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SEGMENTAL ADAPTATION OF POLISH VOICELESS AFFRICATES IN CC CONSONANT CLUSTERS BY NATIVE SPEAKERS OF ENGLISH

The article deals with the patterns of segmental adaptation of Polish voiceless affricates in initial and final CC (consonant + consonant) clusters by native speakers of English. The data have been collected in an online loanword adaptation experiment in which 30 native speakers of Southern British English reproduced Polish words containing such sequences. The major problem posed by the data is the divergent adaptation of the post-alveolar /t͡ʂ/ vs. the pre-palatal /t͡ɕ/, with the former substituted mainly with the coronal plosive [t] and the latter realised as the palato-alveolar affricate [t͡ʃ]. It is argued that these patterns of nativisation are due to the highly-ranked IDENT-IO[dist] constraint, which militates against the modification in the value of the feature [distributed]. Furthermore, it is demonstrated that the experimental results provide evidence in favour of the fundamental assumptions underlying the phonological approach to loan assimilation, namely the phonological input view as well as the faithful perception view.

Keywords: *Polish voiceless affricates*, *loanword adaptation*, *Optimality Theory*, *consonant clusters*

1. Introduction

Loanword adaptation is a highly complex phenomenon, shaped by a number of linguistic and extra-linguistic factors, such as the nature of the input to this process, the potential role of the borrowing community bilingualism as well as the influence of orthography (see e.g. Kang 2011 for an overview of the most important issues relevant to loan nativisation). In this light, it comes as no surprise that various theoretical approaches to this process have been proposed in the literature in order

to account for the mechanisms behind modifications in the sound structure of borrowings which result from the differences between the phonological systems of the source and the target language. The models under discussion attach different degrees of importance to factors such as the role of native phonological constraints or the role of perception in loan assimilation. A multitude of theoretical solutions proposed in the literature can be classified into three broad approaches. According to the phonological adaptation view, loan nativisation takes place in the phonological component of grammar (e.g. Itô and Mester 1995; Paradis and LaCharité 1997). On the other hand, the phonetic adaptation view assumes that the vast majority of sound modifications in loans occur during the perception stage (e.g. Boersma and Hamann 2009; Peperkamp et al. 2008). The phonetic-phonological adaptation view claims that both perception and phonology are active in processing loans to various degrees (e.g. Silverman 1992; Kang 2003).

This paper is intended as a contribution to this on-going loan nativisation debate. We report on an online loanword adaptation experiment in which 30 native speakers of Southern British English reproduced Polish words with initial and final CC (consonant + consonant) clusters disallowed in English. The major goal of the study has been to find out the most frequent repair strategies applied by native speakers of English in the nativisation of foreign phonotactic structures. The focus of the present paper is not, however, on phonotactics but on the patterns of segmental adaptation of Polish voiceless affricates (dental /t͡s/, post-alveolar /t͡ʂ/ and pre-palatal /t͡ɕ/) in initial and final CC consonant clusters.[1] The article sets itself both descriptive as well as theoretical goals. As regards the former, the major objective is to identify and present the main types of segmental modifications affecting the consonants in question in the process of adaptation as well as to provide a formal account of the data within the framework of Optimality Theory (OT) (Prince and Smolensky 1993/2004, McCarthy and Prince 1995). Furthermore, we would like to demonstrate some broader implications which arise from our data for the general theory of loanword adaptation as well as for the highly controversial issues of the input to loan nativisation and the role of perception in this process.

The article is organised as follows. The most important aspects of the experimental design, including the stimuli, the participants as well as the adopted procedure and the assumptions underlying data categorisation, are dealt with in Section 2. Section 3 is devoted to the presentation and description of the data. The central problem posed by the experimental results is the divergent adaptation of /t͡ʂ/ vs. /t͡ɕ/, with the former realised mainly as the coronal plosive [t] and the latter substituted with the palato-alveolar affricate [t͡ʃ]. In Section 4 the data are formally analysed within Optimality Theory. We argue

[1] We are not concerned with the clusters containing voiced affricates as the experimental stimuli contained only a handful of such sequences. This is because, as pointed out by Rocławski (1981), voiced affricates belong to the least frequent consonantal phonemes in Polish. A detailed account of the whole body of the experimental data can be found in Radomski (2019).

that the observed patterns of nativisation are mainly due to the highly-ranked IDENT-IO[dist] constraint, which prohibits the modification in the value of the feature [distributed]. Section 5 deals with the theoretical implications arising from the account presented in Section 4. It is argued that the experimental results lend support to the fundamental tenets of the phonological approach to loan assimilation, namely the phonological input view as well as the faithful perception view. Our main conclusions are provided in Section 6.

2. Experimental design

This section deals with the design of the experiment on the adaptation of Polish CC consonant clusters by native speakers of English. First, we focus on the experimental stimuli (Section 2.1) and next on the participants (Section 2.2). Finally, we briefly describe the adopted procedure and the assumptions underlying data categorisation (Section 2.3).

2.1. Stimuli

The stimuli used in the experiment comprised 103 authentic Polish words with CC consonant clusters of various structure, including

- 56 words with consonant clusters in word-initial position (48 monosyllabic words and 8 disyllabic words with initial stress),
- 37 words with consonant clusters in word-final position (all of them monosyllabic),
- 10 distractors (mono- and disyllabic Polish words with initial stress containing no segmental or phonotactic structures disallowed in English).

Since this paper is concerned with the segmental adaptation of Polish voiceless affricates, we will focus only on the consonant clusters containing these segments. Altogether, there are 22 experimental stimuli with such structures, including 8 with the dental affricate /t͡s/, 7 with the post-alveolar affricate /t͡ʂ/ and 7 with the pre-palatal affricate /t͡ɕ/. They are listed in (1).

(1) Experimental stimuli with CC consonant clusters containing voiceless affricates

clusters with the voiceless dental affricate /t͡s/

word-initial				word-final			
/#ft͡s/	*wcale*	/ft͡salɛ/	‘at all’	/ft͡s#/	*szewc*	/ʂɛft͡s/	‘a shoemaker’
/#t͡sw/	*cło*	/t͡swɔ/	‘a tariff’	/lt͡s#/	*walc*	/valt͡s/	‘waltz’
/#t͡sn/	*cnota*	/t͡snɔta/	‘a virtue’	/nt͡s#/	*glanc*	/glant͡s/	‘lustre’
/#t͡sf/	*cwał*	/t͡sfaw/	‘gallop’	/t͡sk#/	*Kock*	/kɔt͡sk/	‘a town name’

clusters with the voiceless post-alveolar affricate /t͡ʂ/

word-initial				word-final			
/#t͡ʂk/	*czka*	/t͡ʂka/	'to hiccup, 3rd p. sgl.'	/pt͡ʂ#/	*depcz*	/dɛpt͡ʂ/	'to trample, imp.'
/#ʂt͡ʂ/	*szczaw*	/ʂt͡ʂaf/	'sorrel'	/ʂt͡ʂ#/	*bluszcz*	/bluʂt͡ʂ/	'ivy'
/#t͡ʂw/	*człon*	/t͡ʂwɔn/	'a segment'	/t͡ʂp#/	*liczb*	/lit͡ʂp/	'a number, Gen. pl.'
				/rt͡ʂ#/	*skurcz*	/skurt͡ʂ/	'a cramp'

clusters with the voiceless pre-palatal affricate /t͡ɕ/

word-initial				word-final			
/#ft͡ɕ/	*wcisk*	/ft͡ɕisk/	'a snap-in'	/ft͡ɕ#/	*sprawdź*	/spraft͡ɕ/	'to check, imp.'
/#ɕt͡ɕ/	*ściana*	/ɕt͡ɕana/	'a wall'	/ɕt͡ɕ#/	*gość*	/gɔɕt͡ɕ/	'a guest'
/#t͡ɕm/	*ćma*	/t͡ɕma/	'a moth'	/pt͡ɕ#/	*kopć*	/kɔpt͡ɕ/	'to smoke, imp.'
				/jt͡ɕ#/	*pójdź*	/pujt͡ɕ/	'to go, imp.'

The materials were recorded by a male native speaker of Polish with no speech impediments and digitised at 44.1 kHz sampling rate. The stimuli were next presented to two other native speakers of Polish, who were asked to write down the items they had heard. Both subjects reproduced all items accurately, which proves the correctness of the recorded material and its unambiguous pronunciation.

2.2. Participants

The experimental subjects were 30 native speakers of the southern variety of British English, including 16 women and 14 men, aged between 18 and 30. They were recruited at University College London and St Mary's University College in Twickenham, London. They were either undergraduate or postgraduate students attending non-linguistic programmes as well as junior members of the teaching staff. The majority of the participants were monolingual English speakers, however, all of them had learnt one or two foreign languages at school (usually French, German, Spanish or Italian). Furthermore, two subjects were fluent in French and three in German. The participants reported no speech or hearing disorders as well as declared no knowledge of Polish and other Slavic languages.

2.3. Procedure and data categorisation

The participants were informed that the experimental task is to reproduce a set of Polish words. They performed the repetition task similar to that conducted by Haunz (2007), i.e. they repeated the words presented to them auditorily

through headphones in a randomised order. Each item was played twice and subsequent stimuli were activated by the experimenter after the response to the preceding one had been completed. The responses were recorded with the use of Tascam DR-08 digital recorder and digitised at 44.1 kHz sampling rate.

Next, the recordings were analysed both auditorily and by means of wide-band spectrograms in Speech Analyzer 3.1 software. The subjects' responses were classified into four major categories, namely 'targetlike reproduction', 'vowel epenthesis', 'consonant deletion' and 'segment change'. Where no reliable categorisation was possible, the items were labelled as 'other'.

As regards clusters containing voiceless affricates, the responses in which the post-alveolar /t͡ʂ/ and the pre-palatal /t͡ɕ/ were realised as affricates pronounced in the palato-alveolar region were classified as targetlike and transcribed as [t͡ʃ]. Our assumption was that it is crucial to determine whether a particular affricate is realised as such or rather substituted with a plosive or fricative. If there was no modification in the manner of articulation, we assumed that a given token should be classified as 'targetlike' ignoring any minute differences in the place of articulation.

3. Results

In this section we present the patterns of segmental adaptation of Polish voiceless affricates by native speakers of English observed in the experiment.

The voiceless dental affricate /t͡s/ is found in 8 clusters, including 4 in initial position and 4 in final position. The classification of the responses for sequences with /t͡s/ is provided in Table 1.[2]

The data in Table 1 demonstrate that the dental affricate /t͡s/ is predominantly realised as the coronal plosive [t] in 4 clusters, i.e. initial /#ft͡s/ and /#t͡sw/ as well as final /lt͡s#/ and /ft͡s#/. Some variation can be observed in the adaptation of /#ft͡s/, which is nativised either as [ft] or [fət], i.e. in some cases it undergoes double repair (/ə/ insertion to break up a disallowed cluster and a segmental modification /t͡s/ → [t]). It should be noted that the affricate is substituted with [t], even though [s] would yield an equally well-formed output. The adaptation of the remaining three clusters exhibits the same preference for [t], despite the availability of alternative substitutions, such as [s] or [ts]. Thus, /#t͡sw/ may be realised as [tw] or [sw] as both clusters are well-formed in English, yet the former adaptation is clearly preferred. The same is true for final sequences /ft͡s#/ and /lt͡s#/. It is logically possible to nativise them as [fts] / [lts], [ft] / [lt] and [fs] / [ls]. In the case of /ft͡s#/, the adaptation to [t], i.e. [ft], is selected in almost 90% of cases. The other cluster, i.e. /lt͡s#/, displays greater variability, with 60% of [lt] and 40% of [lt͡s] realisations, yet the /t͡s/ → [t] substitution is

[2] Since deletion was not attested in the adaptation of clusters with voiceless affricates, it is not included in Tables 1-3.

still prevailing. Final /n͡ts#/ is an exception, with 80% of targetlike responses and only 20% of adaptations to [t]. On the whole, the results for the clusters under discussion indicate that the dental affricate /t͡s/ tends to be adapted as [t] despite the fact that [s] (or sometimes [ts] in final position) produces equally well-formed phonotactic sequences in English.

Table 1. Adaptation of CC clusters with /t͡s/

CLUSTER	TARGETLIKE	EPENTHESIS	SEGMENT CHANGE
word-initial			
/#f͡ts/	20%	40% [fət]	40% [ft]
/#t͡sw/	26.7%	0%	73.3% [tw]
/#t͡sn/	33.3%	6.7% [t͡sən]	60% [sn]
/#t͡sf/	86.7%	0%	13.3% [sf]
word-final			
/f͡ts#/	13.3%	0%	86.7% [ft]
/l͡ts#/	40%	0%	60% [lt]
/n͡ts#/	80%	0%	20% [nt]
/t͡sk#/	100%	0%	0%

Different patterns of segmental adaptation of /t͡s/ can be observed in the remaining three clusters, i.e. initial /#t͡sn/ and /#t͡sf/ and final /t͡sk#/. In the case of /#t͡sn/ the predominant substitution is /t͡s/ → [s] (60%), which yields a well-formed English cluster [sn]. This is not surprising given the fact that it is the only repair that produces a licit output. The /t͡s/ → [t] adaptation would result in [tn], which is disallowed in English in initial position due to a violation of the Minimum Sonority Distance Principle (e.g. Steriade 1982). As regards /#t͡sf/, the only modification resulting in a well-formed English cluster is the /#t͡sf/ → [sf] substitution. The /#t͡s/ → [t] adaptation produces a prohibited cluster [tf]. However, in the vast majority of cases /t͡s/ is realised targetlike even though the output is inconsistent with English phonotactics. It seems that the pressure to preserve the input phonological content takes precedence over sonority restrictions in this case. As far as the final /t͡sk#/ cluster is concerned, the adaptation which best satisfies English phonotactic constraints is [sk], yet it is unattested. Instead, the most frequent response is [tsk], a marginal cluster in English occurring mostly in Russian place names, such as *Okhotsk*, *Irkutsk* and *Yakutsk*. The /t͡s/ → [t] mapping is not selected as it results in a disallowed cluster [tk].

To sum up, the data indicate that the dental affricate /t͡s/ is generally substituted with [t], except when this would result in a prohibited cluster, e.g.

*[#tf], *[tk#] or *[#tn]. In certain cases, however, the targetlike realisation of the affricate is selected even though a substitution with a fricative would produce a phonotactically well-formed English sequence.

The post-alveolar affricate /t͡ʂ/ occurs in 7 clusters, including 3 initial ones and 4 final ones. The data on the segmental adaptation of /t͡ʂ/ are presented in Table 2.

Table 2. Adaptation of CC clusters with /t͡ʂ/

CLUSTER	TARGETLIKE	EPENTHESIS	SEGMENT CHANGE
word-initial			
/#t͡ʂk/	60%	40% [t͡ʂək]	0%
/#ʂt͡ʂ/	0%	0%	100% [ʃt]
/#t͡ʂw/	0%	0%	100% [tw]
word-final			
/pt͡ʂ#/	0%	0%	100% [pt]
/t͡ʂp#/	86.7%	0%	13.3% [ʃp]
/ʂt͡ʂ#/	6.7%	0%	93.3% [ʃt]
/rt͡ʂ#/	80%	0%	20% [rt]

Table 2 demonstrates that the segment in question is realised as the coronal plosive [t] in 4 clusters, i.e. initial /#t͡ʂw/ and /#ʂt͡ʂ/ as well as final /pt͡ʂ#/ and /ʂt͡ʂ#/. In all cases, the /t͡ʂ/ → [t] substitution constitutes the most preferred repair strategy in terms of English phonotactic restrictions as it produces well-formed clusters [tw], [pt] and [ʃt] for /#t͡ʂw/, /pt͡ʂ#/ and /ʂt͡ʂ#/ respectively, and a marginal sequence [ʃt] for /#ʂt͡ʂ/. It should be added that the adaptation to the fricative [ʃ] yields outputs which are either prohibited, e.g. /#ʂt͡ʂ/ → *[ʃʃ], /ʂt͡ʂ#/ → *[ʃʃ] and /pt͡ʂ#/ → *[pʃ], or, as in /#t͡ʂw/ → [ʃw], peripheral. In light of these data, it may be argued that the post-alveolar affricate /t͡ʂ/ is realised as [t] because other substitutions result in phonotactically disallowed sequences.

In the remaining clusters, /t͡ʂ/ is mostly nativised as the palato-alveolar affricate [t͡ʃ]. As for /#t͡ʂk/ and /t͡ʂp#/, the /t͡ʂ/ → [t] adaptation is not attested, most probably because it would produce prohibited sequences of two stops, i.e. *[tk] and *[tp]. Again, as in the case of /t͡s/, the targetlike reproduction of the affricate takes precedence over the adaptation to the fricative [ʃ]. An important difference between /t͡s/ and /t͡ʂ/ is that the substitution with [s] results in well-formed sequences for the former, whereas for the latter both the faithful reproduction and the replacement with the fricative [ʃ] yield prohibited clusters. The affricate in /rt͡ʂ#/ is reproduced targetlike in 80% of cases even though

neither *[rt͡ʃ#] nor *[rt#] is a legal English sequence.[3] Still, the more faithful nativisation is preferred.

On the whole, the data under discussion demonstrate that the post-alveolar affricate /t͡ʂ/ is generally adapted as [t], except when this would result in a disallowed sequence, e.g. two stops. In such cases, the targetlike reproduction of the affricate is selected rather than the substitution with a fricative even if the latter would yield a better formed output.

The pre-palatal affricate /t͡ɕ/ is found in 7 clusters, including 3 initial and 4 final sequences. The data on the nativisation of /t͡ɕ/ are provided in Table 3.

Table 3. Adaptation of CC clusters with /t͡ɕ/

CLUSTER	TARGETLIKE	EPENTHESIS	SEGMENT CHANGE
word-initial			
/#ft͡ɕ/	40%	46.7% [fət͡ɕ]	13.3% [ft]
/#ɕt͡ɕ/	60%	0%	40% [st͡ʃ]
/#t͡ɕm/	80%	20% [t͡ɕəm]	0%
word-final			
/pt͡ɕ#/	100%	0%	0%
/ɕt͡ɕ#/	40%	0%	60% [ʃt]
/ft͡ɕ#/	100%	0%	0%
/jt͡ɕ#/	100%	0%	0%

As evidenced in Table 3, the segment under examination is in most cases reproduced targetlike, i.e. as the palato-alveolar affricate [t͡ʃ]. Some variation between adaptation to [t͡ʃ] and [t] can be observed only in the clusters /ɕt͡ɕ#/ and /#ft͡ɕ/, however, the targetlike reproduction of the affricate is still more frequent than the replacement with the coronal plosive. The realisation of /t͡ɕ/ as [t͡ʃ] is predominant both in the clusters where the /t͡ɕ/ → [t] substitution would result in an illicit output, e.g. /#t͡ɕm/ → *[tm], as well as in the sequences where this adaptation would produce well-formed or at least marginal phonotactic structures, e.g. /ɕt͡ɕ#/ → [ʃt], /ft͡ɕ#/ → [ft] or /pt͡ɕ#/ → [pt]. This pattern seems puzzling given the fact that the dental /t͡s/ and the post-alveolar /t͡ʂ/ are usually nativised as [t] in very similar CC clusters, as demonstrated in Table 4.

The question then arises as to the reasons behind this divergent adaptation of /t͡s/ and /t͡ʂ/ vs. /t͡ɕ/ by native speakers of English.

[3] The statement holds true only for non-rhotic varieties of English.

Table 4. Divergent adaptation of /t͡s/ and /t͡ʂ/ vs. /t͡ɕ/

adapted as [t]	**adapted as [t͡ʃ]**
/#ft͡s/	/#ft͡ɕ/
/#ʂt͡ʂ/	/#ɕt͡ɕ/
/ʂt͡ʂ#/	/ɕt͡ɕ#/
/ft͡s#/	/ft͡ɕ#/
/pt͡ʂ#/	/pt͡ɕ#/

In conclusion, an analysis of the patterns of nativisation of Polish voiceless affricates by native speakers of English allows us to formulate the following generalizations:

1. The dental /t͡s/ and the post-alveolar /t͡ʂ/ tend to be realised as [t], except when this substitution would give rise to a prohibited consonant sequence. The adaptation to the coronal plosive is preferred in spite of the availability of alternative repair strategies which would result in phonotactically well-formed clusters, e.g. the substitution with a fricative.
2. The pre-palatal /t͡ɕ/ is realised as [t͡ʃ] in all contexts, although the adaptation to a plosive or a fricative would produce better formed English consonant sequences.

In light of the above, our main goal will be to account for the divergent nativisation of the dental and the post-alveolar vs. the pre-palatal affricates.

4. Analysis

In this section we provide a formal analysis of the data carried out within the framework of Optimality Theory (Prince and Smolensky 1993/2004, McCarthy and Prince 1995). OT is a non-derivational model based on the assumption that phonological structures attested in natural language result from an interaction of two major types of universal constraints, namely markedness constraints and faithfulness constraints. The former encode preferences for unmarked output structures, whereas the latter exert pressure towards the preservation of lexical contrasts, i.e. they penalise any differences between the input and the output.

The markedness constraints employed in our analysis are provided in (2).

(2) Markedness constraints
*[t͡s]: Dental affricates are prohibited.
*[t͡ʂ]: Post-alveolar affricates are prohibited.
*[t͡ɕ]: Pre-palatal affricates are prohibited.

SONORITY:
1. SON-SEQ: Complex onsets rise in sonority, and complex codas fall in sonority. (Kager 1999: 267)
2. SONDIST2: Minimal sonority distance between consonants in a complex onset is 2 points. (on a five-point sonority scale, i.e. vowels > glides > liquids > nasals > obstruents, Clements 1990) (Yildiz 2010: 40)

First of all, it is necessary to include the constraints which account for the lack of the dental, post-alveolar and pre-palatal affricates in the phonemic inventory of English. These are *[t͡s], *[t͡ʂ] and *[t͡ɕ] respectively. In addition, since the adaptation of initial and final consonant clusters is involved, the outputs have to conform to the relevant sonority restrictions, i.e. the Sonority Sequencing Principle (SSP) (e.g. Selkirk 1984) and the Minimum Sonority Distance Principle (MSD) (e.g. Steriade 1982). These are formulated as SON-SEQ and SONDIST2 respectively and referred to with a cover term SONORITY. We assume that the SSP is valid for English and any surface violations of this principle, such as initial clusters of /s/ followed by an obstruent or final CC and CCC sequences with coronal obstruents, are treated as containing a syllable appendix attached to the core syllable. The class of segments that may function as appendices is limited to coronal obstruents, i.e. [-sonorant, + coronal] segments (Giegerich 1992: 149).

The relevant faithfulness constraints are presented in (3).

(3) Faithfulness constraints (McCarthy and Prince 1995)
MAX-IO: Every segment of the input has a correspondent in the output. (No phonological deletion.)
DEP-IO: Every segment of the output has a correspondent in the input. (No phonological epenthesis.)
IDENT-IO[strid]: Correspondent segments in input and output have identical values for [strident].
IDENT-IO[cont]: Correspondent segments in input and output have identical values for [continuant].
IDENT-IO[dist]: Correspondent segments in input and output have identical values of [distributed].
IDENT-IO[ant]: Correspondent segments in input and output have identical values of [anterior].

The constraints MAX-IO and DEP-IO militate against segment deletion and insertion respectively. Modifications in the value of the features [strident], [continuant], [distributed] and [anterior] are penalised by the corresponding IDENT-IO constraints.

As regards /t͡s/, it is mostly substituted with the coronal plosive [t], e.g. /#t͡sw/ → [tw]. Whenever this would result in a prohibited output sequence, the coronal fricative [s] is selected instead of [t], e.g. /#t͡sn/ → [sn] (*[tn]).

Assuming that affricates are strident stops (e.g. Jakobson et al. 1952, Rubach 1994), i.e. that they differ from plosives only in that they are [+strident], the faithfulness constraints violated in the nativisation of the dental affricate /t͡s/ are IDENT-IO[strid] (/t͡s/ → [t]) and IDENT-IO[cont] (/t͡s/ → [s]). Since the value of [continuant] is altered only if the modification of [strident] fails to produce a well-formed output, IDENT-IO[cont] must dominate IDENT-IO[strid].

The /t͡s/ → [t] adaptation in the initial cluster /#t͡sw/ is accounted for in Tableau 1.

Tableau 1. /t͡s/ → [t] adaptation in /#t͡sw/ in *cło* /t͡swɔ/ 'a tariff'

/t͡swɔ/	***[t͡s]**	**SONORITY**	**DEP-IO**	**MAX-IO**	**IDENT-IO [cont]**	**IDENT-IO [strid]**
t͡swɔ	*!					
☞ twɔ						*
swɔ					*!	
t͡sə.wɔ	*!		*			
tə.wɔ			*!			*
tɔ				*!		*

The candidate forms with [t͡s] are eliminated by the high-ranked *[t͡s]. The items containing a deleted consonant or an epenthetic vowel are ruled out by MAX-IO and DEP-IO respectively. The choice between [swɔ] and [twɔ] is determined by IDENT-IO[cont], which favours the latter output.

The nativisation of /t͡s/ as [s] in the initial cluster /#t͡sn/ is illustrated in Tableau 2.

Tableau 2. /t͡s/ → [s] adaptation in /#t͡sn/ in *cnota* /t͡snɔta/ 'a virtue'

/t͡snɔta/	***[t͡s]**	**SONORITY**	**DEP-IO**	**MAX-IO**	**IDENT-IO [cont]**	**IDENT-IO [strid]**
t͡snɔ.ta	*!	*				
tnɔ.ta		*!				*
☞ snɔ.ta					*	
t͡sə.nɔ.ta	*!		*			
tə.nɔ.ta			*!			*
tɔ.ta				*!		*

In Tableau 2 evaluation takes place in a similar manner as in Tableau 1. However, this time it is the candidate with the coronal fricative [s] rather than the plosive [t] that is selected as the optimal output because the latter incurs a violation of SONORITY due to an insufficient sonority distance between C_1 and C_2 (*[tn]).

The central problem posed by the data is the divergent adaptation of /t͡ʂ/ vs. /t͡ɕ/, with the former usually realised as [t] and the latter as [t͡ʃ], e.g. /pt͡ʂ#/ → [pt] vs. /pt͡ɕ#/ → [pt͡ʃ]. Below we will argue that these patterns are crucially related to certain place features of Polish and English affricates. The relevant feature values of the segments under discussion are provided in Table 5 (based on Hall 1997 and Szpyra 1995).

Table 5. Place feature values of Polish and English affricates

	PL post-alveolars	PL pre-palatals	ENG palato-alveolars
[anterior]	–	–	–
[distributed]	–	+	+

On the one hand, English palato-alveolars have the same values of [anterior] and [distributed] as Polish pre-palatals. On the other hand, they differ from Polish post-alveolars with respect to the value of [distributed]. The patterns observed in the data indicate that [distributed] plays a decisive role in the selection of optimal outputs in that any modification of this feature is dispreferred. This is demonstrated in (4).

(4) Avoidance of [distributed] modification

/t͡ʂ/ → [t]	[-dist] → [-dist]	*/t͡ɕ/ → [t]	[+dist] → [-dist]
*/t͡ʂ/ → [t͡ʃ]	[-dist] → [+dist]	/t͡ɕ/ → [t͡ʃ]	[+dist] → [+dist]

As evidenced in (4), the nativisations in which the value of [distributed] is modified, i.e. /t͡ʂ/ → [t͡ʃ] and /t͡ɕ/ → [t], are avoided. Instead, the adaptations where the value of [distributed] is preserved, i.e. /t͡ʂ/ → [t] and /t͡ɕ/ → [t͡ʃ], are selected, the effect of which is the divergent realisation of /t͡ʂ/ vs. /t͡ɕ/.

As regards the relative ranking of the relevant IDENT-IO constraints which arises from the experimental data, IDENT-IO[dist] must dominate IDENT-IO[strid], otherwise the /t͡ʂ/ → [t͡ʃ] substitution, which preserves stridency, would be preferred to the /t͡ʂ/ → [t] adaptation, where IDENT-IO[strid] is violated. In addition, since the value of [anterior] is modified in actual outputs, e.g. /t͡ʂ/ → [t] ([-ant] → [+ant]), IDENT-IO[ant] must be low-ranked. The hierarchy of the relevant IDENT-IO constraints is presented in (5).

(5) Ranking of IDENT-IO constraints
IDENT-IO[cont], IDENT-IO[dist] >> IDENT-IO[strid], IDENT-IO[ant]

Tableau 3 demonstrates the crucial role of IDENT-IO[dist] in the nativisation of the CC sequences with /t͡ʂ/.

Tableau 3. /t͡ʂ/ → [t] adaptation in /pt͡ʂ#/ in *depcz* /dɛpt͡ʂ/ 'to trample, imp.'

/dɛpt͡ʂ/	SON	DEP-IO	MAX-IO	IDENT-IO [cont]	IDENT-IO [dist]	IDENT-IO [strid]	IDENT-IO [ant]
depʧ					*!		
☞ dept						*	*
depʃ				*!			
de.pəʧ		*!					
dep			*!				

The forms with consonant deletion or vowel epenthesis are eliminated by MAX-IO and DEP-IO respectively, whereas [depʃ] is ruled out by IDENT-IO[cont]. The selection between [dept] and [depʧ] is crucially determined by IDENT-IO[dist], which favours the former candidate.

The activity of IDENT-IO[dist] in the adaptation of the clusters with /t͡ɕ/ is presented in Tableau 4.

Tableau 4. /t͡ɕ/ → [ʧ] adaptation in /pt͡ɕ#/ in *kopć* /kɔpt͡ɕ/ 'to smoke, imp.'

/kɔpt͡ɕ/	SON	DEP-IO	MAX-IO	IDENT-IO [cont]	IDENT-IO [dist]	IDENT-IO [strid]	IDENT-IO [ant]
☞ kɒpʧ							
kɒpt					*!	*	*
kɒpʃ				*!			
kɒ.pəʧ		*!					
kɒp			*!				

The evaluation in Tableau 4 proceeds in a similar manner as in Tableau 3. Again, the constraint IDENT-IO[dist] is of key significance in the selection of the optimal output as it rules out [kɒpʧ], leaving [kɒpt] as the winner.

In conclusion, there is compelling evidence that the divergent nativisation of Polish voiceless dental and post-alveolar vs. pre-palatal affricates in CC sequences is mainly due to IDENT-IO[dist], i.e. a constraint which prohibits the input-output differences in the value of [distributed]. The input value of this feature is preserved at the expense of the modification of [strident] or [anterior].

5. Discussion

If the divergent adaptation of Polish dental and post-alveolar vs. pre-palatal affricates in CC clusters is mainly due to the highly-ranked IDENT-IO[dist], a question naturally arises concerning the reasons why this constraint should be highly-ranked in English. In other words, it is necessary to explain why the preservation of the input value of [distributed] takes precedence over the preservation of the input value of [anterior] and [strident] among others. This seems particularly puzzling when one considers the status of the features under discussion in English. It is usually assumed that [distributed] is non-distinctive in English (e.g. Hall 1997, but see Clements 1985 for an opposite view), hence its value can be supplied by default. On the other hand, [anterior] and [strident] are contrastive in English. The former is commonly used to distinguish between [s, z] and [ʃ, ʒ], whereas the latter to account for the contrast between [θ, ð] and [s, z]. Thus, in our data we are faced with a puzzling situation whereby native speakers of English prefer to preserve the input value of a non-contrastive feature [distributed] rather than of a contrastive feature like [anterior] or [strident].

These results run counter to a common hypothesis in loanword adaptation according to which there is a universal preference for the preservation of the input values of those phonological features which are contrastive in the target language at the expense of those which are non-contrastive (e.g. Kang 2011; Clements 2001; Herd 2005; Dresher 2009). Thus, the hypothesis in question predicts that native speakers of English should be more likely to modify the value of the feature [distributed] rather than [anterior] or [strident] in the nativisation of Polish voiceless affricates. Our data show that this is not the case.

A possible explanation for these patterns is that they result from a straightforward application of the native English hierarchy of phonological constraints. Given the assumption of the universality of constraints in Optimality Theory, IDENT-IO[dist] must be part of the phonological component of English. However, the ranking of this constraint with respect to IDENT-IO[strid] and IDENT-IO[ant] (and possibly other constraints) cannot be determined on the basis of the native data alone as [distributed] is redundant in English. In such cases, the nativisation of foreign inputs may reveal generalizations which cannot be formulated on the basis of the native vocabulary. Under this view, online loanword adaptation provides a unique insight into the phonology of the target language in that it allows us to determine constraint rankings for which there is no direct evidence in the native phonology. In other words, it allows us to observe "hidden constraint rankings" (Haunz 2007: 5) or "otherwise latent constraints in action" (Paradis and LaCharité 1997: 382).

Furthermore, the observed patterns of adaptation of Polish voiceless affricates by native speakers of English have significant ramifications for the issue of the input to loanword nativisation. Given the assumption that [distributed] is non-distinctive in English, the experimental data lend support to the phonological input view advocated by Jacobs and Gussenhoven (2000:

198), according to which "language users analyse speech signals in terms of a universal phonological vocabulary, which is of course much larger than the subset incorporated in their native language". In other words, in processing foreign input borrowers are able to utilise phonological distinctions which are not present in their native phonology. Thus, although [distributed] is not active in English, native speakers of this language are able to identify the value of this feature correctly in the input and to modify it accordingly if necessary.

The issue of the input to loanword nativisation is closely related to the role of perception in this process. Thus, the phonological input view is based on the assumption that borrowers faithfully perceive non-native structures which are subsequently modified by the target language phonological component. On the other hand, the major claim of the phonetic input view is that the modifications that loanwords undergo result from misperception of L2 items by L1 speakers. Our data provide evidence for the former stance as they clearly demonstrate that native speakers of English are able to perceive the non-native contrast between the post-alveolar [t͡ʂ] and the pre-palatal [t͡ɕ], which is reflected in the divergent patterns of nativisation of these segments.

On the whole, the obtained results offer valuable evidence for the relative ranking of IDENT-IO[dist] in English, which cannot be determined on the basis of the native data alone. Furthermore, they lend support to the phonological approach to loan adaptation as well as to the phonological input view and its basic assumption concerning the faithful perception of non-native sound structures by borrowers.

6. Conclusions

The results of the online loanword adaptation experiment on the segmental nativisation of Polish voiceless affricates by native speakers of English allow us to formulate the following conclusions:

1. The divergent adaptation of the dental [t͡s] and the post-alveolar [t͡ʂ] vs. the pre-palatal [t͡ɕ] in CC clusters is an effect of the highly-ranked IDENT-IO[dist], i.e. a constraint militating against the modification in the input value of [distributed].
2. In the absence of native evidence, the loanword nativisation data play a decisive role in determining the relative ranking of IDENT-IO[dist] in the phonological component of English.
3. The obtained results demonstrate that in loan adaptation native speakers of English are able to utilise phonological distinctions which are not employed in their native phonology. This lends support to the phonological approach to loan nativisation as well as to the phonological input view.
4. The divergent patterns of adaptation of the post-alveolar [t͡ʂ] vs. the pre-palatal [t͡ɕ] show that native speakers of English are able to perceive the non-native contrast between these two segments. This provides evidence in

favour of the central tenet of the phonological approach to loan nativisation, i.e. the faithful perception view, according to which borrowers faithfully perceive non-native sound structures.

It must be noted that the above generalisations should be regarded as preliminary as they are based on the results of a single study which employs a limited number of the experimental stimuli. Further experimental evidence is necessary in order to verify the validity of these conclusions.

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