $MSE = 0.029$, $p < 0.001$. Thus, once again the good readers were faster than the poor readers and reading speed increased throughout the duration of training. The Group×trial interaction did not approach significance, $F(5,230) = 1.61$, $p =$ n.s., indicating that both good and poor readers made equivalent gains in reading speed throughout the duration of the 12 isolated word repetitions.

Taken together, the results from phase 1 show that training, be it in context or in isolation, leads to faster and more accurate reading in readers of all skill. Due to differences in timing measures, cross condition comparisons were not possible regarding reading speed. However, in terms of reading accuracy, the data clearly favor context training over isolated word training. All readers were able to name more words on the first trial of context training compared to isolated word training. The contextual benefit was observed over the duration of training, with more words being read correctly after the completion of context training versus isolated word training. The benefits of context were more pronounced in poor readers compared to good readers, however, this might not have been the case if the good readers had been working with more challenging material.

### *Transfer phase*

It will be recalled that half of the control words were presented within each transfer condition (24 in isolated word and 24 in context = 48 total). A *t*-test revealed very similar baseline performances for the speed, $t(47) = 0.48$, $p > 0.63$, and accuracy, $t(47) = 1.08$, $p > 0.28$, of the two sets of control words. Therefore, the scores listed for the control condition represent the mean of the reading times for the correct responses (Figure 4), and the sum of the accuracy scores from the isolated word and context conditions (Figure 2).

#### *Reading accuracy: target words*

As depicted in Figure 2, the good readers were more accurate than the poor readers and the trained words were read more accurately than the control words. A 2×3 mixed ANOVA where the between-subject factor was group (good and poor) and the within-subject factor was condition (context, isolated word, and control) found main effects of group, $F(1,46) = 33.40$, MSE = 3906.25, $p < 0.001$, and condition, $F(2,92) = 52.48$, MSE = 613.31, $p < 0.001$. The Group×Condition interaction was also significant, $F(2,92) = 32.82$, MSE = 383.77, $p < 0.001$, reflecting the fact that the poor readers had more difficulty reading the control words than the good readers. A Bonferroni post hoc comparison showed that the words trained in context and in isolation were read more accurately than the words from the control condition, but that the two training conditions produced equal accuracy gains. Once again, it appears that the good readers may have been on ceiling for accuracy. However, when a 1×3 within-subject ANOVA was conducted on the good readers alone, the main effect of condition remained significant, $F(2,46) = 7.70$, MSE = 14.29, $p < 0.001$. Here again a Bonferroni post hoc comparison showed that the two training conditions lead to equal accuracy, but that they both surpassed the control condition.

During phase 1, significantly more words were acquired in context training compared to in isolated word training. Therefore, it is noteworthy that words in the context and isolated word conditions were read with the *same* degree of accuracy at phase 2. This pattern could result from one of two scenarios: (a) the words learned in context might not be

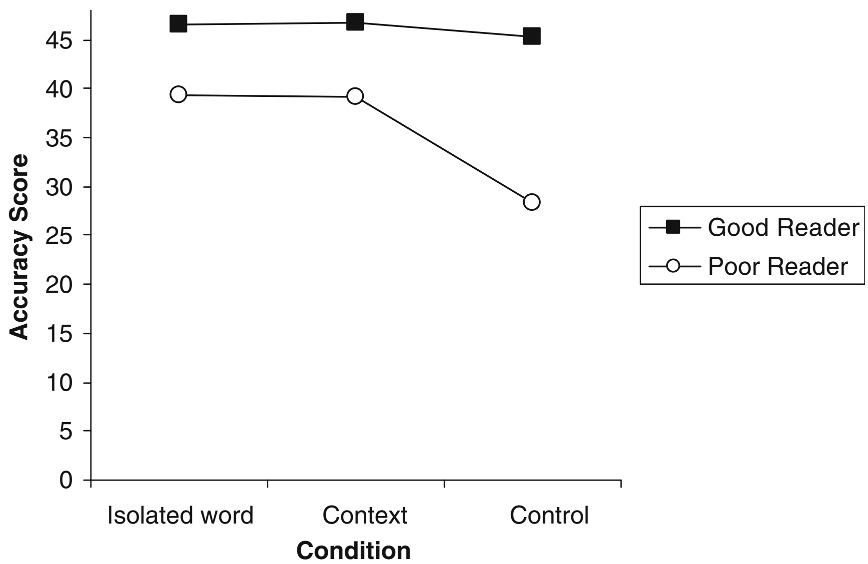


*Figure 2.* Mean accuracy score (out of 48) during transfer as a function of condition and group.

retained as well as the words learned in isolation, or alternatively, (b) the words read in isolation might have improved from training to transfer. The data are presented in Figure 3. These results show that the good readers were more accurate than the poor readers during both phases of the experiment, and that reading was more accurate in general at the end of training compared to at test. The data also indicate that more words were forgotten between training and transfer in the context condition, compared to the isolated word condition – especially in the poor reader group. A 2×2×2 mixed ANOVA where the between-subject factor was group (good, poor) and the within-subject factors were condition (context, isolated word) and phase (training phase, transfer phase) confirm these observations with main effects of condition, $F(1,46)=50.76$, $MSE=1109.08$, $p<0.001$, phase, $F(1,46)=7.92$, $MSE=339.22$, $p<0.01$, and group, $F(1,46)=16.82$, $MSE=7280.27$, $p<0.001$. These main effects were qualified by a significant Condition×Group interaction, $F(1,46)=15.02$, $MSE=328.24$, $p<0.001$, a significant Condition×Phase interaction, $F(1,46)=23.80$, $MSE=485.17$, $p<0.001$, and a significant Condition×Phase×Group interaction, $F(1,46)=20.36$, $MSE=415.04$, $p<0.001$. The Phase×Group interaction approached significance, $F(1,46)=3.68$, $MSE=157.61$, $p=0.061$.

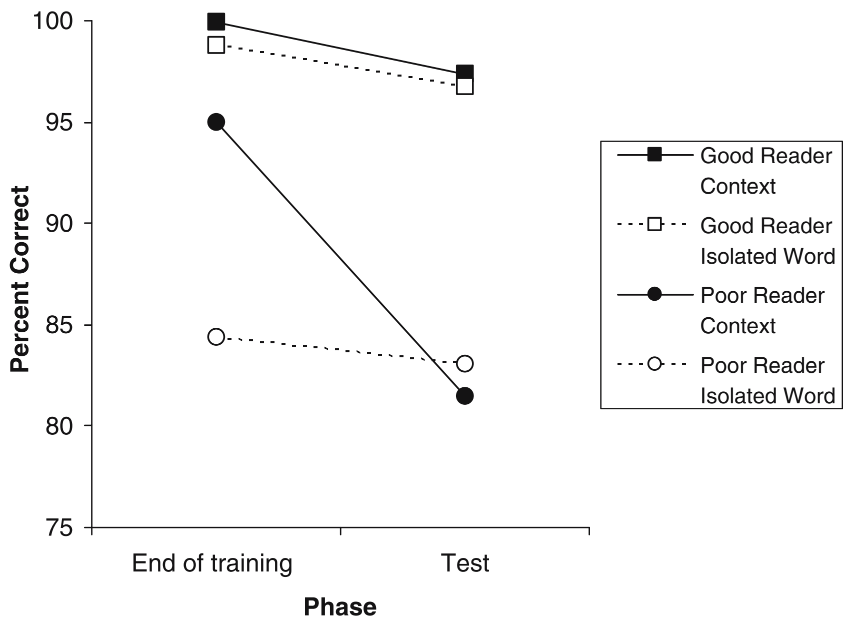


*Figure 3*. Mean accuracy scores (percent) as a function of condition, phase and group.

In order to clarify these interactions, two separate 2(condition: context, isolated word)×2(phase: phase 1, phase 2) within-subject ANOVAs were conducted on each reading group alone. Results for the good readers indicate a main effect of condition, $F(1,23) = 16.08$, MSE = 115.30, $p < 0.001$. However, neither the main effect for phase ($F(1,23) = 3.07$, MSE = 17.19, $p = 0.093$) nor the Condition×Phase interaction ($F(1,23) = 0.232$, MSE = 1.37, $p$ = n.s.) were significant in the good readers alone.

However, results of the within-subject ANOVA for poor readers showed main effects for both condition, $F(1,23) = 36.20$, MSE = 1322.02, $p < 0.001$, and phase, $F(1,23) = 5.99$, MSE = 479.64, $p < 0.03$. The Condition×Phase interaction was also significant in the poor readers, $F(1,23) = 25.77$, MSE = 898.84, $p < 0.001$.

*Reading accuracy: generalization words*

Finally, the accuracy scores for the generalization words are presented in Table 2. These data were analyzed in a 2(group: good, poor)×3(condition: context, isolated word, and control) repeated measure ANOVA. For the generalization words, the main effect of group was significant, $F(1,46) = 54.65$, MSE = 9360.56, $p < 0.001$. However, neither the main effect of condition ($F(2,92) = 0.545$, $p$ = n.s.), nor the Condition×Group interaction ($F(2,92) = 1.157$, $p$ = n.s.) approached significance. These results indicate that the good readers read the generalization words better than the poor readers, but that all of the untrained words were read with similar accuracy regardless of whether they contained trained components.

*Reading speed*

Two separate 2×3 mixed ANOVAs were carried out for the reading speed of the trained words and generalization words. In each case, the between-subject factor was group (good and poor) and the within-subject factor was training condition (context, isolated word, and control).

*Table 2.* Mean accuracy scores (out of 48) and reading times (in seconds) in the transfer phase for generalization words (standard deviations in parenthesis).

| | Good Readers | | Poor Readers | |
|---|---|---|---|---|
| | Accuracy | Reading time | Accuracy | Reading time |
| Word isolated | 45.08 (3.19) | 0.69 (0.09) | 30.04 (10.90) | 1.07 (0.34) |
| Context | 45.29 (4.21) | 0.73 (0.16) | 28.88 (10.24) | 1.08 (0.33) |
| Control | 45.33 (2.85) | 0.72 (0.13) | 28.42 (11.11) | 1.03 (0.22) |

The reading times for the transfer phase of the experiment are presented in Figure 4. Figure 4 shows that the good readers were faster at naming target words than the poor readers. This was confirmed by a 2(group: good and poor)×3(condition: context, word, and control) ANOVA with a main effect of group, $F(1,46) = 37.16$, MSE = 3.26, $p < 0.001$. In addition, Figure 4 illustrates that words trained in isolation were read faster than both the words trained in context and the control words. Again, this observation was confirmed by a main effect of condition, $F(2,92) = 9.93$, MSE = 0.07, $p < 0.001$. A Bonferroni post hoc comparison showed that isolated word training differed significantly from both context training and control, but that the latter two conditions did not differ from one another. The Group×Condition interaction was not significant ($F(2,92) = 0.390$, $p$ = n.s.) indicating that both good and poor readers profited equally from isolated word training compared to context training and control.

Also as indicated in Table 2, good readers read the generalization words faster than the poor readers. This was confirmed by a 2(group: good and poor)×3(condition: context, isolated word, and control) mixed ANOVA with a main effect of group, $F(1,46) = 31.41$, MSE = 4.37, $p < 0.001$. No other comparisons for the speed of reading generalization words were significant.

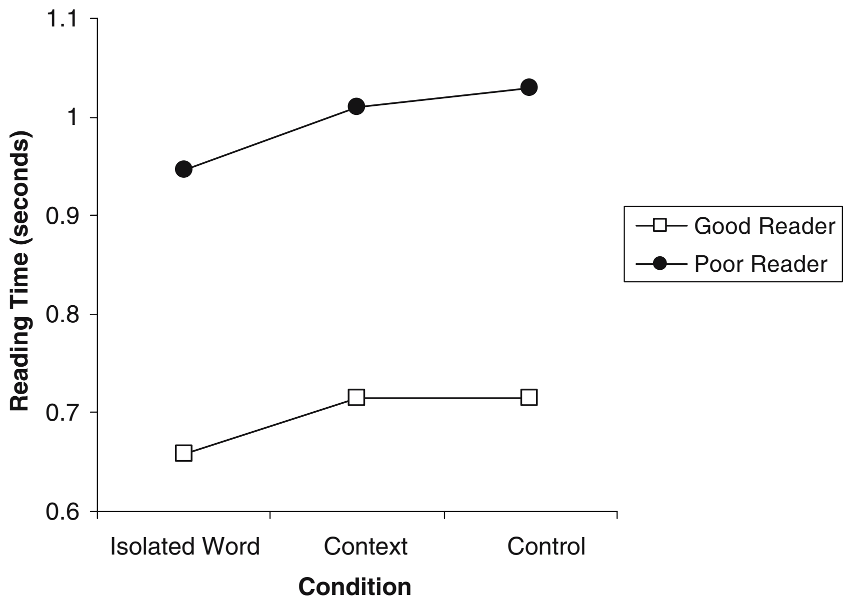


*Figure 4*. Mean reading time during transfer as a function of condition and group.

In general, context and isolated word training resulted in similar levels of word reading accuracy during a novel reading task. However, the words trained in isolation were read faster by both good and poor readers compared to words trained in context. Words trained in context were read more accurately than control words but they were read just as slowly as words that had not been trained. These effects were specific to trained words and did not generalize to words containing trained rime units. Generalization words that shared orthographic rime units with the trained words were not read faster or more accurately than control words.

## Discussion

The contextual superiority hypothesis suggests that information encoded for meaning leads to inherently superior learning. Although this notion has intuitive appeal, the results reported here do not support this claim. At test, poor readers retained more words trained in isolation compared to words trained in context. In addition, words practiced in isolation during training were read faster by all readers in a subsequent reading task than words practiced in context. If learning to read in context results in better word representations in memory, it is difficult to explain why items trained in isolation are at an advantage here. The logic behind the contextual superiority hypothesis breaks down in light of this evidence.

On the other hand, the account provided by the TAP hypothesis provides a framework in which both the findings reported here, as well as those observed by Martin-Chang and Levy (2005), can be interpreted. The key tenet of TAP is that performance will benefit to the extent that the processes incurred at study are reinstated at test. Given that the transfer task involved reading words in isolation, reading performance should receive maximal benefit following isolated word training compared to context training. The findings of the current experiment support this claim. Isolated word training led to more fluency gains at the word level than context training. Words trained in isolation were remembered better by poor readers over the retention period, and they were read faster by all readers at test. In contrast, words trained in context were read no faster than words that had not been trained at all. Similar findings have been reported by Oliphant (1983), who found that reading words in lists facilitated isolated word reading at test, but that reading words in context did not. To be clear, this evidence should not be taken as support for training in isolation under all circumstances. Yet it is essential to the understanding of fluency transfer because it shows that isolated word training can be superior to context training, if the ensuing test involves reading words in lists.

With regards to contributing to the literature on the transfer of word reading fluency, our findings show that for all readers, context training and isolated word training both result in more accurate word reading at test. These findings fit nicely with the data reported by Bourassa et al. (1998), who found improved isolated word accuracy after context training compared to a control condition. However, although the accuracy scores between the two training conditions were equivalent at test, it appears that, at least for poor readers, words were better remembered in the isolated word condition. These findings support the body of work by Samuels and his colleagues (Samuels, 1967; Singer et al., 1973) who found greater accuracy improvements after isolated word training than context training.

When considering the reading time of individual words, we found that while isolated word training resulted in faster reading times for all children at test, context training did not. In contrast to the present finding, Bourassa et al. (1998) did find reading speed benefits on isolated words following context training. What could account for these discrepant results? First, the participants in the Bourassa et al. study read the training story only minutes before reading the transfer list, whereas children in the present investigation had a 1 day retention interval between study and test. Second, during the transfer phase itself, Bourassa et al. blocked the presentation of the trained words versus the new words, and did not include rhyming words as distractors. Thus the children in the Bourassa et al. study were confronted with 80 trained words followed by 80 new words (or visa versa). It is possible that the string of old words engaged conceptual processes similar to those employed while reading in context. While speculative, if this were the case, the conceptual processes engaged at both study and test would be expected to result in faster retrieval times for trained words, which was what Bourassa et al. reported. The current paradigm used only one test list during the transfer task in which trained words, generalization words and new words were presented randomly. Perhaps then, the memory traces of the old words were not retrieved because their familiarity was too low within the randomized set. In sum, the transfer condition in the present experiment involved a larger retention period, more distractors, and was less amendable to conceptual processing, than the transfer task reported by Bourassa and his colleagues.

Although trained words were read more accurately following both training conditions, and faster following isolated word training, corresponding benefits were not observed for generalization words. Yet, it should be noted that the children were only given 3 s to read each word during the transfer phase. Perhaps an increase in accuracy would have been observed for generalization words if the children had been able to use an analogy strategy of reading. However, the primary focus here was on word reading fluency, which requires that words are read both quickly and accurately. Given these restraints, no generalization was found for words containing trained orthographic units. Our findings are consistent with Perfetti's claim that "the major essential development in learning to read is the acquisition of individual word representations" (Perfetti, 1992, p. 154). In addition, Lemoine, Levy and Hutchinson (1993) reported that emphasizing the family relationships amongst words (e.g., grouping the presentation of words so that all of the "at" words appeared together etc.) resulted in enhanced word acquisition. However, in spite of the reading gains on trained words, there was no evidence that the learning generalized to new rhyming words (Lemoine et al., 1993). Thus, the results from the present experiment converge nicely with those reported by Lemoine et al. and suggest that word representations, once formed, do not generalize to other words from the same word families.

In conclusion, training words in context and in isolation both resulted in accuracy benefits in Grade 3 students. However, isolated word training led to better retention of trained words in poor readers and faster word recognition in readers of all skill. The data from Martin-Chang and Levy (2005) and the current investigation show a cohesive pattern of results. When the transfer task involved reading words *in isolation*, good and poor readers showed equivalent gains in reading speed after practicing words *in isolation*. On the other hand, when the transfer task involved reading words *in context* good and poor readers showed equivalent benefits in reading speed when practice took place *in context* (Martin-Chang & Levy, 2005). Therefore, fluency is increased when the same processes are employed while laying-down and accessing word representations from memory.

By implication, this suggests that the method of reading instruction cannot be severed from the desired reading outcomes. Viewed from this standpoint, the dichotomy between teaching children to read in context and in isolation becomes less polarized (Stanovich & Stanovich, 1999). Several prominent researchers have advocated the usefulness of combining context training with code-based strategies in order to improve word recognition in children (e.g., Chall, 1967; Cunningham, Stanovich,

& Stanovich, 2004; Tunmer & Chapman, 1995). Indeed the findings from the current investigation provide empirical evidence suggesting that distinctions between reading in, and out, of context is much more subtle than previously argued. Namely, the findings of Martin-Chang and Levy (2005) suggest that if the goal of training is to provide children with the skills to read meaningful passages quickly, and accurately, while preserving comprehension, then training words in context offers benefits over and above teaching words in isolation. On the other hand, the results from the current experiment indicate that if children need to be able to quickly and accurately identify words that appear in isolation, then training in isolation offers benefits over and above teaching words in context. Given that both contextual and isolated word reading skills are pivotal to the developing reader, a combination of both training methods is strongly endorsed.

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## Note

1. The primary focus of the present investigation was word reading fluency, which is comprised of both accuracy and speed. Reading speed *without* accuracy does not amount to fluency, therefore the children needed to be reading with a high degree of accuracy before we could concentrate on speed. Grade appropriate materials were used in this study, therefore we expected good readers to be near ceiling at the beginning of training and poor readers to be approaching ceiling by the end of training. However, even though accuracy scores were nearing ceiling, reading times were continuing to decline showing evidence of fluency improvement.

## Appendix

*Table A1.*

| List A | | List B | | List C | |
|---|---|---|---|---|---|
| Set A1 | Set A2 | Set B1 | Set B2 | Set C1 | Set C2 |
| Slain | Stain | Crate | Grate | Zest | Pest |
| Drain | Vain | Skate | Mate | Blest | Lest |
| Grain | Main | Plate | Hate | Jest | Vest |
| Brain | Chain | Fate | Rate | Crest | Chest |
| Train | Plain | Late | Gate | Best | Nest |
| Pain | Gain | Date | State | West | Rest |
| Tame | Lame | Prank | Shrank | Rump | Trump |
| Dame | Frame | Flank | Crank | Slump | Hump |
| Blame | Flame | Plank | Tank | Dump | Clump |
| Shame | Fame | Sank | Drank | Bump | Thump |
| Name | Same | Rank | Blank | Stump | Lump |
| Came | Game | Bank | Thank | Jump | Pump |
| Flake | Drake | Wick | Flick | Frill | Grill |
| Snake | Rake | Tick | Nick | Pill | Shrill |
| Wake | Stake | Slick | Prick | Drill | Chill |
| Bake | Cake | Kick | Lick | Mill | Bill |
| Lake | Shake | Trick | Brick | Fill | Hill |
| Make | Take | Pick | Sick | Kill | Still |
| Greed | Tweed | Stunk | Dunk | Chide | Decide |
| Creed | Bleed | Hunk | Punk | Glide | Stride |
| Steed | Breed | Spunk | Shrunk | Bride | Slide |
| Heed | Weed | Junk | Bunk | Hide | Tide |
| Feed | Speed | Skunk | Sunk | Side | Pride |
| Deed | Seed | Drunk | Trunk | Ride | Wide |
| Pat | Brat | Sack | Snack | Chore | Gore |
| Chat | Combat | Shack | Quack | Core | Pore |
| Mat | Bat | Smack | Slack | Swore | Tore |
| Rat | Flat | Stack | Tack | Wore | Sore |
| Cat | Hat | Track | Lack | Score | More |
| Fat | Sat | Black | Back | Shore | Store |
| Trend | Blend | Appear | Sear | Fling | Sling |
| Mend | Lend | Spear | Gear | Sting | Cling |
| Bend | Tend | Rear | Fear | Swing | String |

*Table A1. Continued.*

| List A | | List B | | List C | |
|---|---|---|---|---|---|
| Set A1 | Set A2 | Set B1 | Set B2 | Set C1 | Set C2 |
| Attend | Defend | Near | Hear | King | Bring |
| Depend | Extend | Year | Dear | Wing | Spring |
| Friend | Spend | Clear | Tear | Ring | Thing |
| Pun | Dun | Bland | Gland | Mew | Brew |
| Nun | Bun | Expand | Strand | Hew | Stew |
| Shun | Stun | Band | Brand | Chew | Dew |
| Gun | Spun | Grand | Sand | Crew | Flew |
| Fun | Begun | Hand | Land | Drew | Grew |
| Sun | Run | Stand | Demand | New | Few |
| Rink | Stink | Right | Plight | Par | Char |
| Mink | Brink | Tight | Fright | Afar | Tar |
| Blink | Shrink | Flight | Slight | Cigar | Mar |
| Wink | Link | Bright | Light | Jar | Scar |
| Sink | Pink | Sight | Might | Car | Bar |
| Think | Drink | Night | Height | Far | Star |

*Story for word Set A1*

The animals *came* from all over to get to the zoo. Some traveled on *train*, but others *came* on a boat that left *wake* after *wake* in the pond. Everyone was welcome there. The zookeeper did not *shun* any of the animals. Even the *snake* and the *rat* were welcome. But to stay in the zoo, they all had to *attend* to the *creed*: be kind to others. This helped the animals to get along. Everyone had to *think* of ways to be kind. They tried to do a good *deed* each day. And they tried not to *blame* each other for mistakes or cause anyone *pain*. The animals liked it at the zoo. Even the *fat cat* and the *rat* had *fun* playing together.

The animals had a *friend* at the zoo they could *depend* on. She was a *nun* and her *name* was Mary. Mary liked to *pat* the *mink*. She also rode the *steed* and brushed his coat and she would sometimes *feed* him *grain*. She loved to *bake*; she would use a whole afternoon to *bake* special treats for everyone. She also liked to *make* each animal its own *mat* to sleep on. She tried to *make* everyone feel special by using her time to *chat* with the animals. Sometimes, Mary would even *mend* their hurts. She hated to see any of the animals in *pain*. One winter's day, the *sun* shone brightly through the falling snow. One *flake* landed on Mary's eyelash and made her *blink*. Suddenly the peace was broken. The *steed* galloped in beside the *train*.

"There is a hunter down by the skating *rink* on the *lake*" he said, "He is going to trap the *tame mink*".

"What!" said the *nun*. "He is at the *rink* in our zoo? Did he not *heed* the warnings posted at the *bend* in the road? The sign says "No one shall enter with a *gun*. No animals will be *slain* within the zoo. Everyone must *attend* to the *creed*: be kind to others". I will go to the *lake* and have a *chat* with this hunter" said Mary. "What could be going through his *brain*!" she said.

Mary marched up to the *fat* hunter and said " *Shame* on you! The animals *depend* on us for protection and you trap them for *fun*. This is not a time for *greed*. I *blame greed* for all the animals already *slain* in the forest. Within this zoo, you must *heed* the *trend* to care for the environment. We must *mend* the damage already done. We must grow *grain* to *feed* the animals. You must not *sink* any lower, but become a *friend* to the animals."

But the hunter did not listen. He gave Mary a *wink*. He said she was a silly *dame* and to stop being such a *flake*. Mary did not like having the hunter call her a mean name, but she did not *shun* him – instead she used her *brain*. When the hunter was not looking she hid his *gun* under an old *mat*. Then she started to *drain* all of the gas from his dirty jeep into her old *sink*.

"How can this be?" said the hunter when he returned. "How did my gas *drain* away? Where are my things?" Then he turned to Mary, "I seem to be out of gas," he said "Could I possibly use your truck to drive into town?"

"Hmmm" said Mary with a *wink* as she *pat* the *cat*. "What a *shame*. You were very rude to me, so I won't be able to give you my truck. But you can *think* about how to be a kinder person while you are walking home. I hope the animals will continue the *trend* of being kind as you leave the forest.... ON FOOT."

All of the animals watched Mary's good *deed*. The *snake* gave Mary a slow reptile *blink* and started to *bend* into the shape of a *sun*. Then he made a *pun*. He said that, for a human, she was a pretty *tame dame*. The *pun* made Mary laugh and laugh.

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