

Running head: Form before function in orthographic knowledge

Doublet challenge: Form comes before function in children's understanding of their orthography

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Abstract

Several current spelling models suggest that children cannot have any knowledge of orthographic form before they have acquired knowledge about orthographic function. We evaluated this proposition by using an orthographic choice task to inspect Finnish schoolchildren's knowledge of two aspects of consonant doublet use: the allowed doublet position (an aspect of orthographic form) and the type of phonemic information they represent (an aspect of orthographic function). The results challenged the view of the existing spelling models, since they showed that already at the beginning of the first school year children possessed formal knowledge of doublet use and knew that word-initial doublets are not allowed. However, these children were ignorant of the function of doublets, i.e. that they stand for long consonants.

Keywords: spelling, orthographic form, orthographic function, doublets, Finnish

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Some time ago Ferreiro and Teberosky (1982) made a distinction between young children's knowledge of the function of written language and of its form. Functional knowledge is about how the orthography is related to the phonology and morphology of the language. It is the knowledge that the alphabet represents particular sounds by letters or sequences of letters and that particular morphemes, such as the English past tense suffix, have their own specific spellings. Knowledge of form is purely about patterns within the written language: this is knowledge about the orthographic constraints which determine, for example, that some letter sequences are permissible and others not.

In most models of literacy acquisition the learning about orthographic constraints is said to come quite late. In Frith's (1985) well-known model of reading and spelling children gain knowledge of the formal properties of the orthography only in the third and final stage, called the orthographic stage, of the hypothesised developmental sequence. Gentry (1982) has argued that beginning spellers pay no attention to "acceptable English letter sequence or other conventions of English orthography". Marsh, Friedman, Welch & Desberg (1980) and Ehri (1985) have reached similar conclusions about the late development of knowledge about orthographic constraints.

However, Ferreiro and Teberosky (1982) challenged this view and argued that, in some instances at least, knowledge of orthographic form actually precedes functional knowledge. They claimed that children learn that some letter sequences are permissible and others are not, before understanding what sounds these letters represent or even before fully understanding the connection between phonemes and letters. Ferreiro & Teberosky based this striking claim on

data from semi-structured interviews with preliterate children: before grasping the phonological function of letters, many of these children for example understood that letters within words must be different from each other (“principle of internal variation”) and that most words have to be at least three letters long to be readable (“principle of minimum quantity”).

Evidence for the claim of children’s early sensitivity to orthographic patterns has been provided by Cassar & Treiman (1997) with American and by Pacton, Perruchet, Fayol & Cleeremans (2001) with French children. Both studies dealt with consonant doublets (i.e. ‘geminate’) like ‘pp’ and ‘ss’. Doublets have clear formal properties in English and in French. In both languages (1) doublet consonants appear in the middle of words but never at their beginnings, and (2) some doublet consonants (e.g. ‘xx’ and ‘ww’ in English and ‘kk’ or ‘jj’ in French) are impermissible. In contrast, functional properties of doublets exist in English, but not in French. French doublets have no orthographic function whatsoever, whereas a consonant doublet in English indicates in principle that the preceding vowel is short (e.g. *latter* – *later*). However, this English conditional rule is inconsistent in that many short vowels are not marked in this way (e.g. *canon*–*cannon*, *habit*–*rabbit*, *very*–*merry*, Carney, 1994).

Cassar and Treiman investigated 5-11-year olds’ knowledge about letter doublets. They presented word pairs to the children and asked them to choose the word that looked more like a real word. The words in the pairs varied in doublet position (initial/final, e.g. *baff*-*bbaf*) and legality (orthographically illegal/legal, e.g. *heniss*-*hhenis*). There was also a condition where one of the words had a doublet in the middle and the other did not, preceded by a short or a long vowel (e.g. *tebif*-*tebbif*). In this condition, the words of the pair were pronounced and children had to use their knowledge of the relationship between the pre-consonantal vowel length and the appropriateness of a doublet spelling. The first-grade children, and even some of the

kindergartners, were frequently correct in their judgements about legal doublet position and about which letters can double. However, only children aged 11 years or older were more likely than chance to take the length of the pre-consonantal vowel into account when making their response. The study by Pacton et al. (2001) agreed with these results by showing that young children are sensitive to the formal rules governing doublets even in an orthography in which doublets have no function.

These studies certainly demonstrate an early awareness of formal orthographic constraints, and this is a result of great interest. If formal knowledge precedes functional knowledge, formal knowledge might facilitate the acquisition of functional knowledge. For instance, English-speaking children might eventually become aware of the difference between short and long vowels as a result of noticing that some vowel sounds are regularly followed by double consonants while others are not. Conceptualising doublets as orthographic units would be an advantage in this process. The hypothesis that the experience of learning to read transforms children's phonological sensitivities is a familiar one (Morais, Cary, Alegria & Bertelson, 1979; Morais, Bertelson, Cary & Alegria, 1986), but the idea that formal knowledge might advance this improvement in phonological skills, and consequently in functional knowledge, is new.

However, for different reasons the studies by Cassar & Treiman and by Pacton et al. leave the developmental relationship between children's formal and functional knowledge unclear. In French, functional knowledge about doublets is not relevant, since they have no phonological function, and so Pacton et al.'s study tells us only about young children's knowledge of form and nothing about its relation to functional knowledge. In English the function of doublets is ambiguous since in some cases the distinction between singlets and doublets is effective (*hoping-hopping*) and in others (*canon-cannon*) it is not. Additionally, the

functional rule is a conditional rule while the formal rule is not. Consequently, English children might learn about formal characteristics before functional ones in this case simply because the formal rule is more straightforward than the functional one. We need a study that compares children's knowledge of formal and functional rules which are equally regular and reliable.

The Finnish orthography provides us with the chance to make this definitive comparison with doublets. In spoken Finnish there are short and long consonants and vowels. Long consonants and vowels are spelled with doublets, while short vowels and consonants are represented by single letters. Often the length of a phoneme changes the meaning of the word (e.g. *mato*–*matto* [worm–carpet]; *tuli*–*tuuli* [fire–wind]). Analysis of length is complicated since there is no absolute acoustic duration for a 'long' or a 'short' phoneme. Instead, whether a phoneme of a certain duration is perceived as long or short in a particular word depends on the duration of the surrounding phonemes and on the total duration of the whole word (Lehtonen, 1970). Thus, determining the length of a specific phoneme requires considering the preceding and following phonemes as well. Moreover, the speaker, situation and speaking style have an influence too, and since length is the only suprasegmental feature of Finnish phonology that is visibly marked in the orthography, it also constitutes an exception in this sense. It is extremely difficult for non-native speakers to distinguish short from long consonants, but Finnish children acquire this categorical distinction early in life (Richardson, 1998; Leppänen, Richardson, Pihko, Eklund, Guttorm, Aro & Lyytinen, 2002).

Because the Finnish orthography represents the distinction between long and short consonants in a highly consistent way, there is a regular functional relationship in Finnish between consonant length and the representation of this phonological attribute in spelling. However, this functional rule only applies to word-medial consonants. It does not apply to initial

consonants, since written Finnish words, like written French and English words, never start with a consonant doublet. However, certain types of words¹ cause the initial consonant of the following word to lengthen (except in some Southeastern dialects). Therefore, word-initial long consonants are all spelled with a single consonant letter rather than with a doublet, which makes doublet spelling in Finnish conditional on the doublet position. Consequently, knowledge about legal doublet position offers some clues for doublet use independently of the phonological principle and we have two highly regular rules about doublets: 1) a formal rule that doublets occur in medial positions, never at the beginning or the end of a word and 2) a functional rule that doublets represent long consonants. This provides a good opportunity to study the possible difference between children's knowledge about form and function in the Finnish orthography.

It is already known that Finnish children have difficulty in doubling letters in their spelling. Matilainen (1985), Lyytinen, Leinonen, Nikula, Aro & Leiwo (1995) and Lehtonen (2002) found that beginning spellers at first largely miss out the second letter of doublets in their spellings. They use the correct letter to mark the phoneme in question, but fail to pay attention to the length of the phoneme, as if representing phoneme identity were the default process and representing length an additional operation that these children have not mastered yet. Thus, learning about the function of doublets appears to take time. However, nothing yet is known about Finnish children's knowledge of the formal characteristics of doublets. Our aim was to find out whether children possess a degree of knowledge about the formal aspects of doublets, while they are still ignorant of their function in the orthography.

¹ Word types that lengthen the initial consonant of the following word:

- | | |
|--|---------------------------------|
| i) Singular nominative of words ending in <i>e</i> | v) Third person possessive form |
| ii) Comitative as the attribute of the sentence | vi) Allative of all nouns |
| ii) The second person singular of imperatives | vii) Certain adverbs |

In our task, children in years 1-3 heard sentences that contained pseudo-words. The targets in the pseudo-words were long and short consonants that appeared in word-initial and medial positions. The task for the children was to choose between two alternative written spellings for the pseudo-words, one of which contained a doublet and the other a single spelling. The pseudo-words had to be presented in sentences, because the occurrence of long word-initial consonants depends on the nature of the preceding word.

Method

Participants

The participants were 131 children in years 1-3 in a primary school in Espoo, a large city in southern Finland. The children spoke Finnish as their first language. However, 10 children had to be excluded from the study because they had completed the test in a way that indicated they had been guessing (e.g. they had only circled right-hand side responses throughout the test). This left 42 children (25 boys, 17 girls) in Year 1, mean age 7;2 years (range 6;5-7;8 years), 43 children (28 boys, 15 girls) in Year 2, mean age 8;3 years (range 7;9-8;7 years) and 36 children (17 boys, 19 girls) in Year 3, mean age 9;2 years (range 8;7-9;8 years). The children and the experimenters spoke standard Southern Finnish, and therefore dialectal differences are not relevant in this experiment.

Tasks and Procedure

The first- and second-year children were tested in a single testing session ten days after the start of the school year. Children of one class were tested in a group (approximately 25

children). The third-year children were tested by classroom teachers about four weeks after the first- and second-year children.

The Orthographic Constraints test

The experimental task consisted of 24 three-word sentences that were printed on an A4 sheet. The second word of each sentence was a pseudo-word, and the response sheet presented two alternative spellings for each pseudo-word, i.e. one with a doublet and another with a single spelling. The pseudo-words varied according to the length and the position of the target consonant. Twelve words had a long target consonant, and in 12 words it was short. Twelve words had a word-initial target consonant (e.g. Suono), while in 12 words the target consonant was word-medial (muoSSi). Each pseudo-word was five phonemes long (counting a long phoneme as one phoneme) and with each item the children had a choice between a five-letter and a six-letter word. The experimental sentences and the spelling choices of the pseudo-words are presented in the Appendix.

In the trials in which the target consonant was in the medial position the correct choice was determined by the length of the phoneme. In these trials, it was correct to choose the pseudo-word with a single letter spelling when the phoneme was short and to choose the doublet when this phoneme was long. In contrast, when the target was the initial phoneme, the correct choice was the pseudo-word with a single letter spelling. To eliminate order effects, we gave different versions of the task with the items in different randomised orders to different groups. With half of the items, the correct choice was on the right hand side of the response sheet and with the other half it was on the left-hand side. To draw children's attention to the target words of the

sentence, the two choice words were printed in capital letters and in a bigger font (20 pt) than the other words of the sentence (14 pt lowercase).

The children received three practice trials in which the choice was between two words that differed from each other by one phoneme (one letter in spelling). Doublets were not used in the practice words, because that could have affected the responses of the children. However, the words had to differ from each other both orthographically and phonologically. To do this we used letters that were visually confusable (e.g. N-M, R-P) in the practice trials. Thus, the practice trials invited children to pay attention both to the pronunciation and to the spelling of the word and prepared them for the general cognitive requirements of the task, but its purpose was not directly revealed.

Procedure

The experimenter started by introducing herself and a toy cat and handed out the response sheets. The children heard the following instructions:

“This cat has found some new words that nobody has ever heard before. Now someone should decide how to spell these words, but this cat, unlike all of you children, does not know anything about reading or spelling words. Therefore, he needs you to tell him how the words should be spelled. I (the experimenter) will help here and read out every line of words that you have on the sheet in front of you, and then repeat it. You should listen very carefully, and then circle one of the words that is written with big letters, the one that looks more like a real word.”

The experiment started with the practice trials. After each trial, the experimenter went round the classroom to ensure that everyone knew what to do and only circled one word at a time. She then read out one sentence at a time, and repeated it.

Results

Instead of analysing responses as correct or incorrect, we gave children a point every time they chose a word with a letter doublet in it. Thus, the scores indicated how likely children were to choose doublets in the different conditions and allowed us to determine how the requirements of the condition affected children's choices. Selecting a doublet is correct in the Word-medial Long condition and incorrect in all the others. The mean percentages of children's doublet choices are presented in Table 1. The Long/Short labels refer to the length of the phoneme that children heard in that particular condition. Even if children only used orthographic knowledge, they should be able to reject word-initial doublets in both Long and Short conditions. However, children had to consider phoneme length to be able to choose doublets appropriately in the word-medial condition, since a doublet was only required in the medial long condition. The reliability of the task was .780 (Cronbach's alpha).

INSERT TABLE 1 ABOUT HERE

In all year groups the children were less likely to choose an initial doublet than a medial doublet when they heard a long consonant, and this tendency was stronger in the older children. The length of the initial consonant did not substantially affect the choices of children in any year group. This indicated that the children respected the principle concerning orthographic form that prohibits word-initial consonant doublets.

The length of the medial consonants affected the choices of the children in Years 2 and 3, who were more likely to use a doublet to represent a long medial consonant that they heard than a short one. Therefore, these children were aware of the phonological function of word-medial doublets. However, the first-year children did not choose medial doublets any more often when they heard a long phoneme than when they heard a short one, and thus showed no sign of understanding the functional connection between phoneme length and doublet spelling.

Appropriate selection of doublets

We used a repeated-measures ANOVA to investigate these results. The between-subjects factor was Year (1st/2nd/3rd) and the within-subjects factors were Length (Long/Short) and Position (Initial/Medial). The dependent variable was the number of times that children chose a spelling containing a doublet.

There were significant main effects of Length ($F(1,118)= 141.498, p<.001$), Position ($F(1,118)= 283.621, p<.001$) and Year ($F(2,118)= 14.250, p<.001$). Both the Length and Position main effects were qualified by interactions with Year: Length and Year ($F(2,118)= 37.440, p<.001$), Position and Year ($F(2,118)= 14.182, p<.001$). Moreover, there was a significant interaction between Position and Length ($F(1,118)= 153.672, p<.001$) that was further qualified by an interaction with Year ($F(2,118)= 39.604, p<.001$).

We explored these interactions in separate repeated-measures ANOVAs with Bonferroni corrections for each year group (with the same within-group factors as above). These indicated no significant interaction between Length and Position for the first-year children, but a significant Position main effect emerged ($F(1,41)= 23.130, p<.001$). This suggested that although the first-year children chose word-medial doublets significantly more often than word-initial ones (51% vs. 31%), their choices were not affected by the length of the phoneme that they heard. Therefore, children's choices appeared to be based on their knowledge of the formal principles of the orthography, i.e. the legal position of consonant doublets, while they showed no signs of using functional information about Length.

In contrast, the second-year children's data showed a highly significant interaction between Position and Length ($F(1,42)= 57.673, p<.001$). Paired-sample *t*-tests with Bonferroni

corrections ($\alpha=.006$) further indicated that the second-year children's selection of word-initial doublets was not affected by the length of the phoneme that they had heard, and so the children applied their orthographic knowledge. However, they correctly chose word-medial doublets significantly more often than not if they heard a long phoneme in the middle of the word ($t(42)=7.474, p<.001$) than if they heard a short one.

Nevertheless, the children incorrectly chose word-medial doublets significantly more often than word-initial doublets when they heard a short consonant ($t(42)= -15.065, p<.001$). If children had understood the correspondence between short phonemes and single-letter spellings completely, they should have been equally competent with word-initial and with word-medial short phonemes. In contrast, it seems that second-year children were still in the process of learning the connection between phoneme length and doublets, and their proficient performance in the word-initial positions was aided by their advanced ability to utilise orthographic information about legal doublet position. Word-medial conditions led to poorer performance because both doublets and single spellings can appear word-medially, and thus understanding of the phonological function of doublets is crucial. Orthographic knowledge alone does not lead to correct spelling.

The third-year children's scores were near ceiling and the Position by Length interaction was stronger than in the second-year children's data ($F(1,35)= 225.938, p<.001$). Third-year children were even more likely than second-year children to choose a word-medial doublet when hearing a long phoneme ($t(35)= 15.139, p<.001$) and equally likely to choose single spellings for the two word-initial conditions and for word-medial short phonemes. Thus, orthographic rules no longer helped children beyond the phonemic cues of phoneme length with the word-medial short

phonemes. Instead, children were able to appropriately analyse phoneme length and knew the function of doublets in representing this.

Some Finnish children know how to read when they enter school, and thus it is possible that the responses of the first-year children might in part be influenced by these skilled children's more advanced understanding of the orthography. We cannot directly rule out this alternative, since we were not able to administer a reading test. However, we can check whether the results were significantly affected by those first-year children who demonstrated clear understanding of the phonological function of doublets. To do this, we removed from the first-year sample the children who performed significantly above chance levels in the medial conditions of the orthographic constraints task. We then ran the analyses again.²

Only four children out of 42 performed significantly above chance at the .05 significance level, and even when we used the less conservative significance level .10, only six children did significantly better than chance. Running the analyses without these six children did not change the results at all. Therefore, it appears that the first-year children's knowledge of orthographic form cannot be explained by the limited reading skills or orthographic knowledge that some of these children may possess. Instead, children can use their knowledge of orthographic form before they demonstrate understanding of the phonological function of doublets.

Chance performance

Because this was a two-choice task, children could have achieved 50% correct performance by chance alone. Therefore, we checked whether children's scores in all of the conditions were significantly different from chance by testing the mean percentage of times

² We would like to thank an anonymous reviewer for suggesting this analysis.

children in different year groups chose a doublet in each of the four conditions against 50 by using *t*-tests.

These showed that the second- and third-year children's scores were significantly different from chance in all conditions, while this was not the case for the first-year children's scores in either of the word-medial conditions. Thus, whether the first-year children heard a long or a short word-medial consonant had no effect on their performance, a finding that agrees with the lack of a significant Length by Position interaction in the first-year children's data. However, there was a trend in the correct direction, which suggests that the first-year children's knowledge about the connection between phoneme length and doublet use has already started to develop.

Discussion

The aim of this experiment was to find out about children's knowledge of the orthographic form and phonological function of doublets. We found that children already have some formal knowledge about the legal position of consonant doublets at the beginning of their first school year. However, the first-year children were not aware of the functional connection between doublets and long consonants. In contrast, second- and third-year children chose word-medial doublets significantly more often upon hearing long than short word-medial consonants. They also very rarely chose word-initial doublets independent of whether they heard a long or a short word-initial phoneme, and thus applied their functional knowledge about length selectively only when this was appropriate.

The most interesting finding was that the first-year children were able to reject word-initial consonant doublets although they were ignorant of the correspondence between phoneme length and doublets. This result suggests that children can pay attention to such formal aspects of

print as the legal position of different orthographic patterns, before they fully understand how the orthography functions to represent speech sounds in print. This supports Ferreiro & Teberosky's claim (1982) and shows that children can acquire knowledge of some formal aspects of print independently of and before learning about its function. Moreover, there was no indication that the children's learning about the phonological basis for using doublets, which was demonstrated by the second- and third-year data, had adversely affected their ideas about orthographic constraints. These children, who appropriately assigned doublets to long consonants in the medial position, did not do this with initial long consonants. This would have been expected to happen if the children had started to represent length with doublets regardless of the formal orthographic constraint about legal doublet position.

Our study thus shows that even when the phonological function of doublets is straightforward, children's orthographic knowledge can develop before their phonological understanding of doublet use takes off. The Finnish children learned about the functional significance of doublets in their orthography at a much younger age than the English-speaking children in Cassar & Treiman's study did. Nevertheless, the Finnish children resembled the English-speaking children in that their formal knowledge about the permissible positions for consonant doublets came first. Thus, Cassar & Treiman's finding that only older children have an idea of the conditional phonological rule about English doublet use is only partly due to the inconsistency of this rule. According to the Finnish results, another reason could be that orthographic information about legal doublet position is initially more salient than the relationship between phonology and doublets in both languages. It is likely, though, that the very late understanding of the phonological function of doublets in English is at least partly due to the complex relationship between phonemes and graphemes in English in general, the inconsistency

of the doublet phonological rule in particular and additionally to the fact that the rule in English is conditional rather than a straightforward mapping between a phoneme and an orthographic pattern.

The fact that children can pick up information about the legal position of doublets suggests that they are able to conceptualise doublets as orthographic units. This ability is likely to assist them in working out the phonological function of doublets, since in order to understand that doubling is used to mark long phonemes, it is essential to differentiate between single and doublet consonant letters as meaningful orthographic units. Consequently, we would expect knowledge of the formal properties of doublets to prompt children's understanding of their function, either through instruction, which is likely to play a role, or by more implicit means such as frequency-based learning. Of course, these combine with other skills, such as phonemic awareness, in the learning process.

Our results challenge the long-standing view that all aspects of orthographic knowledge represent a sophisticated form of literacy knowledge that only develops after children have understood the functional properties of the orthography, marking a qualitatively different stage in the process of spelling acquisition. Instead, it seems that even beginning spellers are able to pay attention to at least some salient aspects of orthography, such as doublets, and to an attribute like their position within the word. This suggests that the stage-like sequence in which understanding orthographic conventions only follows the acquisition of phoneme-grapheme correspondences, as advocated by for example Frith (1985) and Gentry (1982), does not accurately describe early spelling acquisition. Instead, the pattern of results fits in with that presented by Cassar & Treiman (1997) and supports their argument that children can use different kinds of spelling information from early on.

The next question to ask is whether children can appreciate differences between vowels and consonants in their use of letter doublets. Vowel letter doublets in Finnish are allowed in the beginning, as well as in the middle or at the end of words. We need to know whether also this is a part of Finnish children's formal knowledge, and if it is, what basis do they have for distinguishing these two kinds of letters and phonemes.

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Appendix

The Design of the Task Presenting the Spelling Choices in Different Pronunciation Conditions.

		Position	
		Word-initial	Word-medial
Length	Short	Hurja <u>Suono</u> (SSuono) haukkuu.	Vanha <u>raiSi</u> (rai SSI) lepää.
		Paksu <u>Soaki</u> (SSoaki) painaa.	Hidas <u>teiSu</u> (tei SSu) pyörii.
		Nuori <u>Laire</u> (LLaire) nukkuu.	Kaunis <u>neiLe</u> (nei LLe) laulaa.
		Märkä <u>Leiti</u> (LLeiti) tippuu.	Kevyt <u>kaiLa</u> (kai LLa) leijuu.
		Hieno <u>Pauno</u> (PPauno) kiiltää.	Lihava <u>koiPu</u> (koi PPu) makaa.
		Pitkä <u>Koika</u> (KKoika) juoksee.	Kuuma <u>haiKi</u> (hai KKi) polttaa.
Long	Long	Tule <u>Surto</u> (SSurto) tänne!	Pieni <u>muoSSi</u> (muo Si) nauraa.
		Pyydä <u>Soksu</u> (SSoksu) sisään!	Musta <u>leiSSo</u> (lei So) inisee.
		Mene <u>Losti</u> (LLosti) pois!	Vihreä <u>taiLLe</u> (tai Le) herää.
		Työnnä <u>Lunka</u> (LLunka) kauas!	Kauhea <u>ryöLLi</u> (ryö Li) karjuu.
		Kisko <u>Patso</u> (PPatso) irti!	Korkea <u>tauPPi</u> (tau Pi) kaatuu.
		Heitä <u>Kitri</u> (KKitri) ulos!	Halpa <u>vauKKu</u> (vau Ku) särkyä.

bold capitals = target clusters; underlining = correct spellings; (parentheses) = incorrect spellings

Table 1

The Mean Percentage of Times that Children Selected Spellings with Doublets in the Different Experimental Conditions (Standard Deviations in Parentheses, the Condition Where a Doublet Spelling Was Required Is Highlighted).

		Year 1	Year 2	Year 3
Word-initial	Long	31 (26)	5 (16)	5 (17)
	Short	31 (28)	7 (18)	5 (14)
Word-medial	Long	54 (26)	67 (23)	89 (22)
	Short	47 (30)	30 (25)	6 (16)