

Implicit and Explicit Instruction of Spelling Rules

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Abstract

In two experiments, we tested the differential effectiveness of explicit and implicit instruction of two Dutch spelling rules for children with and without spelling problems, whose spelling skills were at first-grade level. To assess whether the intervention led to the emergence of rule-based or fragment-based knowledge, performance on practiced words was compared to that of transfer words and pseudowords. The aim of Experiment 1 was the acquisition of a morphological spelling rule. Explicit instruction led to rule-based knowledge in both groups of students indeed. Explicit instruction turned out to be more effective than implicit instruction for the students without spelling problems and equally effective for those with spelling problems. In both groups explicit instruction led to rule-based knowledge, whereas the implicit condition did not reveal the acquisition of any kind of spelling knowledge. The aim of Experiment 2 was the acquisition of an autonomous spelling rule. Explicit instruction and implicit instruction were equally effective in both groups and the spelling knowledge the children in both groups had acquired was fragment-based rather than rule-based. The general conclusion is that differences in the effectiveness of explicit and implicit instruction are determined by both the type of learner and the rule that has to be learned.

Implicit and Explicit Instruction of Spelling Rules

Learning happens everywhere, at school, at work and in spare time. It also occurs in different ways: sometimes explicitly and other times implicitly. Implicit learning refers to situations in which a person learns about the structure of stimuli in their environment without the intention to do so, and such that it is usually hard to express what exactly this knowledge structure is (Cleeremans, 1993; Berry, 1997). Domains in which implicit learning is apparent encompass knowledge about the physical and the social world, category learning, and (first and second) language learning (Reber, 1993). Explicit learning, on the other hand, is intentional and goals determine what will be learned. Participants are usually capable of expressing the acquired knowledge structure. Prototypical examples of explicit learning are the subject matters taught in school, such as arithmetic, reading, and spelling. However, even in these academic domains, a great deal of what is learned is acquired implicitly. Because it is reasonable to assume that most of what people learn is incidental rather than intentional, cognitive models about human learning should incorporate the notion of implicit learning.

Traditionally, education aims at teaching the basic academic skills in a more or less explicit fashion, but cannot at the same prevent students from acquiring part of the required knowledge implicitly. Recently, a number of studies have shown that, for example, spelling knowledge can be acquired implicitly (e.g., Bryant, Deacon, & Nunes, 2006; Bryant, Nunes, & Snaith, 2000; Kemp & Bryant, 2003; Pacton, Perruchet, Fayol, & Cleeremans 2001; Steffler, 2004). The question that then springs to mind is whether allowing students ample exposure to printed materials is as effective as explicit instruction of spelling, that is, the explanation and training of spelling rules and regularities. A direct comparison of the effectiveness of implicit and explicit instruction in spelling has not been conducted yet. The goal of this study is to investigate this issue in students who are at the beginning of their literacy career.

Implicit learning of spelling

Although little research has been done on the subject of implicit instruction in spelling, there is ample proof that spelling knowledge can be learned implicitly (Bryant, Deacon, & Nunes, 2006; Bryant, Nunes, & Snaith, 2000; Kemp & Bryant, 2003; Pacton et al., 2001; Steffler, 2004). For example, Bryant, Nunes, and Snaith (2000) studied a spelling rule that is not explained in English education: The ending of the English past tense is spelled –ed when the past tense has the same sound as the present (learn – learned, walk – walked), and it is spelled phonetically (e.g. –d/-t) when

it has a different sound (tell- told, sleep - slept). Bryant et al. (2000) showed that 8- and 9-year-old children used this rule when writing pseudowords, albeit they were not taught to do so and could not explain the rule. They concluded that children learned this regularity implicitly while reading.

Kemp and Bryant (2003) investigated the case of English words ending in /z/. In plurals, this sound is always spelled as -s, a rule that is also taught to children. Non-plurals with /z/ at the end can be spelled in other ways: -z, -zz, -se, or -ze. Children could also learn the correct spelling of such words based on the frequency of occurrence of certain letter patterns: Plural nouns (spelled with -s) most often end in a consonant before the final /z/, whereas non-plural English words most often end in a vowel before the final /z/. Kemp and Bryant concluded that, when children choose the final grapheme based on frequency rather than on the application of a rule, they would make errors in the spelling of plurals with a vowel before the final /z/, like *bees*. They found that children indeed made these mistakes in the spelling of words and pseudowords, and concluded that children make decisions about spelling based on frequencies rather than on rules (Kemp & Bryant, 2003). Pacton et al. (2001) also showed that knowledge about the use of double consonants and vowels in French is learned implicitly. Children had the knowledge that words in French could not begin with a doubled consonant, although this was never explained to them. Pacton et al. concluded that children derived this knowledge from written language and learned it implicitly.

In conclusion, implicit learning of spelling occurs, but it is not clear yet what exactly is learned. One interpretation, the so-called 'abstract-knowledge' account, is that during the study phase participants have abstracted a rule, which they are able to apply unconsciously during the test phase (Manza & Reber, 1997; Reber, 1993). The alternative view, the so-called 'fragment-based' account, is that information is segmented in small chunks that are memorized, and if these appear in any way in novel items, they will be recognized (Berry, 1997). Performance is then based on statistical structures and the frequency of appearance of certain combinations (Dienes & Altmann, 1997; Pacton et. al, 2001).

In implicit learning, performance on items that were not practiced during training, also called transfer items, generally remains above chance level but is significantly worse than on practiced items. This pattern of results is known as transfer decrement, and is a sign of fragment-based learning (Dienes & Altmann, 1997; Manza & Reber, 1997). After all, if participants had acquired genuine abstract rules, transfer performance on the two sets of stimuli should be equal (Gomez, 1997; Manza & Reber, 1997). Cleeremans and Destrebecqz (2005), for that reason, argued that performance on implicit learning tasks can reveal whether or not learning is actually rule-based or rule-like (as in fragment-based accounts), based on the presence or absence of transfer decrement.

Thus, when rule-based implicit learning takes place, no transfer decrement should be observed, whereas fragment-based implicit learning should lead to a transfer decrement. In this way, the abstractness of implicit learning can be derived. In the present study, the abstractness of implicitly learned knowledge is taken into account.

Explicit learning of spelling

In contrast to implicit learning, explicit learning has been dealt with in literature elaborately (Bosman, van Hell, and Verhoeven, 2006; Butyniec-Thomas & Woloshyn; Nunes, Bryant, & Olsson, 2003; van Leerdam, Bosman, & van Orden, 1998; Wanzek et al., 2006). Explicit learning is intentional and goal-directed. People are usually capable of expressing the acquired knowledge structure. However, the question is to what extent this knowledge can be transferred to new situations. The main goal of explicit instruction is to provide children with explicit knowledge, in this case about the appliance of a spelling rule. When children grasp the rule completely, they should be equally able to apply the rule to practiced and non-practiced words. The presence of a transfer decrement in this context would reveal that the rule was not fully grasped, and that the explicit instruction did not lead to complete explicit knowledge (Gomez, 1997; Manza & Reber, 1997).

Most studies try to realize explicit learning by explicit instruction: The spelling rule or material that is to be learned is named and explained. Bosman, van Hell, and Verhoeven (2006) showed that explicit instruction of the strategy of regularized reading to spell Dutch strange words has an effect on the spelling of such words. Butyniec-Thomas and Woloshyn (1997) compared explicit-strategy instruction to whole-language instruction and found that explicit instruction improves the spelling of children more, particularly when it happens in a meaningful context. Nunes, Bryant, and Olsson (2003) gave children explicit instruction about morphological and phonological spelling rules. Their explicit instruction of morphological spelling rules did improve the spelling of the children, whereas the explicit instruction of phonological spelling rules had no effect on spelling skills. The authors state that the phonological distinction they worked with might have been too hard for the children to learn. However, the effectiveness of a morphological training could also be explained by the morphophonemic nature of English orthography. Although English is phoneme-grapheme inconsistent, it contains a deep morphological structure, which could cause a morphological training to be more effective than a phonological training on spelling skills (Bowers, 2006). Van Leerdam, Bosman, and van Orden (1998) compared four explicit spelling instructions to improve the spelling of words including a spelling problem. Children in all four trainings performed significantly better than children in the implicit baseline condition. Furthermore, Bhattacharya and Ehri (2004) found

that explicit instruction about graphosyllabic analysis helps poor adolescent readers to improve their reading and spelling. In their synthesis of spelling and reading interventions, Wanzek et al. (2006) concluded that explicit spelling instruction of children with learning disabilities was associated with an improvement of their spelling accuracy. Thus, studies on explicit instruction have also been conducted with children with learning problems, in contrast to studies on implicit learning and implicit instruction. They show that explicit instruction is effective for these children. However, it is unclear whether it is more effective for them than implicit instruction. Therefore, a comparative study on explicit and implicit spelling instruction for children with spelling problems is needed.

In the present study, the effectiveness of implicit and explicit instruction of spelling rules is compared. Although explicit spelling instruction has been studied elaborately, the comparison with implicit instruction has not been made yet, but is highly relevant for education. Children with spelling problems are included to give a more integrative picture of the effectiveness of both instructions. The study consists of two experiments, each using a different spelling rule, and was carried out in The Netherlands. Before we describe these experiments in detail, a short overview on Dutch orthography is presented.

Dutch orthography

Dutch orthography is quite regular in its pronunciation. In Dutch, 84.5% of the words is pronunciation-consistent, that is, they cannot be pronounced in a different way, in contrast to 69.3% of the words in English. Spelling consistency is lower, but remains higher than in English: 36.8% of the Dutch words cannot be spelled in a different way, in contrast to 27.7% of the English words (Bosman, Vonk, & van Zwam, 2006). Thus, Dutch orthography is not completely regular. To cover irregularities in the phoneme-grapheme-correspondence rules, the Dutch spelling system follows certain spelling rules. These characteristics of the Dutch spelling, being mainly regular and structural, but also incorporate a number of spelling rules, makes this language highly suitable to investigate the effects of different instruction methods. Another interesting aspect is that Dutch orthography contains two different categories of spelling rules. This makes it possible to compare the effects of implicit and explicit instruction for different categories of spelling rules.

Dutch spelling is highly based on morphology. Most spelling rules are based on the morphological principle (Nunn, 1998). This principle is actually a combination of two principles of the four principles of Dutch spelling, stated by te Winkel (Cohen & Kraak, 1972). Te Winkel (1865) states that 1) words should be written in a manner that represents all audible phonemes in the word (Principle of Received Pronunciation); 2) morphemes should always be spelled in the same way

(Principle of Uniformity); 3) the choice between two graphemes with the same pronunciation depends on the older form of the word, in which the two graphemes had a distinguishable sound, although they have now become indistinguishable (Principle of Etymology); 4) when the three other principles are not applicable, the word should be written analogous to words of which the spelling is known with certainty, and of which it can be assumed that they are formed in a similar way (Principle of Analogy). Dutch spelling rules are mainly based on the morphological principle, which is a combination of the Principle of Uniformity and the Principle of Analogy (Cohen & Kraak, 1972). For a more extensive clarification of these principles, see Nunn (1998) or Bosman, de Graaff, and Gijssels (2006). Morphological spelling rules are adjusted to the language: They describe the patterns that orthography follows and they result from the evolutions language undergoes in time.

Nunn (1998) states that the principles of te Winkel (1865) do not cover all spelling phenomena in Dutch. She proposed a hybrid model, in which autonomous spelling rules are added. Autonomous spelling rules are “rules [that] do not directly refer to the pronunciation of words” (Nunn, 1998, p. 30): they are insensitive of phonological context, but are sensitive to orthographical context. Autonomous spelling rules operate in larger units than the morpheme (Nunn, 1998). Nunn adds a principle for autonomous spelling rules to the principles of te Winkel (1865): The Graphotactic Principle, which states that “the spelling of words must satisfy certain graphotactic conditions” (Nunn, 1998, p. 135). Autonomous spelling rules are made up by spelling inventors to construct a more economical orthography, they have no linguistic base.

The fact that two different broad categories of spelling rules exist, allows us to compare the differential effectiveness of implicit and explicit instruction for autonomous and morphological spelling rules. This gives information about the width of the application of the two forms of instruction.

The present study

In the present study, the effects of implicit and explicit instruction of Dutch spelling rules are examined. To establish potential differences in the effectiveness of both instructions, they were compared for both children with and without spelling problems. Both groups of children were spelling at first-grade level. Next to a comparison of the effectiveness of the two instructions for children with and without spelling problems, performances of both groups are compared to test whether children with spelling problems learn less than children without spelling problems. There is no consensus in literature on this subject. Bosman, van Huygevoort, and Verhoeven (2006) found that their spelling training affected the spelling performance of good and poor spellers equally.

Brown, Sinatra, and Wagstaff (1996) even found that after a year of analogy-based spelling instruction, students' spelling performance converged, indicating that poor spellers made more progress than good spellers. In other studies, more advanced spellers benefited more from training programs than less advanced spellers (van Leerdam, Bosman, & van Orden, 1998).

To compare the effects of explicit and implicit instruction, two experiments were conducted. In each of the experiments, children were pretested on their knowledge of a Dutch spelling rule, were subsequently subjected to an implicit or explicit instruction, and finally posttested on the same materials as in the pretest. In both pretest and posttest, practiced words, transfer words and pseudowords were used, to test for the presence of a transfer decrement. In Experiment 1, the effectiveness of implicit and explicit instruction was determined for a morphological spelling rule. In Experiment 2, an autonomous spelling rule was instructed.

Experiment 1

In the first experiment, a spelling rule based on the morphological principle was used to examine differences in the effects of explicit and implicit instruction for students with and without spelling problems. Performance on three word types was compared to investigate the absence or presence of a transfer decrement.

The morphological spelling rule used was the Dutch *-d/-t* ending rule. Because of the morphological principle, nouns with the phoneme /t/ at the end of the word can be spelled either *-d* or *-t* depending on their plural form. For example, the word *hond* [dog] is spelled with a *-d*, because it is uniform with its plural form *honden* [dogs], whereas the word *krant* [paper], in which the last grapheme is pronounced in the same way as in *hond*, is spelled with a *-t*, because it is uniform with its plural form *kranten* [papers]. To be able to apply this rule, the speller has to have linguistic knowledge: He/she needs to know the plural forms of words. He/she also has to grasp the idea that this rule is only applicable to nouns and adjectives, and not to verbs.

Three questions were put to a test. First, is implicit or explicit instruction more effective, and does this differ for children with and without spelling problems? It was expected that explicit instruction would be most effective for both groups of children. Second, are there differences in progress made by children with and without spelling problems? Third, to what extent is performance after implicit or explicit instruction on a morphological spelling rule rule-based? For explicit instruction, it was hypothesized that performance was completely rule-based. For implicit instruction, the contrary was expected, namely that performance was not rule-based but fragment-based.

Method

Participants

Participants without spelling problems were recruited from four regular education schools in the Netherlands and were all in first grade. Participants with spelling problems were recruited from five special-education schools in the Netherlands and were in different grades. The selection of participants in special education was based on two criteria: Their spelling level had to be comparable to that of regular first graders, and they had to have a spelling delay of at least one year.

Before the first experiment was conducted, all children were tested on letter knowledge, measured by the subtest Letter Dictation of the Diagnostiek voor Technisch Lezen en Aanvankelijk Spellen (DTLAS, Diagnosis of Technical Reading and Initially Spelling; Struiksmā, van der Leij, & Vieijra, 2001). Children who made more than two errors in the graphemes used in the experiment were excluded from the study (errors in *v*, *w*, and *f* were tolerated, because these graphemes sound much alike in Dutch). This resulted in the exclusion of 24 children.

The final sample consisted of 127 children (54.3 % boys, 45.7 % girls). The regular-education sample of 82 children was between 75 and 96 months of age at the start of the study (mean age = 83.9, $SD = 4.8$). The special-education sample of 45 children was between 94 and 128 months of age at the start of the study (mean age = 110.6, $SD = 8.9$). The groups differed significantly with respect to age, $t(56.8) = 18.57, p = .0001$.

The children were assigned to a condition: the explicit or the implicit condition. Moreover, 30 children from regular education were assigned to a control condition, to exclude the possibility that children's progress was caused by the repeated dictation. These children only participated in the pre- and posttest.

Data on word reading and spelling level were gathered from the schools. Reading level was based on the Drie-Minuten-Toets (DMT, Three-Minutes-Test; Verhoeven, 1995) and spelling level was based on the Schaal Vorderingen in Spellingvaardigheid (SVS, Scale of Progresses in Spelling Ability; Van den Bosch, Gillijns, Krom, & Moelands, 1997). These tests were used to assign children to matched conditions. The descriptive statistics can be found in Table 1. Spelling scores did not differ between groups, $F(1, 115) = 3.28, p = .07$, or conditions, $F(2, 120) = 0.04, p = .96$. Reading scores did not differ between groups either, $F(1, 121) = 0.29, p = .59$, or conditions, $F(2, 114) = 2.67, p = .07$. There was no difference in age between the children in the explicit and in the implicit condition, $F(1, 94) = 0.27, p = .60$, or between the group without spelling problems in the control condition and the two experimental conditions, $F(2, 81) = 2.05, p = .14$.

Table 1

Descriptive Statistics of the Participants (Standard Deviations between parentheses)

Group	Condition	N	Boys/Girls	Age	Spelling	Reading
No spelling problems						
	Implicit	24	11/13	83.1 (4.2)	107.9 (8.5)	37.9 (19.2)
	Explicit	28	15/13	83.0 (4.4)	106.7 (6.7)	38.9 (22.4)
	Control	30	13/17	85.3 (5.4)	106.0 (10.1)	30.3 (13.9)
Spelling problems						
	Implicit	22	14/8	107.6 (9.8)	103.2 (6.9)	33.2 (14.3)
	Explicit	23	16/7	113.6 (6.8)	105.2 (3.2)	41.6 (17.3)
Total		127	69/58	93.2 (14.3)	105.9 (7.8)	36.2 (17.9)

Materials

A spelling test was designed to measure children's knowledge of the Dutch d/t spelling rule, containing 24 words. To assess whether the words were not too hard, they were presented to a group of 24 children in first grade, who did not take part in the experiments. No words had to be discarded from the spelling test, and were thus used as pre- and posttest in the experiment.

The spelling test contained 24 words, which obeyed the Dutch d/t spelling rule. Eight of the words were practiced during training, eight were transfer words which were not used in training, and eight were pseudowords. Of each eight words, half were spelled with a /d/ at the end and the other half were spelled with a /t/ at the end. This spelling test was used as a pretest and posttest and is included in the appendix.

Procedure

At the first day of the experiment, all children were pretested on their knowledge of the spelling category that was to be instructed. On the second day, the children in the implicit and in the explicit condition received training on the spelling rule. The children in the control group did not receive training.

Implicit Condition. The children received a list with basewords. Each baseword was a plural form of a word. Children were asked to write down the singular form next to the plural baseword. Thus, they had to turn plurals into singulars. For example: 2 *honden* (baseword) – 1 *hond* (target word). The first exercise was an example. As an introduction, the children were told that they were

going to practise words that were written differently than they were said, and were asked to think of such words. After that, the instructor gave an example of a word (the first target word on the list), and showed how this word should be spelled. The spelling rule was not explained, children were only shown the correct spelling of the singular words. The first examples on the list were demonstrated, with increasing use of input from the class. The last exercises were done independently, while the instructor helped when needed. The children did eleven exercises independently. When all children were finished, they received feedback on the correctness of their spelling, and were required to correct their errors.

Explicit Condition. The children received a list with the same exercises as in the implicit condition. The same introduction was given and the first exercises were also demonstrated. The spelling rule that was used to spell the target word was made explicit and was explained by the instructor. The children finished the exercises by themselves. When all children were finished, feedback was provided by giving the correct answers and an explanation of these answers. The students were also instructed to correct their errors.

All groups were instructed on the same day. Training took about half an hour and was given in groups of approximately ten children. After a break, all children made the posttest, which was the same dictation as in the pretest.

Results

Spelling performance was evaluated using the number of correct spellings in the part that signified the spelling rule. Thus, writing of *hod* instead of *hond* (dog) was considered correct, because of the correct spelling of the target grapheme. Missing or illegible words were considered incorrect. Subsequently, the difference score between posttest and pretest on each word type was computed and entered in the analyses. The descriptive statistics can be found in Table 2. These variables were used in a 3 (Condition: implicit vs. explicit vs. control) x 2 (Group: children without spelling problems vs. children with spelling problems) x 3 (Word Type: practiced words vs. transfer words vs. pseudowords) design in SPSS GLM.

The first analysis pertained to the question whether performance increased between pretest and posttest for each group, condition, and word type. This was tested by planned comparisons (contrasts), using a significance level of $\alpha = .05$. In the group without spelling problems, children in the explicit condition made significant progress on all word types (see Table 2). Neither the children in the implicit condition nor those in the control condition showed significant progress on any of the word types. In the group of children with spelling problems, those in the explicit condition showed

significant progress on the practiced words, and a marginally significant progress on the transfer words, but no significant progress on the pseudowords. In the implicit condition, children with spelling problems only gained significant progress on practiced words.

Then, it was investigated whether performance differed significantly between conditions. This was indeed the case in the group without spelling problems. The explicit condition made significantly more progress than the control condition, $F(1,79) = 8.20, p = .01$, partial $\eta^2 = .09$, and significantly more progress than the implicit condition, $F(1,79) = 6.09, p = .02$, partial $\eta^2 = .07$. In the group with spelling problems, the difference in progress between the explicit and implicit condition was not significant, $F(1,43) = 0.62, p = .44$, partial $\eta^2 = .01$.

The next question was whether children with spelling problems made less progress than children without spelling problems. The children in the control condition were not taken into account in this analysis, because these were all children without spelling problems. The progress made by the two groups of children did not differ significantly, $F(1,95) = 0.07, p = .80$, partial $\eta^2 = .00$.

With respect to the third question, to what extent implicit and explicit learning effects were rule-based, the absence of implicit learning effects in both groups shows that neither rule-based nor fragment-based learning occurs. For children without spelling problems in the explicit condition, there were no significant differences in the progress on different word types. The difference in progress between practiced words and transfer words was not significant, $F(1, 79) = 1.41, p = .24$, partial $\eta^2 = .02$, and the difference in progress between transfer and pseudowords was not either, $F(1, 79) = 2.18, p = .14$, partial $\eta^2 = .03$. For the children with spelling problems, there were no significant differences either in the progress on different word types in the explicit condition. The progress on practiced words did not differ significantly from the progress on transfer words, $F(1, 43) = 2.05, p = .16$, partial $\eta^2 = .05$, and neither did the progress on transfer words and the progress on pseudowords, $F(1, 43) = 0.02, p = .89$, partial $\eta^2 = .00$. In sum, these results revealed no transfer decrements for both groups in the explicit condition.

Table 2

Mean, Standard Deviation and F test of the Progress between Pretest and Posttest in Experiment 1

Condition	Word type	Mean	SD	<i>F</i> (1,122)	<i>p</i>	Partial η^2
No spelling problems						
Explicit	Practiced	0.79	1.45	10.17	.002	.08
	Transfer	0.46	1.07	4.61	.03	.04
	Pseudo	0.93	1.33	12.90	.0001	.10
Implicit	Practiced	0.21	1.06	0.61	.44	.01
	Transfer	0.13	1.12	0.28	.59	.00
	Pseudo	0.38	1.28	1.80	.18	.02
Control	Practiced	-0.07	1.55	0.08	.78	.00
	Transfer	0.00	1.34	0.00	1.00	.00
	Pseudo	-0.03	1.61	0.02	.89	.00
Spelling problems						
Explicit	Practiced	0.83	1.34	9.24	.003	.07
	Transfer	0.43	1.24	3.32	.07	.03
	Pseudo	0.39	1.59	1.88	.17	.02
Implicit	Practiced	0.55	0.86	3.85	.05	.03
	Transfer	0.27	0.83	1.25	.27	.01
	Pseudo	0.27	0.77	0.87	.35	.01

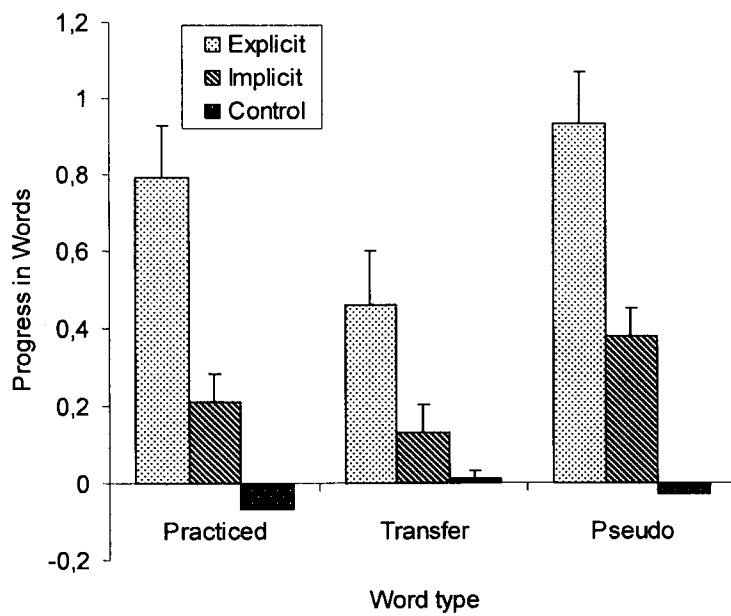


Figure 1. Mean progress for each word type and condition in children without spelling problems

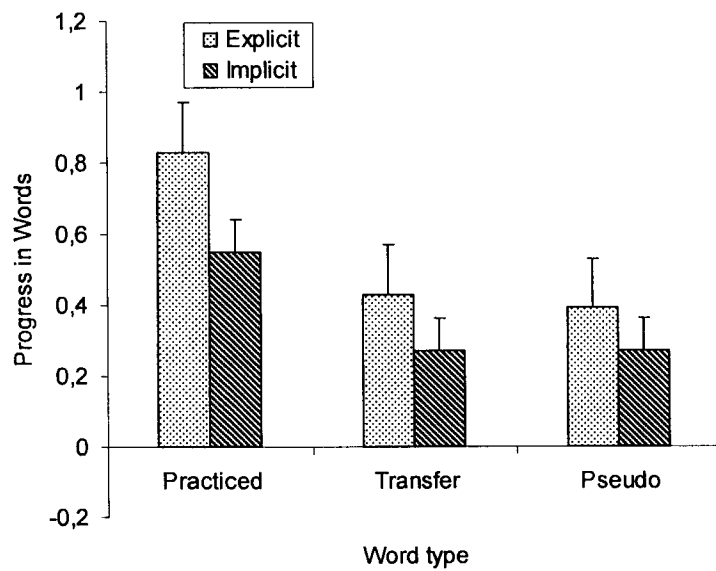


Figure 2. Mean progress for each word type and condition in children with spelling problems

Conclusion

In Experiment 1, children were given an implicit or an explicit instruction on a morphological spelling rule. Three questions were put to a test. First, is implicit or explicit instruction more effective, and does this differ for children with and without spelling problems? In this experiment, it showed that the explicit instruction yielded progress on all word types in both groups, whereas the implicit instruction yielded only significant progress on the practiced words for children with spelling problems. The progress that was expected in both the implicit condition and the explicit condition on practiced words, was absent in the implicit condition in the group without spelling problems. For children without spelling problems, the explicit instruction was more effective than the implicit instruction, but this difference was not found for children with spelling problems.

With respect to the second question, whether there are differences in progress made by children with and without spelling problems, the answer is negative. No differences between the two groups were found.

The third question, to what extent performance after implicit or explicit instruction on a morphological spelling rule is rule-based, could not be answered for the implicit condition. These children did not learn a rule, and thus, performance was neither fragment-based nor rule-based. In the explicit condition, analyses showed that progress did not differ significantly over word types in both groups. This means that children are just as able to apply the rule that they were taught to practiced or familiar words as to transfer and pseudowords, indicating that the children truly learned a rule.

In conclusion it can be said that the explicit instruction was most effective to instruct a morphological spelling rule. Children abstracted a rule and were able to generalize it to other types of words.

Experiment 2

In Experiment 2, an autonomous spelling rule was used to examine the effect of implicit and explicit instruction for children with and without spelling problems. Performance on three word types was compared, to investigate the absence or presence of a transfer decrement.

The autonomous spelling rule used in this experiment was the Dutch open syllable rule, or Vowel Degemination (Nunn, 1998). The sound of a long vowel at the end of a syllable (an 'open' syllable) in a multi-syllabic word leads to vowel reduction, as in *been* – *be-nen* (leg-legs). No vowel reduction appears in words with digraphs like *dier* – *die-ren* (animal – animals) and words with closed syllables, like *beest* – *bees-ten* (beast – beasts). This rule does not require linguistic knowledge and is applicable to all word types, not solely to nouns and adjectives, like the spelling rule in Experiment 1.

The same three questions that were tested in Experiment 1 were subject of investigation in Experiment 2. First, is implicit or explicit instruction more effective and are there differences for children with and without spelling problems? Again, it was hypothesized that explicit instruction would be most effective for both groups of children. Second, does the progress made by children with and without spelling problems differ? Third, to what extent is performance after an implicit or explicit instruction of an autonomous spelling rule rule-based? It was expected that performance after an implicit instruction would be fragment-based, and that performance after an explicit instruction would be rule-based.

Method

Participants

The same children who participated in Experiment 1 also took part in Experiment 2. Due to illness or absence, 7 children who participated in Experiment 1, did not participate in Experiment 2. Also, 8 children who did not participate in Experiment 1 participated in Experiment 2. The final sample of Experiment 2 consisted of 126 children (69 % boys, 27 % girls). The regular-education sample of 80 children was between 78 and 100 months of age at the start of the second experiment (mean age = 86.8, $SD = 4.6$). The special-education sample of 46 children was between 97 and 134 months of age (mean age = 113.5, $SD = 9.4$). The groups differed significantly with respect to age, $t(56,1) = 17.9, p = .0001$. The children were assigned to the implicit, explicit and control condition in the same manner as in Experiment 1.

The changes in the composition of the sample had no consequences for the equality of reading and spelling scores over groups and conditions. Reading level and spelling level did not differ with respect to conditions, $F(2,113) = 2.59, p = .08$, and $F(2,120) = 0.05, p = .96$, respectively. There were no differences in reading and spelling level with respect to groups either, $F(1,113) = 0.44, p = .51$, and $F(1,120) = 2.49, p = .12$, respectively. Age did not differ between the explicit and implicit condition, $F(1,93) = 0.05, p = .83$. In the group without spelling problems, age did not differ over the 3 conditions, $F(1,43) = 1.58, p = .22$.

Materials

A spelling test was designed to measure children's knowledge of the Dutch open syllable rule, containing 24 words. After conducting the spelling test to a group of children from first grade who did not take part in the experiments, two words were replaced, because they were too difficult.

The test contained 24 words that obeyed the open syllable rule. Eight of them were training words, eight were transfer words, and eight were pseudowords. Of each eight words, half contained open syllables and the other half did not. The final version of the spelling test was used as both pretest and posttest, and is included in the appendix.

Procedure

At the first day of the experiment, all children were pretested on their knowledge of the spelling category that was to be instructed. On the second day, the children in the explicit and implicit condition received an instruction on the spelling rule. The instructions were the same as in the first experiment. In the exercises in the implicit and explicit training, the children now had to turn singulars into plurals, for example: 1 *been* (baseword) – 2 *benen* (target word; 1 leg – 2 legs). In the explicit condition, the rule about open syllables was explained and the graphemes for which it had to be applied were written on the blackboard. In the implicit instruction, the rule was neither explained nor mentioned. The children in the control condition received no training. After a break, the children made the posttest, which was the same as the pretest.

Results

Spelling performance was evaluated using the number of correct spellings of the open syllable rule. Thus, writing *bamen* instead of *bramen* (blackberries) was considered correct, because of the correct spelling of the target graphemes. Missing or illegible words were considered incorrect. Subsequently, the difference score between posttest and pretest on each word type was computed and entered in the analyses. These variables were used in a 3 (Condition: implicit vs. explicit vs. control) x 2 (Group: children without spelling problems vs. children with spelling problems) x 3 (Word Type: practiced words vs. transfer words vs. pseudowords) design in SPSS GLM.

In this experiment, the increase in performance between pretest and posttest was also first examined. Planned comparisons were applied to test a significant progress for each group, condition and word type. A significance level of $\alpha = .05$ was used. All children in the explicit condition, both with and without spelling problems, made significant progress on the practiced and transfer words (see Table 3). In both groups, children in the implicit condition made significant progress on all word types. The children in the control group showed no significant progress on either of the word types.

Then, the difference in progress between the conditions was tested. In the group without spelling problems, no difference was found between progress made in the implicit and explicit condition, $F(1,77) = 0.82, p = .37$, partial $\eta^2 = .01$. The difference between the explicit condition and

the control group was significant, $F(1,77) = 8.89, p = .004$, partial $\eta^2 = .10$, as well as the difference between the control group and the implicit condition, $F(1,77) = 15.84, p = .0001$, partial $\eta^2 = .17$. In the group with spelling problems, there was no difference between the explicit and the implicit condition either, $F(1,44) = 0.54, p = .47$, partial $\eta^2 = .01$.

Furthermore, it was tested whether children with spelling problems made less progress than children without spelling problems. The children in the control condition were not taken into account in this analysis, because these were all children without spelling problems. The progress made by the two groups of children did not differ significantly, $F(1, 93) = 0.91, p = .34$, partial $\eta^2 = .01$.

The differences in progress on the three word types were looked at in the implicit condition, to find out whether a transfer decrement would occur. For the children without spelling problems in the implicit condition, there was a significant difference between the progress made on practiced words and on transfer words, $F(1, 77) = 11.53, p = .001$, partial $\eta^2 = .13$, and no significant difference between the progress made on transfer words and pseudowords, $F(1, 77) = 0.84, p = .36$, partial $\eta^2 = .01$. Again, the same pattern was seen in children with spelling problems in the implicit condition. The difference in progress between the practiced and transfer words was marginally significant, $F(1, 43) = 3.93, p = .054$, partial $\eta^2 = .08$, and the difference in progress between the transfer and pseudowords was not, $F(1, 43) = 0.07, p = .80$, partial $\eta^2 = .00$. The results reveal a transfer decrement in the implicit condition.

To test the assumption that no transfer decrement occurs in the explicit condition, differences in the progress on the three word types was looked at. For the children without spelling problems, there was no significant difference between the progress on practiced words and the progress on transfer words in the explicit condition, $F(1, 77) = 0.02, p = .89$, partial $\eta^2 = .00$. The progress made on the pseudowords in this condition differed significantly from the progress made on the transfer words, $F(1, 77) = 5.15, p = .03$, partial $\eta^2 = .06$. For children with spelling problems in the explicit condition, the same pattern of performance was found (see Figure 3 and Figure 4). There was no significant difference in progress on practiced and transfer words, $F(1, 43) = 0.02, p = .90$, partial $\eta^2 = .00$, but there was a difference in progress on transfer and pseudowords, $F(1, 43) = 5.63, p = .02$, partial $\eta^2 = .12$.

Table 3

Mean, Standard Deviation and F test of the Progress between Pretest and Posttest in Experiment 2

Condition	Word type	Mean	SD	<i>F</i> (1,121)	<i>p</i>	Partial η^2
No spelling problems						
Explicit	Practiced	1.13	1.70	13.60	.0001	.10
	Transfer	1.08	1.84	12.16	.001	.09
	Pseudo	0.38	1.58	1.74	.19	.01
Implicit	Practiced	1.92	1.47	41.26	.0001	.25
	Transfer	0.88	1.42	8.36	.005	.07
	Pseudo	0.60	1.41	4.63	.03	.04
Control	Practiced	0.03	0.80	0.01	.91	.00
	Transfer	0.13	1.20	0.22	.64	.00
	Pseudo	-0.13	0.89	0.27	.61	.00
Spelling problems						
Explicit	Practiced	0.86	1.62	6.91	.01	.05
	Transfer	0.90	1.41	7.42	.007	.06
	Pseudo	0.10	1.41	0.10	.76	.00
Implicit	Practiced	1.38	1.80	24.52	.0001	.17
	Transfer	0.67	1.69	6.23	.01	.05
	Pseudo	0.58	1.67	3.48	.07	.03

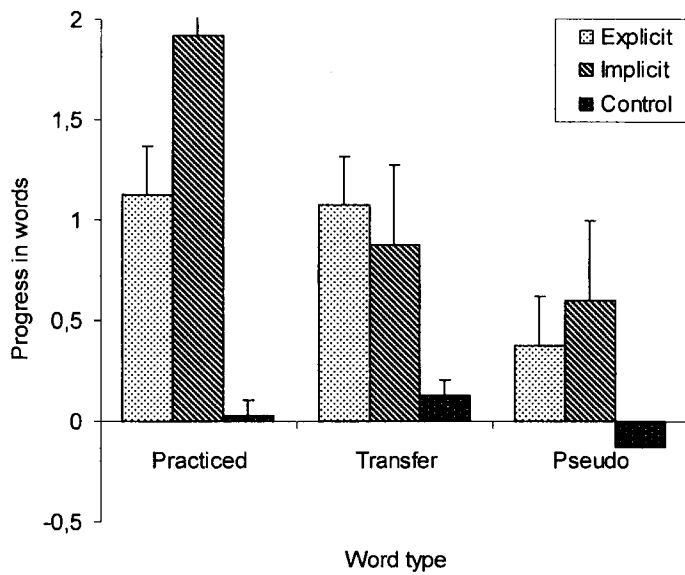


Figure 3. Mean progress for each word type and condition in children without spelling problems

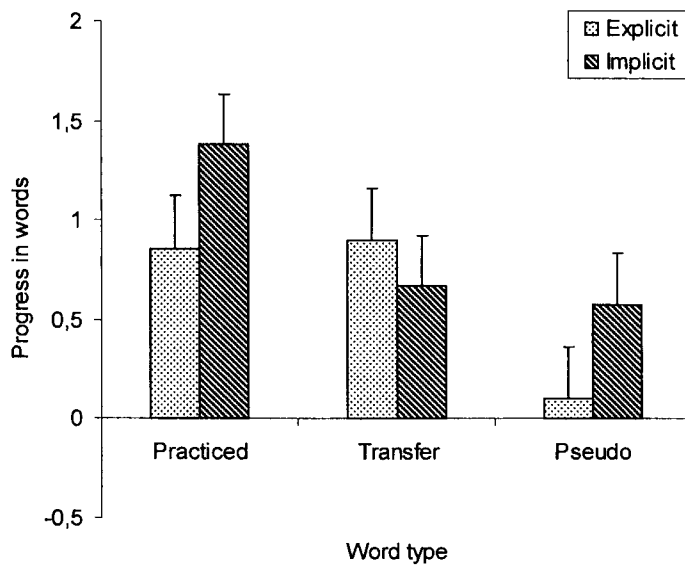


Figure 4. Mean progress for each word type and condition in children with spelling problems

Conclusion

In Experiment 2, children received implicit or explicit instruction on the open syllable rule. Three questions were attempted to answer. First, is implicit or explicit instruction more effective and are there differences for children with and without spelling problems? The results show that children in both conditions gained progress. The findings of Experiment 2 did not reveal a significant difference between the two instruction methods.

With respect to the second question, whether the progress made by children with and without spelling problems differs, the answer is negative again. No difference emerged between the both groups of children.

For the third question, to what extent performance after an implicit or explicit instruction of an autonomous spelling rule is rule-based, transfer decrement was analyzed. The results revealed a transfer decrement in both the implicit and the explicit condition. This means that the performance of the children in the implicit condition was fragment-based rather than rule-based: The children did not abstract a rule. The same can be said for the children in the explicit condition. Their performance was not rule-based, so the instructed rule was not truly grasped.

General Discussion

In the present study, two experiments were conducted to examine the effectiveness of implicit and explicit instruction of spelling rules for children with and without spelling problems. In both experiments, the aim was to answer three questions.

The first question was which instruction would yield the best performance. In Experiment 1, in which the children learned a morphological spelling rule, children without spelling problems in the explicit condition made more progress than in the implicit condition and control group. For children with spelling problems, this difference did not occur. In both groups, children in the implicit condition did not make progress on transfer and pseudowords. In Experiment 2, in which the children learned an autonomous spelling rule, children in both the implicit and explicit condition made progress and for both children with and without spelling problems, there were no differences in the effectiveness of both instructions.

Two conclusions can be drawn. First, explicit instruction seems to be more effective for the instruction of a morphological spelling rule (at least for children without spelling problems), but both methods are equally effective for the instruction of an autonomous spelling rule. It seems that the effectiveness of both instructions depends on the context in which it is used, in this case: The kind of spelling rule that was instructed. A difference is found between a morphological spelling rule and an

autonomous spelling rule. As explained earlier, autonomous spelling rules have no linguistic base. They do not refer to spoken language, as do morphological spelling rules.

The implicit instruction did not yield a significant progress for the morphological spelling rule, but it did for the autonomous spelling rule. This could be caused by the form of the exercises. In Experiment 1, the children had to turn given plurals into singulars. Plurals were given, in order to avert children from making mistakes in the inflection of singulars (i.e. saying the plural form of *hond* is *honten* instead of *honden*), which would lead to errors with undetectable sources. Children could have either incorrectly used the rule or correctly used the rule with the wrong plural. This nevertheless led to some children noticing that inflection from plural to singular could simply be achieved by removing *-en*. They did not actively attend to the different forms of the words, whereas attention to information is crucial for implicit learning (Hoffmann & Sebal, 2005). This may explain why an implicit learning effect did not occur in the first experiment.

The second conclusion that can be drawn is that for children with spelling problems, there are no differences between both instructions for both spelling rules. Both instructions yielded progress.

For the second question, whether there were differences in the progress made for children with spelling problems and children without spelling problems, both experiments lead to the same conclusion: Children with spelling problems did not differ significantly in their progress from children without spelling problems. This is in accordance with the results of Bosman, van Huygevoort and Verhoeven (2006), who found that their spelling training equally affected children with and without spelling problems.

The third question asked in this study was: To what extent is performance after implicit or explicit instruction on a spelling rule rule-based? To answer this question, transfer decrement was looked at. We will first consider the results for the implicit instruction. In Experiment 1, children in the implicit condition showed no progress, so transfer decrement could not be looked at. The children did not learn a rule, but they did not gather information about the occurrence of fragments either. Thus, learning was neither rule-based nor fragment-based. In the implicit condition in Experiment 2, which studied the instruction of an autonomous spelling rule, children did make progress. Although the progress in the implicit condition on transfer words and pseudowords was significant (marginally significant on pseudowords for children with spelling problems), it was smaller than on the practiced words. The appearance of a transfer decrement gives information about the level of abstractness of the knowledge that is learned. Cleeremans and Destrebecqz (2005) argue that the presence of a transfer decrement in implicit learning tasks shows that learning is fragment-based rather than rule-based. This means that the children in this experiment improved their performance, based on the information they

gathered about the occurrence of certain fragments or chunks (Berry, 1997). They did not abstract the underlying rule, as was the interpretation of Reber (1993) of implicit learning. Instead, they unconsciously noticed the frequencies of occurrence of letter combinations and other phenomena, like the occurrence of a single vowel at the end of a syllable. These findings give information about the implicit learning of spelling knowledge. Pacton et al. (2001) already showed that uninstructed spelling knowledge, that was implicitly learned, was fragment-based. Also Pacton, Fayol and Perruchet (2005) conducted a study in which they studied the use of graphotactic and morphological characteristics of words in children. Although the children increasingly made use of morphological characteristics, they also kept using graphotactic information about the frequencies of occurrence. Therefore, Pacton et al. (2005) concluded that the children could learn morphological spelling rules implicitly, but that their performance is based on statistical representations instead of abstracted rules, or, stated otherwise, is fragment-based rather than rule-based. The present study shows that implicitly instructed spelling rules also leads to fragment-based knowledge of these rules.

Fragment-based learning is best explained by a connectionist model-approach. In connectionist models (also called neural networks) processing activity follows from large amounts of processing units which form connections. Knowledge is stored in the connections of the system, leading to typically opaque internal representations (for an overview on connectionism, see Cleeremans, 1993). Connectionists assume no separate learning systems. The model learns implicitly, by exposure to stimuli. Each time the same fragment is presented, the connections are strengthened (Pacton et al., 2001). Implicit learning effects are often explained by connectionist models (Kemp & Bryant, 2003; McClelland, 1988; Pacton et al., 2001), because they do not assume realization of knowledge or rules. Since the introduction of connectionist models as an explanation for word reading by Seidenberg and McClelland (1989), many different models have been proposed. Although these models have mainly been tested for reading tasks, the spelling of words can also be accounted for by a connectionist model (Brown & Loosemore, 1994; Bullinaria, 1997). The finding of fragment-based learning is a confirmation of the utility of connectionist models for the learning of spelling.

With respect to the explicit condition, no transfer decrement was seen in the learning of a morphological spelling rule. This means the children in the explicit condition truly learned a rule, which they were equally able to apply to practiced words, transfer words and pseudowords. In Experiment 2, a transfer decrement did occur, for both children with and without spelling problems. The influence of the word type on their performance shows that the children did not have abstract knowledge about the rule (Gomez, 1997; Manza & Reber, 1997). Thus, children did acquire rule-based knowledge about the morphological spelling rule, but they did not for the autonomous spelling rule.

This could be caused by the difficulty of both rules. Apparently, the morphological spelling rule is easier to grasp than the autonomous spelling rule. This could be explained by the linguistic base of the morphological rule. Also, the autonomous spelling rule discusses four contrasts: *aa* versus *a*, *oo* versus *o*, *ee* versus *e*, and *uu* versus *u*. The morphological rule, on the other hand, discusses only one contrast: *d* versus *t*. More graphotactic contrasts make it harder to learn a rule in a fixed length of time. The order of explanation in schools reflects this difficulty: Whereas the morphological rule is normally introduced in the second half of first grade, the autonomous rule is not explained before the end of first grade or the beginning of second grade.

Nunes, Bryant, and Bindman (1997) stated that spelling rules are learned in stages, and thus, that generalization and the correct application of rules takes time and exercise. Abstract knowledge of the *d/t* rule appears to be more quickly achieved than of the open syllable rule. To induce a transfer effect to pseudowords, more experience with material is needed. Also, O'Sullivan and Pressley (1984) found that, next to more practice, elaborated explanation about the use of a strategy and how to apply it raises the degree of transfer in children.

The present study shows that implicit learning of spelling rules can be derived by implicit instruction. Although this was demonstrated before in laboratory settings (Reber, 1993), this experimental study was conducted in a natural setting and compared the effectiveness of implicit instruction to that of explicit instruction. Although it was already clear that implicit learning occurs (Kemp & Bryant, 2003; Pacton et al., 2001; Pacton et al., 2005), we now know that it is not more effective than explicit instruction, for some rules even less effective, and that this does not differ for children with and without spelling problems.

The present study leads to some important practical implications. It makes clear that explicit instruction of a spelling rule is more effective than implicit instruction, at least for morphological spelling rules. Teachers should be aware that children do not acquire abstract knowledge about spelling rules just by reading words that obey that rule. A spelling rule has to be instructed explicitly to lead to abstract knowledge. Explicit instruction with enough rehearsal, repetition and instruction can be best used to instruct spelling rules to induce generalization. Even poor spellers benefit from explicit instruction and in first instance, they learn just as much as children without spelling problems.

Although the present study only contains a short instruction, the effects of explicit instruction are clear. In the future, studies with a longer spelling instruction could be conducted. This would presumably lead to abstract knowledge on both kinds of spelling rules after an explicit instruction. It is promising to know that explicit instruction leads to better acquaintance of spelling rules, because next to the positive effects on spelling, abstract knowledge of a spelling rule also makes children able to

direct their own spelling process and develop metacognitive skills. With an eye on educational practice, the present study shows that there is an urgent need to reform spelling instruction into a more explicit and deliberate part of the school curriculum.

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Appendix

Spelling Test

Experiment				
1		2		
Practiced words				
meid <i>girl</i>	punt <i>dot</i>	kronen <i>crowns</i>	kleuren <i>colors</i>	
hond <i>dog</i>	plant <i>plant</i>	bramen <i>blackberries</i>	boeken <i>books</i>	
paard <i>horse</i>	ruit <i>pane</i>	weken <i>weeks</i>	poorten <i>gates</i>	
vriend <i>friend</i>	kist <i>chest</i>	benen <i>legs</i>	beesten <i>beasts</i>	
Transfer words				
hoed <i>hat</i>	geit <i>goat</i>	knopen <i>buttons</i>	bloemen <i>flowers</i>	
hand <i>hand</i>	bult <i>bulge</i>	draden <i>threads</i>	dieren <i>animals</i>	
hoofd <i>head</i>	kast <i>closet</i>	repen <i>bars</i>	taarten <i>pies</i>	
zwaard <i>sword</i>	taart <i>pie</i>	ramen <i>windows</i>	feesten <i>parties</i>	
Pseudowords				
kied	loet	grapen	noeken	
lurd	dant	wemen	tuipen	
vold	rist	proken	doorten	
poerd	neert	vogen	faasten	