Learning pronunciation variants in a second language: Orthographic effects

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ABSTRACT

The present study investigated the effect of orthography on the learning and subsequent processing of pronunciation variants in a second language. Dutch learners of French learned reduced pronunciation variants that result from schwa-zero alternation in French (e.g., reduced /ʃnij/ from *chenille* 'caterpillar'). Half of the participants additionally learnt the words' spellings, which correspond more closely to the full variants with schwa. On the following day, participants performed an auditory lexical decision task, in which they heard half of the words in their reduced variants, and the other half in their full variants. Participants who had exclusively learnt the auditory forms performed significantly worse on full variants than participants who had also learnt the spellings. This shows that learners integrate phonological and orthographic information to process pronunciation variants. There was no difference between both groups in their performances on reduced variants, suggesting that the exposure to spelling does not impede learners' processing of these variants.

Keywords: second language acquisition, phonological variation, orthography

1. INTRODUCTION

In classroom settings, second language (L2) learners typically learn most words on the basis of spelling. Previous studies focusing on native listening suggest that the recognition of a word is less costly the more closely its pronunciation corresponds to its spelling (e.g., [5, 9, 10]). This raises the question of how exposure to spelling affects L2 learners' processing of spoken words.

In running speech, words occur in several pronunciation variants. They may appear in full or in reduced variants, in which segments are weakly articulated or completely absent (e.g. English *police*, full: /pə'li:s/, reduced: /pli:s/) [1, 2]. The full variant of a word typically corresponds more closely to its spelling than the reduced variant. As a consequence, spelling may affect the processing of full and reduced variants differently.

One study investigating the effect of orthography on the recognition of pronunciation variants is provided by Racine et al. [6]. It tested the performance of native French readers and pre-readers in a word monitoring task. The important comparison was their performance on word types such as *casserole* 'casserole', which are almost never produced with schwa (as /kasə'ʁɔl/) although the spelling indicates one. For these word types, pre-readers recognized the infrequent variants with schwa more slowly than the more common reduced variants. In contrast, readers performed equally well on both variants.

The current study takes this study by Racine et al. [6] as a starting point. We investigated the effect of spelling on how low proficiency Dutch learners of French, who are only familiarised with the reduced variants of schwa-zero alternation words, subsequently comprehend these reduced variants and the corresponding full variants. Dutch listeners are not familiar with schwa-zero alternation as it occurs in French, and they may therefore have more difficulties than natives to recognize the unfamiliar variants with schwa in a lexical decision task. Importantly, they may be less likely to take spelling as evidence for alternate full variants with schwa, such that their subsequent comprehension of full and reduced variants is not affected.

In a training phase, Dutch learners of French learnt reduced variants that result from schwa-zero alternation, such as reduced /ʃnij/ *chenille* 'caterpillar'. Importantly, one group received auditory training only, whereas the other group also learnt the words' spellings. On the second day, participants performed an auditory lexical decision task in which half of the words reoccurred in their reduced variants, while the other half occurred in their full variants.

The comprehension of reduced variants in L2 possibly depends on whether the absence of schwa creates a consonant cluster that is word-initially illegal in the learner's native language (e.g., illegal /rm/ in reduced *remous* /rmu/ 'swirl' versus legal /pl/ in reduced *pelouse* /pluz/ 'lawn'). As has been found for native listeners [8], illegal clusters may form a cue to the absent schwa. This cue may facilitate the recognition of unfamiliar full variants for L2 learners. In order to investigate this issue, we incorporated in our study words with legal onset clusters in their reduced variants as well as words with illegal onset clusters in their reduced variants.

2. METHOD

2.1. Participants

Forty-eight Dutch native students at Radboud University, Nijmegen, were paid to participate in the experiment. Their average age was 20.7 years and on average they had taken French classes at school for 3.1 years. They were divided into two groups of 24 participants such that the average score in the LexTale Test for Proficiency in French [4] did not significantly differ between groups (t[44.13] = 0.72, p >.1). One group was trained with spelling as additional information (+SP), and the other group was not (-SP).

2.3. Materials

The target stimuli were 24 low-frequency bisyllabic French word types which can undergo schwa-zero alternation (e.g., *la chenille*). Average lemma frequency of these 24 target word types was 8.21 per million according to the *Corpus des sous-titres* in the *Lexique 3* database [4]. Nine target word types had reduced variants with onset clusters that are legal in Dutch, and the remaining fifteen had reduced variants with illegal onset clusters in Dutch.

From each of the 24 target word types, a matched pseudoword was derived for the lexical decision task. We created each of these 24 pseudowords by combining the initial syllable of the corresponding target word type with a real syllable of French.

The experimental stimuli further comprised 72 high-frequency French words that were used as fillers. Of these 72 words, 42 were bisyllabic with twelve containing schwa in initial syllable, and 30 monosyllabic. Average lemma frequency was 272.9 per million according to the *Corpus des sous-titres*. Additionally, 72 pseudowords were derived from the 72 filler words by substituting one or two phonemes.

A female native speaker of French recorded all stimuli preceded by the definite article *le* or *la* in a sound attenuated booth at a 44.1 kHz sampling rate and 16-bit resolution on a mono channel. For each of the target word types and the corresponding pseudoword types, she produced both reduced and full variants. The reduced variants of the target word types were recorded twice: one recording was used in the training phase, and the other recording in the lexical decision task. Average durations of the reduced variants including the articles were 812ms (range: 556 - 973) and 825ms (range: 562 - 998) in the training and lexical decision task, respectively. Average duration of the full variants was 858ms (range: 553 - 1026).

There were four experimental master lists for the lexical decision task, each of which consisted of 192 trials: 24 target trials, 72 word filler trials, and 96 pseudoword filler trials. Each of the four master lists represented a different pseudo-randomized sequence of the 192 experimental trials. For each masterlist, two experimental mirror sublists were created, in each of which half of the 24 target word types were presented as full variants, and the other half as reduced variants. Importantly, a target word type that occurred as a full variant in one sublist occurred as a reduced variant in the other sublist, and vice versa. Participants were randomly assigned to one of the eight sublists, six participants per list.

2.3. Procedure

Participants were individually trained and tested on two consecutive days. They performed all tasks in a sound attenuated booth.

The training phase (Day 1) consisted of two parts: in the first part, participants had to memorize the translations of the target word types. In each trial, they heard a target word type in its reduced variant and then saw the Dutch translation on the screen. Participants in the +SP group additionally saw the spelling of the target word type prior to hearing the reduced variant. Each target word type was repeated four times with a lag of at least three intervening trials.

In the second part of the training phase, participants heard the reduced variants of the target word types again. In this part, a trial consisted of the auditory presentation of a reduced target variant, after which participants had to provide the corresponding Dutch translation using a computer keyboard. Again, participants in the spelling group first saw the spelling of the target word type. If the translation participants provided was incorrect, the correct translation appeared on the screen. As in the first part of the training phase, each target word type was presented four times, and there were at least three intervening trials between repeated trials.

In the lexical decision task (Day 2), each trial consisted of a visual warning signal, which was displayed for 200ms, and which was followed by the auditory presentation of a stimulus. Participants were instructed to decide as quickly and accurately as possible whether the stimulus they heard was a word or a nonword. They indicated their response by pressing one of two buttons on a response box placed in front of them. At 200ms after the button press, the next trial started.

In order to assess how well participants had learnt the meanings of the words, we conducted a vocabulary test after the lexical decision task. Participants again heard the 24 target word types in their reduced variants. After a target word type had

been presented, participants had to select the correct Dutch translation out of four possible translations that were displayed on the screen.

3. RESULTS

There was no significant difference between the accuracies of the -SP and +SP group in the vocabulary test (-SP: 87.3%, +SP 84.5%; $\chi^2 = 1.62$; df = 1; p > .1).

3.1. Response accuracy

Three target word types elicited more than 40 % errors (*nonword* responses) in their reduced variants and were excluded from the analyses. Further, data from three participants, whose overall error rates were higher than 35 %, were discarded. After RTs had been log-transformed, we removed 25 responses that fell more than 2.5 standard deviations beyond or below the mean reaction time (RT) of the responses to target word types. The resulting data set consisted of 875 (of the 1152) target trials.

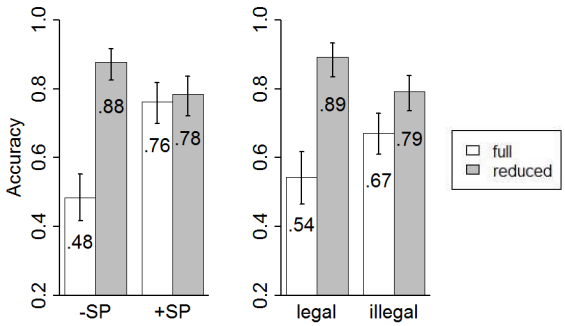
We analysed response accuracy using generalized linear mixed effect models with a binomial link function. We started from an initial model which included *Reduction Type* of the target word type (full vs. reduced), *Spelling* (-SP vs. +SP), and *Phonotactic Legality in Dutch* (legal vs. illegal), as well as the control variables *Trial Number* (1:192), and *Identification in the Vocabulary Test* (correct vs. incorrect) referring to whether the target word was identified correctly by the participant in the vocabulary test. Moreover, all two and three-way interactions of *Reduction Type*, *Spelling*, *Phonotactic Legality in Dutch*, and *Identification in the Vocabulary Test* were included. The final statistical model was obtained with a backwards stepwise selection procedure, in which insignificant predictors were removed from the model. The final model is summarized in Table 1.

The analyses revealed that correct responses (*word* responses) became less likely at later trials. More importantly for our research question, the effect of *Reduction Type* was modulated by *Phonotactic Legality* and by *Spelling* (as illustrated in Figure 1). In order to interpret these two interactions, we split up the data by *Reduction Type* and analysed responses to reduced and full variants separately, including only those predictors that were significant in the regression model shown in Table 1. First, we analysed the responses to reduced variants. A main effect of *Phonotactic Legality* ($\beta = 1.20$, $p < .01$) indicates that participants responded more accurately to reduced variants with legal than with illegal onset clusters. *Spelling* failed to reach significance ($\beta = -0.91$, $p = .057$). Thus, the inclusion

Table 1: Model predicting participants' accuracy. Reference levels: *Reduction Type* (*Red. Type*)*:* reduced, *Spelling*: no spelling, *Phonotactic Legality in Dutch* (*Phon. Leg.*): illegal

Fixed effects		*β*	*SE*	*p* <
(intercept)		-2.56	0.35	.001
Red. Type		-1.77	0.29	.001
Spelling		-0.78	0.40	.056
Phon. Leg.		1.10	0.32	.001
Trial Number		-0.01	0.00	.001
Red. Type x Spelling		2.27	0.37	.001
Red. Type x Phon. Leg.		-1.63	0.39	.001
Random effects			*variance*	*SD*
Word Type	Intercept		0.00	0.00
Participant	Intercept		0.90	0.95

Figure 1: Accuracy as a function of *Reduction Type* and *Spelling* (left), and of *Reduction Type* and *Phonotactic Legality in Dutch* (right). Error bars correspond to 95 % confidence intervals.



of spelling in the training phase did not significantly decrease the rate at which reduced variants were recognized.

Subsequently, we analysed the responses to full variants. Again, *Phonotactic Legality in Dutch* yielded a significant effect ($\beta = -0.53$, $p < .05$). Full variants were recognized more accurately when the corresponding reduced variants started with illegal onset clusters. Moreover, there was a significant effect of *Spelling* ($\beta = 1.47$, $p < .001$), indicating that full variants were recognized significantly more reliably when spelling had been included in the training phase.

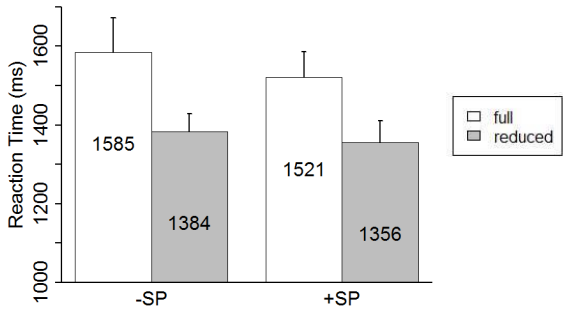
3.2. RTs

The analyses of RTs were restricted to the 636 target trials in which participants had responded correctly. The RTs were measured from stimulus onset and log-transformed so that they approximated a normal distribution. We included the same predictors in the model as for the analysis of accuracy, adding the two control variables *Log-Duration of the Target* and *Log-RT of the Preceding Trial*. The selection

Table 2: Model predicting log-transformed reaction times. Reference levels: *Reduction Type (Red.Type):* reduced

Fixed effects		*β*	*SE*	*t*	
(intercept)		5.20	0.61	8.57	
Red. Type		0.11	0.28	3.84	
Trial Number		-0.00	0.00	-4.78	
Log-Duration		0.19	0.08	2.32	
Preceding Log-RT		0.11	0.04	3.14	
Random effects		*variance*	*SD*	*Corr.*	
Word Type	Intercept	0.005	0.07		
	Red. Type	0.006	0.08	-0.95	
Participant	Intercept	1.112	1.06		
	Red. Type	0.011	0.11	0.18	
	Preceding Log-RT	0.022	0.15	-1	-0.15
Residual		0.027	0.17		

Figure 2: Reaction time as a function of *Reduction Type* and *Spelling*. Error bars correspond to 95 % confidence intervals.



procedure was the same as for the accuracy analyses. The final model is summarized in Table 2.

We found a significant effect of *Reduction Type*, showing that reduced variants were identified as words significantly more quickly than full variants. *Spelling* did not yield a significant effect, and there was no interaction of *Spelling* with *Reduction Type*. This implies that the inclusion of spelling in the learning phase did not affect how fast a variant was identified as a word. Mean RT as a function of *Reduction Type* and *Spelling* is shown in Figure 2. We further found that RTs were faster at later trials and for shorter variants, and that they varied as a function of the RTs of the preceding trial. *Phonotactic Legality* did not yield a significant effect, nor did it interact with any other predictor.

4. DISCUSSION AND CONCLUSION

The present study was set up to investigate the role of orthography in L2 word processing. We investigated how the exposure to spelling affects the comprehension of words' full and reduced variants by L2 learners who have only learnt these words' reduced variants.

We found that full variants were recognized significantly more accurately when spelling had been part of the training phase. Importantly, Racine et al. [6] found a comparable pattern when comparing native French readers with pre-readers. Apparently, spelling has the same effect on natives as on L2 learners who are not familiar with the reduction pattern at issue. Furthermore, we see that the pattern is independent of participants' age (school children in [6] versus adults in our study).

One way to interpret this data pattern in our study is to hypothesize that spelling stimulated learners to create lexical phonological representations for full variants, in addition to those for reduced variants, which they created on the basis of the auditory input. The same hypothesis has been suggested by [7] for native listeners. Alternatively, spelling may have stimulated participants to create orthographic representations which are activated by the words' full variants and facilitate the processing of these variants. These two accounts are not mutually exclusive (as also pointed out in [1]).

Spelling did not affect participants' performance on reduced variants. This suggests that the activation of the lexical representations for the reduced variants was not hindered by the phonological or orthographic representations for the full variants.

Finally, our data show an effect of the phonotactic legality of the onset consonant cluster in the reduced variant. Reduced variants were recognized less often when they contained an illegal cluster. One trivial explanation is that participants partly relied on phonotactic criteria when deciding about the lexicality of an item. Full variants, in contrast, were recognized more accurately if the corresponding reduced variant had an illegal consonant cluster. This finding suggests that phonotactic constraints helped participants to reconstruct the absent schwa (as found for native listeners in [8]) and to store the full variant when they learnt the words.

To conclude, L2 learners' knowledge of a word's spelling may facilitate their processing of the word's full form. Simultaneously, the exposure to spelling does not hinder them when processing reduced variants that they have often heard before.

5. ACKNOWLEDGEMENTS

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