

THE INFLUENCE OF SPELLING RULES ON PHONOLOGY*

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The influence of spelling conventions on phonological knowledge was investigated. In Experiment 1 five-year old preliterate children and eight-year-old literate children were compared on their intuitive syllabification (word fragmentation) of disyllabic Dutch words with a single intervocalic consonant (e.g. /ãp\l/, 'apple'). The larger number of ambisyllabic responses in the older age group could either be a reflection of the eight-year-olds' more mature phonology or an interaction between phonological knowledge and spelling conventions. Experiments 2 and 3, using literate and illiterate adults respectively, were designed to disentangle these alternative accounts.

1. Introduction

The central question in this paper is how phonological knowledge may be influenced by extraneous sources. This is an instance of the more general question whether knowledge of one domain of the linguistic system may be influenced by other domains. For instance, in prosodic bootstrapping, the possible interactions between the phonological structure of words and their assignment to particular parts of speech has been hypothesized (Kelly 1996). Other research has demonstrated the influence of conventional spelling on spoken morphology (Levin, Ravid and Rapaport in press).

The experiments reported in this paper address the question whether phonological knowledge is affected by the knowledge of spelling. More particularly, we will investigate whether language user's intuitive syllabification of Dutch words is affected by their knowledge of the spelling system. Since aspects of both the phonology and the

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orthography of the language are implied, we will briefly outline the features that are relevant for present purposes.

1.1 Phonological regularities

Syllabification is governed by a number of universal principles. One such principle which is of crucial importance for the present study is the *Obligatory Onset Principle* (Hooper 1972; Kahn 1976; Selkirk 1982). This principle holds that the consonant immediately preceding a vowel is the onset of the syllable to which that vowel belongs. This means that Dutch words such as /tafəl/ (<tafel>, 'table') and /mø̀səl/ (<mossel>, 'mussel') are syllabified as /ta . fəl/ and /mø̀ . səl/.

In addition to these universal principles of syllable structure (Clements 1990) there are also some language specific (i.a. phonotactic) constraints, which may override the universal principles. Of crucial interest in the present study is the language specific constraint that holds in Dutch with respect to the well-formedness of syllable rhymes: the *Bipositional Rhyme Constraint* (Fikkert 1994) or the *Bimoraic Minimality Constraint* or *Branching Rhyme Constraint* (Kager 1989). This constraint holds that in Dutch short (lax) vowels cannot occur in open syllables. In other words, a well-formed syllable in Dutch must end in a long vowel (VV) or in a sequence of a short (lax) vowel and a consonant (VC); an 'unchecked' short vowel is not allowed.

For Dutch words where a long vowel in their first syllable is followed by a single intervocalic consonant (e.g., /tafəl/, table), no conflict arises between the universal and language specific constraints and no syllabification problems should arise (/ta . fəl/). However, for words where a short vowel is followed by a single intervocalic consonant (e.g. /mø̀səl/) the universal Obligatory Onset Principle predicts a different syllabification (/mø̀ . səl/) than the language specific Bipositional Rhyme Constraint (/mø̀s . əl/). Among phonologists of Dutch, there appears to be a consensus in this respect (see Booij 1995 for a recent overview of the relevant literature) to view the single intervocalic consonant following a short vowel as ambisyllabic, i.e. belonging both to the coda of first syllable and to the onset of the second syllable. Thus /mø̀səl/ would be represented as /mø̀s . əl/ and be syllabified accordingly. This implies that children acquiring Dutch should learn at some

point to resolve the conflict between the universal principle of onset maximization and the language specific constraint.

1.2 Regularities in spelling

The differences between long and short vowels are reflected in the Dutch orthographic system. Short vowels are always represented as one single grapheme. Long vowels are spelled as two graphemes in closed syllables and as one grapheme in open syllables (though this regularity is not exceptionless as can be seen in <zee> 'sea' versus <zebra> 'zebra'). The phonological length difference is further taken care off by the intervocalic consonant: a single grapheme is written when the preceding vowel is long and a double grapheme when the preceding vowel is short. Thus in Dutch /modV/ ('fashion') is written with a single grapheme <d> as <mode> and /mødVr/ ('mud') is written with a double grapheme <d> as <modder>.

Syllabification or word splitting rules prescribe that a hyphen should be written between the two consonants following a short vowel (<mod-der>) and before the single consonant following a long vowel (<mo-de>). In this way the splitting rules reflect the ambisyllabicity of the consonant following a short vowel and the non-ambisyllabicity of the consonant following a long vowel.

In this study we investigate whether the language specific phonological constraint that holds with respect to short vowels affects syllabification behaviour and at what age. Most importantly, we want to investigate whether knowledge of spelling rules plays a role. Experiment 1 compares the intuitive syllabifications of five-year olds (5YO), i.e. a preliterate group, and eight-year olds (8YO), i.e. a literate group. If children acquire the Bipositional Rhyme Constraint around the age of three to four, as Fikkert (1994) has claimed, we should observe a good number of ambisyllabic responses following a short vowel in the 5YO group. If knowledge of spelling rules affects intuitive syllabification, the number of ambisyllabic responses should be even larger in the 8YO group.

2. Experiment 1

2.1 Method

Subjects

Twenty five-year olds (age range: 5;5.18 - 6;5.13, mean age: 5;10.0) and twenty eight-year olds (age range: 7;7.25 - 8;4.26, mean age: 8;0.3) participated in this experiment. The younger subjects were in the third year of kindergarten. None of them had had even elementary spelling instruction. Children in the 8YO group were in the second grade of primary school. The children were tested in their school in the Flemish village Merchtem. All children were native speakers of Dutch. No hearing or speech deficits were reported by their teachers.

Stimuli

The stimuli were 44 disyllabic monomorphemic words with a single intervocalic consonant. The main phonological contrast was between short and long vowels in the first syllable ($n = 22$ for each type). In addition the following factors were controlled for: stop vs. fricative intervocalic consonant, initial vs. final main stress, voiced vs. voiceless intervocalic consonant. These factors were counterbalanced in so far as phonotactic restrictions permitted. This set of critical items was mixed with an equal number of stimuli with two or three intervocalic consonants. The resulting stimulus set ($n = 88$) was used in the three experiments reported in this paper.

Procedure

Two random presentation orders were used, one for each half of the subjects. The experiment was run in a separate room. The first experimenter explained the task: the children had to repeat the words slowly (*in stukjes* 'in fragments') and they were asked to clap their hands rhythmically (one clap per syllable). This procedure was illustrated with a few examples and then the child was asked to show his/her understanding of the procedure using his/her own name (if possible) and a few other sample words. After the trials the same procedure was used for each word in the experimental list: the word was read by the first experimenter, the child syllabified the word, and a second experimenter recorded the

response on a scoring sheet. All experimntal sessions were tape recorded. The same procedure was used in the three experiments reported in this paper.

Scoring

Scoring the data was done during the experimental session by one experimenter. After the experiment, the second experimenter, who read the test words during the test, scored subjects' responses from the tape, after which the two scores were compared. In cases of disagreement, which very rarely occurred, the response was not further considered in the analyses.

2.2 Results and discussion

In virtually all cases subjects syllabified in accordance with the universal Obligatory Onset Principle (e.g. /ãp\l/ was syllabified as either /ã . p\l/ or /ãp . p\l/ but not as /ap . \l/): in 99.5 % of the cases in the 5YO group, in 99 % of the cases in the 8YO group. In other words, the children did not allow onsetless second syllables.

We were particularly concerned with the question whether the children respected the language specific Bipositional Rhyme Constraint. If they adhered to that principle a long vowel should only occur in an open syllable and a short vowel should only occur in a closed syllable. Hence, since the Obligatory Onset Principle was respected, we expect an ambisyllabic intervocalic consonant after a short vowel. In Table 1 the children's syllabifications are classified as either 'open syllable' responses (VV-CV or V-CV) or 'closed syllable' responses ((V)VC₁-C₁V(V)). The small minority of V(V)C-V cases is not considered.

Table 1: Response frequencies and percentages (with respect to row totals) of five- and eight-year-olds' syllabifications relative to the length of the preceding vowel

		Open syllable		Closed syllable		Total
		N	%	N	%	
5YO						
	V	356	85.2	62	14.8	418
	VV	424	92.6	34	7.4	458
8YO						

V	317	77.1	94	22.9	411
VV	417	90.7	43	9.3	460

The results in Table 1 show that in a vast majority of cases both the 5YO and 8YO groups prefer 'open syllable' segmentations, both in the context of a short and a long vowel. In the case of a long vowel this is predicted by the phonological analysis. However, in the context of a short vowel the phonological analysis predicts an ambisyllabic consonant. Yet, in both age groups the ambisyllabic syllabification pattern occurred in less than 25 % of the cases. This means that for words with a short vowel in the first syllable, both groups of children violated the Bipositional Rhyme Constraint to a considerable extent.

The frequency of ambisyllabic responses was determined both by the phonological length of the preceding vowel and by subjects' age. In both the 5YO and 8YO groups, subjects made significantly more ambisyllabic responses in the short vowel condition than in the long vowel condition (5YO: $\chi^2 = 12.29$, $p < .0005$; 8YO: $\chi^2 = 29.95$, $p < .0001$). This suggests that children in both age groups were 'aware' that vowel length is an important phonological factor for syllabification in Dutch. However, neither subject group used vowel length as part of a phonological rule (i.e., a long vowel is never followed by an ambisyllabic consonant, a short vowel is always followed by an ambisyllabic consonant). A comparison of the 5YO and the 8YO groups revealed no significant difference between the response patterns for words with a long vowel in the first syllable ($\chi^2 = 1.11$, $p > .10$), whereas such a difference was obtained for words with a short vowel ($\chi^2 = 8.77$, $p < .005$). This suggests that children in the 8YO group adhered more to the language specific Bipositional Rhyme Constraint than the younger children.

These findings replicate the results reported by Gillis and De Schutter (1996), who found an even more marked increase of the ambisyllabic pattern in their comparison of 5YO and 8YO children. Gillis and De Schutter proposed two possible explanations for this increase in ambisyllabic responses: (i) a development of phonological knowledge between the ages of five and eight, or (ii) the influence of external factors, more particularly, the acquisition of the spelling system. The first hypothesis entails that the Bipositional Rhyme Constraint in Dutch is acquired at a relatively late age. Indeed, the data of the present study suggest that five-year old children are just becoming 'aware' of the constraint. The second grade children (the 8YO group) still showed weak signs of the acquisition of the

constraint, whereas the third grade children in Gillis and De Schutter's (1996) study showed an already more pronounced awareness of the constraint. This notion of late development goes against Fikkert's (1994) claim that the constraint is acquired at the age of three or four.

The hypothesis that eight-year old children have developed a more full-grown knowledge of the phonological component of their language will be further investigated in the second experiment. The hypothesis makes the straightforward prediction that adults will adhere to the Bipositional Rhyme Constraint even more than children in the 8YO group (as a matter of fact, adults should have fully acquired the constraint). In other words, we should expect considerably more ambisyllabic syllabifications in a group of adults than in the 8YO group.

3. Experiment 2

3.1 Method

Subjects

Twenty-four undergraduate students of the University of Antwerp (UFSIA) took part on a voluntary basis in the experiment. All were native speakers of Dutch.

Stimuli, procedure and scoring

See Experiment 1.

3.2 Results and discussion

Of the 1056 syllabifications, only a single one (0.09%) violated the Obligatory Onset Principle. All other syllabifications were either 'open syllable' responses (V)V-CV(V) or 'closed syllable' responses with an ambisyllabic intervocalic consonant following a short vowel, i.e. VC₁-C₁V(V). In Table 2 the results of the adults' syllabifications are presented relative to the quality of the preceding vowel.

Table 2: Response frequencies and percentages (with respect to row totals) of adults' syllabifications relative to the length of the preceding vowel

	Open syllable		Closed syllable		Total
	N	%	N	%	
V	429	85.3	74	14.7	503
VV	552	100	0	0	552

Adults always retain a long vowel in an open syllable. When there is a short vowel in the first syllable, they tend to close that syllable in only a minority of cases (14.7%). Thus in a large majority of the adult's syllabifications, the Bipositional Rhyme Constraint is violated.

The present experiment was set up to test the hypothesis that eight-year old children are on their way towards the full acquisition of the language specific Bipositional Rhyme Constraint. If the hypothesis is true, there should be a steady increase in the number of ambisyllabic syllabifications over the three age groups studied in Experiments 1 and 2: the 5YO, the 8YO and the adult groups. This prediction is not borne out by the results. Adults, rather than making more ambisyllabic responses than subjects in the 8YO group, made fewer such responses (8YO: 22.4 %; adults: 14.7 %), a significant difference ($\chi^2 = 10.04$, $p < .002$). As a matter of fact, their number of closed syllable responses was almost identical to that observed in the 5YO group (14.8 %).

This finding seems to reject the idea that the difference between the 5YO and the 8YO children must be accounted for in terms of a further phonological development between the ages of five and eight. An alternative account is to attribute the increase in ambisyllabic responses to the influence of subjects' knowledge of spelling, more particularly, the rules for splitting written words. Experiment 3 was designed to test this hypothesis.

The interference of the spelling rules may be seen in words with a short vowel in the first syllable: words like /mɒd\ɾ/ ('mud') are spelled with a double intervocalic consonant: <modder>. Such words are split between the two consonant graphemes: <mod-der>. These rules are learnt at school around the age of eight, which makes it possible that this ongoing learning process affects the children's 'intuitive' syllabifications. If this is what happens, the learning of spelling rules is the crucial factor determining ambisyllabic responses rather than age. This leads to the prediction that illiterate adults, who do not

know these rules, should produce less ambisyllabic responses in words like /mød\ɪ/ (<modder>, 'mud') than children in the 8YO group. As far as ambisyllabic responses are concerned, illiterate adults are expected not to differ from the 5YO group.

4. Experiment 3

4.1 Method

Subjects

All subjects who took part in this experiment, attended an alphabetization course. None of them was able to read. A total of 18 subjects participated on a voluntary basis. All were native speakers of Dutch.

Stimuli and procedure

See Experiment 1.

Scoring

The same scoring procedure as in the previous experiments was adopted. The most common problem with the illiterate subjects was that there did not occur a clearly audible pause between the two parts of the word. In that case the subject's response was marked as 'no response' and not considered for analysis. This occurred rather frequently: 22.6 % of subjects' responses did not contain an audible pause. After checking the responses of all subjects, two subjects were removed (leaving 16) because more than one third of their responses were of the 'no response' type.

4.2 Results and discussion

The responses of the illiterate subjects show the same pattern as those of the other subject groups with respect to the Obligatory Onset Principle. In only two cases (0.37 %, N = 545) an onsetless second syllable was produced.

In Table 3 the syllabification patterns of the illiterate adults are given for long and short preceding vowels. For words with a long vowel in the first syllable, illiterate adults adhere to the Bipositional Rhyme Constraint. In only 3.6 % of the responses, the syllable is closed. However, for words with a short vowel in the first syllable, the constraint is violated in a fair number of cases: in 73.9 % an 'open syllable' response is produced. This pattern was also obtained for the subject groups in the previous two experiments. However, compared to these other groups, the number of 'closed syllable' responses in the short vowel condition is the highest for the illiterate subjects: 26.1 % for illiterate adults, 14.7 % for literate adults, 14.8 % for the 5YO group and 22.4 % for the 8YO group. The illiterates made significantly more such responses than both the 5YO group ($\chi^2 = 12.45$, $p < .0005$) and the group of literate adults ($\chi^2 = 13.86$, $p < .0002$) but did not differ from the 8YO group ($\chi^2 = 0.83$, $p > .10$). Clearly, this is not the expected result: if the learning of graphemic splitting rules accounts for the large number of ambisyllabic responses in the 8YO group, one would expect the illiterates to resemble the 5YO group more than the 8YO group.

Table 3: Response frequencies and Percentages (with respect to row totals) of illiterate adults' syllabifications relative to the length of the preceding vowel

	Open syllable		Closed syllable		Total
	N	%	N	%	
V	176	73.9	62	26.1	238
VV	294	96.4	11	3.6	305

5. General discussion

The crucial evidence for the Bipositional Rhyme Constraint comes from Dutch words with a short vowel in the first syllable and a single intervocalic consonant (e.g. <mossel> /mø.s\l/, 'mussel'). According to phonological analyses, the conflict between the prediction of the language universal Obligatory Onset Principle (/mø . s\l/) and that of the language specific Bipositional Rhyme Constraint (/mø.s\l/) will be resolved by ambisyllabic syllabification: /mø.s.s\l/. If anything, this syllabification pattern would be reinforced by the

splitting rules in Dutch spelling, which prescribe splitting between the two consonants (<mos-sel>).

In Experiment 1 we found that the ambisyllabic pattern occurred more frequently in the data of the 8YO group than in the data of the 5YO group. This outcome could be accounted for in terms of phonological development (further acquisition of the Bipositional Rhyme Constraint between the ages of five and eight) or in terms of another development: the acquisition of written language, viz. the conventions for graphemic splitting.

Experiment 2 was designed to distinguish between these two accounts. If the increase in ambisyllabic responses in the 8YO group results from the development of phonological knowledge, adults should make even more such responses. At the very least, the adults' pattern of ambisyllabic responses should resemble that of the 8YO group more than that of the 5YO group. The results of the experiment disconfirmed this prediction, suggesting that learning the rules for graphemic splitting at about the age of eight affects subjects' intuitive syllabifications.

Experiment 3 was designed as a further and more direct test of the hypothesis that ambisyllabic syllabification is affected by knowledge of an extra-phonological component of the language. Illiterate adults, who find themselves in the same position as the 5YO group as far as knowledge of the written language is concerned, should perform like the 5YO group and unlike the 8YO group. However, the frequencies of ambisyllabic responses of the illiterate and 8YO groups did not differ, whereas a difference was obtained between the illiterate group and both the 5YO and literate adult groups.

Thus considered, the entire data pattern seems to defy a consistent interpretation. However, more careful inspection of the results suggests that the pattern of ambisyllabic responses across the four subject groups needs an explanation in terms of both phonological and spelling factors. Table 4 shows, for each subject group, the distribution of responses across open and closed (ambisyllabic) syllables as a function of the phonological class of the intervocalic consonant (stop versus fricative) after a short vowel. Both in the 5YO group and in the illiterate adult group, the distribution of responses across the two syllable types is significantly affected by the type of intervocalic consonant (5YO: $\chi^2 = 4.58$, $p < .05$; illiterate adults: $\chi^2 = 44.07$, $p < .0001$), whereas no such effect was

found in the 8YO group and the literate adult group (8YO: $\chi^2 = .97$, $p > .25$; literate adult: $\chi^2 = .32$, $p > .50$).

In the 5YO group we observe that subjects' tendency to make ambisyllabic responses is determined by a phonological factor: the contrast between stops and fricatives, the latter category inducing a higher frequency of ambisyllabic responses. When subjects learn to spell (8YO group), their knowledge of spelling rules leaks into their intuitive (phonological) syllabification, which manifests itself in two ways: (i) a marked increase in ambisyllabic responses (for stops: $\chi^2 = 6.85$, $p < .01$; for fricatives: $\chi^2 = 3.05$, $p = .08$) and (ii) the disappearance of the phonological contrast between stops and fricatives observed in the 5YO group. In the group of third graders studied by Gillis and De Schutter (1996) this effect was even more pronounced, a finding which indicates that explicit training in the use of spelling rules affects subjects' intuitive syllabification.

Literate adults resemble the 5YO group in the frequency of ambisyllabic responses but resemble the 8YO group in the absence of an interaction with the phonological category of the intervocalic consonant. Apparently they have learnt not to mix up phonological rules and spelling rules (as a matter of fact, some subjects explicitly asked whether they had to split according to the word's orthography or to its phonology), which results in a return to the uncorrupted stage of the 5YO group. On the other hand, their knowledge of the spelling system seems to have left a more lasting mark on their syllabification behaviour; unlike subjects of the 5YO group they no longer treat stops and fricatives differently. This difference is irrelevant in spelling.

Table 4: Open and closed syllable response relative to the intervocalic consonant in the four groups of subjects

Group		Stops	Fricatives
5YO	open syllable	161 (89.4 %)	195 (81.9 %)
	closed syllable	19 (10.6 %)	43 (18.1 %)
8YO	open syllable	143 (79.4 %)	174 (75.3 %)
	closed syllable	37 (20.6 %)	57 (24.7 %)
LIT	open syllable	182 (84.3 %)	247 (86.1 %)
	closed syllable	34 (15.7 %)	40 (13.9 %)
ILL	open syllable	103 (94.5 %)	73 (56.6 %)
	closed syllable	6 (5.5 %)	56 (43.4 %)

Finally, the group of illiterate adults resembles the 5YO group as far as the phonological contrast between stops and fricatives is concerned. As a matter of fact, in the case of the illiterate adult this contrast has become quite extreme: about half of the responses to words with an intervocalic fricative are ambisyllabic. In a sense, the illiterate adult appears as a ‘magnified’ version of a five year old child. As far as the frequency of ambisyllabic responses is concerned the illiterates differ from all other groups (all $p < .01$), except from the 5YO group in the environment of a stop consonant ($p > .10$). As the illiterate adults have no knowledge of spelling rules the large number of ambisyllabic responses in the context of fricatives cannot be affected by orthographic factors. It is not immediately clear what caused it.

6. Conclusion

In this paper we investigated how subjects solve the conflict between a universal principle of syllabification (maximization of the onset) and a language specific constraint (the Bipositional Rhyme Constraint), and how their (intuitive) phonological knowledge may be influenced by extraneous sources. The following conclusions can be formulated:

(i) Preliterate children (5YO group), literate children (8YO group), literate adults, and illiterate adults all make more ambisyllabic responses in the context of a short vowel than in the context of a long vowel, as predicted by the Bipositional Rhyme Constraint. Some ‘awareness’ of the constraint is already present at the age of five. However, the constraint is never used as a rule in an intuitive syllabification task (i.e., always ambisyllabic response following short vowel, never ambisyllabic response following long vowel).

(ii) In an intuitive syllabification task, subjects do *not typically* make ambisyllabic responses to bisyllabic Dutch words where a short vowel is followed by a single intervocalic consonant, even if these subjects have a good knowledge of the phonological structure of the language (i.e. literate adults). If the intuitive syllabification task used in these experiments sheds light on subjects’ phonological knowledge, this finding disconfirms the belief that the conflict between the universal Obligatory Onset Principle and the language specific Bipositional Rhyme Constraint results in ambisyllabicity. Note that a possible ‘contamination’ by subjects’ knowledge of Dutch spelling (i.e. splitting rules) would only act to reinforce the ambisyllabic pattern.

(iii) Ambisyllabic syllabification in this task is controlled by a phonological factor, i.e. the stop/fricative (continuant) contrast, in subject groups who have no knowledge of the Dutch spelling system (five year olds and adult illiterates). It is controlled by a spelling factor in subject groups who have learnt to write (eight-year-olds and literate adults). Spelling appears to have a double effect. In subject groups who are actively learning the spelling rules for graphemic splitting it leads to an increase in the frequency of ambisyllabic responses and removes the contrast between stops and fricatives (a phonological contrast being irrelevant to a process that is controlled by spelling). In subject groups who have long learnt to write the direct influence of spelling has disappeared (drop in the frequency of the ambisyllabic pattern) but an indirect effect (the lack of a contrast between stops and fricatives) remains. Thus knowledge of spelling seems to have a lasting effect on phonological operations.

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