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To Show or Tell: Improving the Spelling of Rule-Based Words with Explicit or Implicit Practice

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ABSTRACT

Purpose: Children make spelling errors despite classroom instruction on phoneme-grapheme connections and spelling rules. We examined whether additional practice helps to decrease the number of spelling errors for a morphological spelling rule. We distinguished explicit practice in applying a spelling rule from implicit exposure to correct word forms.

Method: After a dictation task, Dutch second graders ($n = 139$; 46.8% girls) were matched and randomly divided over explicit, implicit, and no-additional practice conditions. Additional practice was based on evidence-based exercises and encompassed five sessions. The dictation task included target words that were practiced, as well as transfer words that were not.

Results: Both explicit and implicit practice resulted in better performance on target words (large effect) as well as transfer words (medium to large effect) compared to no-additional practice. There were no differences between implicit and explicit practice.

Conclusion: These findings indicate that spelling performance can be improved by additional practice, both by telling and showing. Using evidence-based explicit or implicit exercises after classroom instruction has taken place can (further) improve children's spelling of rule-based words.

Introduction

Spelling is complex and error prone. With rapid forms of written communication, such as e-mails, tweets and apps, becoming the norm, it seems appealing not to bother with correct spelling. However, misspelled words make a text more difficult to read, and can cause readers to devalue the content of the text (Graham et al., 2011). Accordingly, correct (verb) spelling has been associated with higher numbers of followers on Twitter (Schmitz et al., 2018). Moreover, insufficient spelling skills can interfere with the writing process, by making writers forget the ideas they meant to write down (Graham et al., 2002), or select only words they know how to spell (Graham & Harris, 2005). As such, spelling ability is an important determinant of writing success in particular (Tops et al., 2013), but also of school achievement and choice of secondary education in general (Savolainen et al., 2008). Given the importance of correct spelling, studies into successful spelling acquisition are needed.

There has been debate concerning how spelling is *learnt* and how spelling should be *taught*. With respect to how spelling is *learnt*, different frameworks and theories have been proposed. These approaches differ in their interpretations of the moment and way phonological, orthographic and morphological information are integrated in spelling, in the extent to which implicit exposure to orthography is assumed to influence spelling acquisition and in the acknowledgment/incorporation of

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the influence of explicit learning and teaching (e.g., Critten et al., 2016; Nunes et al., 1997; Pacton & Deacon, 2008; Steffler, 2004; Templeton & Morris, 2000; Treiman & Cassar, 1997; see Treiman & Kessler, 2014, for an overview). Empirical studies of spelling acquisition have tended to focus on the role of implicit linguistic and orthographic information, rather than also include the role of instruction (de Bree & van den Boer, 2021; de Bree et al., 2017; Kemp & Bryant, 2003; Pacton et al., 2005; Sobaco et al., 2015; Treiman & Wolter, 2018). The opposite picture emerges in the literature on how spelling should be *taught*. This literature has tended to focus on effective principles of teaching (for reviews, see Galuschka et al., 2020; Graham & Santangelo, 2014). The focus is on explicit forms of instruction, whereas not much attention is paid to the role that implicit exposure to orthography plays in spelling acquisition. In the current study we compare the effects of implicit and explicit practice in relation to the spelling of Dutch rule-based words.

In Dutch, as in most alphabetic languages, phoneme-grapheme relations are less consistent than grapheme-phoneme relations (Bosman & Van Orden, 1997). Spelling consistency (phoneme-to-grapheme) is only 36.8%, compared to pronunciation consistency (grapheme-to-phoneme) of 84.5% (Bosman et al., 2006). As a result, learning to spell requires more than converting sounds to letters. The spelling-to-sound principle is overruled in certain instances (Bos & Reitsma, 2003), for instance due to morphological consistency. Such morphological spelling rules are difficult to acquire (e.g., Gillis & Ravid, 2006; Kemp & Bryant, 2003; Notenboom & Reitsma, 2007). An example is that the morpheme *hond* is spelled identically in the singular (*hond*) and plural form (*honden*), even though the 'd' at the end of the singular is pronounced /t/ /hOnt/. This morphological consistency requires knowledge of orthographic spelling rules and ignoring the phonology of the singular (/t/). In order to become adequate spellers, children thus need to know when to overrule phoneme-grapheme association and rely on word-specific knowledge and on spelling rules and patterns instead. In the current study, we focus on the acquisition of one particular morphology-related spelling pattern, to evaluate the impact of additional implicit and explicit practice on spelling rule-based words containing this inflection.

From a young age, children are exposed to written texts/information. As a result, some spelling knowledge is acquired implicitly; by being exposed to written language and attending to it, children track the frequencies of letters, combinations of letters, morphemes and words in the input (Treiman & Kessler, 2014). On the basis of this input, they acquire orthographic information implicitly. Children learn about spelling without being aware they are attending to it. They learn implicitly what writing looks like and how letters can or cannot combine, and begin to apply this knowledge in their own "writing" before they acquire phoneme-grapheme relations (e.g., Treiman, 2017). This sensitivity to orthographic information that has not been taught but was obtained seems to increase with age (e.g., Pacton et al., 2001; van der Ven & de Bree, 2019). This increase with age seems to be due to increased word knowledge and exposure to orthography through reading (e.g., Cunningham & Stanovich, 1991; Georgiou et al., 2020). Even when explicit instruction on spelling rules has taken place, children still spell words based on implicit knowledge (e.g., Steffler, 2004).

Although implicitly acquired knowledge can improve spelling, it can also lead to the deduction of incorrect spelling patterns (e.g., de Bree & van den Boer, 2021; Kemp & Bryant, 2003; van der Ven & de Bree, 2019). Indeed, recent meta-analyses indicate that directly and systematically (explicitly) teaching students how to spell is the most successful approach to learning spelling (Galuschka et al., 2020; Graham & Santangelo, 2014). Explaining rules and strategies to spell unknown words (explicit instruction) in combination with systematic word study activities (explicit guided practice) has been associated with better spelling performance than other ways of spelling instruction (Graham & Santangelo, 2014). Instruction on phoneme-grapheme relations, morphological and orthographic patterns promotes spelling by increasing insight in the spoken and written language system, including deviances from a direct and transparent mapping of phonemes to graphemes (Galuschka et al., 2020). It speaks to the general approach of explicit direct instruction, in which phases (such as teaching, guided practice, independent processing) and instructional techniques (such as participation, modeling, practice, and process-oriented feedback) are used to promote learning (e.g., Chamalaun et al., 2022; Harris et al., 2017).

In line with these findings, Dutch education in general, and spelling instruction in particular, is mostly focused on explicit instruction and guided practice. On the basis of explicit instruction, people know what they know; explicit knowledge can easily be verbalized. In the case of spelling, children are usually capable of repeating both the acquired spelling rules and the rationale behind them (in line with the evidence-based practices presented by Harris et al., 2017). However, this approach to teaching spelling is not as successful as it could or should be. Dutch children's spelling performance near the end of primary school, and over the course of secondary school, is below the level that is expected (Bonset, 2010). This could partly be due to knowing, but not applying spelling rules. For instance, adults have been found to state spelling rules but not use them in their spelling (de Schryver et al., 2013). Furthermore, educational professionals state that explicitly applying rules during spelling exercises is sometimes too difficult for poor spellers (Bos & Reitsma, 2003), which provides information both about the effect they perceive as well as their belief in the potential effect of their instruction. Moreover, it has been shown that implicit orthographic information, acquired via exposure to correct word forms, affects spelling even after spelling instruction on the relevant spelling rules has taken place (e.g., de Bree et al., 2018). For instance, within a set of words following the same rule, orthographic and semantic familiarity are associated with higher correct scores. Accordingly, it has been suggested that explicit instruction and practice should be supplemented with incidental and more implicit methods of exposure, such as frequent reading and writing, and presenting correct forms of the words to be learned (Graham, 1999; Harris et al., 2017).

In the current study we examined whether supplementing explicit classroom instruction and practice with either implicit or explicit additional practice can improve children's spelling of rule-based words. We focused specifically on Dutch spelling of nouns ending in plosives (t, d, p, b). In Dutch, words never end with a voiced sound, due to word-final devoicing. Word-final *d* is thus pronounced as /t/: the word *hond* (*dog*) is pronounced as /hOnt/. Due to this devoicing, it cannot be derived from a word's pronunciation whether it ends in -d or -t. In the case of nouns, the correct spelling can be derived from the principle of morphemic consistency (also referred to as the principle of uniformity or principle of resemblance), as *d* is pronounced as /d/ in the plural form. To find the word-final grapheme, children are taught to use the plural word form (e.g., *honden* /hOnd@n/ *dogs*). This allows them to determine whether the singular ends in -d or -t (e.g., *hond dog*). The same rule also applies to words ending in -p or -b. These words are usually addressed in the spelling curriculum, but later than words ending in -t/-d.

Although this "rule" is explicitly taught and practiced in early elementary school (near the end of Grade 1 or at the start of Grade 2), these words continue to be written incorrectly. On the one hand, it has been found that Dutch children produce incorrect -t endings in spelling nouns ending in -d (e.g., *hont; Gillis & Ravid, 2006). These errors occurred in about 50% of the words in Grade 1. In Grade 2, after explicit instruction on this type of words, the error rate dropped to 20%. Nevertheless in Grades 3 to 6, endings for 5 to 12% of the nouns were still written incorrectly. These findings suggest reliance on phonological rather than morphological information in spelling these nouns. On the other hand, Neijt and Schreuder (2007) found that Grade 1 and 2 children obtained higher correct scores on a spelling completion task for -d targets than on the -t targets. The children incorrectly chose "d" for -t-targets (*harden instead of harten, *heart*s) more often than -t for -d-targets (*borten for borden, *plat*e)s). These findings suggest incorrect use of -d in addition to phonological strategies resulting in incorrect -t. As /t/ is often spelled as "d" but /d/ is never spelled as "t," children might choose -d in case of uncertainty. This could be overgeneralization of the rule or relate to frequency of the grapheme in the word-final position.

These studies show that errors remain after the spelling rule has been taught. The explicit classroom instruction and practice have not resulted in mastery of this particular spelling pattern. There are two possible approaches for improving the spelling of these rule-based nouns. One is more of what has already been provided in class; additional explicit practice in correctly naming and applying the rule. The assumption would be that explicit practice is the most effective form of practice, but schools may not always be able to provide enough moments of explicit practice to truly establish the rule in

memory. The other possible approach is implicit practice, through the exposure to word forms. Exposure provides learners with the correct orthography of the specific noun, without attending to underlying spelling rules or patterns. This exposure could facilitate word-specific orthographic knowledge. We compared these two approaches in the current study.

The effectiveness of additional practice can be derived from outcomes on target words that were presented during the practice sessions. However, for practice to be truly effective, an effect should be established on new, untrained words as well. To this end, we included trained target words, but also transfer words, which were untrained nouns ending in -t or -d. Furthermore, we included generalization words, i.e., nouns ending in -p or -b. The rule of morphological consistency is first taught for nouns ending in -t or -d and later for -p and -b. Inclusion of -p and -b targets allowed us to establish whether training of -t/-d words results only in close transfer to untrained -t/-d words, or perhaps also in far transfer to words with other endings following the same rule. If explicit and/or implicit practice lead to word-specific knowledge, effects are only expected on target words. If a rule is acquired, spelling of both trained and transfer words should improve. If the general principle of morphological consistency is understood, independent from the specific trained -t/-d words, an effect of practice would be expected not only on target and transfer words, but on generalization words as well.

Some studies have compared children's spelling outcomes after explicit and implicit training. The general pattern of findings is that both implicit and explicit training have a positive effect on spelling, as spelling outcomes are better than in groups without a spelling training, but that the effects of explicit instruction and practice are stronger and longer lasting (Bryant et al., 2006; Burton et al., 2021; Cordewener et al., 2015; Kemper et al., 2012; Singh et al., 2021). The positive effect of implicit training is not always significant (e.g., Burton et al., 2021; Kemper et al., 2012). This might partly be due to differences in variety in the tasks/games used during the training (see Burton et al., 2021).

Three studies are of particular importance to the current study as they directly compared effects of implicit and explicit approaches to spelling of target and transfer words in unselected samples of Dutch children in early elementary school. Hilte and Reitsma (2011) found that for second graders practicing a set of context-sensitive phonological rules, both implicit and explicit practice improved spelling of target words (large effect size compared to no practice) as well as transfer words (medium effect size compared to no practice). In contrast, Kemper et al. (2012) found an advantage of explicit over implicit practice for children in Grade 1 (medium effect size), learning the morphological rule targeted in the current study. Similarly, Cordewener et al. (2015) showed that target and transfer words, relying on a morphological or phonological spelling rule, were spelled better by first graders after explicit than implicit instruction, although both methods of instruction were superior to a no-instruction control condition (small effect sizes). In all three studies, children completed similar spelling exercises in both conditions, but either were (explicit) or were not (implicit) presented with the relevant spelling rule.

Different from the current study, these three previous studies examined the effects of explicit and implicit instruction on spelling rules that were unfamiliar to the children, as these rules were not yet taught in class. As there is clear evidence for the effectiveness of explicit instruction for spelling (Galuschka et al., 2020; Graham & Santangelo, 2014), we focused instead on the potential of implicit and explicit approaches to *improving* children's spelling of words for which the underlying rule had already been taught explicitly in class. Moreover, we adopted a slightly different approach to implicit practice. In these three previous studies, implicit practice was implicit *instruction*, as children were aware that they were practicing spelling of words. Instead, in our implicit *practice* condition, children were not aware that they were practicing spelling. Furthermore, in our explicit condition, children were *practicing* the rule explicitly, as explicit *instruction* on the rule had been provided previously by the teacher and as the specific rule was rehearsed during the practice session.

There are differences across studies in the way that implicit practice has been operationalized. In the current study we modeled implicit practice after a study by Protopapas et al. (2017). In this approach, children are truly unaware that they are practicing/learning spelling. Protopapas et al. (2017) showed that orthographic representations of known words can be strengthened through

perceptual learning procedures. Difficult-to-spell words were presented in color among sequences of black items. In five experiments, Greek fourth- and fifth-graders had to press a button in response to seeing colored items. Their knowledge of words that appeared in color increased, even though reading of the items was not required and even discouraged due to the short presentation time (i.e., 133 ms per item). The interpretation is that the colored words and required behavioral response focused attention on the word and resulted in implicit orthographic learning, as evidenced by faster word recognition. With sufficient training intensity (i.e., 20 trials), transfer to reading and spelling tasks emerged. Furthermore, in a sixth experiment, Protopapas et al. (2017) showed that it was even possible to obtain transfer effects to untrained words with the same derivational affixes as trained words. In short, implicit learning of the spelling of words occurred through exposure to correct word forms while reinforcement signals focused children's attention on target stimuli.

Present study

We compared the effects of explicit and implicit spelling practice on the spelling of nouns ending in -t/-d. Instruction on the underlying rule of morphological consistency had already been provided in the classroom. The focus of the current study was therefore not on spelling instruction, but on ways to practice and improve spelling performance after classroom instruction. As the rule under study is taught in the first semester of Grade 2, our study was conducted in the second semester of Grade 2. After a pretest dictation, children were assigned to explicit, implicit or no-additional practice conditions. After five sessions for the explicit and implicit practice groups, we assessed spelling outcomes on target words that were trained, transfer words (similar -t/-d words) and generalization words (-p/-b words).

As the meta-analysis of Graham and Santangelo (2014) showed that increasing the amount of formal spelling instruction and practice enhanced spelling skills of children in elementary school, we expected positive effects of explicit practice. In line with previous studies (Cordewener et al., 2015; Hilte & Reitsma, 2011; Kemper et al., 2012) we expected an effect on both target words and transfer words. As there are also indications that explicit instruction can best be supplemented with implicit exposure to obtain positive spelling outcomes (Graham, 1999; Harris et al., 2017), we also expected positive effects of implicit practice. Based specifically on the findings of Protopapas et al. (2017), we expected improved spelling of target, and possibly of transfer words, with implicit practice, as a result of focusing children's attention on correct word forms. We were not sure what to expect for generalization words, as none of the previous studies included generalization words, where the same rule has to be applied to words ending in different phonemes. Nevertheless, as the rule for morphological consistency does not include a specific reference to word endings, children might improve their spelling of phonologically ambiguous words ending in -p or -b, in addition to -t or -d, by referring to the plural form as well. These effects are more likely to occur with explicit practice than with implicit practice.

Next to correct scores, outcomes of the additional explicit and implicit practice sessions can also be studied on the basis of the errors that are/were made. Based on the study by Gillis and Ravid (2006) we expect mainly incorrect t-for-d endings, indicating reliance on a spelling-to-sound strategy. However, it has been shown that Dutch children also use incorrect d-for-t endings (de Bree & van den Boer, 2021; Neijt & Schreuder, 2007). Such errors would indicate that children do not simply move from phonologically-based spelling to the correct application of rules, but draw upon different explicit spelling strategies and implicit cues during spelling (e.g., Critten et al., 2016). They might for instance rely on the frequency of occurrence of certain bigrams in word-final position. If *nd* occurs more frequent than *nt*, children might write **krand* for *krant*. Alternatively, children might know the spelling rule, but have insufficient knowledge of the meaning of the words and/or their plural form. If they do not know the plural of *krant*, they could incorrectly think that it is **kranden*, and therefore **krand*. We tested whether both types of errors were present in the spellings of the current sample as well, to determine whether errors stem from phonology-based spelling strategies or indicate reliance

on multiple (implicit) cues. Moreover, we tested whether additional practice was associated with a decrease in both types of errors to determine whether additional practice results only in a more accurate use of spelling rules (decrease in t-for-d errors) or in more accurate word representations as well (decrease in d-for-t errors).

Method

Design

Our study was conducted in the second half of second grade in two cohorts (2018 and 2019). Before starting the study, we checked with the teachers that children in all participating classrooms had received regular classroom instruction on the rule under study, the rule on morphemic consistency. The ethics committee of the University of Amsterdam approved the study (2018-CDE-8742), indicating that the study adhered to all common ethical standards. Power analysis indicated that 102 participants were needed for detecting small interaction effects across three groups with a power of .95 (Faul et al., 2007).

Children completed a pretest dictation. We planned to match three classmates with equal error rates and randomly assign them to the explicit, implicit or no-additional practice conditions. We followed this procedure in three schools (four classes). An additional school was able to participate only in the control condition. Consequently, we matched pairs of classmates in the two remaining participating schools and randomly assigned them to the two additional practice conditions. After five sessions of additional practice for the explicit and implicit practice groups, we administered a posttest dictation.

Participants and procedure

Children were recruited from 7 classrooms in 6 schools in the Netherlands. Parents of the children provided written informed consent before the start of the study. Children were free to accept or decline participation on each task/session. A total of 142 second graders participated, who were distributed as evenly as possible across the three conditions. In all, 44 children received explicit practice, 45 implicit practice and 53 no-additional practice. Three children did not complete the posttest and were therefore removed from the dataset. The analyses were conducted for 44 children who received additional explicit practice, 44 children who received additional implicit practice, and 51 children who received no-additional practice (see [Figure 1](#)).

Participant characteristics for these groups are presented in [Table 1](#). The three groups differed in age, $F(2,136) = 7.627$, $p = .001$, with the children in the no-additional-practice group being slightly older than children in both additional practice groups ($p < .01$). The groups did not differ on the distribution of boys/girls, $\chi^2(2) = 2.254$, $p = .324$, and on the percentage of children who spoke only Dutch or (also) another language at home, $\chi^2(4) = 6.611$, $p = .158$. More than 20 different languages were spoken at home. Arabic/Berbers (children from Morocco; $n = 23$) or Turkish ($n = 16$) were most common. Although a substantial number of children spoke another language at home, this was often in addition to Dutch and all children learned to spell the Dutch orthography with a similar amount of classroom instruction concerning spelling rules.

Materials

Stimuli

A total of 40 words were selected, ten words each of target words, transfer words, generalization words and fillers (see [Table A1](#) in the [Appendix](#)). Target words were those words that were presented during additional practice. All target words required application of the spelling rule for morphemic consistency to determine final grapheme -d or -t. Half of the words ended

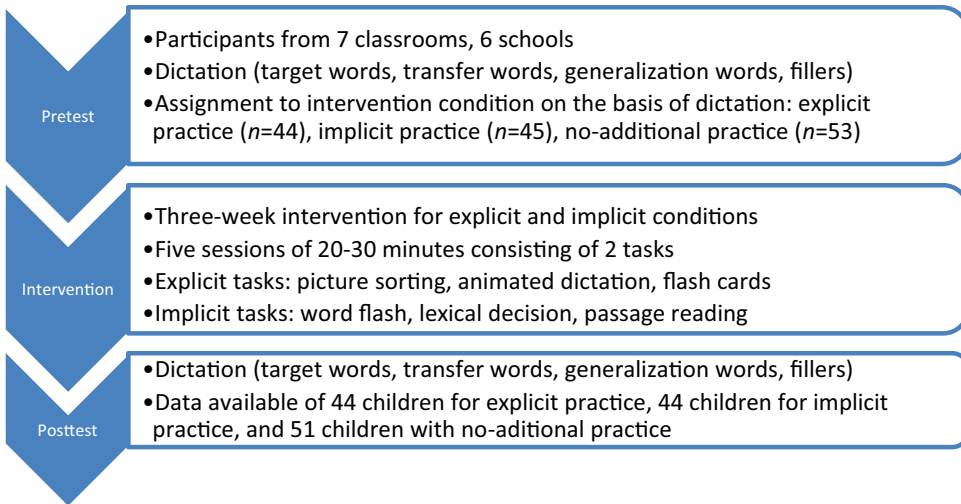


Figure 1. Study design.

Table 1. Participant characteristics.

Characteristics	Explicit practice	Implicit practice	No additional practice
% Girls	54.5	47.7	39.2
Age year;months	7;8	7;8	8;0
Home language(s)			
% Only Dutch	31.8	34.1	52.9
% Dutch and another language	56.8	5.0	33.3
% Not Dutch	11.4	15.9	13.7

with -d (e.g., hond *dog*) and half of the words ended with -t (e.g., kat *cat*). Similar to the target words, the transfer words contained five words ending in -d (e.g., mond *mouth*) and five words ending in -t (e.g., gat *hole*), that all required application of the spelling rule for morphemic consistency. These words were not presented during additional practice. Generalization words consisted of five words each that required morphemic consistency but that ended on -b (e.g., web *web*) or -p (e.g., stip *dot*) rather than -d or -t. Fillers consisted of five pairs of two words that targeted different spelling difficulties or rules that are taught in second grade (e.g., sneeuw *snow*).

Target and transfer words were matched in vowel, CV-structure and word frequency (based on Subtlex; Keuleers et al., 2010, see also OSF: <https://osf.io/3d8cx/>; Table A1). Target and transfer words did not differ in frequency, $t(18) = 0.001$, $p = .999$, nor did words ending in -d and words ending in -t (target: $t(4.175) = 1.426$, $p = .224$; transfer: $t(8) = 0.785$, $p = .455$). Target and transfer words also did not differ in frequency of the plural form, $t(18) = 0.855$, $p = .404$, nor did the plurals of words ending in -d and words ending in -t (target: $t(4.007) = 1.090$, $p = .337$; transfer: $t(8) = 0.286$, $p = .782$).

Spelling ability

A spelling-to-dictation task was used to measure spelling ability of morphemic consistency at pretest and posttest. The same 40 words were presented at pretest and posttest, but in a different order. Each word was embedded in a short sentence, always as the final word of the sentence. The sentence was read aloud once, followed by the task to spell the stimulus (e.g., “Ik wil graag in bad. Schrijf op: bad” “*I would like to take a bath. Write down bath*”). Scores consisted of the number of words written correctly within each category. For target, transfer and generalization words, we focused specifically on rule-based errors. As such, only

word-final graphemes were scored (e.g., *baart for “baard” *beard* was considered incorrect). For fillers, we coded all errors. Test-retest correlations for the control group can be considered as an indication of reliability (target words: .67; transfer words: .60; generalization words: .79; fillers: .84)

Additional practice

The children in the no-additional-practice group received only regular classroom instruction. Children in the explicit or implicit practice conditions attended five sessions of additional spelling practice, in small groups of four or five children, spread over three weeks. Each session took 20–30 minutes, leading to a total of about two hours additional practice time. The sessions were carried out at school during any lesson except spelling, to ensure that the practice was truly *additional*. These sessions were provided by graduate students of Child Psychology and Education who had already completed Teacher Training college. They were instructed on the theoretical background and core principles of additional spelling practice and practiced administering each session. Scripts were provided on how to perform each exercise during each session.

Three different explicit and three different implicit exercises were designed. In each session children completed two of these exercises. In each exercise the target word was presented once, resulting in two exposures to the target word per session, and a total of ten exposures across the intervention. Children were rewarded a sticker for active participation in each session to maintain motivation and attention.

Explicit practice. During explicit practice, children were repeatedly presented with the spelling rule targeting morphemic consistency. Before each exercise, the trainer presented the spelling rule orally and visually to the children. Children were encouraged to say both the target word and the rule before completing the exercises, which either required sorting the word or writing it down. Subsequently, the trainer provided feedback. As feedback, the trainer indicated the correct answer by modeling the correct application of the spelling rule. For target words they said: “Yes, *this is a make-it-plural word, if you make it longer you hear ‘t’ (or ‘d’)*.” All other words in the explicit exercises consisted of phonologically consistent words. For these words the feedback was to: “*Spell the word as you hear it*”. The exercises were all based on suggestions of Harris et al. (2017) for evidence-based practices in explicit spelling instruction.

Exercise 1 - Picture sorting. Children were presented with three containers: one for words ending in “d”, one for words ending in “t”, and one for other words. Children received 20 pictures on 20 cards; 10 target words, 10 fillers. They first named the picture, then sorted each picture individually, before being presented with feedback. The trainer indicated the correct container for the picture by modeling the correct application of the spelling rule. This exercise was presented 4 times, once in each session except for session 4.

Exercise 2 - Animated dictation. Children were presented with a slideshow containing 20 moving images (gif-files); 10 target words, 10 fillers. Children were asked to first name and then write down the word each image referred to. This exercise was presented 4 times, once in each session, except for session 2.

Exercise 3 - Flash cards. Children were divided into pairs. First, the trainer dictated the 10 target words to child 1, who wrote each word on a separate flash card, and received feedback from the trainer. In the meantime, child 2 completed a word search task that did not contain target words. Next, child 1 and 2 worked together in a visual dictation task: child 1 showed each flash card to child 2 for three seconds, after which child 2 wrote down the word, and received feedback from the trainer. This

exercise was presented in session 2 and session 4. Each child once had the role of “child 1” and once had the role of “child 2”.

Implicit practice. During implicit practice, children were presented with the target words in exercises presented as “games with words”. Children were not made aware that exercises were aimed at improving their spelling performance. Reinforcement signals associated with the targets ensured attention to the target words (Protopapas et al., 2017).

Exercise 1 - Word flash. Children were presented with four slideshows of 20 words each. Each word appeared on the screen for 2 seconds. The majority of the words were presented in black, but some were presented in color. Children were asked to count for each slideshow how many words appeared in color. Target words were always presented in color. Children counted individually and wrote down their answer, before the answer was discussed. This exercise was presented 4 times, once in each session except for session 4. Different slideshows were used in each session.

Exercise 2 - Lexical decision. Children were presented with a list of 32 letter strings, 16 real words and 16 pseudowords (e.g. drep). Target words were always presented, but each wordlist contained different fillers and pseudowords. Children were asked to circle the real words. The task was completed individually. This exercise was presented 4 times, once in each session, except for session 2.

Exercise 3 - Passage reading. Children were presented with a story consisting of 10 sentences. Each sentence contained one of the target words. There were two versions of the story. Children were asked to read the story and circle all letters “d” (session 2) or letters “t” (session 4). Children first read the story individually and then searched for the target letters in pairs. To ensure close reading (and thereby attention to the target words), children were also asked to answer one question about the story (e.g., Hoe heten de dieren uit de Dorpsstraat? *What are the names of the animals living in the ‘Dorps’street?*).

Results

Treatment fidelity

All groups of additional implicit or explicit practice received the intended 5 sessions of additional practice. Of these 5 sessions, children attended an average of 4.86 sessions ($SD = 0.41$, range 3–5) of additional implicit practice, and 4.89 sessions ($SD = 0.49$, range 2–5) of additional explicit practice. For each exercise, trainers rated the involvement of each child on a 5-point scale, ranging from 1 = “did not complete the exercise nor listen to the trainer at all” to 5 = “was focused on the instruction and exercise”. Across all 10 exercises, children in the implicit condition received an average involvement score of 4.84 ($SD = 0.35$, range 3.00–5.00), and in the explicit condition average involvement was 4.54 ($SD = 0.54$, range 3.10–5.00). The attendance and rated involvement were thus generally high.

Data screening

Prior to analysis of the spelling correct scores, data on all four word sets were checked for outliers and distributions. There were no missing values and all variables were sufficiently normally distributed (kurtosis and skewness < 1). One extremely low score was identified ($Z < 3.3$) on the pretest for transfer words. We analyzed the data with and without this outlier. Because the conclusions were the same, we present the results including the outlier. Descriptive statistics are presented in Table 2.

Table 2. Number of correct spellings per word set, group and measurement.

Word set	Explicit practice				Implicit practice				No additional practice			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range
Target	7.80 (1.50)	5–10	9.36 (0.94)	7–10	7.64 (1.53)	4–10	8.61 (1.53)	5–10	8.06 (1.33)	4–10	7.76 (1.37)	4–10
Transfer	8.14 (1.36)	5–10	8.70 (1.36)	5–10	8.23 (1.84)	2–10	8.73 (1.48)	5–10	8.78 (1.22)	5–10	8.22 (1.68)	4–10
Generalization	7.84 (1.46)	5–10	8.75 (1.26)	5–10	8.00 (1.86)	4–10	8.36 (1.71)	5–10	7.39 (1.78)	4–10	7.92 (1.97)	4–10
Filler	7.39 (1.99)	2–10	7.89 (1.83)	3–10	7.57 (2.27)	2–10	7.86 (1.98)	4–10	8.08 (1.75)	2–10	8.29 (1.86)	2–10

Please note that although both additional-practice groups spelled more words correctly at posttest than at pretest, children who received additional practice still made a substantial number of errors at posttest.

Spelling outcomes

We first conducted a repeated measures ANOVA on the number of words spelled correctly, including Condition (no additional practice, explicit practice or implicit practice) as between-subjects variable, and both Time (pretest, posttest) and Set (target, transfer, generalization, filler) as within-subjects variables. To control for potential clustering effects, we included school as a covariate. The main effect of School, as well as interactions of Time, Set and Time * Set with School were not significant (F 's < 1). There were main effects of Time and Set, as well as interactions between Time and Condition, and Set and Condition (p 's < .05). However, as the three-way interaction between Time, Set and Condition was significant, $F(6,268) = 4.526$, $p < .001$, $\eta_p^2 = .092$, follow-up analyses were conducted to interpret the effects.

Three follow-up repeated measures ANOVAs were conducted comparing (1) explicit practice to no additional practice, (2) implicit practice to no additional practice, and (3) explicit to implicit practice. In each analysis, School was included as a covariate, but there were no significant main effects of School, nor interaction effects with School, with the exception of a significant Set * School interaction, $F(3,83) = 5.311$, $p = .002$, $\eta_p^2 = .161$, in the comparison of explicit to implicit practice, which is considered a chance finding. Due to multiple testing, in each of these follow-up analyses, the alpha level was adjusted to .017.

Explicit practice compared to no additional practice

In the comparison of explicit practice and no additional practice, there was a main effect of Time, and there were interactions between Time and Condition, and Set and Condition (p 's < .017). Again, the three-way interaction between Time, Set and Condition was significant, $F(3,90) = 6.940$, $p < .001$, $\eta_p^2 = .188$. We conducted four follow-up repeated measures ANOVAs, one for each Set, because we were mainly interested in the interaction between Time and Condition for each word set. Again, School was included as a covariate, but there were no significant main effects of School, nor interaction effects with School. Due to multiple testing, in each of these follow-up analyses the alpha level was adjusted to .013.

For target words, there was no overall effect of Time, $F(1,92) = 2.510$, $p = .117$, $\eta_p^2 = .027$, but a significant effect of Condition, $F(1,92) = 7.565$, $p = .007$, $\eta_p^2 = .076$. Importantly, the significant interaction between Time and Condition, $F(1,92) = 42.871$, $p < .001$, $\eta_p^2 = .318$, indicated that the improvement on target words over time was larger for explicit practice than for no additional practice. Findings were similar for transfer words. There were no main effects (Time: $F(1,92) = 0.021$, $p = .884$, $\eta_p^2 = .000$; Condition: $F(1,92) = 0.282$, $p = .596$, $\eta_p^2 = .003$), but the significant interaction, $F(1,92) =$

15.969, $p < .001$, $\eta_p^2 = .148$, indicated larger improvement on transfer words after explicit practice than no additional practice. For generalization words, the interaction effect was not significant, $F(1,92) = 1.436$, $p = .234$, $\eta_p^2 = .015$. There was also no main effect of Condition, $F(1,92) = 3.184$, $p = .078$, $\eta_p^2 = .033$. The significant effect of Time, $F(1,92) = 7.030$, $p = .009$, $\eta_p^2 = .071$, indicated improvement in the spelling of generalization words over time in both groups. For fillers, there were no significant effects (Time: $F(1,92) = 2.969$, $p = .088$, $\eta_p^2 = .031$; Condition: $F(1,92) = 3.102$, $p = .082$, $\eta_p^2 = .033$; Time * Condition: $F(1,92) = 0.977$, $p = .326$, $\eta_p^2 = .011$).

Implicit practice compared to no additional practice

In the comparison of implicit practice and no additional practice, there were no main effects, but there were interactions between Time and Condition, and Set and Condition (p 's $< .017$). Again, the three-way interaction between Time, Set and Condition was significant, $F(3,90) = 6.369$, $p < .001$, $\eta_p^2 = .175$, indicating follow-up analyses. For target words, there were no main effects (Time: $F(1,92) = 2.833$, $p = .096$, $\eta_p^2 = .030$; Condition: $F(1,92) = 0.241$, $p = .624$, $\eta_p^2 = .003$). However, the significant interaction between Time and Condition, $F(1,92) = 19.380$, $p < .001$, $\eta_p^2 = .174$, indicated that the improvement on target words over time was larger for implicit practice than for no additional practice. Findings were similar for transfer words, with no main effects (Time: $F(1,92) = 0.065$, $p = .799$, $\eta_p^2 = .001$; Condition: $F(1,92) = 0.094$, $p = .760$, $\eta_p^2 = .001$), but the significant interaction effect, $F(1,92) = 10.529$, $p = .002$, $\eta_p^2 = .103$, indicating larger improvement on transfer words after implicit practice than no additional practice. For generalization words (Time: $F(1,92) = 0.116$, $p = .734$, $\eta_p^2 = .001$; Condition: $F(1,92) = 1.504$, $p = .223$, $\eta_p^2 = .016$; Time * Condition: $F(1,92) = 0.082$, $p = .775$, $\eta_p^2 = .001$) and fillers (Time: $F(1,92) = 2.131$, $p = .148$, $\eta_p^2 = .023$; Condition: $F(1,92) = 1.652$, $p = .202$, $\eta_p^2 = .018$; Time * Condition: $F(1,92) = 0.032$, $p = .859$, $\eta_p^2 = .000$), there were no significant effects.

Explicit practice compared to implicit practice

The comparison of explicit to implicit practice indicated no significant differences between the conditions. There was a main effect of Time, $F(1,85) = 26.288$, $p < .001$, $\eta_p^2 = .236$, and a main effect of Set, $F(3,83) = 7.776$, $p < .001$, $\eta_p^2 = .219$, but not of Condition, $F(1,85) = 0.177$, $p = .675$, $\eta_p^2 = .002$. The interactions between Time and Condition, $F(1,85) = 4.475$, $p = .037$, $\eta_p^2 = .050$, Time and Set, $F(3,83) = 3.023$, $p = .034$, $\eta_p^2 = .098$, and Set and Condition, $F(3,83) = 2.072$, $p = .110$, $\eta_p^2 = .070$, were not significant. There were no three-way interactions.

Results for randomized schools

As an additional check on the robustness of the data, we ran the analyses for only those schools for which we achieved random assignment of students across all three intervention conditions. These analyses included 82 students (26 implicit practice, 25 explicit practice and 31 no additional practice). School was included in these analyses, but as can be expected with random assignment, there were no main or interaction effects for School. The results of the overall repeated measures ANOVA were comparable. Although the main effects of Time and Set were not significant, the interactions between Time and Condition and Set and Condition were (p 's $< .01$). Importantly, the three-way interaction between Time, Set and Condition, $F(6,154) = 3.921$, $p = .001$, $\eta_p^2 = .132$, again pointed to the need for follow-up analyses.

When comparing explicit practice to no additional practice, there was a three-way interaction between Time, Set, and Condition, $F(3,51) = 5.313$, $p = .003$, $\eta_p^2 = .238$. Follow-up analyses per Set established that the interaction between Time and Condition, indicating an effect of explicit practice, was significant for target words, $F(1,53) = 29.909$, $p < .001$, $\eta_p^2 = .361$, but not for transfer words, $F(1,53) = 4.704$, $p = .035$, $\eta_p^2 = .082$, generalization words, $F(1,53) = 1.769$, $p = .189$, $\eta_p^2 = .032$, and fillers, $F(1,53) = 0.194$, $p = .662$, $\eta_p^2 = .004$. For the comparison of implicit practice to no additional practice, an interaction between Time, Set, and Condition was also attested, $F(3,52) = 5.119$, $p = .004$, $\eta_p^2 = .228$. Follow-up analyses per Set established that there was an effect of implicit practice for target words, $F(1,54) = 10.304$, $p = .002$, $\eta_p^2 = .160$, but not for transfer words, $F(1,54) = 2.073$, $p = .156$, $\eta_p^2 = .032$.

Table 3. Proportions of errors per word set, group, and measurement.

Word	Explicit practice		Implicit practice		No additional practice	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Target						
-t	.22	.06	.26	.11	.21	.22
-d	.22	.06	.22	.16	.18	.22
Transfer						
-t	.16	.10	.17	.08	.12	.15
-d	.21	.16	.19	.17	.13	.20

Note. An error for a target or transfer word ending in -t indicates incorrect use of d; an error for a target or transfer word ending in -d indicates incorrect use of t.

= .037, generalization words, $F(1,54) = 2.503$, $p = .119$, $\eta_p^2 = .044$, and fillers, $F(1,54) = 1.131$, $p = .292$, $\eta_p^2 = .021$. Finally, a comparison between explicit and implicit practice only rendered a significant main effect of Time, $F(1,48) = 9.425$, $p = .004$, $\eta_p^2 = .164$.

In all, the results for the subset of schools for which we achieved random assignment to conditions, mirror those for all children. The only exception is that the analyses with the entire sample also yielded effects on transfer words in the explicit and implicit practice condition, whereas this effect was not attested in the randomized subset only. As we cannot be sure whether this is due to power, or to school characteristics, these effects will be interpreted with caution.

Error patterns of target and transfer words

In addition to the correct scores, we examined the types of errors made for the words ending in -t or -d. In Table 3 we present errors for words ending in -t (incorrect use of d as in *kaart for kaart *card*) and in -d (incorrect use of t, as in *baart for baard *beard*) for target and transfer words on both pretest and posttest by children in the implicit, explicit and no-additional-practice conditions. In line with the main analyses, we focused on these rule-based errors. Across targets, conditions and measurements, other errors (e.g. *kart for kaart) were made in less than 5% of the spellings.

The proportions of errors clearly showed that both t-for-d and d-for-t errors are made. An independent sample t-test on the item means at pretest indicates that the proportion of t-for-d errors ($M = .19$, $SD = .16$) and d-for-t errors ($M = .19$, $SD = .15$) does not differ significantly, $t(18) = 0.019$, $p = .985$. This was also true when target and transfer words were tested separately. For the two groups of additional practice, we tested a potential change in errors from pretest to posttest with paired samples t-tests. For words ending in t the proportion of errors was significantly lower at posttest ($M = .09$, $SD = .07$) than at pretest ($M = .20$, $SD = .15$), $t(9) = 3.078$, $p = .013$. The proportion of errors for words ending in d was also lower at posttest ($M = .14$, $SD = .10$) than at pretest ($M = .21$, $SD = .15$), $t(9) = 2.944$, $p = .016$. These effects were also significant when tested separately for explicit and implicit additional practice. Additional practice is thus associated with a decrease in both t-for-d and d-for-t errors.

Discussion

The aim of the current study was to evaluate whether additional spelling practice positively affected children's spelling and, specifically, whether additional explicit practice was as beneficial as additional implicit practice. We studied spelling of singular nouns ending in -t/-d of Grade 2 spellers. These words all end in the sound /t/, whereas some are spelled with -t (taart, plural taarten, *cakes*) and others are spelled with -d (baard, plural baarden, *beards*). The plural form is needed to understand whether "t" or "d" should be spelled. Children assigned to the explicit or implicit conditions received five practice sessions; children in the no-additional-practice condition received none. We assessed spelling

outcomes on target words that were trained in the practice conditions, transfer words (similar untrained -t/-d words) and generalization words (-p/-b words that rely on the same rule).

Both additional explicit practice and additional implicit practice had positive effects on target words, as compared to no additional practice. Effects of both types of practice on transfer words were established for the complete dataset, but not for the subset of randomized schools. In both analyses, effects did not differ between explicit and implicit practice. There were no effects of additional practice on generalization words or fillers. These findings are in line with the spelling instruction literature showing both the protracted nature of spelling acquisition and the need for spelling practice (Galuschka et al., 2020; Graham & Santangelo, 2014). They also agree with the finding that repeated practice is important (Hattie, 2008). The children without additional practice showed a decrease in spelling outcomes on the target and transfer words.

In the study by Cordewener et al. (2015), as well as other previous studies (Hilte & Reitsma, 2011; Kemper et al., 2012), the spelling rule was taught to children prior to classroom instruction. In our study, additional practice was provided after classroom instruction of the -t/-d/-rule had taken place. Although we conducted an *additional* practice study, the correct score in the practice groups was still not perfect. The increases in spelling correct scores for the practice groups and not the no-additional-practice group is thus both an indication of additional practice effects as well as a limitation in the extent to which the additional practice sessions are effective. Similarly, the finding that there were no clear effects of additional practice on spelling generalization words indicates that explicit instruction of the rule in relation to specific types of words (-t/-d words and -p/-b words) is required.

Interestingly, we found no differences in the effects of explicit practice and implicit practice. These findings only partly agree with the general pattern of findings in the literature, in which both types of instruction impact positively on spelling outcomes but in which effects of explicit instruction are stronger (Bryant et al., 2006; Burton et al., 2021; Cordewener et al., 2015; Kemper et al., 2012; Singh et al., 2021). They run counter to the studies that did not find a positive effect of implicit training at all (e.g., Burton et al., 2021; Kemper et al., 2012). With these studies in mind, the effect of implicit practice in the current study is perhaps surprisingly large. Various aspects of the current study might have contributed to this effect. Possibly, the inclusion of a variety of tasks/games (based on Protopapas et al., 2017) in the implicit condition had a beneficial effect (see also Burton et al., 2021). Alternatively, the implicit practice condition might not have been as implicit as we intended. The dictation tasks combined with the continued presentation of the target words might not have disguised the true goal of the experiment. If that were true, this would reduce the effect that can be ascribed to implicit practice, but not the effectiveness of the tasks developed for the current study. Moreover, although not significant in the current study, it is important to note that the effect sizes related to explicit and implicit practice do suggest that when tested on a larger scale, explicit practice might prove to be more effective than implicit practice.

Turning to educational implications, we would like to stress that explicit spelling instruction is essential and that the amount of formal instruction affects spelling outcomes. Teaching spelling is more effective than informal approaches to improving spelling (Graham & Santangelo, 2014). The findings of our study, together with the evidence base of the literature, thus lead to the tentative implication that classroom instruction is essential and can be supplemented with more and sustained explicit exercises, but that implicit exercises could additionally be used (e.g., Harris et al., 2017). Children partly acquire spelling knowledge through orthographic exposure and reading (e.g., Georgiou et al., 2020). Targeting reading exercises to specific words and word types can enhance learning of spelling. Furthermore, these exercises could provide variation from the more traditionally used explicit exercises, which could foster involvement and engagement when spelling categories continue to be practiced, which is likely to have a positive effect on learning (e.g., Fredricks et al., 2004). Furthermore, the findings add to the body of research indicating that teachers need to be aware that children (partly) acquire their spelling on the basis of mere exposure to written materials.

In our additional practice sessions, the implicit practice condition provided exposure to and focused attention on the specific words, including the occurrence of specific grapheme sequences

(frequency of final -t and -d, or final -rt and -rd). Explicit practice also contained exposure to these patterns, mainly through children's own spelling of the items, as well as explicit explanation, practice and feedback. The suggestion that the explicit condition might have yielded stronger results could therefore be due to the instruction and feedback or to the combination of instruction and feedback with exposure. Future studies could more clearly distinguish between these aspects of explicit practice. In line with studies that report that explicit instruction can best be supplemented with implicit learning to obtain positive spelling outcomes (Graham, 1999; Harris et al., 2017), future studies could also explicitly address combinations of explicit and implicit practice. Please note that in the current study implicit practice was provided in addition to explicit classroom instruction, so our results concerning implicit practice do actually reflect a combined approach.

With respect to the types of errors made, they were virtually all -t/-d errors. Both -t errors for -d targets (*baart for *baard*, *beard*), as well as -d errors for -t targets (*taard for *taart*, *cake*) occurred. Earlier work has reported a reliance on phonology, with -t errors being made for -d targets (Gillis & Ravid, 2006), to match the pronunciation of the word (*baard* is pronounced /bart/). In contrast, a dominance of -d errors has also been reported (Neijt & Schreuder, 2007), suggesting incorrect use of -d. We found a combination of both types of errors, and established that both types of errors decreased with additional practice. Our findings of both t-for-d and d-for-t errors indicate that children do not merely move from a phonology-based to a rule-based spelling strategy, but rely on multiple cues in spelling words. Unfortunately, we cannot be sure which cues they relied on. We did, for example, not tap children's knowledge about the spelling rule they were tested on. We therefore have no idea as to the origin of these errors. We do not know whether children in the different conditions were able to reproduce this rule and whether they think they applied the rule during the spelling process. We know from previous research that being able to produce a spelling rule is no guarantee for spelling the words correctly (e.g., de Schryver et al., 2013). Nevertheless, it would have been useful to assess whether the knowledge of the rule was present in all three groups, to either accept or exclude certain reasons behind spelling errors. Future work could focus on the factors contributing to the types of errors made, to assess whether these stem from phonological, non-phonological or statistical cues or are based on instruction. It can be assessed for instance, whether errors relate to both spoken and written singulars (Kerkhoff et al., 2014), word frequency and familiarity with words (de Bree et al., 2018), and/or reliance on graphotactic patterns (Frisson & Sandra, 2002; van der Ven & de Bree, 2019).

In the current study, children were provided with only a limited number (five) of practice sessions. It is remarkable, in this light, that there were in fact effects of both explicit and implicit additional practice. It seems that positive effects can be gained after a limited number of sessions (see also studies of Kemper et al., 2012; Hilde & Reitsma, 2011; Cordewener et al., 2015, that all provided between 1 and 6 sessions). At the same time, it also becomes apparent that more and sustained practice is needed to fully acquire spelling rules, as children still made errors after additional practice. It would therefore be interesting to see whether prolonged practice ultimately results in perfect spelling of rule-based words.

In this study, we focused specifically on rule-based errors. Coding of final graphemes only fits with the idea of explicit instruction and practice, with its focus on direct instruction of the rule and feedback on children's application thereof. During implicit practice, in contrast, children are exposed to correct, complete word forms, without focusing on specific spelling difficulties within the words. This type of practice might result in the extraction of different spelling patterns from the input than explicit practice. For the current study, the type of error coding did not matter much. The large majority of errors were errors in the final grapheme, and the results were the same when all errors were coded and analyzed. Nevertheless, in future studies comparing explicit and implicit practice it should be carefully considered which error coding is used.

A related consideration is the reliability of spelling scores. In the current study we found adequate to good test-retest correlations. We were not sure what to expect from the reliability of a dictation test that focuses on specific types of words. Most previous studies that also do not rely on standardized measures of spelling have not reported reliability of the spelling tasks that were used (e.g., Cordewener et al., 2015; Hilde & Reitsma, 2011; Kemper et al., 2012; Lervåg & Hulme, 2010; Notenboom & Reitsma,

2007; Steffler, 2004). The stability of spelling performance in the lower grades has been shown to be rather low when using standardized measures that include different items per grade (Georgiou et al., 2020), but was also found to be adequate when the same words are repeatedly used (e.g., Lervåg & Hulme, 2010). In contrast, it has been shown that the ability to spell a specific set of words can vary from one measurement to the next (Steffler, 2004), and that spelling of specific words seems to depend more on word-specific characteristics such as semantic and orthographic familiarity with the word than on knowledge of spelling rules (e.g., de Bree et al., 2018). In all, it seems important to study stability of spelling performance over time, as well as reliability of measures used to follow spelling development.

This study is qualified by some limitations concerning the design. First, children were matched, and randomly assigned to practice conditions, but not all schools were able to participate in all three conditions. Given the rather small sample size, as well as phased data collection, we were not able to apply a randomized controlled trial (RCT). A larger-scaled RCT would be needed to confirm the results of the current study. With a larger scale, data could also be analyzed using more advanced multilevel techniques, allowing to control not only for school, but also for classroom, and perhaps even practice group. Second, we only included an immediate posttest. Effects should be studied for a longer period of time to also draw conclusions about the long-term impact of (the types of) additional practice. Hilde and Reitsma (2011) reported that advantages of explicit instruction disappeared at a follow-up measurement, so current findings should be interpreted carefully, keeping in mind the timing of the posttest.

In conclusion, we found positive effects of both explicit and implicit exercises when provided as additional practice, after classroom instruction, on children's spelling of rule-based words. No additional practice was associated with increases in error rates over time. The findings seem to agree best with frameworks of spelling in which a role for both implicit learning and explicit instruction is provided (e.g., Treiman & Kessler, 2014). Additional spelling practice in small groups using evidence-based exercises is beneficial. These findings call for further investigation. One issue is whether such additional practice would also be effective in a classroom-based design. Another is whether such effects would be visible both on dictation as well as on writing tasks. Furthermore, it is important to establish whether additional small-group-practice would be equally beneficial for a selective group of persistently poor spellers, as all children in Grade 2 were included in the current study. In all, our findings confirm that spelling is a protracted process. Even after classroom instruction and additional practice, errors are still made on spelling words that take a rule. Our findings indicate that continuous repetition of and practice with the different spelling rules is required in the literacy curriculum. Luckily both explicit and implicit forms of practice can be alternated to keep these lessons interesting.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

- Bonset, H. (2010). Spelling in het onderwijs: hoe staat het ermee, en hoe kan het beter? *Levende Talen Tijdschrift*, 11, 3–17.
- Bosman, A. M. T., & Van Orden, G. C. (1997). Why spelling is more difficult than reading. In C. A. Perfetti & L. Rieben (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 173–194). Erlbaum.
- Bosman, A., Vonk, W., & van Zwam, M. (2006). Spelling consistency affects reading in young Dutch readers with and without dyslexia. *Annals of Dyslexia*, 56, 271–300. <https://doi.org/10.1007/s11881-006-0012-4>
- Bos, M., & Reitsma, P. (2003). Experienced teachers' expectations about the potential effectiveness of spelling exercises. *Annals of Dyslexia*, 53, 104–127. <https://doi.org/10.1007/s11881-003-0006-4>
- Bryant, P., Nunes, T., Pretzlik, U., Bell, D., Evans, D., & Olsson, J. (2006). From the laboratory to the classroom. In T. Nunes & P. Bryant (Eds.), *Improving literacy by teaching morphemes* (pp. 65–103). Routledge.

- Burton, L., Nunes, T., & Evangelou, M. (2021). Do children use logic to spell logician? Implicit versus explicit teaching of morphological spelling rules. *British Journal of Educational Psychology*, *91*, 1231–1248. <https://doi.org/10.1111/bjep.12414>
- Chamalaun, R., Bosman, A., & Ernestus, M. (2022). Teaching verb spelling through explicit direct instruction. *L1-Educational Studies in Language & Literature*, *22*, 1–29. <https://doi.org/10.21248/l1esll.2022.22.1.379>
- Cordewener, K. A. H., Bosman, A. M. T., & Verhoeven, L. (2015). Implicit and explicit instruction. The case of spelling acquisition. *Written Language & Literacy*, *18*, 121–152. <https://doi.org/10.1075/wll.18.1.06cor>
- Critten, S., Sheriston, L., & Mann, F. (2016). Young children's spelling representations and spelling strategies. *Learning and Instruction*, *46*, 34–44. <https://doi.org/10.1016/j.learninstruc.2016.09.001>
- Cunningham, A. E., & Stanovich, K. E. (1991). Tracking the unique effects of print exposure in children: Associations with vocabulary, general knowledge, and spelling. *Journal of Educational Psychology*, *83*(2), 264–274. <https://doi.org/10.1037/0022-0663.83.2.264>
- de Bree, E., Geelhoed, J., & van den Boer, M. (2018). Overruled!: Implicit cues rather than an orthographic rule determine Dutch children's vowel spelling. *Learning and Instruction*, *56*, 30–41. <https://doi.org/10.1016/j.learninstruc.2018.03.006>
- de Bree, E., & van den Boer, M. (2021). Wrong place, wrong time: Children's sensitivity to present tense spelling conventions. *Applied Psycholinguistics*, *42*(5), 1221–1242. <https://doi.org/10.1017/S0142716421000254>
- de Bree, E., van der Ven, S., & van der Maas, H. (2017). The voice of Holland: Allographproduction in written Dutch past tense inflection. *Language Learning and Development*, *13*(3), 215–240. <https://doi.org/10.1080/15475441.2016.1217777>
- de Schryver, J., Neijt, A., Ghesquière, P., & Ernestus, M. (2013). Zij surfde, maar hij durfde niet. De spellingproblematiek van de zwakke verleden tijd in Nederland en Vlaanderen. *Dutch Journal of Applied Linguistics*, *2*(2), 133–151. <https://doi.org/10.1075/dujal.2.2.01de>
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. <https://doi.org/10.3758/BF03193146>
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*(1), 59–109. <https://doi.org/10.3102/00346543074001059>
- Frisson, S., & Sandra, D. (2002). Homophonic forms of regularly inflected verbs have their own orthographic representations: A developmental perspective on spelling errors. *Brain and Language*, *81*(1–3), 545–554. <https://doi.org/10.1006/brln.2001.2546>
- Galuschka, K., Görden, R., Kalmar, J., Haberstroh, S., Schmalz, X., & Schulte-Körne, G. (2020). Effectiveness of spelling interventions for learners with dyslexia: A meta-analysis and systematic review. *Educational Psychologist*, *55*, 1–20. <https://doi.org/10.1080/00461520.2019.1659794>
- Georgiou, G. K., Torppa, M., Landerl, K., Desrochers, A., Manolitsis, G., de Jong, P. F., & Parrila, R. (2020). Reading and spelling development across languages varying in orthographic consistency: Do their paths cross? *Child Development*, *91*(2), e266–e279. <https://doi.org/10.1111/cdev.13218>
- Gillis, S., & Ravid, D. (2006). Typological effects on spelling development: A crosslinguistic study of Hebrew and Dutch. *Journal of Child Language*, *33*(3), 621–659. <https://doi.org/10.1017/S0305000906007434>
- Graham, S. (1999). Handwriting and spelling instruction for students with learning disabilities: A review. *Learning Disability Quarterly*, *22*, 78–98. <https://doi.org/10.2307/1511268>
- Graham, S., & Harris, K. R. (2005, February). "The impact of handwriting and spelling instruction on the writing and reading performance of at-risk first grade writers", Paper presented at *The Pacific Coast Research Conference*, Coronado, CA.
- Graham, S., Harris, K. R., & Fink-Chorzempa, B. F. (2002). Contribution of spelling instruction to the spelling, writing, and reading of poor spellers. *Journal of Educational Psychology*, *94*, 669–686. <https://doi.org/10.1037/0022-0663.94.4.669>
- Graham, S., Harris, K. R., & Hebert, M. (2011). It is more than just the message: Analysis of presentation effects in scoring writing. *Focus on Exceptional Children*, *44*(4), 1–12. <https://doi.org/10.1201/b10962-2>
- Graham, S., & Santangelo, T. (2014). Does spelling instruction make students better spellers, readers, and writers? A meta-analytic review. *Reading and Writing*, *27*, 1703–1743. <https://doi.org/10.1007/s11145-014-9517-0>
- Harris, K. R., Graham, S., Aitken, A. A., Barkel, A., Houston, J., & Ray, A. (2017). Teaching spelling, writing, and reading for writing: Powerful evidence-based practices. *Teaching Exceptional Children*, *49*, 262–272. <https://doi.org/10.1177/0040059917697250>
- Hattie, J. (2008). *Visible learning. A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
- Hilte, M., & Reitsma, P. (2011). Effects of explicit rules in learning to spell open- and closed-syllable words. *Learning and Instruction*, *21*, 34–45. <https://doi.org/10.1016/j.learninstruc.2009.10.002>
- Kemp, N., & Bryant, P. (2003). Do bees buzz? rule-based and frequency-based knowledge in learning to spell plural -s. *Child Development*, *74*(1), 63–74. <https://doi.org/10.1111/1467-8624.00521>
- Kemper, M. J., Verhoeven, L., & Bosman, A. M. T. (2012). Implicit and explicit instruction of spelling rules. *Learning and Individual Differences*, *22*, 639–649. <https://doi.org/10.1016/j.lindif.2012.06.008>

- Kerkhoff, A. O., de Bree, E. H., & Buessler, H. A. (2014). Saying t and writing d: The case of alternating plurals. In R. Kager, K. Sebregts, & J. Grijzenhout (Eds.), *Where the principles fail : A festschrift for Wim Zonneveld on the occasion of his 64th Birthday*. Utrecht Institute of Linguistics. ISBN 978-94-6093-999-0.
- Keuleers, E., Brysbaert, M., & New, B. (2010). SUBTLEX-NL: A new frequency measure for Dutch words based on film subtitles. *Behavior Research Methods*, 42(3), 643–650. <https://doi.org/10.3758/BRM.42.3.643>
- Lervåg, A., & Hulme, C. (2010). Predicting the growth of early spelling skills: Are there heterogeneous developmental trajectories? *Scientific Studies of Reading*, 14(6), 485–513. <https://doi.org/10.1080/10888431003623488>
- Neijt, A., & Schreuder, R. (2007). Asymmetrical phoneme–grapheme mapping of coronal plosives in Dutch. *Written Language & Literacy*, 10(2), 139–154. <https://doi.org/10.1075/wll.10.2.04nei>
- Notenboom, A., & Reitsma, P. (2007). Spelling Dutch doublets: Children’s learning of a phonological and morphological spelling rule. *Scientific Studies of Reading*, 11(2), 133–150. <https://doi.org/10.1080/10888430709336556>
- Nunes, T., Bryant, P., & Bindman, M. (1997). Morphological spelling strategies: Developmental stages and processes. *Developmental Psychology*, 33, 637–649. <https://doi.org/10.1037/0012-1649.33.4.637>
- Pacton, S., & Deacon, S. H. (2008). The timing and mechanisms of children’s use of morphological information in spelling: A review of evidence from French and English. *Cognitive Development*, 23(3), 339–359. <https://doi.org/10.1016/j.cogdev.2007.09.004>
- Pacton, S., Fayol, M., & Perruchet, P. (2005). Children’s implicit learning of graphotactic and morphological regularities. *Child Development*, 76, 324–339. <https://doi.org/10.1111/j.1467-8624.2005.00848.x>
- Pacton, S., Perruchet, P., Fayol, M., & Cleeremans, A. (2001). Implicit learning out of the lab: The case of orthographic regularities. *Journal of Experimental Psychology: General*, 130, 401–426. <https://doi.org/10.1037/0096-3445.130.3.401>
- Protopapas, A., Mitsi, A., Koustoumbardis, M., Tsitsopoulou, S. M., Leventi, M., & Seitz, A. R. (2017). Incidental orthographic learning during a color detection task. *Cognition*, 166, 251–271. <https://doi.org/10.1016/j.cognition.2017.05.030>
- Savolainen, H., Ahonen, T., Aro, M., Tolvanen, A., & Holopainen, L. (2008). Reading comprehension, word reading and spelling as predictors of school achievement and choice of secondary education. *Learning and Instruction*, 18, 201–210. <https://doi.org/10.1016/j.learninstruc.2007.09.017>
- Schmitz, T., Chamalaun, R., & Ernestus, M. (2018). The Dutch verb–spelling paradox in social media: A corpus study. *Linguistics in the Netherlands*, 35, 111–124. <https://doi.org/10.1075/avt.00008.sch>
- Singh, D., Wonnacott, E., & Samara, A. (2021). Statistical and explicit learning of graphotactic patterns with no phonological counterpart: Evidence from an artificial lexicon study with 6–7-year-olds and adults. *Journal of Memory and Language*, 121, 104265. <https://doi.org/10.1016/j.jml.2021.104265>
- Sobaco, A., Treiman, R., Peereman, R., Borchardt, G., & Pacton, S. (2015). The influence of graphotactic knowledge on adults’ learning of spelling. *Journal of Memory and Cognition*, 43, 593–604. <https://doi.org/10.3758/s13421-014-0494-y>
- Steffler, D. J. (2004). An investigation of grade 5 children’s knowledge of the doubling rule in spelling. *Journal of Research in Reading*, 27(3), 248–264. <https://doi.org/10.1111/j.1467-9817.2004.00230.x>
- Templeton, S., & Morris, D. (2000). Spelling. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. III, pp. 525–543). Lawrence Erlbaum Associates.
- Tops, W., Callens, M., Van Cauwenbergh, E., Adriaens, J., & Brysbaert, M. (2013). Beyond spelling: The writing skills of students with dyslexia in higher education. *Reading & Writing: An Interdisciplinary Journal*, 26(5), 705–720. <https://doi.org/10.1007/s11145-012-9387-2>
- Treiman, R. (2017). Learning to spell words: Findings, theories, and issues. *Scientific Studies of Reading*, 21, 265–276. <https://doi.org/10.1080/10888438.2017.1296449>
- Treiman, R., & Cassar, M. (1997). Spelling acquisition in English. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 61–80). Lawrence Erlbaum Associates.
- Treiman, R., & Kessler, B. (2014). *How children learn to write words*. Oxford University Press.
- Treiman, R., & Wolter, S. (2018). Phonological and graphotactic influences on spellers’ decisions about consonant doubling. *Journal of Memory and Cognition*, 46, 614–624. <https://doi.org/10.3758/s13421-018-0793-9>
- van der Ven, S., & de Bree, E. (2019). Variation is the spice of spelling: The effect of implicit cues on Dutch past tense spelling is dependent on age, literacy and task format. *Scientific Studies of Reading*, 23(5), 369–385. <https://doi.org/10.1080/10888438.2019.1579217>

Appendix

Table A1. Stimuli.

Target			Transfer			Generalization		Filter	
Word ¹	Freq s ²	Freq p ²	Word ¹	Freq s ²	Freq p ²	Word ¹	Freq s ²	Word ¹	Freq ²
<i>bad bath</i>	42.58	3.50	<i>pad toad</i>	41.99	0.78	<i>web web</i>	4.51	<i>sneeuw snow</i>	24.31
<i>hond dog</i>	168.65	51.34	<i>mond mouth</i>	165.93	1.89	<i>krab crab</i>	3.86	<i>meeuw gull</i>	0.64
<i>baard beard</i>	11.64	0.82	<i>paard horse</i>	83.63	46.03	<i>slab bib</i>	0.02	<i>buren neighbors</i>	30.14
<i>kind child</i>	333.3	474.49	<i>wind wind</i>	35.61	5.51 ³	<i>rib rib</i>	2.17	<i>kussen pillow</i>	45.62
<i>speld pin</i>	2.65	0.96	<i>held hero</i>	59.64	14.98	<i>schub scale</i>	0.18	<i>lach laugh</i>	46.72
<i>Average d:</i>	111.76	106.22	<i>Average d:</i>	77.36	13.84				
<i>kat cat</i>	52.85	15.46	<i>gat hole</i>	49.97	5.14	<i>step scooter</i>	0.53	<i>vlag flag</i>	17.79
<i>lont fuse</i>	2.79	0.30	<i>kont buttocks</i>	73.57	1.04	<i>trap stairs</i>	52.28	<i>zooi mess</i>	9.65
<i>taart cake</i>	31.35	3.34	<i>kaart postcard</i>	79.67	11.56	<i>stap step</i>	126.53	<i>kooi cage</i>	13.81
<i>lint ribbon</i>	7.98	0.82	<i>tint shade</i>	0.64	0.19	<i>stip dot</i>	1.56	<i>ijs ice</i>	58.70
<i>munt coin</i>	10.89	6.43	<i>punt point</i>	73.77	4.47	<i>drup drop</i>	0.69	<i>reis trip</i>	90.37
<i>Average t:</i>	21.17	5.27	<i>Average t:</i>	55.52	17.09				
<i>Average:</i>	66.47	55.74	<i>Average:</i>	66.44	15.47	<i>Average</i>	19.23	<i>Average:</i>	33.78

Note. ¹ English translation in italics. ² Freq s = frequency of the word in singular form, and Freq p = frequency of the word in plural. Frequencies are derived from Subtlex (Keuleers et al., 2010). ³ For this target, there is only a frequency for the verb dominant target (winden = to fart).