



Phonological and morphological consistency in the acquisition of vowel duration spelling in Dutch and German

Karin Landerl^{a,*}, Pieter Reitsma^b

^a *Department of Psychology, University of Salzburg, 5020 Salzburg, Austria*

^b *PI Research, Vrije Universiteit, Amsterdam, P. O. Box 366, 1115 ZH Duivendrecht, The Netherlands*

Received 3 November 2004; revised 19 April 2005

Available online 21 June 2005

Abstract

In Dutch, vowel duration spelling is phonologically consistent but morphologically inconsistent (e.g., *paar–paren*). In German, it is phonologically inconsistent but morphologically consistent (e.g., *Paar–Paare*). Contrasting the two orthographies allowed us to examine the role of phonological and morphological consistency in the acquisition of the same orthographic feature. Dutch and German children in Grades 2 to 4 spelled singular and plural word forms and in a second task identified the correct spelling of singular and plural forms of the same nonword. Dutch children were better in word spelling, but German children outperformed the Dutch children in nonword selection. Also, whereas German children performed on a similar level for singular and plural items, Dutch children showed a large discrepancy. The results indicate that children use phonological and morphological rules from an early age but that the developmental balance between the two sources of information is constrained by the specific orthography.

© 2005 Elsevier Inc. All rights reserved.

Keywords: Cross-linguistic comparison; Morphology; Vowel spelling; Spelling acquisition

* Corresponding author. Fax: +43 662 8044 5126.
E-mail address: karin.landerl@sbg.ac.at (K. Landerl).

Introduction

Alphabetic orthographies represent the phonemic structure of language. But few orthographies adhere closely to the phonological principle that one grapheme corresponds to one and only one phoneme and vice versa. In most orthographies, there exists a certain degree of inconsistency or even irregularity in grapheme–phoneme and phoneme–grapheme relations. One reason for these inconsistencies at the phonological level is another central orthographic principle, namely that morphemes should be spelled consistently. The principle of morpheme consistency leads to different spellings for the same sounds. For example, whereas the word spelling *mist* can be explained by the phonological principle alone, the homophonous word *missed* receives a more complex spelling because it consists of the morphemes *miss* and *ed*. The two principles are of different importance in different orthographies. For English, it has been argued that phonological inconsistencies and irregularities are the cost for consistency on the morphological level (Chomsky & Halle, 1968). For example, the consistent spelling of the word stem in *heal* and *health* or in *sign* and *signature* enables the reader to identify the morphological relation between the words even though the pronunciations are different. On the phonemic level, the morphological consistency leads to the irregular pronunciation /ain/ for the rime segment in *sign*.

Orthographies that represent the morphological level rather than the phonological level are termed *deep* because morphology represents a deeper level of language structure than does phonology (Lieberman, Liberman, Mattingly, & Shankweiler, 1980). Orthographies that primarily represent the phonological level are termed *shallow*. Consistency on the phonological and morphological levels is likely to have different advantages and disadvantages. Orthographies stressing the transparency of the morphological structure are assumed to be efficient for fluent readers because they provide more direct access to the meaning of a word. In learning to read and spell, however, acquisition of the alphabetic principle is generally seen as an important first step. There is now cogent evidence that this first hurdle in reading and spelling acquisition is more easily mastered in shallow orthographies than in deep orthographies (Aro & Wimmer, 2003; Frith, Wimmer, & Landerl, 1998; Juul & Sigurdsson, 2005; Seymour, Aro, & Erskine, 2003; Wimmer & Landerl, 1997).

In most orthographies, learning about the grapheme–phoneme code is not sufficient. Children will also have to learn about specific orthographic features and markers occurring in their orthographies. Cross-linguistic comparisons can be useful in determining the processes involved in the acquisition of orthographic skills. In the current study, we compared the acquisition of vowel duration spelling in German and Dutch. Both orthographies use letter doubling to mark long and short vowel phonemes (vowel doublets and postvocalic consonant doublets, respectively), but vowel duration spelling follows different principles in the two orthographies. In Dutch, it is fully determined by a number of context-sensitive phonological rules that define when letters (vowels as well as consonants) must be doubled. Morphological knowledge is not relevant. On the contrary, the same word stem is spelled differently depending on the phonological context (e.g., *paar–paren* [English: pair–pairs]). In

German, in contrast, vowel duration spelling is highly inconsistent on the phonological level. Letter doubling is only one of a number of options to mark vowel duration. But German closely adheres to the principle of morpheme consistency. Thus, once the spelling of a certain word stem is stored, it can be applied to all word forms including that stem morpheme (e.g., *Paar–Paare*).

To summarize, in Dutch, vowel duration spelling is phonologically consistent but causes morphological inconsistency. In German, representation of long and short vowel phonemes is phonologically highly inconsistent but morphologically consistent. Contrasting the two orthographies allows us to examine the role of phonological and morphological consistency in the acquisition of one and the same orthographic feature. Models of spelling development (Bryant, Nunes, & Aidinis, 1999; Ehri, 1992, 1997; Frith, 1985; Henderson, 1985; Henderson and Beers, 1980; Nunes, Bryant, & Bindman, 1997a, 1997b) all suggest that children shift from a predominantly sound-based approach to a later incorporation of morphological information. Thus, although the Dutch letter doubling rules are rather complex, they should be relatively easy to acquire because they are completely phonology based and do not require any morphological understanding. In contrast to Dutch, morphological relations in German are highly important; so long as children do not consider the morphemic structure of words, they would have to store the spelling of each word form individually in their orthographic lexicon.

In contrast, empirical findings show that children do use morphological information in their spelling attempts from a very early age (Kemp & Bryant, 2003; Levin & Koriat, 1993; Treiman & Cassar, 1997; Treiman, Cassar, & Zukowski, 1994). Treiman and colleagues (1994) showed that even 5-year-olds are better at spelling the medial stop consonant in *dirty* than in *duty*. In American English, these flap consonants sound more like /d/ than like /t/. The root *dirt*, however, clearly ends with a /t/ phoneme and not a /d/ phoneme. Obviously, even very young children have a basic understanding that *dirt* and *dirty* are morphologically related and that words from the same word family should receive the same spelling. This early understanding of the relevance of morphological relations for the spelling of word stems might help German children to work out the phonological inconsistencies of vowel duration spelling. Once they know how to spell the word stem, spelling of other word forms might be a minor problem. If, however, Dutch children make the very same linguistically plausible assumption—that words from the same word family should be spelled the same—they will have a hard time learning the conditional rules of vowel duration spelling.

Orthographic representation of phoneme duration (consonants as well as vowels) has been recognized as a particular spelling problem for a long time. During recent years, the problem has received an increasing amount of interest in different orthographies (Juil & Sigurdsson, 2005; Landerl, 2003; Lehtonen & Bryant, 2004, 2005; Lyytinen, Leinonen, Nikula, Aro, & Leiwo, 1995). In many orthographies, letter doubling is used to represent phoneme duration. However, there is considerable variation in the transparency and consistency of this orthographic function. In many French word spellings, for example, consonant doublets have no orthographic function whatsoever (e.g., the segments *om* and *omm* are pronounced similarly in the French

words *moment* [English: moment] and *pomme* [English: apple]), whereas in English they indicate in principle that the preceding vowel is short (e.g., *hopping–hoping*). This conditional rule is inconsistent in that many short vowel phonemes are not marked in this way (e.g., *canon–cannon*) and that double consonants sometimes occur after long vowel phonemes (e.g., *grass, ball*). Cassar and Treiman (1997) and Pacton, Perruchet, Fayol, and Cleermans (2001) showed that even very young children have some knowledge of positional constraints on double consonants in French and English, for example, that they do not occur in the word-initial position. However, in Cassar and Treiman's (1997) study, only children age 11 years or over started to take into account the duration of the preconsonantal vowel phoneme when deciding whether a nonword should be spelled with a single or double consonant.

Lehtonen and Bryant (2005) confirmed these findings for Finnish children. In a forced-choice paradigm, even children at the beginning of Grade 1 selected double consonant spellings significantly less often than they did single consonant spellings in the word-initial position, but they did not use phoneme duration to choose between single and double consonant spellings in the word-medial position. But in this Finnish sample, the 8-year-old second graders already showed a basic understanding of both the functional constraints and the positional constraints of consonant doublets. This is not surprising given that in Finnish the orthographic function of consonant doublets is much more straightforward than in English. In Finnish, letter doublets (both vowels and consonants) represent long phonemes. Thus, the orthographic function is not conditional as it is in English (a double consonant marks duration of the vowel phoneme *before* the consonant that must be doubled). In addition, Finnish is a highly consistent orthography, meaning that there are no exceptions to the rule of letter doubling.

Juul and Sigurdsson (2005) directly compared spelling of consonant doublets in Danish and Icelandic. In Danish, a deep orthography, the consonant doubling rule is similar to that in English: A double consonant marks a preceding short vowel phoneme. However double consonants never occur in the word-final position, and the doubling rule applies only to stressed vowel phonemes. After short unstressed vowel phonemes, sometimes the consonant is doubled and sometimes it is not. Icelandic, in contrast, is more like Finnish: Double consonants mark long consonant phonemes, but as in Danish, they can occur only after a short vowel phoneme. Not surprisingly, Danish third and fourth graders had considerably more problems spelling consonant doublets than did their Icelandic counterparts.

German, like Danish, also applies the conditional rule that consonant doublets mark the preceding vowel phoneme as short (e.g., *Wasser, Bett*). Instead of doubling the graphemes *z* and *k*, the complex graphemes *tz* and *ck* are used after short vowel phonemes (e.g., *Katze, Decke*). However, if another consonant follows within the same morpheme, the postvocalic consonant is not doubled (e.g., *Wind, Bank*). For long vowel phonemes, the situation is even more complex in that they are sometimes marked by vowel doublets (e.g., *Haar, Beet*), but this way of long vowel phoneme marking is in fact rather exceptional. More typical variants are a so-called silent *h* following the vowel grapheme (e.g., *sehr, Bahn, Sohn*), a special vowel digraph for long /i:/ (e.g., *Dieb, Lied*), and no orthographic marking at all (e.g., *Tal, Besen, Ofen*).

The high inconsistency¹ of vowel duration spelling is evident from the fact that a number of homophones differ only in how they represent the long vowel phoneme (e.g., *Wal*–*Wahl* [whale–election], *mehr*–*Meer* [more–sea], *Lid*–*Lied* [eyelid–song]). On the morphological level, the spelling of a morpheme is highly consistent in all word forms. For example, the stem morpheme *schwimm*- is spelled consistently in the words *schwimmen*, *schwimmt*, *Schwimmer*, and *Schwimmbekken* (to swim, he swims, swimmer, and swimming pool, respectively).

As in all other Germanic orthographies, double consonants mark preceding short vowel phonemes in Dutch. But consonant doublets are written only in the intervocalic position (e.g., *zwemmen* [to swim], but *zwem*, *zwemt* [I swim, he swims]). Long vowel phonemes are marked by vowel doublets, but only in closed syllables. In open syllables, long vowel phonemes are not orthographically marked (e.g., *boom*–*bomen* [English: tree–trees]). Thus, although both vowel and consonant doublets are completely predictable based on these context-sensitive phonological rules, the phonological consistency in this case causes inconsistency on the morphological level because the same word stem receives different spellings in different word forms.

In the current discussion, the terms *long vowels* and *short vowels* are used in a strictly linguistic–phonological sense and not in the sense that they are frequently used in the context of English orthography, where the terms stand for different pronunciations for similar or identical vowel graphemes (e.g., *hid* vs. *hide*). This orthography-based terminology is specific to English and is not relevant in Dutch and German, the two orthographies compared in the current study. Dutch and German long and short vowels differ in vowel duration. In both languages, a slight difference in vowel quality is associated with vowel duration that is best described by the phonological feature tense/lax. For example, long vowels are systematically tense, whereas short vowels are lax (e.g., Dutch: *beek*–/be:k/ [brook] vs. *bed*–/bet/ [bed]; German: *Beet*–/be:t/ [flower bed] vs. *Bett*–/bet/ [bed]). In both orthographies, native speakers refer to vowels as long and short, indicating that the duration difference is more prominent to them than is the tense/lax difference. This is probably due to the fact that both orthographies use the same vowel letters to represent long and short vowel phonemes. The duration difference between short and long vowel phonemes is more marked in German than in Dutch. However, Dutch long vowels tend to diphthongize, and this is not the case for German vowels (Booij, 1995; van Berkel & Sauer, 2001).

Vowel duration spelling has been demonstrated to be a particular problem in spelling acquisition in both German (Klicpera & Gasteiger-Klicpera, 2000) and Dutch (Geelhoed & Reitsma, 1999; Notenboom & Reitsma, 2003). However, the reasons for these difficulties might be quite different in the two orthographies. A direct comparison of the development of vowel duration spelling in Dutch and in German allows us to examine the relative influence of phonological and morphological consistencies on children's spellings.

¹ German has highly consistent grapheme–phoneme correspondences but a high degree of inconsistency in phoneme–grapheme correspondences. Thus, German is shallow for reading but deep for spelling.

In the current study, Dutch and German children at the beginning of Grades 2, 3, and 4 were given two tasks. In a word spelling task, they had to produce both singular and plural forms of short familiar words, half of which included a long vowel phoneme and half of which included a short vowel phoneme. Because Dutch and German are closely related linguistically, we were able to use cognates, that is, words that are highly similar in spelling and pronunciation and that are identical in meaning. The main difference between the items in the two languages was that in German the stem of the singular and plural form received the same spelling (e.g., *Boot–Boote*, *Klasse–Klassen*), whereas in Dutch the spelling changed according to the conditional rules described above (e.g., *boot–boten*, *klas–klassen*). Furthermore, according to the differences between the orthographies, the German items included different forms of long or short vowel spellings (e.g. silent *h*), vowel doublets, or no orthographic marking for long vowel phonemes, whereas the Dutch items included vowel and consonant doublets (where required) as the only consistent markers of vowel duration.

If phonological consistency is the dominant factor in spelling acquisition, then Dutch children should exhibit faster acquisition of orthographically correct vowel duration spelling than do German children. However, we hypothesize that comprehension of morphological consistency develops early as well. This second orthographic principle should interfere with Dutch children's spelling attempts, but it should help German children because acquisition of the orthographically correct spellings of the word stems is assumed to progress very slowly in German. However, once children know the correct spellings of the word stems, they should be able to spell both singular and plural forms of the words. Thus, we predict a similar performance level for singular and plural words. For Dutch children, in contrast, there might not be a strong correspondence between accuracy for singular and plural spellings because each spelling must be worked out based on the phonological structure of the particular word. On the contrary, Dutch children might erroneously assume that word stems should have identical spellings in different word forms. In that case, they could show very high performance in one condition but very low performance in the other condition.

Naturally, word spelling depends heavily on lexical knowledge; the more word spellings children know, the better they will perform in a word spelling task. Good performance on a word spelling task does not necessarily mean that children fully understand the principles of vowel duration spelling; the individual word forms may be stored separately. Likewise, poor performance might be due to unfamiliarity with the dictated word spellings so that the children are not able to show their understanding of the relevant orthographic principles. Thus, we also gave children a nonword task that depends less on their knowledge of word spellings. We used a paradigm where children had to select each correct spelling from four alternatives. Children were presented with a consonant–vowel–consonant (CVC) nonword “morpheme” that was introduced as either a singular or plural noun form (e.g., “This is a /na:l/”, “These are two /na:lən/”). At the same time, children were presented with a spelling of that nonword that was correct in their orthography (Dutch: *naal/naalen*; German: *Naal/Naalen*). The children's task was to identify the correct spelling of the nonword in plural/singular form (e.g., “Now, circle the correct spelling for two /na:lən/”, “Cir-

cle the correct spelling for one /na:l/"). In both orthographies, the presented spelling provided sufficient information for the correct spelling of the demanded (non)word form. Although the presented items were the same in the two orthographies, children had to select different responses. The Dutch children had to apply the standard context-sensitive phonological rules of consonant and vowel doubling to find the correct spelling, whereas the German children had to identify the spelling of the "stem morpheme" of the presented nonword and find the nonword form that included the same spelling. Half of the items in each condition (plural selection and singular selection) included a long vowel phoneme, and the other half included a short vowel phoneme. Children would be able to perform this task adequately only if they had a good understanding of the orthographic principles relevant in their orthography. Once again, general models of spelling acquisition would predict that the sound-based strategy required in Dutch should be relatively easy. But notice that the Dutch task required selection of a spelling that looked different from the presented one. German children, in contrast, need not make any explicit decisions about phonology and how to represent it in spelling. Based on the principle of morpheme consistency, their task was to find the item with the identical spelling of the stem "morpheme."

Method

Participants

Altogether, 437 school children from Grades 2, 3, and 4 participated in The Netherlands and Germany. Table 1 presents the subject details of each language group. All testing was done at the beginning of the school year. All tests were carried out as classroom tests. The German sample consisted of children from two classes per grade level, and all were from the same elementary school near Augsburg. The Dutch participants came from three different elementary schools in the Amsterdam area. The samples did not include children with special needs (e.g., language or general learning difficulties); therefore, they provide a good indication of normal literacy development in the two languages.

Table 1
Numbers of participants and mean ages for each grade level

	German		Dutch	
	<i>n</i>	Age	<i>n</i>	Age
Grade 2	43 (26 boys and 17 girls)	7 years 10 months (4 months)	120 (52 boys and 68 girls)	7 years 9 months (6 months)
Grade 3	42 (20 boys and 22 girls)	8 years 9 months (5 months)	102 (55 boys and 47 girls)	8 years 10 months (7 months)
Grade 4	52 (28 boys and 24 girls)	9 years 9 months (5 months)	98 (48 boys and 50 girls)	9 years 8 months (5 months)

Note. In age columns, standard deviations are in parentheses.

Tasks

Word spelling

Children were asked to spell short (one- and two-syllable) familiar words. Each word was dictated in both singular and plural versions. One set of 10 singular–plural word pairs (20 words) had a short stressed vowel phoneme, and another set of 10 singular–plural word pairs had a long stressed vowel phoneme. Only cognates were used. In German, the word stems of these word pairs receive the same spelling according to the principle of morpheme consistency (e.g., *Klasse–Klassen*, *Boot–Boote*). However, because especially long vowel spellings are inconsistent, children must be familiar with the spelling of the particular word stem. In Dutch, in contrast, the same words are spelled differently in singular and plural according to the phonologically consistent context-sensitive phonological rules (e.g., *klas–klassen*, *boot–boten*).

To determine Dutch children's understanding of morpheme consistency, another five singular–plural word pairs were added to the Dutch test in a control condition. These control items were selected specifically to mimic the requirements of German vowel duration spelling; that is, they were phonologically inconsistent but received the same word stem spelling in both singular and plural. Each control item included either the diphthong /au/ or the diphthong /ai/. Both of these diphthongs can be represented by two different graphemes in Dutch (*au* or *ou* for /au/ and *ei* or *ij* for /ai/). Thus, for these items, the problem for the Dutch spellers is similar to the task requirements of long and short vowel spelling in German. Lexical knowledge is needed to get the spelling of the vowel right, but because these words adhere to the principle of morpheme consistency, lexical knowledge of the word stem spelling is sufficient to get both singular and plural word forms right. Thus, altogether, the word spelling test consisted of 40 items (20 long and 20 short vowel phoneme spellings) for the German participants and 50 items (20 long and 20 short vowel phoneme spellings + 10 control words) for the Dutch participants. Each word was embedded in a sentence that served to disclose the meaning of the target word. The words were dictated in random order with singular and plural spellings of the same word several sentences apart. Each child received a worksheet with the sentence frames on it and had to fill in the words dictated by the experimenter. The German and Dutch word items are presented in Appendix A.

Nonword selection

This task was introduced to get a picture of children's understanding of the orthographic principles relevant for vowel duration spelling in their orthography without any concealing influence of lexical knowledge. Using nonwords allowed us to present exactly the same spoken stimuli in Dutch and German. However, because of the differences between the two orthographies, different responses were required. The nonword task consisted of two conditions. In the plural selection task, children were presented with the pronunciation and spelling of a CVC nonword (e.g., /na:l/–*naal*).

The experimenter then pronounced the plural form of this nonword (/na:lən/) and asked children to select the adequate spelling for that plural nonword from four different spellings (*nallen–nalen–naalen–naalef*). For the singular selection condition, children heard and saw the same CVC nonwords ending with the plural morpheme *–en* (e.g., German: /na:lən/–*naalen*; Dutch: *nalen*). Then the experimenter pronounced the singular form of that nonword (/na:l/) and asked children to select the most adequate spelling from four variants (*naal–nal–nall–naak*). For both the plural and singular selection conditions, there were 30 items (15 with long vowels and 15 with short vowels). Notice that each CVC syllable was presented as a target four times: singular with short vowel phoneme (/nal/), singular with long vowel phoneme (/na:l/), plural with short vowel phoneme (/nalən/), and plural with long vowel phoneme (/na:lən/). The four response alternatives always included a simple spelling of the CVC syllable: one spelling with a vowel doublet, one spelling with a consonant doublet, and one spelling with a consonant letter that did not occur in the pronunciation. Examples are presented in Appendix B. The sequence of the response alternatives was systematically varied for each item.

For each condition, children received a worksheet that showed the spellings of the four response alternatives of each item. The experimenter presented the target spelling in large print on a card (size 30 × 21 cm) to the whole class and said, “This says /nal/—one /nal/. If there are two of them, we would call them two /nalən/. Now look at the spellings on your worksheet and circle the one that spells /nalən/ correctly.” Children were first familiarized with the concept of nonwords. The experimenter explained that these were new words that did not yet exist in Dutch or German. Children were told to determine what the correct spelling of these new words would be if they were spelled according to the orthographic rules the children had learned. Four practice items were presented on top of each worksheet. For these practice items, the experimenter explained step by step how the children could find the correct answers. The practice items mainly helped children to understand the requirements of the task. The practice items did not include vowel or consonant doublets because this would have required us to explain the orthographic rules that we wanted to test. Still, for the Dutch group it was important to point out that sometimes stems in different word forms receive different spellings. For example, the singular form of the practice nonword *deiven* is *deif* and not *deiv* because *v* in the word-final position is not allowed. In German, analogous items were presented, but the correct response was always the one that was consistent with the target according to the principle of morpheme consistency.

Some adaptations had to be made for the German items. First, because the nonwords were presented as nouns, they all were spelled with an uppercase first letter according to German orthography, where the first letter of all nouns is uppercase. Second, as outlined in the Introduction, in German there are several ways of representing long vowel phonemes, whereas in Dutch there is only one acceptable way of spelling a long vowel phoneme. Therefore, some German long vowel spellings were marked by a double vowel, and others were marked by a silent *h* following the vowel letter. For the long vowel /u:/, only *uh* spellings were presented because doubling the *u* letter is illegal in German orthography. Those items that included a double *k* in

Dutch were replaced by the corresponding German grapheme *ck* because doubling of *k* is illegal in German.

The items in each of the two conditions were presented in a fixed random order with CVC structures that differed only in vowel duration several items apart. Half of the participants worked on the plural selection task first, and the other half received the singular selection task first. The word spelling task was always presented between the two nonword conditions.

Results

Word spelling

The scoring of the word spelling task focused on the stressed vowel and the subsequent consonant(s) because these graphemes represent vowel duration, the orthographic feature in which we were especially interested. Errors on other parts of the word (e.g., *Schpinnen* for *Spinnen*) were not considered. Most of these incorrect spellings were phonologically acceptable in that they represented the phoneme sequence adequately but did not conform to the conventions of the orthography.

Fig. 1 presents the mean numbers of correct vowel duration spellings for the two language groups. Children's performance was analyzed in two Orthography (German or Dutch) \times Grade Level (Grade 2, 3, or 4) \times Word Form (singular or plural) \times Vowel Duration (short or long) analyses of variance (ANOVAs): one by subjects and one by items. This procedure seemed to be necessary because our main criterion for selecting the words was that similar forms should exist in both orthographies. Balancing for word frequency would have been very difficult. The items analysis ensures that effects are not item specific. The following main effects were reliable in both analyses: orthography, $F_{\text{subjects}}(1,403) = 78.4$, $p < .001$, $F_{\text{items}}(1,18) = 13.8$, $p = .002$; grade level, $F_{\text{subjects}}(2,403) = 191.0$, $F_{\text{items}}(1,18) = 317.7$, $ps < .001$; and word form, $F_{\text{subjects}}(1,403) = 246.3$, $F_{\text{items}}(1,18) = 353.0$, $ps < .001$. The main effect of vowel duration was reliable in the subjects analysis, $F_{\text{subjects}}(1,403) = 6.9$, $p = .015$, but not in the items analysis.

The theoretically most interesting effect is the significant interaction between orthography and word form, $F_{\text{subjects}}(1,403) = 155.9$, $F_{\text{items}}(1,18) = 114.6$, $ps < .001$. This interaction reflects our prediction that for Dutch children it should be easier to spell singular word forms than to spell plural word forms because the singular form can be spelled by simple phoneme-grapheme translation, whereas the plural form requires consideration of context-sensitive phonological rules. In German, the main hurdle is to memorize the correct orthographic spelling of the word stem, which can then be equally applied to singular and plural word forms. The predicted difference between the orthography groups can be seen in Fig. 1. The Dutch children were at ceiling on the singular word forms, even in Grade 2, but they showed marked difficulty with plural spellings, especially in the lower grades, and even committed some errors in Grade 4. German children's performance overall was lower than that of Dutch children, with the difference between singular and plural spellings being

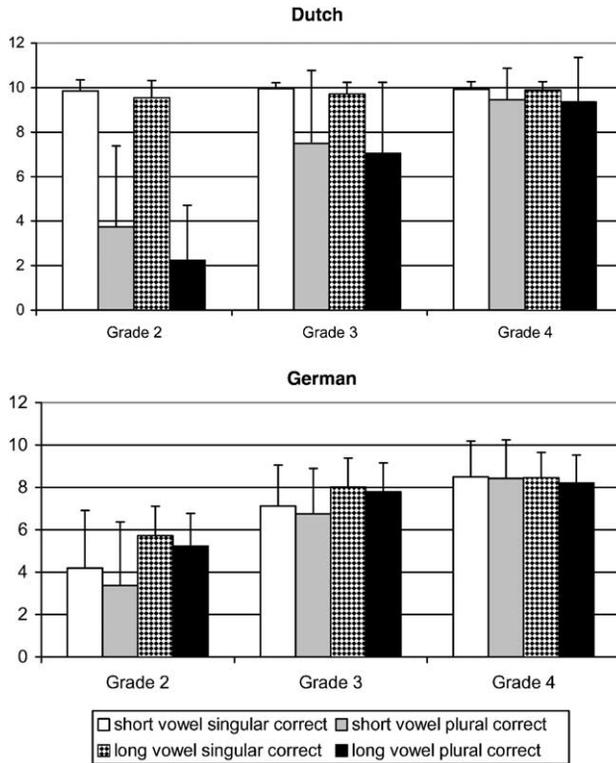


Fig. 1. Word spelling: Number of correct spellings for Dutch and German children (maximum = 10).

smaller but still significant, $F_{\text{subjects}}(1, 134) = 34.2$, $p < .001$, $F_{\text{items}}(1, 19) = 13.1$, $p = .002$. Word form interacted with grade level, $F_{\text{subjects}}(2, 403) = 73.4$, $F_{\text{items}}(2, 36) = 362.2$, $ps < .001$, and the Orthography \times Word Form effect was also modified by an interaction with grade level, $F_{\text{subjects}}(2, 403) = 53.2$, $F_{\text{items}}(2, 36) = 296.1$, $ps < .001$, reflecting the fact that it decreases with increasing grade level. The Orthography \times Grade Level \times Vowel Duration interaction was reliable in both analyses, $F_{\text{subjects}}(2, 403) = 21.7$, $p < .001$, $F_{\text{items}}(2, 36) = 4.4$, $p = .02$, and the Orthography \times Grade Level \times Word Form \times Vowel Duration interaction was reliable in the subjects analysis, $F_{\text{subjects}}(2, 403) = 3.3$, $p < .05$, and borderline significant in the items analysis, $F_{\text{items}}(2, 36) = 3.1$, $p = .06$.

Fig. 1 shows that German second and third graders were better at spelling short vowel words than at spelling long vowel words, whereas the pattern was reversed for the equivalent Dutch groups. The most likely explanation for the German vowel duration effect is that some of the long vowel words did not require an orthographic marker and could be spelled correctly by simply translating each phoneme into the corresponding grapheme (e.g., *Schaf*), whereas all items in the short vowel condition required a specific orthographic marker, namely a double consonant after the short vowel phoneme. In Dutch, it was the long vowel plural spellings that posed a particu-

lar problem. Interestingly, for these words, a strategy of simple phoneme–grapheme translation would be sufficient because they do not require any orthographic marking in terms of letter doubling (e.g., *schapen*). However, it should be noted that in the Dutch curriculum long vowel phonemes are introduced as complex graphemes (e.g., /a:/–*aa*). Thus, one could argue that children are applying their phoneme–grapheme knowledge and do not consider the context-sensitive rule that long vowel phonemes are marked by doubling only if they occur in a closed syllable. In Grade 4, the influence of vowel duration was no longer reliable. Further interactions that were significant in the subjects analysis but not in the items analysis were Orthography \times Vowel Duration, $F_{\text{subjects}}(1,403)=62.2$, $p<.001$, and Grade Level \times Vowel Duration, $F_{\text{subjects}}(2,403)=3.2$, $p<.05$.

The question in which we were most interested was whether children would use consistent spellings for singular and plural word forms. Quite impressively, in nearly all (98%) incorrect plural spellings for short vowel words, Dutch children simply reproduced the singular spelling and added the required plural morpheme *–en* without doubling the consonant as is required (e.g., *man–manen* instead of the correct *mannen*). For the words including a long vowel phoneme, Dutch children also most often wrote the singular word and added the *–en* ending but did not reduce the double vowel of the singular spelling to only one vowel (e.g., *naam–naamen* instead of *namen*). This was the case in 93% of errors in Grade 2, 83% of errors in Grade 3, and 85% of errors in Grade 4.

The theoretically most interesting question for the German sample is whether children apply the principle of morpheme consistency in spelling. At all three grade levels, performances on singular and plural conditions were comparable; however, this finding does not tell us whether the children spelled the very same words correctly in singular and plural word forms. Thus, we analyzed how consistent children were in the spelling of the word stem. There are two possibilities of consistency. The first and most obvious possibility is that the children spell both the singular and plural forms of the same word stem correctly. The other possibility is that the children spell both the singular and plural forms of the same word stem incorrectly but use the same spelling for both word forms. Table 2 presents, for all three grade levels, how often children produced consistent or inconsistent spellings for singular and plural word forms. Children used different spellings for the singular and plural word forms in only 10 to 20% of word pairs. Children rarely applied the orthographically correct spelling of the word stem to one word form but not the other word form. For the vast majority of items, both singular and plural word forms were spelled in a consistent way. Not surprisingly, the proportion of orthographically correct word pairs increased with grade level. For those word pairs where children used consistent but incorrect spellings for both word forms, the most typical error was to leave out any orthographic markers (e.g., double consonants or vowels, silent *h*). This is evident from the lower section of Table 2, which presents the types of errors that children produced. Thus, for these spellings, it is not clear whether children applied the principle of morpheme consistency or whether they used a phonologically based strategy of simple phoneme–grapheme translation.

Table 2
Percentages of consistent and inconsistent spellings of singular and plural word forms and percentages of error types in German

Grade level	Short vowel words				Long vowel words			
	2	3	4	Total	2	3	4	Total
Singular and plural consistent								
Singular correct/Plural correct	30.0	64.8	81.0	58.6	49.8	75.2	80.8	68.6
Singular incorrect/Plural incorrect (identical spellings)	47.9	21.4	9.6	26.3	33.0	14.3	10.0	19.1
Total	77.9	86.2	90.6	84.9	82.8	89.5	90.8	88.7
Singular and plural not consistent								
Singular correct/Plural incorrect	11.7	6.4	4.0	7.4	7.9	5.0	3.9	5.6
Singular incorrect/Plural correct	3.7	2.7	3.3	3.2	2.6	2.6	1.4	2.2
Singular incorrect/Plural incorrect (different spellings)	6.5	4.5	2.1	4.4	6.7	2.9	4.0	4.5
Total	21.9	13.6	9.4	15.0	17.2	10.5	9.3	12.3
Types of errors								
No orthographic marking	92.1	70.9	72.9	78.6	81.4	53.5	48.0	61.0
Explicit marking of short vowel ^a	—	—	—	—	11.6	24.7	31.6	22.6
Explicit marking of long vowel	7.8	28.8	28.1	21.6	7.0	18.9	12.3	12.7
Explicit marking of both long and short vowels (e.g., <i>Stemme</i>)	0.2	0.4	0.0	0.2	0.0	2.9	8.2	3.7

^a Explicit marking of short vowels leads to correct spellings for short vowel words because there is only one consistent way in which to mark short vowels in German.

The lower section of Table 2 also shows how often German children used an incorrect version of short or long vowel marking and how often they used long and short vowel marking in the same (incorrect) word spelling. Note that for short vowel words, an error category for explicit marking of short vowel does not exist; if children explicitly marked a short vowel, they produced a correct spelling because there is only one way of orthographic marking of a short vowel in German (i.e., doubling the consonant letter after the vowel). Because of the inconsistency of German long vowel spelling, it is possible to use an incorrect orthographic marker that still denotes a vowel phoneme as long (e.g., spelling *Paar* incorrectly as *Pahr*).

An interesting question is how well the German children understand that there is a phonological basis of orthographic marking of long and short vowel phonemes. If they have a basic understanding of the phonological background, then they should not explicitly mark long vowel phonemes as short (by doubling the consonant) or mark short vowel phonemes as long (by doubling the vowel or adding a silent *h* after the vowel). In principle, of course, it is possible to build up word (stem)-specific memory entries without understanding why some words are spelled with a double consonant and others are spelled with a double vowel or an *h* after the vowel letter. Indeed, Table 2 shows approximately 20% of errors that violate the phonological basis of German vowel duration spelling (long vowel marking for a short vowel word or short vowel marking for a long vowel word). As a matter of fact, for the long vowel words, children used a short vowel spelling (double consonant) more often than they

used another variant of marking a long vowel phoneme (e.g., spelling *Paar* incorrectly as *Pahr*). There is an interesting developmental pattern in that second graders used an inadequate orthographic marker only infrequently; they nearly always used simple phoneme–grapheme translation, ignoring any necessary orthographic markers. Among third and fourth graders, this strategy was still dominant; however, there was a clear increase in incorrect use of orthographic markers. Obviously, children start to understand that phoneme–grapheme translation is not always sufficient; however, they do not have a full understanding of the function of orthographic markers. An error type that occurred very rarely at all grade levels was that both the vowel and the subsequent consonant received an orthographic marker (e.g., *Stiemme* instead of *Stimme*). This shows that children have a basic understanding of possible orthographic patterns because such spellings are orthographically illegal in German. It seems surprising that the fourth graders showed the highest proportion of this error type, at least for long vowel words. One would assume that after more than 3 years of reading and spelling experience, they should have a very good understanding of orthographic patterns. Closer inspection of children’s incorrect spellings showed that most errors of this type occurred for the word *Stiel–Stiele* (incorrectly spelled, e.g., as *Stielle*). There is a highly similar German word *Stille* (pronounced with a short vowel phoneme), and children probably confused these two spellings.

In the Dutch word spelling task, a set of five control word pairs was included. Analogous to the requirements of the German spelling test, for these control items Dutch spellers also had to apply the principle of morpheme consistency for inconsistent word spellings (e.g., *vrouw–vrouwen*). The pattern of performance on these control items was in fact more comparable to the pattern observed among the German sample than among the Dutch sample for spelling short and long vowel words in the sense that the difference between singular and plural spellings was much reduced. The respective mean scores for singular and plural spellings were 4.0 and 3.9 in Grade 2, 4.7 and 4.5 in Grade 3, and 4.9 and 4.8 in Grade 4. Only the effect of grade level was reliable in both subjects and items analyses, $F_{\text{subjects}}(2, 269) = 34.6, p < .001, F_{\text{items}}(2, 8) = 11.6, p = .004$. The effect of word form was significant in the subjects analysis, $F_{\text{subjects}}(1, 269) = 7.6, p = .006$, but not in the items analysis. The interaction was not reliable.

Nonword selection

For this task, our expectations were quite different from those for the word spelling tasks. We hypothesized that this task should be easy for German children because they only had to identify the nonword that had an identical spelling to the stem of the presented target (e.g., *Naal–Naalen*). For Dutch children, we expected a conflict between those nonword spellings that were consistent with the target nonword but incorrect (e.g., *naal–naalen*) and the correct nonword adhering to the complex but highly consistent rules of vowel duration spelling (e.g., *naal–nalen*). This is exactly what is reflected in Fig. 2. German children were at ceiling in all conditions, even in Grade 2, whereas their Dutch counterparts showed a clear development from choosing the consistent spelling as often as, or even more often than, the correct spelling in Grade 2 to selecting the correct one in Grade 4. The other two response

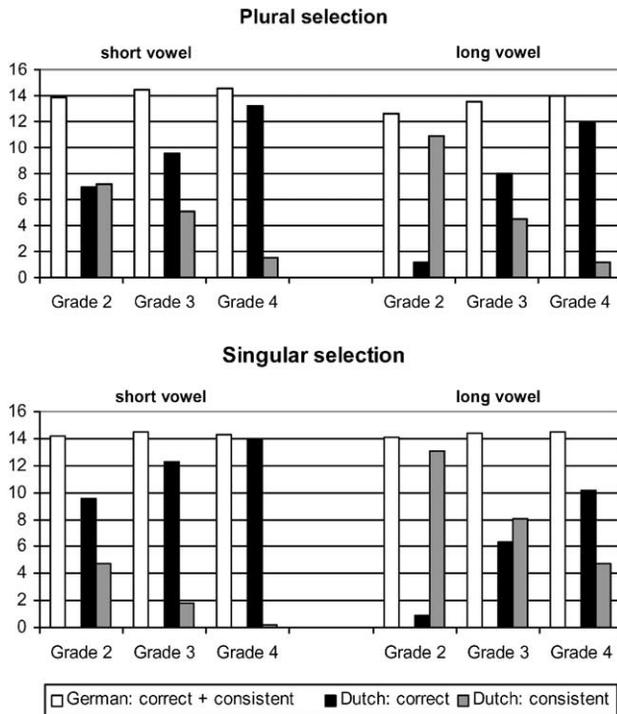


Fig. 2. Nonword selection: Number of correct and consistent (for German) and correct versus consistent (for Dutch) nonword selections for plural and singular selection (maximum = 15).

options (incorrect and inconsistent foil and phonologically inadequate foil) were hardly ever chosen and therefore are not represented in Fig. 2.

Because of the apparent ceiling effect in the German sample, no further statistical analysis was performed for this language group. However, we wanted to know whether the principle of morpheme consistency is applied by German children even earlier than Grade 2. Thus, we gave the task to an additional sample of 42 first graders (mean age 6 years 9 months) who had received only some 6 months of formal reading instruction. Even these young children performed above chance level on the 15 items in each condition with t scores between 9.5 and 12.4, $p < .001$. Their mean numbers of correct nonword selections for the four conditions were between 9.4 and 11.5.

The responses of the Dutch children were subjected to two Grade Level \times Task (plural or singular selection) \times Vowel Duration (short or long) ANOVAs: one for correct responses and one for incorrect but consistent responses. Both ANOVAs showed the same pattern. There was a highly significant effect of grade, reflecting the fact that the number of correct responses increased and the number of incorrect but consistent responses decreased from Grade 2 to Grade 4, $F_s(2, 317) = 126.7$ and 115.0 , for correct and incorrect but consistent responses, respectively, $p < .001$. Post hoc Scheffe tests showed that all differences between grade levels were reliable ($p > .05$). Children gave slightly but significantly more correct responses in the singular selection task than in

the plural selection task, $M_s = 17.3$ and 16.3 , respectively, $F(1, 317) = 6.8$, $p < .05$. This difference between tasks was not found for the incorrect but consistent responses. Children produced reliably more correct responses for short vowel duration than for long vowel duration, $M_s = 21.5$ and 16.8 , respectively, $F(1, 317) = 288.1$, $p < .001$. Likewise, children produced fewer incorrect but consistent responses for short vowel duration than for long vowel duration, $M_s = 7.2$ and 14.8 , respectively, $F(1, 317) = 241.9$, $p < .001$. A plausible explanation for this effect is that long vowel spellings require changes to the vowel grapheme itself, whereas the changes in the short vowel condition affect the consonant letter following the vowel phoneme.

There were interactions between grade level and task, $F(2, 317) = 7.6$ and 3.6 for correct and consistent responses, respectively, $p < .03$, and between grade level and vowel duration, $F(2, 317) = 29.1$ and 28.1 for correct and consistent responses, respectively, $p < .001$. Post hoc tests showed that for correct responses the difference between plural selection and singular selection was reliable only in Grade 2, whereas for incorrect but consistent responses the difference was significant only in Grade 4. The effect of vowel length was reliable for all grade levels in both analyses, but it decreased systematically for correct responses and increased for incorrect but consistent responses with increasing grade level. Finally, task interacted with vowel duration, $F(1, 317) = 64.8$ and 168.6 for correct and consistent responses, respectively, $p < .001$. Reducing a presented consonant or vowel doublet to a single letter, as is required for short vowels in the singular selection task (*nallen–nal*) and for long vowels in the plural selection task (*naal–nalen*), turned out to be easier than doubling a letter, as is required for short vowels in the plural selection task (*nal–nallen*) and for long vowels in the singular selection task (*nalen–naal*). The latter condition was especially susceptible to incorrect but consistent selections, probably because the incorrect but consistent item (*nal*) is orthographically legal, but note that the letter sequence *nal* must be pronounced with a short vowel in Dutch.

Discussion

Two main differences were evident in Dutch and German children's performance in our tasks that were designed to assess the understanding and application of the orthographic principles relevant for vowel duration spelling in the two orthographies. First, there was a clear language difference depending on the kind of task that was given. Dutch children performed better overall than their German counterparts in the word spelling task requiring active production of correct spellings, but German children outperformed their Dutch age equivalents in the nonword selection task. Second, the two language groups show a marked difference in pattern of performance. German children performed at a similar level for singular and plural items, but Dutch children showed a large discrepancy. These differences seem to suggest different trajectories of acquisition of vowel duration spelling. However, we argue that the differences are probably due to application of similar principles by Dutch and German children. It is the orthographies that require the principles to be applied differently. Our findings suggest that from an

early age, children assume that different word forms of the same word family should be spelled in the same way—even if this assumption is wrong.

In the word spelling task, even the youngest group of Dutch children was well able to provide orthographically correct spellings for familiar one- and two-syllable words in singular form. The reason is that these words can be spelled correctly by a simple strategy of phoneme–grapheme translation. In the Dutch curriculum, children are taught different graphemes for long and short vowel phonemes (e.g., *a* for short vowel /a/ and *aa* for long vowel /a:/). Correct application of these correspondences to the dictated words results in orthographically correct spellings for one-syllable words (e.g., *pan* [English: pan], *paar* [English: pair]). The plural forms are spelled consistently with the singular forms (e.g., incorrect: *panen*, *paaren*) most often by the second graders, but here Dutch orthography requires a different spelling following a set of context-sensitive phonological rules (correct: *pannen*, *paren*). Although there is a clear increase in correct spellings for plural forms in Grades 3 and 4, even fourth graders sometimes do not apply the context-sensitive rules and spell the plural word forms consistently with the singular word forms.

It is difficult to say whether children (incorrectly) assume that different word forms of the same word family should be spelled consistently or whether this finding simply reflects the fact that young Dutch children use a straightforward strategy of phoneme–grapheme translation for both singular and plural, necessarily also resulting in consistent spelling of the two word forms. The first explanation would indicate an inadequate application of the principle of morpheme consistency, whereas the second alternative would indicate the use of a nonconditional phonological strategy. The findings of the word spelling task do not allow us to decide between these two explanations. However, the nonword selection task provides relevant information. In all conditions of this task, Dutch children showed a systematic development from choosing the spelling that was consistent with the presented nonword to choosing the spelling that adhered to the context-sensitive phonological rules of Dutch orthography. The most critical condition in this task is selection of the singular spelling for plural nonwords with a long vowel (e.g., *nalēn*–/na:lən/). In this case, a nonconditional phonological strategy would lead to the correct selection of *naal* because children learned in the curriculum that a long vowel /a:/ is spelled as *aa*. Therefore, this condition does not require the application of any complex context-sensitive rule. Simple phoneme–grapheme translation suffices to find the correct response. However, the findings show that children do not apply such a strategy of simple phoneme–grapheme translation but systematically choose the incorrect but consistent spelling *nal*. The younger children nearly always preferred this spelling, and even the fourth graders chose the consistent but incorrect spelling for approximately one third of all items.²

² To see how long it takes Dutch children to acquire the orthographic rules of vowel duration spelling, we tested an additional 111 children at the beginning of Grade 5 (mean age 10 years 8 months). In the nonword selection task, their performance was not significantly better than that of the fourth graders, indicating that they still had problems in correctly applying the complex rules. For word spelling, their performance was at ceiling.

Additional evidence that Dutch children apply the principle of morpheme consistency comes from the 10 control words that were included in the Dutch word spelling task. These words included a phonologically ambiguous vowel diphthong (e.g., /au/ can be spelled as *au* or *ou*). Here the principle of morpheme consistency is not overruled by phonological rules. As in German, different word forms receive the same spelling (e.g., *vrouw*–*vrouwen*). For these items, performance of the Dutch children resembled that of the German sample much more closely in that there was a high correspondence between singular spellings and plural spellings. This finding shows that differences between Dutch and German groups are unlikely to be due to differences in language or schooling; rather, they likely reflect a specific orthographic phenomenon.

The word spelling task overall was clearly harder for the German sample than for the Dutch children. Even in Grade 4, the German sample's performance was significantly lower than that of the Dutch sample. However, in contrast to the Dutch language group, there was only a small difference between correct spellings of singular and plural word forms in the German sample. The analysis of the incorrect spellings shows that German children, just like Dutch children, often applied a strategy of sequential phoneme–grapheme translation. Typically, the necessary orthographic markers (e.g., double consonants or vowels, silent *h*) were missing from their spellings. This sound-based approach also explains why performance was better on long vowel words than on short vowel words. Some of the long vowel words in our task did not include an additional orthographic marker (e.g., *Name*). Orthographically unmarked stressed vowels are always long in German. Thus, applying the simple strategy of sequential phoneme–grapheme translation resulted in orthographically correct spellings for some long vowel words but for none of the short vowel words, which always required a consonant doublet.

The reason why it takes German children several years to acquire the orthographically correct spellings required in our word spelling task is the inconsistency of the German spelling system. Unlike in Dutch, in German there are no clear rules or algorithms that would help to derive the correct spelling of a word children have not seen in writing before. Children need to be familiar with the correct spellings to be able to reproduce them. Thus, the developmental increase in spelling performance from Grade 2 to Grade 4 was to be expected. The main question we asked in the current study is whether young spellers can exploit morpheme consistency, which is a central principle of German orthography. The first finding relevant here is that even second graders used consistent spellings for singular and plural word forms in approximately 80% of all spellings and that fourth graders did so in approximately 90% of all spellings. This is a first indication that children assume that different word forms including the same stem have the same spelling. However, especially for the younger children, the consistent spellings were due mainly to the fact that they did not spell any orthographic markers but rather used a simple strategy of phoneme–grapheme translations (e.g., *Pfane* instead of *Pfanne* [English: pan]). This strategy, which was also observed among the Dutch children, leads to consistent spellings of different word forms, but it is difficult to tell whether any knowledge about morphemes and how they should be spelled is involved.

The more interesting observation is that it is unusual for German children to use different spellings for singular and plural word forms. In Grades 3 and 4, different spellings for the two word forms occurred in only approximately 10% of all word pairs. At the beginning of Grade 2, the percentage was still somewhat higher (roughly 20%), but even after only 1 year of reading and spelling instruction, children seem to have a basic understanding of the principle of morpheme consistency. The finding that word pairs where the singular is spelled correctly but the plural is incorrect were more frequent than word pairs where the plural is spelled correctly but the singular is incorrect suggests that correct spellings are sometimes first acquired for the simple word form and only in a second step are generalized to other word forms, a finding that is in line with [Carlisle's \(1988\)](#) research. But in general, German children from an early age are quite capable of applying orthographic markers to both singular and plural word forms.

Impressively, the inconsistencies of the orthography even make it hard for children to work out the phonological basis of the orthographic markers they must include in their spellings. Although short vowel phonemes are not consistently marked by a subsequent consonant doublet, consonant doublets can follow only short vowel phonemes and never long vowel phonemes. And although long vowel phonemes are not consistently marked by a vowel doublet or a silent *h* after the vowel, these markers can never occur if the vowel phoneme in a word is short. The error analysis showed that young children are not always familiar with these phonological restrictions. Although the most typical error type was to leave out all orthographic markers, in approximately 20% of the incorrect spellings children included orthographic markers that did not correspond with the vowel durations of the words. Incorrect marking of long vowel phonemes as short was even more frequent than applying other variants of long vowel marking (e.g., writing a silent *h* instead of doubling the vowel letter).

One explanation for this imprecise use of vowel duration marking is that children have problems correctly identifying whether a vowel phoneme is long or short. A relation between identification of phoneme duration and spelling skills has been demonstrated in several studies ([Juil, 2004](#); [Landerl, 2003](#); [Lehtonen & Bryant, 2004](#)). However, note that the Dutch children did not exhibit any problems in correctly identifying long and short vowel phonemes. Even the youngest children were nearly errorless in the singular condition of the word spelling task that required them to decide whether they should write one or two vowel letters depending on the duration of that vowel phoneme. The ease with which Dutch children seem to identify vowel duration is even more surprising given the fact that Dutch long vowel phonemes are shorter in duration than German long vowel phonemes. But in contrast to German vowels, Dutch vowels tend to diphthongize, and this might facilitate vowel duration identification.

The difference between vowel duration spelling skills of Dutch and German children could also be due to differences in orthographic consistency. The consistency of this feature is very high in the Dutch spelling system, and children are actually taught different graphemes for short and long vowel phonemes. German, in contrast, represents this feature with very low consistency. It is possible that the unclear representation in word spellings makes it difficult to work out the high relevance of this feature

for orthographically correct spelling. In the Introduction, we discussed findings showing that the orthographic function of consonant doublets is understood earlier in consistent orthographies than in inconsistent orthographies (Cassar & Treiman, 1997; Juul & Sigurdsson, 2005; Lehtonen & Bryant, 2005). Our results are in line with these findings.

The nonword selection task turned out to be very easy for the German children. From the beginning of Grade 2, children performed close to ceiling, and even a sample of first graders performed above chance level. Thus, in the context of this task, children readily give up their sound-based strategy and make use of the principle of morpheme consistency. It could be argued that children do not understand the linguistic background of the task and simply select the item that looks most similar to the target. However, understanding of singular–plural relations is an early development (Berko, 1958), so we can take it for granted that the 6- to 10-year-old participants of the current study understood the morphological relation between the presented nonwords. The task format certainly invites children to select the visually most similar item from the four alternatives, but we would argue that selecting the same spelling for words that are obviously morphologically related *is* applying the principle of morpheme consistency.

In models of spelling development (Bryant et al., 1999; Ehri, 1992, 1997; Frith, 1985; Henderson, 1985; Henderson & Beers, 1980; Nunes et al., 1997a, 1997b), morphological information is assumed to become relevant during later stages of spelling development only. The findings presented here suggest that sometimes it is easier for young children to use a simple morphological rule than to use a complex phonological rule. Although Dutch spelling of vowel duration is completely consistent on the phonological level, children have difficulty in understanding and correctly applying the context-sensitive rules. One reason why this feature is so difficult to acquire might be that the phonological rules violate the principle of morpheme consistency. Thus, the findings once more confirm Treiman’s (1993) assumption that children use very different sources of information for their spelling attempts. Cross-linguistic studies will help us to identify the kinds of information that children access during spelling and how they interact.

Acknowledgment

We thank Tessa de With and Kathrin Röger for collecting the data reported in this study.

Appendix A. Dutch and German items of the word spelling task

	Dutch	German	English translation
Long vowel words	boot–boten uur–uren	Boot–Boote Uhr–Uhren	boat clock

(continued on next page)

Appendix A. (continued)

	Dutch	German	English translation
	boon–bonen	Bohne–Bohnen	bean
	oor–oren	Ohr–Ohren	ear
	paar–paren	Paar–Paare	pair
	steel–stelen	Stiel–Stiele	stick
	naam–namen	Name–Namen	name
	schaap–schapen	Schaf–Schafe	sheep
	rood–roder	rot–röter	red ^a
	jaar–jaren	Jahr–Jahre	year
Short vowel words	bed–bedden	Bett–Betten	bed
	kat–katten	Katze–Katzen	cat
	man–mannen	Mann–Männer	man
	pan–pannen	Pfanne–Pfannen	pan
	pil–pillen	Pille–Pillen	pill
	rok–rokken	Rock–Röcke	skirt
	spin–spinnen	Spinne–Spinnen	spider
	stal–stallen	Stall–Ställe	barn
	stem–stemmen	Stimme–Stimmen	voice
	klas–klassen	Klasse–Klassen	class
Control words	touw–touwen		rope
	vrouw–vrouwen		woman
	pauw–pauwen		peacock
	meid–meiden		girl
	lijn–lijnen		line

^a The second word form for this adjective is the comparative (redder).

Appendix B. Examples of items in the nonword selection task in Dutch and German

Target	Long vowel duration				Target	Short vowel duration			
	Response items					Response items			
	VC	VVC	VCC	Other		VC	VVC	VCC	Other
Dutch: Plural selection:									
naal:	<u>Nalen</u>	naalen	nallen	naalef	nal:	nalen	naalen	<u>nallen</u>	nallek
feep:	<u>Fepen</u>	feepen	feppen	feepet	fep:	fepen	feepen	<u>feppen</u>	feppel
Doon:	<u>Donen</u>	doonen	donnen	doonet	don:	donen	doonen	<u>donnen</u>	donnek
fuup:	<u>Fupen</u>	fuupen	fuppen	fuuper	fup:	fupen	fuupen	<u>fuppen</u>	fupper
Dutch: Singular selection:									
Nalen:	Nal	<u>naal</u>	nall	naak	nallen:	<u>nal</u>	naal	nall	nas
Fepen:	Fep	<u>feep</u>	fepp	feek	feppen:	<u>fep</u>	feep	fepp	fes
Donen:	Don	<u>doon</u>	donn	dool	donnen:	<u>don</u>	doon	donn	dog
Fupen:	Fup	<u>fuup</u>	fupp	fuum	Fuppen:	<u>fup</u>	fuup	fupp	fur
German: Plural selection:									
Naal:	Nalen	<u>Naalen</u>	Nallen	Naalef	Nall:	Nalen	Naalen	<u>Nallen</u>	Nallek
Feep:	Fepen	<u>Feepen</u>	Feppen	Feepet	Fepp:	Fepen	Feepen	<u>Feppen</u>	Feppel

Appendix B. (continued)

Target	Long vowel duration				Target	Short vowel duration			
	Response items					Response items			
	VC	VVC	VCC	Other		VC	VVC	VCC	Other
Dohn:	Donen	<u>Dohnen</u>	Donnen	Dohnet	Donn:	Donen	Dohnen	<u>Donnen</u>	Donnek
Fuhp:	Fupen	<u>Fuhpen</u>	Fuppen	Fuhper	Fupp:	Fupen	Fuhpen	<u>Fuppen</u>	Fupper
German: Singular selection:									
Naalen:	Nal	<u>Naal</u>	Nall	Naak	Nallen:	Nal	Naal	<u>Nall</u>	Nas
Feepen:	Fep	<u>Feep</u>	Fepp	Feek	Feppen:	Fep	Feep	<u>Fepp</u>	Fes
Dohnen:	Don	<u>Dohn</u>	Donn	Dool	Donnen:	Don	Doon	<u>Donn</u>	Dog
Fuhpen:	Fup	<u>Fuhp</u>	Fupp	Fuhm	Fuppen:	Fup	Fuup	<u>Fupp</u>	Fur

Note. Correct responses are underlined.

References

- Aro, M., & Wimmer, H. (2003). Learning to read: English in comparison to six more regular orthographies. *Applied Psycholinguistics*, 24, 621–635.
- Berko, J. (1958). The child's learning of English morphology. *Word*, 4, 150–177.
- Booij, G. (1995). *The phonology of Dutch*. Oxford, UK: Oxford University Press.
- Bryant, P., Nunes, T., & Aidinis, A. (1999). Different morphemes, same spelling problems: Cross-linguistic developmental studies. In M. Harris & G. Hatano (Eds.), *Learning to read and write: A cross-linguistic perspective* (pp. 112–133). Cambridge, UK: Cambridge University Press.
- Carlisle, J. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*, 9, 247–266.
- Cassar, M., & Treiman, R. (1997). The beginnings of orthographic knowledge: Children's knowledge of double letters in words. *Journal of Educational Psychology*, 89, 631–644.
- Chomsky, N., & Halle, M. (1968). *The sound pattern of English*. New York: Harper & Row.
- Ehri, L. (1992). Review and commentary: Stages of spelling development. In S. Templeton & D. R. Bear (Eds.), *Development of orthographic knowledge and the foundations of literacy: A memorial Festschrift for Edmund H. Henderson* (pp. 307–332). Hillsdale, NJ: Lawrence Erlbaum.
- Ehri, L. (1997). Learning to read and learning to spell are one and the same, almost. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 237–269). Mahwah, NJ: Lawrence Erlbaum.
- Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, M. Coltheart, & J. Marshall (Eds.), *Surface dyslexia* (pp. 301–329). Hillsdale, NJ: Lawrence Erlbaum.
- Frith, U., Wimmer, H., & Landerl, K. (1998). Differences in phonological recoding in German- and English-speaking children. *Scientific Studies of Reading*, 2, 31–54.
- Geelhoed, J., & Reitsma, P. (1999). *PI-dictee*. Lisse, Switzerland: Swets & Zeitlinger.
- Henderson, E. H. (1985). *Teaching spelling*. Boston: Houghton Mifflin.
- Henderson, E. H., & Beers, J. W. (Eds.). (1980). *Developmental and cognitive aspects of learning to spell: A reflection of word knowledge*. Newark, DE: International Reading Association.
- Juul, H. (2004). *Phonemic quantity awareness and the consonant doublet problem*. Unpublished manuscript, University of Copenhagen.
- Juul, H., & Sigurdsson, B. (2005). Orthography as a handicap? A direct comparison of spelling acquisition in Danish and Icelandic. *Scandinavian Journal of Psychology*, 46, 263–272.
- Kemp, N., & Bryant, P. (2003). Do bees buzz? Rule-based and frequency-based knowledge in learning to spell plural -s. *Child Development*, 74, 63–74.

- Klicpera, C., & Gasteiger-Klicpera, B. (2000). Sind Rechtschreibschwierigkeiten Ausdruck einer phonologischen Störung. [Are spelling difficulties an expression of a phonological deficit?]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*, 32, 134–142.
- Landerl, K. (2003). Categorisation of vowel length in German poor spellers: An orthographically relevant phonological distinction. *Applied Psycholinguistics*, 24, 523–538.
- Lehtonen, A., & Bryant, P. (2004). Length awareness predicts spelling skills in Finnish. *Reading and Writing: An Interdisciplinary Journal*, 17, 875–890.
- Lehtonen, A., & Bryant, P. (2004). Doublet challenge: Form comes before function in children's understanding of their orthography. *Developmental Science*, 8, 211–217.
- Levin, I., & Koriat, O. (1993). Sensitivity to phonological, morphological, and semantic cues in early reading and writing in Hebrew. *Merrill–Palmer Quarterly*, 39, 213–232.
- Liberman, I. Y., Liberman, A. M., Mattingly, I. G., & Shankweiler, D. L. (1980). Orthography and the beginning reader. In J. F. Kavanagh & R. L. Venezky (Eds.), *Orthography, reading, and dyslexia* (pp. 137–153). Baltimore, MD: University Park Press.
- Lyytinen, H., Leinonen, S., Nikula, M., Aro, M., & Leiwo, M. (1995). In search of the core features of dyslexia: Observations concerning dyslexia in the highly orthographically regular Finnish language. In V. Berninger (Ed.), *The varieties of orthographic knowledge II: Relationships to phonology, reading, and writing* (pp. 177–204). Dordrecht, Netherlands: Kluwer Academic.
- Notenboom, A., & Reitsma, P. (2003). Investigating the dimensions of spelling ability. *Educational and Psychological Measurement*, 63, 1039–1059.
- Nunes, T., Bryant, P., & Bindman, M. (1997a). Learning to spell regular and irregular verbs. *Reading and Writing: An Interdisciplinary Journal*, 9, 427–449.
- Nunes, T., Bryant, P., & Bindman, M. (1997b). Morphological spelling strategies: Developmental stages and processes. *Developmental Psychology*, 33, 637–649.
- Pacton, S., Perruchet, P., Fayol, M., & Cleermans, A. (2001). Implicit learning out of the lab: The case of orthographic regularities. *Journal of Experimental Psychology: General*, 130, 401–426.
- Seymour, P. H. K., Aro, M., & Erskine, J. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, 94, 143–174.
- Treiman, R. (1993). *Beginning to spell*. Oxford, UK: Oxford University Press.
- 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* (pp. 61–80). Mahwah, NJ: Lawrence Erlbaum.
- Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, 65, 1318–1337.
- van Berckel, A., & Sauer, C. (2001). *Langenscheidts praktisches Lehrbuch Niederländisch [Langenscheidt's practical textbook of Dutch]* (5th ed.). Berlin: Langenscheidt.
- Wimmer, H., & Landerl, K. (1997). How learning to spell German differs from learning to spell English. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Research, theory, and practice across languages* (pp. 81–96). Mahwah, NJ: Lawrence Erlbaum.