# LISTENING TO NONNATIVE LANGUAGE WHICH VIOLATES NATIVE ASSIMILATION RULES

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## ABSTRACT

Recent studies using phoneme detection tasks have shown that spoken-language processing is neither facilitated nor interfered with by optional assimilation, but is inhibited by violation of obligatory assimilation. Interpretation of these results depends on an assessment of their generality, specifically, whether they also obtain when listeners are processing nonnative language. Two separate experiments are presented in which native listeners of German and native listeners of Dutch had to detect a target fricative in legal monosyllabic Dutch nonwords. All of the nonwords were correct realisations in standard Dutch. For German listeners, however, half of the nonwords contained phoneme strings which violate the German fricative assimilation rule. Whereas the Dutch listeners showed no significant effects, German listeners detected the target fricative *faster* when the German fricative assimilation was violated than when no violation occurred. The results might suggest that violation of assimilation rules does not have to make processing more difficult per se.

## 1. INTRODUCTION

Continuous speech is subject to many phonological adjustment processes. Variation in length of phonemes, vowel reduction, elision of vowels, consonant and vowel epenthesis, reduction of consonant clusters, varying position of word stress and assimilation; all of these processes occur constantly in spoken language. Some of these processes are obligatory whereas others are optional. The occurrence of such adjustments in continuous speech can provide listeners with cues for phoneme recognition.

It has been shown that lawfully assimilated phonemes do not have a stronger facilitation effect on the detection of a following phoneme than unassimilated phonemes, which implies that assimilation can not be used predictively to assist performance. In contrast, violation of obligatory assimilation rules significantly slows RTs, suggesting that processing is more difficult under these conditions [1,2]. In Dutch for example, the word *kaas* before *boe*r may be realised as *kaazboer* instead of *kaasboer*. In a phoneme monitoring task it was shown that voice assimilation did not facilitate recognition of the subsequent consonant /b/. Dutch listeners detect the target phoneme equally fast whether it is lawfully assimilated or unassimilated, if assimilation is optional. However, they find it harder to detect a target phoneme if it violates obligatory Dutch voice assimilation, such as /p/ in *kaazplank*, because of the unconditioned voicing, than when no violation is involved, such as /p/ in *kaasplank* [1].

In Japanese, assimilation of place for a nasal and a following stop consonant is obligatory. In words like *tombo* the moraic nasal is realised as the bilabial [m] before the bilabial obstruent [b], in *kondo* the moraic nasal is alveolar before [d]. Japanese listeners were found to be sensitive to the violation of this obligatory rule. Their RTs in a phoneme detection task are slower in rule-violated items than in lawfully assimilated items [2]. The constraints of adjustment processes are, however, language-specific. For instance in Dutch the same place assimilation rule is optional. In order to find out how the knowledge of the phonological structure of ones' native language affects the perception of spoken nonnative languages, Dutch listeners were presented with the same Japanese material. Indeed, Dutch listeners show no difference in their RTs between assimilated and rule-violated cases.

For them no violation of their native language was involved. Processing of a nonnative language might correspondingly be influenced by violations of native language phoneme transitions. Obligatory phonological rules of the native language of a listener may be violated when listening to a nonnative language. The present study therefore sought to examine whether phoneme detection is sensitive to the violation of a native assimilation rule during processing of a nonnative language. Two closely related languages were chosen for investigation: Dutch and German. The distribution of the palatal fricative [ç] and the velar fricative [x] in standard German provided the phonological background. The two fricatives stand in near-complementary distribution in German: the velar fricative [x] occurs after back vowels, the palatal fricative [ç] after front vowels, glides, sonorant consonants, wordinitially and in the diminutive suffix *-chen* [3]. This distribution does not apply for standard Dutch, since the Dutch phoneme repertoire contains only the velar form of the fricative [x].

Two types of legal monosyllabic Dutch nonwords were examined. One type contained a front vowel followed by the velar fricative [x] in penultimate word position, the other type contained a back vowel followed by the velar fricative [x] in penultimate word position. Nonwords with back vowels, such as *bacht*, containing the phoneme string [ax] were correct realisations in standard Dutch and German. But in nonwords such as *becht*, the phoneme string [ex] violated the German fricative assimilation rule, in that a front vowel is followed by the velar fricative [x]. A phoneme detection task was used [4]. In two separate experiments, Dutch and German listeners were presented with the Dutch material. Their task was to detect the target fricative [x] in the Dutch nonwords. The predictions were the following: if native violations influence processing of a nonnative language, the German listeners should be slower to detect [x] in the front-vowel contexts (illegal in German) than in the back-vowel contexts (legal in German), while Dutch listeners were predicted to show no difference between the two types of monosyllabic nonwords (both legal in Dutch).

## 2. EXPERIMENT 1

### 2.1. Subjects

Twenty four native speakers of Dutch, students of the university of Nijmegen, took part in the experiment. They were paid for their participation.

### 2.2. Materials and Procedure

28 monosyllabic items, nonwords in Dutch and German, were selected. All items ended with the velar fricative [x] followed by the plosive [t], having the syllable structure CVCC or CCVCC. With the help of the CELEX-database [5] they were checked for homophones. The items were matched with Dutch and German constraints on word construction, using phonemes that occur in both languages. The vowels used were [a], [o], [e] and [i]. 14 of the chosen nonwords contained the vowels [e] or [i], 14 more nonwords contained the vowels [a] or [o]. In addition 308 mono- and bisyllabic fillers were selected. 84 of the fillers contained the fricative [x] at different positions across the nonwords. 14 more representative practice items were created. Out of the remaining 336 items four pseudo-randomized lists were built, with the restriction that for at least two items before a target item, only fillers without the target fricative [x] were used.

All materials were recorded onto DAT tape in a sound-proof booth by a female native speaker of Dutch. The materials were transferred to a computer and measured using the Xwaves speech editor. The speech files were then transferred to the hard-disk of a personal computer, running the NESU experiment control software. Items were presented in the list orders, with D/A conversion direct from disk, and played over Sennheiser headphones. Subjects were tested in a sound-proof booth. They were instructed to listen to the Dutch nonwords and press the button in front of them with their preferred hand as fast as possible if they detected the target fricative [x] in one of the nonwords. The computer timed and stored RTs. Each subject heard the practice list followed by one of the four experimental lists. Prior to statistical analyses, RTs (originally measured from the onset of the items) were adjusted so as to measure from the onset of the target phoneme.

### 2.3. Results and Discussion

Mean RTs (from target onset) and mean error rates are given in Table 1. Missed responses and RTs outside the range of 100 to 1500 msec were treated as errors. Analyses of Variance (ANOVAs), with both subjects (F1) and items (F2) as the repeated measure were performed.

| Context | Front vowel (e.g., becht) | Back vowel (e.g., bacht) |
|---|---|---|
| Mean | 539 | 531 |
| Error rate | 1.4% | 2.1% |

**Table 1**. Mean RTs (msec) and mean error rates for responses of Dutch subjects to the penultimate velar fricative [x] after back or front vowels.

For the Dutch subjects, performing the task of native listening, no phonological violation was included in the material. In accordance with that they showed no difference in their RTs between the two types of monosyllabic nonwords. Whether a front vowel or a back vowel preceded the target fricative [x] made a difference of only 8 msec in the mean RTs. This effect was, as expected, neither significant by subjects nor by items (F1 & F2<1). The low percentage of errors indicates that subjects had no problems detecting the target phoneme [x] in the two types of nonwords. The small number of errors did not require an error analysis. In addition, an analysis of phoneme length was performed. It is possible that RTs might be influenced by differences in the length of the presented target phonemes, as length provides just a simple measure of acoustic difference between targets across contexts. The duration of the target phonemes was measured and the target phoneme [x] was on average 15 msec shorter after the front vowels [i] and [e], with an average length of 178 msec, than after the back vowels [o] and [a], with the average length of 193 msec ($t(13) = 2.1$, $p > 0.05$).

Experiment 2 tested how German listeners reacted to the two types of Dutch nonwords when detecting the target phoneme [x], since for them violation of the German fricative assimilation rule was involved in items containing a front vowel.

## 3. EXPERIMENT 2

### 3.1. Subjects

Twenty four students of the university of Regensburg were paid to take part in the experiment. They were all native speakers of German and had no knowledge of Dutch.

### 3.2. Materials and Procedure

The same Dutch materials, the same lists and the same procedure as described in Experiment 1 were used.

### 3.3. Results and Discussion

Mean RTs (from target onset) and mean error rates are given in Table 2. Missed responses and RTs outside the range of 100 to 1500 msec were treated as errors. The RTs of the German listeners were 498 msec to nonwords containing a back vowel and 470 msec to nonwords containing a front vowel. Thus German subjects detected the fricative [x] 28 msec *faster* when the German fricative assimilation was violated than when no violation occurred. ANOVAs were again performed. The difference in the RTs was significant by subjects, $F1(1,23) = 4.8$, $p < 0.05$. By items, however, the effect did not reach significance, $F2(1,26) = 3.0$, $0.05 < p < 0.1$. Again, the low percentage of errors indicates that the subjects had no problems performing the task. No error analysis was performed.

| Context | Front vowel (e.g., becht) | Back vowel (e.g., bacht) |
|---|---|---|
| Mean | 470 | 498 |
| Error rate | 1.1% | 0.8% |

**Table 2**. Mean RTs (msec) and mean error rates for responses of German subjects to the penultimate velar fricative [x] after back or front vowels.

The results of Experiment 2 indicate that the violation of a native assimilation rule does influence the process of listening to a nonnative language. Whereas in earlier studies violation of an assimilation rule resulted in slower RTs [1,2], RTs in Experiment 2 were faster to items containing such violation. It seems that the target phoneme occurring in an illegal position for German listeners "popped out" and actually speeded up the detection.

Since RTs of German listeners were faster than those of Dutch listeners, a posthoc analysis was performed to check for the presence of interaction effects of language and context. In an overall ANOVA no effect for language or context was significant by subjects and items, but the interaction effect was marginally significant by subjects and items ($F1(1,46) = 3.7$, $0.05 < p < 0.1$; $F2(1,26) = 3.3$, $0.05 < p < 0.1$). A t-test showed that Dutch listeners' reactions to the fricative [x] after a front vowel were significantly slower than German listeners' reactions ($t1(46) = 2.3$, $p < 0.05$; $t2(13) = 5.8$, $p < 0.001$). The difference in reactions to the fricative [x] after a front vowel may be due to the fact that those items contain phonological violation for the German listeners. After a back vowel no significant difference was found between the subject groups ($t1(46) = 0.9$, $p > 0.1$; $t2(13) = 2.1$, $0.05 < p < 0.1$).

## 4. CONCLUSION

The present study builds on previous work on language-specific listening. Earlier studies have already reported evidence that the process of listening in a nonnative language is influenced by the native language of the listener [2,6,7]. French listeners show sensitivity to syllabic structure not only in their native language, but also when listening to English, whereas English listeners do not show that sensitivity, neither when listening to their native language, nor when listening to French [6]. Japanese listeners are sensitive to the violation of an obligatory assimilation rule for Japanese, whereas Dutch listeners, for whom the same rule is only optional, presented with these Japanese materials, show no difference between assimilated and rule-violated cases [2]. The results of the present study are a confirmation of previous findings in the sense that the process of listening is language-specific. They add new conclusions about the effect of violation of native assimilation rules on the process of nonnative listening in the sense that violation does not necessarily result in slower RTs but can cause faster RTs than lawfully assimilated phonemes.

The findings can not be generalized for all nonnative consonants, since the degree of difficulty in processing nonnative languages varies across contrasts and languages [8]. All phonemes which were used in the items of Experiment 1 and 2, including the target phoneme [x], belong to the phoneme repertoires of the native and the nonnative listeners. Response times might show different patterns for processing, however, if listeners have to detect a phoneme that does not belong to their native language phoneme repertoire, but still violates a native phonological rule (e.g., the phoneme does not assimilate place of articulation as required in the native language of the listener).

There are three possible explanations for the counterintuitive finding of Experiment 2. The results might be due to the fact that the German listeners were listening to a nonnative language. The effect of violation of a native assimilation rule might be the reverse when listening to a nonnative language than when listening to native language. When the Dutch listeners were listening to Japanese materials in the experiments of Otake et al. no violation of a native assimilation rule was involved for them, so it can still be that violation of assimilation speeds up detection in nonnative listening. The second explanation for the finding of Experiment 2 could be found in the nature of the tested assimilation rule. The fricative assimilation rule of German is a progressive assimilation rule. Previously only regressive assimilation rules had been tested. The fact that a rule works forward and not backwards might cause different patterns in processing. Third, the present study explored an assimilation rule which applies within syllables. Other studies tested at least across syllable boundaries. These three possible explanations are currently being tested in further experiments.

## 5. REFERENCES

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