

English learners' perception of Czech palatal stops in high-front vs. other vowel contexts

Kateřina Braunov

The present study is focused on the perception of palatal stops /c/ and /j/ by native English learners of Czech. Palatal stops are a new category for them, therefore their perception could be difficult. However, their perception could be also influenced by their context. Palatal stops could be more difficult to perceive if followed or preceded by high-front vowels /ɪ/ or /i/ than by other vowels (suggested by some findings by Atkey, 2001). The hypotheses were tested on a group of 12 native English speakers and a control group of 14 native Czech speakers by means of Forced Choice Phoneme Selection task. L1 English speakers did not have major problems with the perception of palatals in context of different preceding vowels. However, they had problems with the perception of palatals in context of different following vowels. They had problems with the perception of both voiced and voiceless palatals followed by high-front vowels.

Key words: *high-front vowels, non-native contrast, palatal stops, perception*

1 Introduction

The present study deals with the perception of Czech palatal stops by native English learners. They can have problems with their perception since they do not have them in their phonemic inventory.

Before I proceed to the description of palatal stops I will first introduce abbreviations used in my paper. English learners when acquiring a second language (L2) in this case Czech, which is called target language, have already knowledge of their native language grammar, which is called the first language (L1). In my paper I will therefore use the following abbreviations: L1en for their native language and I will refer to them as to L1en speakers and to native Czech speakers as to L1cz speakers.

The palatal stops /c j/ are oral stops which means that from the articulatory point of view they are characterised by creation of complete closure of the airflow in the vocal tract and its sudden release which is followed by a burst of noise. The closure during their production (see Figure 1) is made by the tongue blade, which is raised towards the hard palate. Moreover, the tip of the tongue is leaning against the lower teeth (incisors), which enables to raise the tongue blade toward the palate. The palatal stop /j/ is produced at the same place like /c/ but unlike /c/ the vocal cords are vibrating during its production (see Petr 1986, 44).

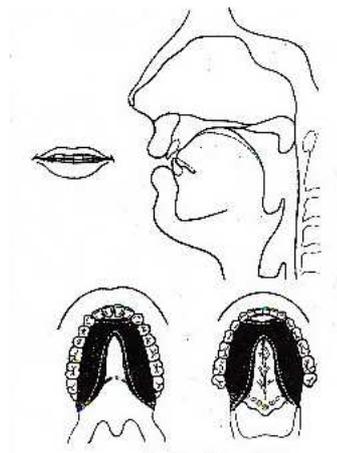


Figure 1:
Articulation of Czech palatal stops /c/ and /ɟ/ (adapted from Hála 1975, 183)

The duration of palatal stops is very variable. It depends on the position and quality of surrounding vowels. The following values are average values for palatals in the intervocalic position as measured by Machač (2006). The voiceless palatal stop /c/ has the constriction interval about 65 ms long and the voiced /ɟ/ shorter (about 49 ms) (Machač 2006, 36).

Czech palatal stops are also characterised by the longest duration of burst from all Czech consonants. The average time of burst for /c/ is 46 ms and for /ɟ/ 25 ms (see Machač 2006, 36).

The burst of palatal stops is very specific, which is due to their production. Creating a closure of /c/ involves movement of the largest part of the tongue. The tongue blade is raised to touch the hard palate, making the contact area the most extended from all articulatory movements there are. During the release of the closure there is a long and low gap between the hard palate and the tongue through which the air escapes during the burst. The shape of the gap may cause rapid flow of air and turbulences, marked in the spectrum as higher frequency noise.

The formant transitions for palatals are, except for F1, usually falling. The locus for F2 is very high, around 2.5 kHz (Palková 1994, 225). When followed or preceded by high-front vowels, which have high F2 (average values are between 2.1 - 2.8 kHz) there are going to be virtually no CV formant transitions (see Figure 2) because the locus of /c/ for F2 is in the same place as F2 of /ɪ/. However, when a palatal stop is followed e.g. by /a/ which has middle values of F2 (average values are between 1.1 - 1.5 kHz) there are falling F2 formant transitions (see Figure 3) so the palatal stops should be distinguished more easily.

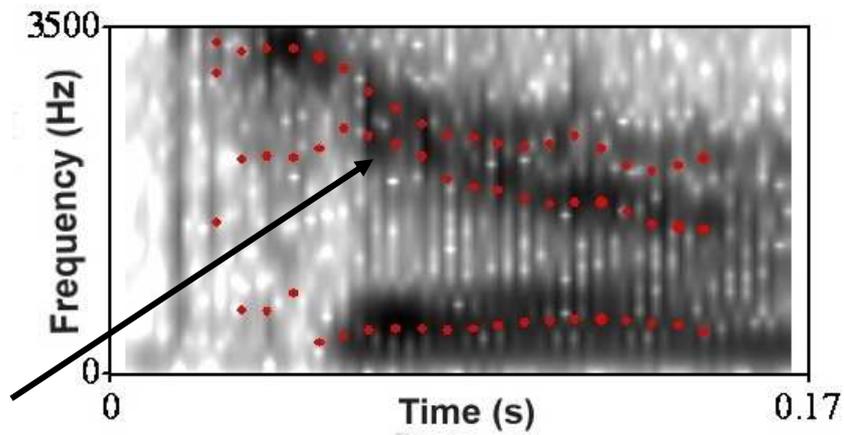


Figure 2:
Spectrogram of syllable **[ca]** from word **[cafo]** as pronounced by a native female speaker of Czech; the arrow points to F2.

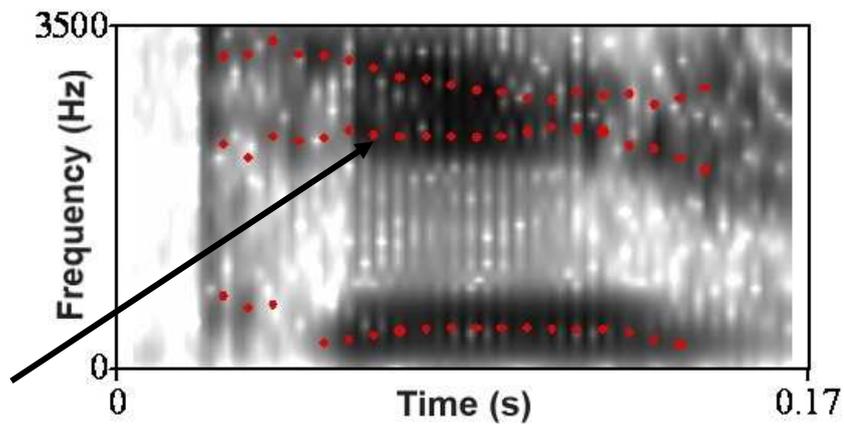


Figure 3:
Spectrogram of syllable **[ci]** from word **[cifo]** as pronounced by a native female speaker of Czech; the arrow points to F2.

2 Hypotheses

The hypotheses for my study are the following. The first of them is that for English learners of Czech, palatal stops are more difficult to perceive than alveolar or velar stops because they are a new category for them.

However, the perception of palatal stops could also be possibly influenced by their context: by preceding or following vowels. For English learners of Czech, palatal stops could be more difficult to perceive if followed or preceded by high-front vowel /ɪ/ or /i:/ than by other vowels (as suggested by some findings by Atkey, 2001) because the locus of /c/ of second-formant C-V transitions is in the same place as F2 of /ɪ/, therefore there are not going to be any large and audible C-V formant transitions.

3 Methodology

3.1 Subjects

The present study tested the hypotheses on a group of twelve native speakers of American English (L1en speakers) between 20 and 46 years of age who self-reported normal-hearing (except for Subject 6 who reported problems with one ear). All subjects had English speaking parents and were born in the USA. They lived in the Czech Republic for a longer period of time though the length of their exposure to Czech was not the same. It ranged from one year and two months to twenty years.

All subjects lived in the Czech Republic, but they used Czech in different situations and had different motivation to learn Czech. Some of them worked in the Czech Republic as missionaries; they used Czech for their work and therefore needed to speak Czech in the most-native sounding way. A few of them reported that they used Czech minimally, only in some situations, when speaking with Czech friends and for a basic public communication. Others were working there as university teachers, and used Czech in various situations in family and in public places.

Some of the subjects attended Czech language courses either before or after their arrival to the Czech Republic.

In the perception experiment a control group of fourteen native Czech speakers was also included. The L1cz speakers were students at Palacký University Olomouc, they were between 22 and 29 years of age and all self-reported normal-hearing.

3.2 Stimuli

Both groups of subjects identified the tested segments /t/, /d/, /c/, /ʃ/, /k/ or /g/ in the Forced Choice Phoneme Selection (FCPS) task. The task consisted of 250 disyllabic nonsense words stimuli, which resembled real Czech words as little as possible. Each of the stimuli contained one of the tested segments /t/, /d/, /c/, /ʃ/, /k/ or /g/. (Velar stops were included in the perception experiment because it was supposed that L1en speakers could perceive a new category of palatal stops possibly as either alveolar stops or velar stops, because both categories are next to palatal stops.)

The tested segments occurred in the stimuli word initially, medially and finally; voiced stops /d/, /ʃ/ and /g/ were not in the word final position because in Czech they are subjects to final devoicing.

To test my hypothesis each of the tested segments in the word initial and medial position were followed, in case of word final stops preceded, by each vowel /a/, /ɛ/, /ɪ/, /o/, /u/; by both short and long vowel (in case of palatal stops followed by a vowel only word final palatals were analyzed, since in the FCPS task there were no stimuli in the word medial position preceded by high-front vowels). Examples of some stimuli in the FCPS task can be seen below in the Table 1.

word initial	[cɛfo]	[cɪfo]	[cafo]	[cofo]	[cufo]
stop	[cɛ:fo]	[ci:fo]	[ca:fo]	[co:fo]	[cu:fo]
word medial	[mudɛs]	[mudɪs]	[mudas]	[mudos]	[mudus]
stop	[mudɛ:s]	[mudi:s]	[muda:s]	[mudo:s]	[mudu:s]
word final	[sulɛk]	[sulɪk]	[sulak]	[sulok]	[suluk]
stop	[sulɛ:k]	[suli:k]	[sula:k]	[sulo:k]	[sulu:k]

Table 1: Examples of nonsense stimuli in the FCPS task.

The nonsense word stimuli were produced by two female native Czech speakers, students at Palacký University, age 22 and 26. Stimuli were edited and approximately half of the stimuli in the FCPS task were by one speaker and half by the other; both speakers were represented almost equally, with respect to tested segments and quality of vowels.

The stimuli in the FCPS task were presented in a random order and each of them was presented only once. Subjects could hear the stimulus twice because in the FCPS task there was a replay button.

3.3 Procedure

The FCPS task was presented on computers. The test was run in Praat. The subjects heard the stimuli over Sennheiser HD 202 headphones and on the computer screen they saw six response buttons, with labels *t*, *d*, *t'*, *d'*, *k* and *g* and were asked to click on the button according to which tested segment they heard in the stimuli.

Before the proper test began subjects were given instructions in Czech and there was a trial test to make subjects familiar with the procedure. There were six response buttons and a replay button in the trial test and the tested segments were in the word initial, medial and final position as in the FCPS task. Unlike in the proper test there were only 18 stimuli with tested segments and the stimuli were real Czech words; e.g. *ticho* [cɪxɔ] ‘silence’, *puk* [puk] ‘puck’ or *mladý* [mladi:] ‘young’.

Subjects were also told that the sound they heard in e.g. [pocɛfi:] is represented by the button with the label *t'* not to confuse the sound with its orthographical representation. The orthographic form of [pocɛfi:] is *poříší* so they might have clicked on the button with label *t*.

After the trial test subjects proceeded to the experiment. Between both tests and within the FCPS task there were breaks to avoid test fatigue.

4 Analysis of results

Results of the FCPS task were submitted to repeated measures ANOVA with one between-subject factor, L1 (Czech, English), and two within-subject factors, Place (alveolar, palatal, velar) and Voice (voiced, voiceless), which revealed that there was no significant effect of Voice and that there was also no significant interaction of Voice with other factors, therefore this factor was excluded from the analysis.

Repeated measures ANOVA with one between-subject factor L1 (Czech, English) and one within-subject factor Place (alveolar, palatal, velar) revealed that there was a significant interaction (can be seen on Figure 4) of Place and L1 [$F(2, 48) = 4.2107$, $p = .0207$].

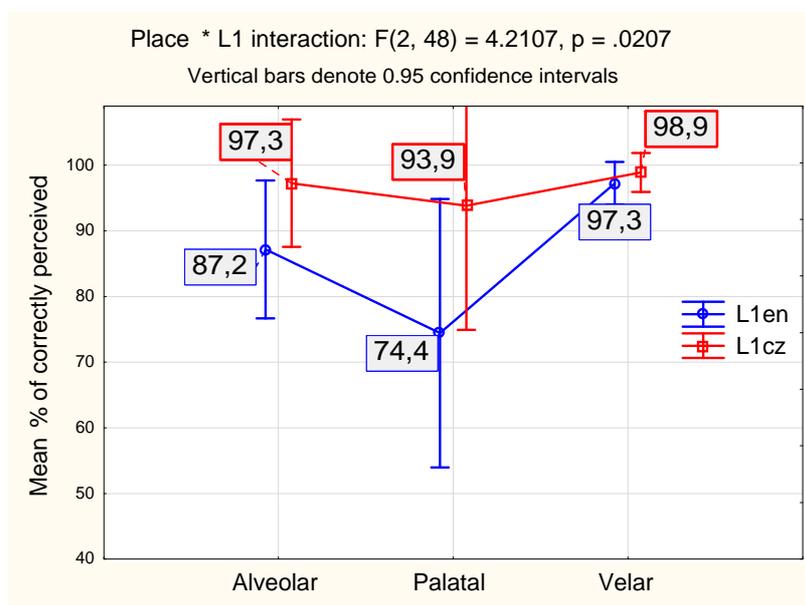


Figure 4:
Mean percentage of correctly perceived alveolar, palatal and velar stimuli followed by a vowel by L1en and L1cz speakers.

Tukey's *post hoc* test revealed that there was a significant difference between L1cz speakers' and L1en speakers' responses to palatal stimuli followed by a vowel and between L1en speakers' responses to palatal and velar stimuli followed by a vowel at $\alpha=0.01$. According to Tukey's *post hoc* test L1en speakers' responses to palatal stimuli did not differ significantly from their responses to alveolar stimuli followed by a vowel.

As I focused in this paper on perception of palatal stops by L1en learners of Czech, the following analysis will consider only palatal stops followed by a vowel.

The data for the L1en learners were submitted to repeated measures ANOVA with within-subject factors Following Vowel (high front, other) and Voice (voiceless, voiced), which revealed that the main effect of Voice was not significant ($p=.1635$). However, the main effect of Following Vowel was found to be significant [$F(1, 11) = 19.775$, $p = .0001$]. The L1en learners of Czech perceived correctly about 65% of palatals followed by high-front vowels and about 84% of palatals followed by other vowels and there was not any significant difference between L1en responses to voiced and voiceless palatal stimuli.

Repeated measures ANOVA with one between-subject factor L1 (Czech, English) and with one within-subject factor Following Vowel (high front, other) revealed no significant interaction of L1 and Following Vowel ($p = .1564$). There was not any significant difference between perception of L1cz and L1en speakers. This means that L1cz speakers had also problems with perception of palatals followed by high-front vowels.

Now I will concentrate on the perception of palatal stops preceded by vowels, as it was accounted for above, only on palatal stops in the word final position. To examine the perception of palatal stops preceded by a vowel, repeated measures ANOVA with between-subject factor L1 (Czech, English) and within-subject factor Place (alveolar, palatal, velar) were carried out which revealed a significant interaction (as can be seen in Figure 5) of Place and L1 [$F(2, 48) = 6.3877, p = .00347$].

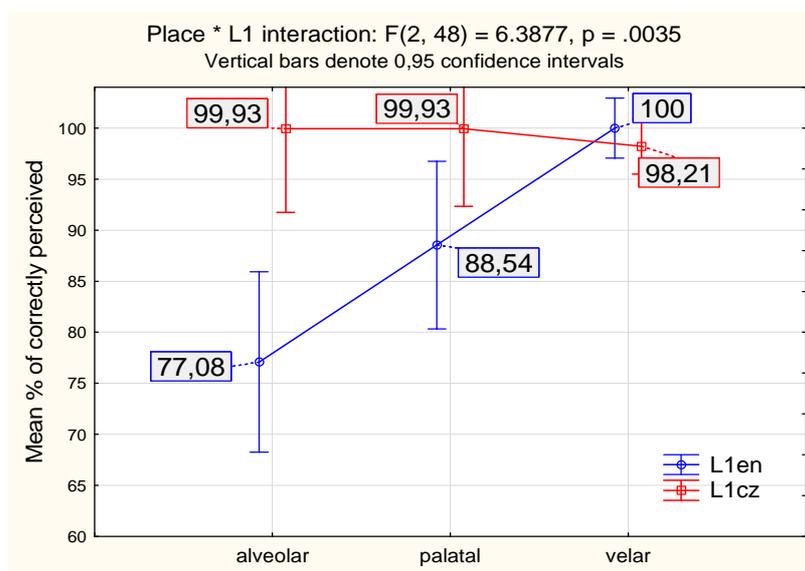


Figure 5:
Mean percentage of correctly perceived final alveolar, palatal and velar stimuli preceded by a vowel by L1en and L1cz speakers.

Tukey's *post hoc* test revealed that there was a significant difference between L1en speakers' and L1cz speakers' responses to alveolar stimuli preceded by a vowel and between L1en speakers' responses to alveolar and velar stimuli preceded by a vowel at $\alpha=0.01$. According to Tukey's *post hoc* test L1en learners' of Czech responses to palatal stimuli preceded by a vowel did not differ significantly from L1cz speakers' and they also did not differ from their responses to alveolar stimuli preceded by a vowel.

Repeated measures ANOVA with one within-subject factor Preceding Vowel (high front, other) indicated that L1en learners of Czech did not have any significant ($p = .6482$) problems with perception of palatal stops preceded by high-front vowels.

Repeated measures ANOVA with between-subject factor L1 (Czech, English) and with within-subject factor Preceding Vowel (high front, other) revealed that there was not any significant ($p = .6151$) interaction of L1 and Preceding Vowel. Neither group of speakers have any problems with the perception of palatal stops preceded by high-front vowels.

5 Conclusions

To summarize the findings of my research: the first hypothesis was not confirmed in its entirety. L1en learners of Czech had more problems than L1cz speakers with perception of palatal stops followed by vowels. However, according to *post hoc* Tukey's test there was

no significant difference between L1en speakers' responses to palatal and alveolar stimuli followed by vowels, there was a difference only between their responses to palatal and velar stimuli followed by a vowel.

Velar stops unlike palatal stops were for L1en learners of Czech an old established category and therefore they did not have problems with their perception. However, the category of palatal stops was probably confused with alveolar stops, therefore there was not a significant difference between their perception.

On the other hand, L1en learners of Czech did not have significant problems with word final palatals preceded by a vowel. Tukey's *post hoc* test revealed that there was not any significant difference between L1en and L1cz speakers' responses to this palatal stimuli preceded by a vowel. As in the case of consonants followed by a vowel, there was no significant difference between L1en speakers' responses to word final palatal and alveolar stimuli preceded by a vowel.

The second hypothesis was also only partly confirmed. L1en learners of Czech did not have problems with the perception of word final palatals preceded by high-front vowels. However, they perceived palatal stops significantly worse in the context of different following vowels. They had problems with the perception of both voiced and voiceless palatals followed by high-front vowels. In spite of the fact that voiceless palatal stops have stronger burst and so the speakers could possibly have less problems with their perception, the difference between the perception of voiceless and voiced palatal stops was not significant.

Results of the perception experiment suggests that the context could be also important for the perception of non-native contrast and that palatals followed by high-front vowels were perceived differently from word final palatals preceded by high-front vowels, they were probably identified by transitions into consonants.

The present paper brings up questions and suggestions for further research. It seems that there is a close link between the ability to perceive and produce non-native contrasts. According to a range of studies, the summary of them is in Llisterra (1995), it is supposed that perception precedes production and that second language learners are able to produce sounds they are able to categorize and distinguish perceptually.

Results of the perception experiment revealed that L1en learners of Czech could have problems with the perception of palatals in the context of high-front vowels. The production of palatal stops by L1en learners of Czech should be examined if they would be able to produce palatal stops and would produce better palatals followed by other vowels than palatals followed by high-front vowels.

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