

# Native dialect matters: Perceptual assimilation of Dutch vowels by Czech listeners

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**Abstract:** Naive listeners' perceptual assimilations of non-native vowels to first-language (L1) categories can predict difficulties in the acquisition of second-language vowel systems. This study demonstrates that listeners having two slightly different dialects as their L1s can differ in the perception of foreign vowels. Specifically, the study shows that Bohemian Czech and Moravian Czech listeners assimilate Dutch high front vowels differently to L1 categories. Consequently, the listeners are predicted to follow different paths in acquiring these Dutch vowels. These findings underscore the importance of carefully considering the specific dialect background of participants in foreign- and second-language speech perception studies.

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## 1. Introduction

An ever-growing body of research has shown that adult second-language (L2) learners often have difficulties acquiring sounds of the L2. It is well known that a major contributing factor to these difficulties is learners' experience with their native language (L1) (e.g., [Flege et al., 1997](#)). Several models have been proposed that aim to explain how the L1 sound system constrains learners' perception and/or production of L2 sounds. For example, the Speech Learning Model proposed by [Flege \(1995\)](#) has as its starting point learners' perception of (dis)similarity of L2 sounds to the closest L1 sounds. According to the Perceptual Assimilation Model (PAM) ([Best, 1995](#); extended to L2 in [Best and Tyler, 2007](#)), cross-language assimilation patterns, i.e., the way non-native sounds are perceived in terms of listeners' native categories, can predict L2 perception. PAM predicts that non-native sounds perceived as (equally good) examples of a single native category will turn out to be (the most) difficult L2 contrasts for L2 learners to acquire. The Second Language Linguistic Perception model (L2LP) ([Escudero, 2005](#)) also regards cross-language perception as a predictor of L2 perception. If a listener's L1 has fewer categories than the non-native language, both PAM and L2LP predict single-category assimilations, i.e., perception of different non-native categories via a *single* L1 category. If the reverse is true, i.e., the non-native language exhibits fewer categories than the L1, two- or multiple-category assimilations are predicted, i.e., perception of different non-native categories via *different* L1 categories. The L2LP states that the L1 system is copied at the start of L2 learning and various scenarios may occur during acquisition that adjust this copied L1 sound system to become more similar to the L2 system. For single-category assimilations, L2 learners

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have to either split their (copied) L1 category or create a new one; for two-category assimilations, learners have to shift their perceptual boundary, which is, according to L2LP, a less demanding task than splitting or creating a new category (Escudero, 2005). Experimental research has indeed demonstrated that *cross-language* assimilation patterns can be a useful predictor of *second-language* perception (e.g., Guion *et al.*, 2000; Mayr and Escudero, 2010). Hence, several recent studies have investigated naive listeners' perception of non-native vowels in order to predict the initial stage of L2 development (Gilichinskaya and Strange, 2010; Escudero and Chládková, 2010; Escudero and Williams, 2011).

Varieties of one language (even those with the same phonemic inventories) can differ both in how speech sounds are produced phonetically and in how they are perceived. For this reason, several studies have been carried out to investigate the effects of L2 variety in L2 speech perception. For instance, Escudero and Boersma (2004) showed that Spanish learners of Scottish English will, at the beginning of their L2 development, have more difficulty perceiving the /i:r-/ contrast than Spanish learners of Southern British English because these two vowels are not contrasted by duration in Scottish English. Baker and Smith (2010) showed that English learners of Québec French differ from English learners of European French in how accurately they can discriminate the French /i-y-u/ contrast.

Importantly, while learners of different L2 varieties have some different perceptual assimilation patterns, it is also likely that the specific dialect of the listener's L1 may affect foreign-language or L2 perception. The L2LP states that *acoustic differences* between listeners' native languages and dialects predict *perceptual differences* (Escudero, 2005). However, previous studies that investigate foreign or L2 vowel perception have often pooled participants with different L1 varieties. For instance, Flege *et al.* (1997), as well as Morrison (2008), tested Spanish learners of English and pooled learners from Spain and various Latin American countries. Similarly, Russian and Spanish listeners from different Russian- and Spanish-speaking countries, respectively, were pooled in a cross-language perception experiment reported in Kondaurova and Francis (2008). Not taking into account learners' specific L1 dialect background could have obscured possible systematic differences between learners. In the present study, we examine whether speakers of two only slightly different varieties of the same language, all of whom have experience with both varieties, will exhibit variety-specific assimilation patterns that could result in different difficulties in acquiring the L2 vowel system. Specifically, we tested the cross-language perception of Dutch vowels by speakers of two different varieties of Czech.

The present study focuses on the dialect of Dutch spoken in the western part of the Netherlands (Gussenhoven, 1992). This variety of Dutch has 12 monophthongal vowels /i i e y ø: a: α o: ɔ u/ which are differentiated by their spectral properties. The vowels /i i e y α ɔ u/ are phonetically short, and the vowels /e: ø: o:/ are long. While 9 of the 12 Dutch monophthongs can be described in terms of their steady-state spectral properties, the three Dutch monophthongs /e: ø: o:/ are characterized by a degree of formant movement (Adank *et al.*, 2004). The Czech Republic is linguistically a relatively homogeneous country with two major dialectal areas: the western part of the country (Bohemia) and the eastern part (Moravia). Both the Czech spoken in Bohemia and the Czech spoken in Moravia have ten monophthongal vowels, five short vowels /i e a o u/ and five long vowels /i: e: a: o: u:/. The short-long counterparts share similar spectral properties and are distinguished primarily by duration (Dankovičová, 1997). One exception is the high front vowel contrast /i:r-/, which in Bohemia is distinguished perceptually more by a spectral difference and somewhat less by a smaller durational difference than in Moravia (Podlipský *et al.*, 2009).

We expect that Bohemian and Moravian listeners' perception of the Dutch vowels will generally be similar in that most cross-language assimilation patterns will largely be based on duration. Unlike Czech, which uses duration as a primary cue for vowel identity, Dutch long and short vowels are largely differentiated by spectral properties. It is therefore expected that some Dutch vowels will be perceived in terms of the

spectrally closest Czech category with duration of the Dutch stimulus being a predictor of whether it maps onto the short or the long member of a Czech vowel pair. Specifically, Czech has fewer vowel phonemes than Dutch in the non-low non-back vowel region (four as opposed to seven). In line with the predictions of PAM and L2LP, a number of single-category assimilations can therefore be expected for vowels in this region. We expect the following specific difference between Bohemian and Moravian perceptual assimilation patterns. As noted above, Moravians, but not Bohemians, favor the durational difference over the spectral difference when perceiving the Czech /i:-ɪ/ contrast. Since the Dutch /i-ɪ/ contrast is realized solely by spectral properties, Moravian listeners are expected to assimilate both of these phonetically short non-native vowels to a single native category, namely /ɪ/, whereas Bohemian listeners are more likely to perceive this Dutch vowel contrast in terms of two native categories, namely, /i:/ and /ɪ/.

## 2. Method

### 2.1 Participants

The participants were 41 speakers of Czech; 19 were speakers of Bohemian Czech (BC) and 22 speakers of Moravian Czech (MC). The BC participants were 5 males and 14 females, aged 20–33 (mean = 22.8), and the MC participants were 7 males and 15 females, aged 20–35 (mean = 23.6). The participants were university students or recent graduates and had no knowledge of or previous exposure to Dutch. They were raised in monolingual settings and had never spent more than a month in a foreign country. All participants had frequent exposure to the other dialect: the BC listeners were exposed to MC because they had been studying at a university in Moravia, and the MC listeners were exposed to BC through media and contact with BC classmates.

### 2.2 Stimuli

Stimuli were recorded by a female and a male native speaker of Dutch from the western “Randstad” area of the Netherlands who were 22 and 23 years old, respectively. The speakers read sentences presented visually as *Hoor je hVb*. “You hear hVb”, where V was one of the 12 Dutch monophthongs. The 12 different phrases were randomized and repeated five times. The recordings were made in a sound-treated room with a Marantz PDM671 recorder (44.1 kHz sampling rate, 16 bits quantization) and a head-mounted microphone Samson QV. The whole *hVb* monosyllables served as stimuli in the subsequent perception experiment. Per speaker, we selected four repetitions of each of the 12 different hVb monosyllables to yield a total of 96 tokens. Figure 1 plots the Dutch vowels and compares them to Czech vowels recorded in Chládková *et al.* (2009).

The *hVb* context is phonotactically possible in both Czech and Dutch. To make the task as natural as possible, we tested identification of monosyllables rather than isolated vowels, since in Czech isolated vowels rarely form a word on their own. Importantly, the flanking consonants have similar productions in Czech and Dutch, i.e., the word-initial glottal fricative is voiced [ɦ], and the word-final bilabial plosive is realized as voiceless [p], which minimized the foreign nature of the stimuli for the Czech listeners.

### 2.3 Procedure

The experiment consisted of a multiple forced-choice identification task. The 96 monosyllables were presented in a random order. Participants were tested via circumaural headphones in a quiet room. On each trial, participants had to identify a stimulus as one of ten hVb nonsense words displayed in Czech orthography on a computer screen. Prior to testing, the experimenter (a native Czech speaker) instructed the participants that they would hear nonsense but possible Czech nouns spoken by a Czech man and a woman and upon hearing each word they had to choose which of the ten words it was. The experiment was preceded by a short practice round containing a subset of 24

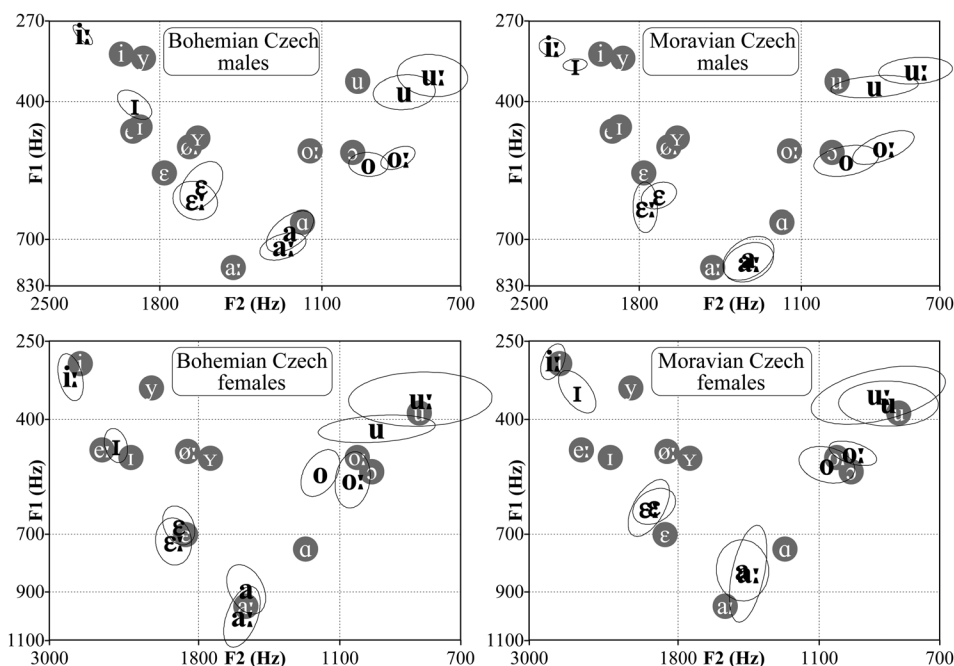


Fig. 1. Average F1 and F2 values of the Dutch vowel stimuli from the present study (white symbols in gray circles, male values in top panels, female values in bottom panels), and F1 and F2 of Czech vowels (black symbols, ellipses show 1 standard deviation from the mean (data from Chládková et al. 2009).

stimuli, in which each intended vowel category was presented once for both the female and the male voice. The purpose of the practice round was to familiarize participants with the task and the nature of the stimuli.

### 3. Results and discussion

Responses split by Dutch vowel category are reported as mean percentages in Table 1. Table 1 suggests that BC and MC listeners assimilated the majority of Dutch vowels to L1 categories in similar ways. To find out whether there are differences between

Table 1. Perception of Dutch vowels by naive Czech listeners split by L1 dialect.<sup>a</sup>

label	Bohemian Czech response percentages												Moravian Czech response percentages											
	i	ɪ	e:	ɛ	y	ʏ	ø:	a:	ɑ	ɔ	o:	u	i	ɪ	e:	ɛ	y	ʏ	ø:	a:	ɑ	ɔ	o:	u
i:	62	-	-	-	24	-	-	-	-	-	-	-	34	-	-	-	18	-	-	-	-	-	-	-
ɪ	38	61	-	-	51	18	-	-	-	-	-	-	66	55	-	-	66	15	-	-	-	-	-	-
e:	-	-	70	11	-	11	49	-	-	-	-	-	-	8	66	8	-	13	45	-	-	-	-	-
ɛ	-	35	23	87	-	47	14	-	-	-	-	-	34	27	88	-	49	21	-	-	-	-	-	-
a:	-	-	-	-	-	-	-	78	5	-	-	-	-	-	-	-	-	-	74	9	-	-	-	-
a	-	-	-	-	-	-	-	21	78	-	-	-	-	-	-	-	-	-	26	67	-	-	-	-
o:	-	-	-	-	-	-	25	-	-	13	74	-	-	-	-	-	-	17	-	-	15	71	-	-
o	-	-	-	-	-	7	7	-	16	87	24	-	-	-	-	-	-	6	-	20	82	27	-	-
u:	-	-	-	-	20	-	-	-	-	-	-	18	-	-	-	-	9	-	6	-	-	-	-	15
u	-	-	-	-	5	16	-	-	-	-	-	82	-	-	-	-	6	15	-	-	-	-	-	84

<sup>a</sup>Columns represent the 12 Dutch stimulus categories, rows represent the 10 Czech response categories; each cell shows how often on average (in %) each label was used for each stimulus. Responses below 5% are not displayed.

MC and BC responses to the 12 Dutch stimuli, we carried out paired *t*-tests on all the possible stimulus-response pairings. For each stimulus category we tallied the number of responses. Given that participants were presented with eight tokens for each Dutch vowel category (i.e., 4 tokens  $\times$  2 speakers), the range of possible values for each possible stimulus-label combination was 0 to 8. We then compared the responses of MC listeners to those of BC listeners. Since there were mostly two relevant response labels for each of the 12 stimuli, we performed a Bonferroni correction for the multiple comparisons and thus tested at a significance level of 0.002 [ $\alpha = 0.05/(2 \times 12)$ ].

We will first discuss perceptual mappings of those Dutch vowels for which the tests did not reveal a significant effect of dialect as they still serve as interesting predictors of L2 perception. As expected, the results show several single-category assimilations in the non-low non-back vowel region. Even though the Dutch mid-high front vowel /i/ was perceived more than 50% of the time as the Czech short high front vowel /ɪ/, it and the Dutch rounded vowel /y/ were also perceived more than a third of the time as the Czech mid-low vowel /ɛ/. The Dutch mid-low vowel /ɛ/ was also perceived as the Czech vowel /ɛ/ but to a far greater extent (more than 85% of the time) than either Dutch /i/ or /y/. This labeling of Dutch /ɛ-ɪ-y/ suggests that learners may have some difficulties perceiving this Dutch three-way contrast. However, Dutch /y/ was about one-sixth of the time identified as the Czech high back vowel /u/, which suggests that Czech listeners do perceive the rounding difference between the Dutch /y/ and /i/. The results further show that the Dutch non-back vowels /ɛ:/ and /ø:/ were perceived as a single Czech category, namely /ɛ:/. Interestingly, the non-back rounded vowel /ø:/ was in approximately one-quarter of the cases mapped onto the Czech back rounded vowel /o:/ as well. Thus listeners do perceive the rounding in /ø:/. The perceptual split of Dutch /ø:/ between the Czech front unrounded vowel /ɛ:/ and the back rounded vowel /o:/ implies that this non-native vowel is indeed perceived as different from either of the Czech vowels.

As for the remaining vowels, the Dutch mid-low back vowel /ɑ/ and the Dutch low central vowel /a:/ were mostly perceived as the Czech low central vowels /a/ and /a:/, respectively. However, Dutch /a:/ was not mapped exclusively onto Czech /a:/, as it was sometimes perceived as Czech /a/. Similarly, Dutch /ɑ/ was sometimes perceived as Czech /o/, which suggests that Czech listeners can perceive the spectral difference between Dutch /ɑ/ and /a:/. Dutch /ɔ/ was almost exclusively heard as Czech /o/, while Dutch /u/ was perceived as Czech /u/ or /u:/. These assimilation patterns suggest that learners could re-use their native /o/ category and the spectral /u-u:/ region to correctly perceive the Dutch vowels /ɔ/ and /u/, while they will probably have to follow a more complicated scenario for the /ɑ-a:/ contrast: they will either have to create a new spectral category for Dutch /ɑ/, or split their copied L1 /a a:/ category.

We will now report on the differences between MC and BC responses. The statistical analyses revealed that there is a significant difference between BC and MC responses for the stimulus /i/;  $t[39] = 5.506$ ,  $p = 2.6 \times 10^{-6}$  (two-tailed). Inspection of the data shows that this stimulus was labeled more often as Czech /i:/ by BC listeners and as Czech /ɪ/ by MC listeners. BC listeners used the label /i:/ for this stimulus 61.8% of the time [the 95% confidence interval (c.i.) for this mean value is 53%–70.7%]. On the other hand, MC listeners used the label /i:/ for this stimulus only 34.4% of the time (95% c.i. = 28.4 – 40.3), meaning the difference between the two groups is 27.5 (95% c.i. of the mean difference = 17.4 – 37.6). That is, when hearing Dutch /i/, BC listeners used the label /i:/ 27.5% more often than MC listeners, who in turn used the label /ɪ/ more often. No other stimulus-response pairing yields a significant between-group difference at the 0.002 level. As was noted in the introduction, MC and BC listeners weight durational and spectral cues to the Czech /i:/-/ɪ/ contrast differently: MC but not BC listeners use duration as the primary cue to this contrast. This explains why BC and MC listeners of the present study differ in how they perceive the Dutch high front vowel. As the Dutch vowel /i/ is short it assimilated to the Czech /ɪ/ category for the MC listeners, while for BC listeners a high but short Dutch

/i/ could be accepted as a “long” Czech /i:/. In this way, BC listeners’ perception of the Dutch /i-ɪ/ contrast more closely resembles a Dutch listener’s perception of this contrast in the sense that BC listeners mostly assimilated this two-way non-native contrast to their *two-way* Czech contrast /i:-ɪ/, while MC listeners perceived the two Dutch vowels /i-ɪ/ mainly in terms of a *single* native category /ɪ/. The L2LP model (see Sec. I) predicts that MC learners of Dutch will face greater difficulty learning the Dutch /i-ɪ/ contrast than their BC neighbors. In order to successfully acquire the Dutch /i-ɪ/ contrast, BC learners can re-use their existing high vs mid-high spectral boundary and will only have to lower their (already relatively low) reliance on duration for this contrast, whereas MC learners will have to create a new spectral vowel category, namely a mid-high category.

In the high vowel region, Dutch and Czech both exhibit front unrounded and back rounded vowel categories. In the same vowel region, Dutch also has a front rounded vowel category, which Czech lacks, namely /y/. Czech listeners may therefore perceive the Dutch high front rounded vowel /y/ as either a front unrounded L1 vowel (/i:/ or /ɪ/) or a back rounded L1 vowel (/u:/ or /u/). Indeed, Table 1 shows that the stimulus /y/ was given four possible response labels by both groups of listeners, namely, /i:/, /ɪ/, /u:/, and /u/. To investigate whether an L1 dialect difference similar to that revealed for the front unrounded vowel /i/ could also be found for the front rounded vowel, we performed a further statistical analysis. This subsequent analysis was aimed at addressing a more specific question, namely, whether in the high vowel region BC and MC differ in their use of long-vowel vs short-vowel labels for the Dutch stimuli (recall from Sec. I that BC and MC listeners differ in their use of duration as a cue to the short–long contrast in Czech high front vowels). Since the Dutch high front rounded vowel /y/ assimilated to both back and front vowels in Czech, for each group we summed all /i:/ and /u:/ responses (i.e., long-vowel labels; 44% for BC and 27% for MC), and all /ɪ/ and /u/ responses (i.e., short-vowel labels; 56% for BC and 72% for MC). We ran three separate paired *t*-tests on the percentage of long responses and on the percentage of short responses, one for the stimulus /y/, one for /i/, and one for /u/. This testing used a Bonferroni corrected  $\alpha$  of 0.017 (0.05/3). The analyses reveal that BC differ from MC in their use of the long labels not only for the stimulus /i/ (the same finding as above), but also for /y/ ( $t[39]=2.459$ ,  $p=0.009$ ). For Dutch /y/, BC listeners chose the long responses, /i:/ or /u:/, 17.5% more often than MC listeners (c.i. = 3.1%–31.8%). This result reflects the fact that, just as with the Dutch /i-ɪ/ contrast, MC listeners mostly assimilated both vowels /y-ɻ/ to a short Czech vowel, /ɪ/ or /u/, while BC listeners perceived /y/ in nearly half of the cases as a long Czech vowel, /i:/ or /u:/. On the basis of L2LP, and on the assumption that both BC and MC acquire the contrast between front rounded and front unrounded vowels, BC learners are once more predicted to have less difficulties with the Dutch /y-ɻ/ contrast than MC learners.

#### 4. Conclusions

This study demonstrates that slight differences between listeners’ L1 dialects affected cross-language perceptual assimilation of some foreign vowel contrasts. This finding supports the L2LP (Escudero, 2005) according to which acoustic differences between listeners’ native languages and dialects predict perceptual differences. In the present study, the between-dialect differences in the acoustic dimensions that signal the L1 Czech short–long contrast in high front vowels led to different perceptual assimilation patterns in the non-native Dutch high front vowel region. Bohemian Czech listeners differed from Moravian Czech listeners in how the Dutch /i-ɪ/ and /y-ɻ/ contrasts were perceived in terms of L1 categories. As a result, Bohemian and Moravian Czech individuals are predicted to follow different learning paths when acquiring Dutch as an L2.

The present findings have implications for future studies. Although it may seem to be a trivial requirement, it is by no means standard practice in cross-language and L2 speech perception studies to consider not only L1, but also L1 dialect as a

factor affecting listeners' performance. Our results demonstrate that even slight acoustic, and hence also perceptual, differences between listeners' native dialects can surface in cross-language perception. Future cross-language perception studies should avoid grouping participants with different L1-dialect backgrounds. If such grouping is used in L2 perception studies, it should first be assessed whether potential L1-dialect differences do not lead to baseline differences in cross-language perception, which could in turn lead to dialect-dependent differences in L2 speech acquisition.

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