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## CLUSTER REDUCTION FROM THE PERSPECTIVE OF ARTICULATORY PHONOLOGY: A CASE OF POLISH AFFRICATES\*

### Abstract

Sequences of affricates followed by homorganic fricatives are simplified to affricates in preconsonantal context in Polish. Similarly, geminates are reduced in this environment, which results from the fact that length distinction is not licensed in this position. Despite common motivation, the two types of reduction cannot be handled by the same rule. Unlike geminates, sequences of affricates and fricatives cannot undergo the process of degemination. However, the simplification is motivated by the phonetic adjacency of identical fricative portions, which leads to a conclusion that the rule belongs to the domain of phonetic implementation. Therefore, an Optimality Theoretic solution is aided by the theory of Articulatory Phonology, which can capture the phonetic facts of reduction processes.

### 1. Introduction

Despite many combinatorial possibilities, Polish cluster formation is restricted with respect to geminates. Specifically, they are prohibited to occur in consonantal adjacency. In descriptive terms, their distribution in Polish is limited to intervocalic and word-initial positions, provided that initial geminates are followed by a vowel. In order to ban their occurrence elsewhere, Polish employs the strategies of degemination and epenthesis. The former applies among others<sup>1</sup> in the environment of consonants: both preconsonantal (e.g. /sevill+ski/ → [sevɨlski] ‘Sevillan’)<sup>2</sup> and postconsonantal (e.g. /pjɛɲkn+nɨ/ → [pjɛɲkɨ] ‘beautiful’), whereas the latter is used to

avoid clusters of word-initial geminates followed by a consonant (e.g. /v + vʒɛɛɲu/ → [vɛ + vʒɛɛɲu] ‘in September’).

In this paper, I refer to the process of degemination. Section 2 presents evidence for the underlying geminates in Polish and shows some facts of degemination, with emphasis on preconsonantal environment. Section 3 compares this rule with the process of cluster simplification affecting preconsonantal sequences of affricates followed by homorganic fricatives. It is argued that degemination cannot be used to account for this cluster simplification. Section 4 offers a solution within Optimality Theory (OT), which must be aided by the theory of Articulatory Phonology (AP). I argue that the standard approach to cluster reduction within AP is inefficient and suggest an alternative based on the theory of local constraint conjunction.

## 2. Geminates in Polish

Geminates in Polish are predominantly found in intervocalic position, which typologically is an expected distribution. As claimed in Thurgood (1993) and Muller (2001), geminates crosslinguistically are less common when adjacent to a vowel at one side and they are most rare in interconsonantal position. Such distribution can be attributed to perceptual salience in that the constriction for geminates is most perceptible when flanked by segments requiring little constriction (Pająk 2009a, Dmitrieva 2009).

Polish has a phonemic distinction between geminates and single consonants, as shown in (1) below. Pluses denote morpheme boundaries.

(1) [bud+a]	‘kennel’	vs.	[budd+a]	‘Buddha’
[ɔtɔ]	‘here’	vs.	[ɔtt+ɔ]	‘proper name’
[gam+a]	‘scale’	vs.	[gamm+a]	‘gamma’
[al+a]	‘proper name’	vs.	[allax]	‘Allah’
[pas+a]	‘belt’ gen. sg.	vs.	[pass+a]	‘streak’

The data above show that geminates can occur in exactly the same context as singleton consonants. In both columns, these segments are flanked by vowels and they belong to the stem. The length of consonants is thus used contrastively to differentiate between the meanings of words. This contrast must be encoded underlyingly since any rule responsible for a change of consonantal length, specifically gemination or degemination, would be conditioned by identical environment.

Examples in (1) present instances of morpheme-internal geminates. They are known as true geminates, in the sense that they are present in the underlying structure. Polish also has fake geminates, which arise due to

morphological and phonological processes.<sup>3</sup> On the surface, they all function contrastively, as shown in (2) below.

- |     |          |                   |     |                       |                   |
|-----|----------|-------------------|-----|-----------------------|-------------------|
| (2) | [lɛtɛ+ɛ] | ‘summer’ loc. sg. | vs. | [lɛtɛ+tɛɛ]            | ‘to fly’ imp. pl. |
|     | [ran+i]  | ‘wounds’          | vs. | [ran+ni] <sup>4</sup> | ‘wounded’         |
|     | [lɛk+i]  | ‘medicines’       | vs. | [lɛk+ki]              | ‘light’ adj.      |
|     | [niš+i]  | ‘niche’ gen. sg.  | vs. | [niš+ši]              | ‘lower’           |

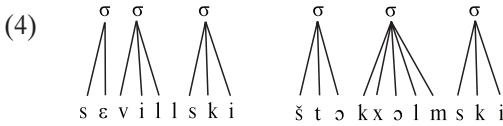
In this article, the distinction into true and fake geminates plays no role since both types are subject to the process of degemination. In general terms, this rule deletes one root node of a geminate, thus converting it into a singleton consonant. The relevant data is presented below.

As shown above, the intervocalic position preserves the contrast in consonantal length. The situation looks different in consonant adjacency, as shown in (3).

- |         | nouns        |             | adjectives                   |
|---------|--------------|-------------|------------------------------|
| (3) (a) | [sevill+a]   | ‘Seville’   | vs. [sɛvil+ski]              |
|         | [sibill+a]   | ‘Sibyl’     | vs. [sibil+ski]              |
|         | [lɔzann+a]   | ‘Lausanne’  | vs. [lɔzɔn+ski] <sup>5</sup> |
|         | [navarr+a]   | ‘Navarre’   | vs. [navar+ski]              |
| (b)     | [gvatɛmal+a] | ‘Guatemala’ | vs. [gvatɛmal+ski]           |
|         | [bɔtsfan+a]  | ‘Botswana’  | vs. [bɔtsfɔn+ski]            |
|         | [gur+a]      | ‘mountain’  | vs. [gur+ski]                |

An observation can be made that underlying geminates in (3a) are reduced in preconsonantal position. Whenever the adjectivising morpheme *-ski* is added, geminates are simplified to singleton consonants. Examples in (3b) show that stems ending in a single coda preserve their consonants. Consequently, deletion takes place only if the stem ends in a geminate.

It is interesting to ask what motivates this cluster reduction. When comparing two subsets in (3), it may seem that segmental count is a driving force behind deletion. Specifically, only one consonant surfaces before the suffix. However, this hypothesis is belied by words such as [sɛrp+ski] ‘Serbian’ and [štɔkxɔlm+ski] ‘Stockholmian’, where stems end in two consonants.<sup>6</sup> Another option to consider concerns the syllable structure. As Rubach – Booij (1990) correctly point out, in [sɛvil+ski] the second [l] violates the sonority hierarchy (Jespersen 1904, Selkirk 1982) and thus cannot be syllabified. As a result, its extrasyllabic status motivates degemination. For clarity I present the syllabification of ‘Sevillian’ and ‘Stockholmian’ in (4) below.



A legitimate question to ask is why the extrasyllabic sonorant is not saved by adjunction to a higher constituent – phonological word. As a matter of fact, this strategy is used in a number of words e.g. *Jędrka*, *Piotrka*, *piosnka*. Rubach – Booij (1990) solve this conundrum by rule ordering; specifically, when degemination applies first, it erases the material to be adjoined.

It seems that extrasyllabicity accounts for non-occurrence of geminates preconsonantly. So far I have shown that it may be correct for geminate sonorants. Let us now turn to examples which show degemination of obstruents, as shown in (5).

nouns			adjectives
(5) [ɔdɛss+a]	‘Odessa’	vs.	[ɔdɛski]
[frantsus] <sup>7</sup>	‘Frenchman’	vs.	[frantsuski]
[pariš]	‘Paris’	vs.	[pariski]
[bjawɔruɛ]	‘Belarus’	vs.	[bjawɔruski]

The data set above presents stems with final fricatives. It might seem that corresponding adjectives are formed by adding the suffix *-ki*. Such morpheme division would not block degemination in [ɔdɛski] since the underlying geminate is reduced before [k]. However, there are two lines of criticism against such an analysis. First, the suffix *-ki* is added to bound stems (e.g. [swɔt + ki] ‘sweet’, [gwat + ki] ‘smooth’, [xrup + ki] ‘crunchy’) whereas *-ski* is added only to nouns. Second, it remains problematic why fricatives of different places of articulation change into [s] in the context of a velar consonant. Such assimilatory behaviour is idiosyncratic and unattested elsewhere in Polish. Consequently, I assume that the adjectivising suffix in (5) is *-ski* rather than *-ki*. Under this analysis, degemination targets fricatives in all examples in (5) and it must be preceded by an assimilatory process before an alveolar fricative.<sup>8</sup> To illustrate rule interaction, let us consider the derivation of //bjawɔruɛ + ski//. An assimilatory process produces a geminate fricative in /bjawɔrus + ski/, which is then subject to degemination, thus giving a desired output [bjawɔruski].

Let us now consider the initial question. Can extrasyllabicity motivate degemination in (5)? The answer is negative. Fricatives can be syllabified in all clusters above since Polish permits various combinations of obstruents at syllable margins (Rubach 1999). Consequently, /frantsus+ski/ could have a syllable boundary between two alveolar fricatives, thus forcing the second

[s] to join the onset of the last syllable. In the light of this, motivation for cluster reduction must lie outside the syllable structure. To identify the driving force, let us make an observation that geminates are not permitted in adjacency of consonants, which results from the fact that this position does not license length distinction in Polish. As studies by Pająk (2009a) and Dmitrieva (2009) show, the perceptual salience of geminates is attenuated in consonantal adjacency, which can be accounted for in terms of articulatory gestures. Specifically, geminates occupy an area of little constriction and to achieve the most significant salience they must be flanked by gestures requiring wide constriction of articulators. Any deviation from this structure needs to be penalised in Polish.<sup>9</sup>

To conclude this section, geminates are reduced in preconsonantal position due to the reasons of perceptual salience. It has been shown that consonantal sonorants (3) and fricatives (5) constitute the input to the rule. It is now of interest to look at other classes of obstruents.<sup>10</sup> Hence, the next section focuses on the behaviour of affricates in the environment of the adjectivising suffix *-ski*.

### 3. Cluster reduction of homorganic affricates and fricatives

Polish has 6 affricates in the inventory: [tʂ], [dʐ], [tʂʃ], [dʐʃ], [tʂɕ] and [dʐɕ]. All of them can be found in the underlying representation but they can also emerge due to a number of phonological processes.<sup>11</sup> Below I list several Polish place names with word-final affricates and show their adjectival derivatives.

nouns			adjectives
(6) [grujɛtʂ]	‘Grójec’	vs.	[grujɛtʂki]
[ɕɛrɔtʂ]	‘Sieradz’	vs.	[ɕɛrɔtʂki]
[karpɔtʂ]	‘Karpacz’	vs.	[karpɔtʂki]
[wutɕ]	‘Łódź’	vs.	[wutʂki]
[nɔtɕ]	‘Noteć’	vs.	[nɔtʂki]

The adjectivising suffix in (6) is *-ski* for the reasons outlined in section 2. There is a parallel behaviour with respect to assimilatory processes since both in (5) and (6) word-final obstruents assume alveolar place of articulation. However, cluster reduction presents a challenge. In descriptive terms, the fricative of the suffix becomes deleted. This process takes place in the environment which is typical for degemination, yet there is no geminate in phonological sense. Instead, what is present underlyingly is a sequence of an affricate followed by a fricative, as in /grujɛtʂ + ski/. To solve this dilemma, various analyses have been advanced, notably by Gussmann (1978). I shall present them below.

In accordance with descriptive facts, it is the fricative which undergoes deletion. Consequently, Gussmann (1978) proposes a process of [s]-deletion, which needs to be further specified to exclude the [s] of the suffix. This analysis is assailable on several grounds. First, the process of [s]-deletion replaces degemination in /frantsus + ski/, thus rendering the reduction of a fricative geminate qualitatively different from the reduction of a sonorant geminate. This leads to an *ad hoc* categorisation within a class of geminates. Second, the process of [s]-deletion is unmotivated elsewhere in Polish. In other words, it serves only to simplify clusters of preconsonantal [ss] and [tss], which in turn excessively complicates its formula. Consequently, the rule of [s]-deletion needs to be rejected in favour of a process which would not paralyse degemination elsewhere.

In a strive to develop a unified approach towards the clusters listed above, Gussmann (1978) advances two analyses pivoting around the process of degemination. One analysis is to create a derived geminate out of a sequence of [tss]. This would require imposing agreement with respect to the feature [continuant]. Specifically, it is proposed that the second segment change its value with respect to this particular feature. As a result, there would emerge a geminate affricate, which would be subject to the process of degemination. As Gussmann (1978) correctly observes, such analysis suffers a shortcoming that it postulates a change unmotivated elsewhere in the phonology of Polish. To clarify the matter, it is not affrication which is atypical for Polish (see Coronal Palatalisation in Rubach 1984) but its progressive direction and the segment targeted. Consequently, feature change is rejected to leave room for a solution exploiting phonetic aspects of affricates. On the melody tier, every affricate consists of a plosive followed by a fricative. In a cluster of [tss], it happens that two qualitatively identical fricative portions are adjacent to each other, which according to Gussmann (1978) legitimises the use of degemination to simplify such a cluster. Again, an advantage of such an analysis lies in the common strategy to simplify [ss] and [tss] clusters. However, the costs outweigh the gains since affricates need to lose their monosegmental status in order to submit the fricative portion to degemination. In other words, affricates become decomposable into sequences of homorganic stops and fricatives, which in Polish leads to a loss of contrast in meaning, as shown in (7) below.

- |     |        |         |     |        |                 |
|-----|--------|---------|-----|--------|-----------------|
| (7) | [tʃi]  | ‘if’    | vs. | [tʃi]  | ‘three’         |
|     | [tʃij] | ‘whose’ | vs. | [tʃij] | ‘rub’ imp. sg.  |
|     | [dʒem] | ‘jam’   | vs. | [dʒem] | ‘doze’ imp. sg. |

Had affricates lost their monosegmental status, the words in the left column would become homophonous with the corresponding words

containing sequences of stops and fricatives, thus leading to a loss of contrast in meaning.

To conclude, none of the analyses proposed so far can account for the deletion of [s] in preconsonantal clusters of affricates and fricatives. Despite the fact that in parallel cases degemination takes place, it cannot be extended to operate in simplification of these clusters. A different mechanism must be active there, which however is driven by the same motivation as degemination (see section 2). Indisputably, there is adjacency of fricative portions in [ts] cluster although phonologically they fail to constitute a geminate. This adjacency motivates simplification but its phonetic character leads to a conclusion that the rule in question belongs to the domain of phonetic implementation (Laskowski 1975, Rubach 1994). The following section explores details of this solution.

#### 4. Optimality Theoretic analysis

Inherent in phonetic implementation is the idea of gradualness. This presents a challenge for generative framework, which deals with categorical changes and accepts no intermediate stages in the application of a given rule (Rubach 1976, Browman – Goldstein 1986). Precisely, this inefficiency of generative models has led to the rise of Articulatory Phonology (AP) – a theory which abstractly encodes not only spatial relations but also linguistic timing, thus opening the way to gradualness in sound changes. This model has been advanced notably by Browman and Goldstein (1986 *et seq.*) and subsequent work has focused on incorporating AP within Optimality Theory (Prince – Smolensky 1993, McCarthy – Prince 1995; henceforth OT). In this section, I shall make crucial reference to papers by Bradley (2007), Gafos (2002) and Davidson (2003).

AP dispenses with the idea of segments with bundles of features since such a view fails to capture the facts of fluent speech. Instead, it introduces the notion of a gesture, a dynamically defined articulatory movement, which leads to a constriction in the vocal tract. Gestures are interrelated and by default they never appear in isolation in fluent speech. Consequently, cluster reduction in section 3 is conceptualised as gestural overlap. To give an example, let us consider the word /grujɛts + ski/. The deletion of the fricative is a direct result of the overlapping movement of adjacent gestures. Specifically, it is either the velar gesture [k] or the alveolar gesture [ts] which overlaps the fricative. The former represents the phenomenon of gestural hiding since adjacent gestures activate different articulators, whereas the latter illustrates gestural blending since, by contrast, gestures occupy the same articulator. This distinction however plays no role in OT formalization

of gestural overlap, which is done by a family of alignment constraints. The details of this mechanism follow below.

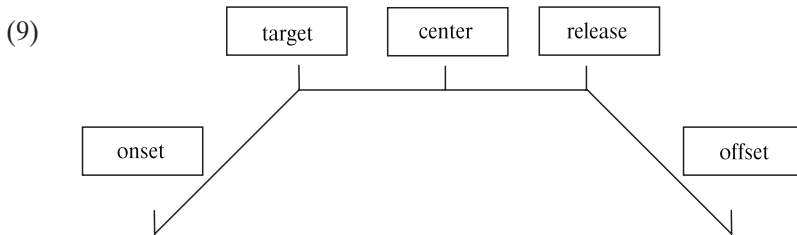
Alignment constraints in OT constitute a distinct family from two competing forces of faithfulness and markedness in that they neither regulate the input-output correspondences nor they mandate segmental changes. Instead, they are responsible for association of edges within different phonological and morphological domains pertaining to output forms (McCarthy – Prince 1993). The pattern in (8) below presents general alignment.

(8) Align (Category<sub>1</sub>, Edge<sub>1</sub>, Category<sub>2</sub>, Edge<sub>2</sub>)

$\Lambda$  Category<sub>1</sub>  $\vee$  Category<sub>2</sub> such that Edge<sub>1</sub> of Category<sub>1</sub> and Edge<sub>2</sub> of Category<sub>2</sub> coincide

‘For every category<sub>1</sub> there exists some category<sub>2</sub> such that the {L, R} edge of category<sub>1</sub> and the {L, R} edge of category<sub>2</sub> coincide.’

To clarify, edge stands for the left or right margin of a domain whereas category specifies various domains, such as: stems, syllables, segments etc. AP makes crucial use of alignment, yet it needs to change the referents of edge in order to express the gradualness of changes. Specifically, categories in AP are aligned with temporal landmarks inherent in the articulation of every gesture (Gafos 2002, Davidson 2003). The figure below illustrates the temporal structure of a gesture.<sup>12</sup>



It should also be noted that according to the model categories in AP take the shape of gestures. In the light of these modifications to alignment, cluster reduction results from aligning corresponding temporal landmarks of adjacent gestures. I assume after Bradley (2007) that alignment should refer to C-centers.

With reference to cluster reduction in /grujets + ski/, let us consider the alignment of consonantal gestures in the suffix. (10) shows a relevant constraint.



(10) Align (/s/, centre, /k/, centre)

‘In a sequence /sk/, align the centre of /s/ gesture with the centre of /k/ gesture.’

For the constraint in (10) to ensure the reduction of /s/, it needs to dominate a faithfulness constraint MAX militating against deletion. However, placing such an alignment constraint in an undominated position would make it impossible for the morpheme /ski/ to surface. As the data in section 2 show, this is an incorrect solution. To attenuate the force of the constraint, one could locally conjoin it (for the theory of constraint conjunction, see Smolensky 1993) to restrict its application in the position after affricates.<sup>13</sup> Although this could be a promising solution, let us first consider the constraint itself, against which there are several lines of criticism. To begin with, the ALIGN constraint in (10) is particular in its design in that it targets a sequence of two specific gestures. This suggests that the given gestures exhibit exceptional behaviour with regards to other clusters. As the data in (11) show, this is incorrect.

(11) (a)	[partatʃ̃]	‘botcher’	vs.	[partatʃtʃɔ]	‘botch-up’
	[bɔgatʃ̃]	‘rich man’	vs.	[bɔgatʃtʃɔ]	‘affluence’
(b)	[ɔbivatɛ]	‘citizen’	vs.	[ɔbivatɛlstʃɔ]	‘citizenship’
	[aktɔr]	‘actor’	vs.	[aktɔrstʃɔ]	‘acting’

The examples in (11b) show that the shape of the suffix is *-stʃɔ*. Consequently, there must be a process of cluster simplification in (11a), which is analogous to the one presented with the morpheme *-ski*. The only difference lies in the gesture after the fricative. This renders the constraint in question inapplicable. Possibly, as a repair strategy, one could generalise the shape of the second category to C, any consonantal gesture. Despite a seeming advantage, the constraint becomes even more problematic. Now any cluster /sC/ in the language is penalised, which is an undesirable solution, considering the abundance of Polish data to the contrary (e.g. [miska] ‘bowl’, [vispa] ‘island’, [lista] ‘list’, etc.). An expectation is that such a constraint be ranked low in the hierarchy, which would technically solve the problem of /sC/ clusters in numerous output forms. However, the issue why this constraint enters the hierarchy at all remains unclear, which leads us to the second line of criticism.

The superiority of OT over rule-based frameworks resides in explicit articulation of the driving force behind seemingly unrelated processes. By introducing a constraint which penalises /sC/ sequences, no such motivation is revealed. Worse still, the force responsible for cluster reduction, i.e. elimination of length distinction in consonantal adjacency, remains obliterated. The formula of alignment, however, does not allow to add a condition that Align is operative iff the first category is preceded by an

identical gesture. Consequently, it follows from its definition that the idea of alignment cannot account for the nature of cluster reduction in homorganic sequences of affricates and fricatives.

On a general level, it is interesting to ask whether alignment constraints are able to express the phenomenon of any cluster reduction. They are designed to capture the facts of gestural overlap and so far they have been used in the literature to express the gradualness of changes. The moment one gesture fully masks the other, overlap reaches the end of scale, which raises a problem. Specifically, alignment constraints by definition are responsible for collocation of edges and not for expressing dominance. In other words, there is nothing in the formula of a constraint to indicate which gesture appears on the surface. If the direction of overlap were invariably regressive, dominance would naturally follow from the template of gestural alignment. However, phonology knows of numerous cases of progressive overlap, be it coarticulation or masking. Consequently, I claim that a different mechanism within OT is required to account for phonostylistic cluster reduction, yet I leave the matter open.

Given the discussion above, I shall not entertain the option of using alignment constraints to account for the simplification of [tʃs] sequences. Instead, I shall suggest a solution pivoting around the idea of marked affricate + fricative clusters. To a great extent, this line of reasoning follows from the initial distinction of directionality of overlap. Since the analysis of the right margin of [tʃsC] has proven to be unpromising, the alternative approach concerning the other edge needs to be considered. The details of this analysis follow below.

Polish seems to have a dispreference towards clusters of affricates followed by homorganic fricatives. According to the *Dictionary of contemporary Polish* [trans. *Słownik współczesnego języka polskiego*, 1996], no such sequences are attested in the lexicon, which would suggest that Polish has an undominated constraint against them. Its formula is shown in (12) below.

- (12) \*Aff<sub>i</sub>+Fric<sub>i</sub>  
 ‘Sequences of affricates followed by homorganic fricatives are forbidden.’

This markedness constraint however is violated by a number of words because, as data in (13) show, Polish does have such sequences in rapid speech.

	Careful speech		Rapid speech
(13) (a)	[tfartʃi]	‘harder’	~ [tfartʃ̃si]
	[ɔdʒivjate]	‘to nourish’	~ [ɔdʒ̃ivjate]
	[ɔtɛate]	‘to sift out’	~ [ɔt̃ɛate]

- (b) [pjɛntɕɛt]      ‘five hundred’    ~    [pjɛntsɛt]  
       [dzɛvjɛntɕɛt]    ‘nine hundred’    ~    [dzɛvjɛntsɛt]

Homorganic clusters in (13) emerge due to assimilatory processes, which include affrication (13a) and place assimilation (13b).<sup>14</sup> This fact does not differentiate them from words in (6) or (11a), where surface affricates are frequently derived. Thus, it is not the origin but the context where one should seek differences. The deletion in words such as [grujɛtski] follows from preconsonantal position of the cluster, which is not the case in (13). The question now is how to incorporate this information into the format of the markedness constraint in (12). It is impossible to simply expand it by the addition of a consonant (C) since this segment cannot be penalised in output forms. The consonant is the trigger, not the target. In other words, its presence is a prerequisite for the applicability of \*Aff<sub>i</sub>+Fric<sub>i</sub>. I suggest that this conditional mode can be expressed by means of a constraint conjunction. It remains now to be asked what should be conjoined as a force verbalising this condition.

Let us recall that the difference between words such as /grujɛts + ski/ and examples in (13) resides in the fact that the former group contains a consonant following the problematic cluster. This cannot have implications for the syllable structure since in both groups obstruents can enter the onset due to the rule of Obstruent Sequencing Suspension in syllabification (Rubach 1999). What is different however is the position of C-centre, the mean of all plateau midpoints for the gestures in a sequence (Browman – Goldstein 1988). It is claimed that this global property is crosslinguistically characteristic of onsets and its position is relatively stable with respect to the following coda (Pouplier 2011 and citations therein). The addition of a consonant to [tss] sequence shifts the C-centre to the right edge of the given cluster. This move is potentially problematic in the light of the limitation in cluster formation of strident coronals. Specifically, when two such sounds occur word-initially, they only allow another strident but non-coronal segment to follow the cluster, as in the word [st̪sfani] ‘cunning’. In AP terms, this means that the C-centre of a sequence of strident coronals is only sensitive to another strident, which can be illustrated by means of the constraint in (14).

- (14) C-CENTRE (strid, cor)  
       ‘The C-centre in a cluster of strident coronals can be shifted exclusively by another strident sound.’

Interestingly, strident coronals in [st̪sfani] are sequenced in a reverse order with respect to the clusters of affricates and fricatives presented in this article, which follows from a dispreference against the latter group.

Consequently, it is virtually impossible to find a sequence of an affricate followed by a homorganic fricative and an additional consonant word-initially.

A reviewer asks a question whether the above generalisation about phonotactic restrictions is not invalidated by words such as *trzmieł* ‘bumblebee’ or *trznadęł* ‘yellowhammer’. In rapid speech, after affrication has taken place, these forms are said to be pronounced respectively as [tʃ̣smjɛł] and [tʃ̣snadɛł]. Consequently, they contain sequences of homorganic affricates and fricatives followed by an additional consonant, the combination of which is, to my view, unattested. The reviewer correctly noticed that in Cracow Polish sequences of homorganic affricates and fricatives are simplified to affricates, which means that *trzmieł* and *trznadęł* are respectively pronounced there as [tʃ̣smjɛł] and [tʃ̣snadɛł]. I postulate that the same phenomenon occurs in Standard Polish in preconsonantal environment, yet this issue requires further research.

With reference to the constraint in (14), it remains to be asked which place it should occupy in the ranking. It seems that it is not violated by any attested forms. This is however belied by several words which add segments at the left margin of clusters of strident coronals, such as [pʃ̣tʃ̣owa] ‘bee’, [fʃ̣tʃ̣optɛ] ‘to instigate’ and [xʃ̣tɛitɛ] ‘to baptise’. It is interesting that all additional segments belong to the class of non-coronals, yet this fact does not have to invalidate the constraint. It only suggests that the position of C-CENTRE (strid, cor) in the ranking should be low.

To conclude the analysis of the constraints introduced above, \*Aff<sub>i</sub>+Fric<sub>i</sub> as well as C-CENTRE (strid, cor) occupy low positions in the hierarchy, yet they need to be placed higher than a constraint against deletion MAX. Importantly, the conjunction of the new constraints has to outrank its components to ensure cluster reduction in a specific environment. This is illustrated in the following evaluation of /grujɛts + ski/ in (15).

(15) Tableau for /grujɛts + ski/

/grujɛts + ski/	DEP	MAX (ROOT)	C-CENTRE & *Aff <sub>i</sub> +Fric <sub>i</sub>	C-CENTRE	*Aff <sub>i</sub> +Fric <sub>i</sub>	MAX
a. grujɛtsski			*!	*	*	
b. grujɛtski						*
c. grujɛski		*!				*
d. grujɛtsseki	*!				*	

The faithful candidate (15a) is eliminated due to a fatal violation of the constraint conjunction C-CENTRE & \*Aff<sub>i</sub>+Fric<sub>i</sub>. The winning candidate (15b) emerges as the optimal output despite the violation of a low-ranked

MAX. Other candidates cannot be eliminated by means of the conjunction; therefore, the burden of evaluation is passed onto other constraints. Specifically, candidate (15c) satisfies  $*\text{Aff}_i + \text{Fric}_i$  but at the cost of affricate deletion. This is penalised by MAX (ROOT), which prohibits deletion of segments in the root. Candidate (15d) incurs a violation of  $*\text{Aff}_i + \text{Fric}_i$  but it satisfies C-CENTRE (strid, cor) at the cost of vowel insertion. This is a less optimal solution, which is penalised by DEP a high-ranked constraint against insertion. Interestingly, candidate (15d) is similar to the words in (13) in that a sequence of an affricate and a fricative is followed by a vowel. As is clear from the tableau, the constraint conjunction cannot eliminate such words.<sup>15</sup>

Although the ranking in (15) ensures the selection of the output with simplified [tss] sequence, it faces a problem with the evaluation of /sevilla + ski/. Neither of the constraints used so far can eliminate the lateral geminate since the system has been adjusted to handle sequences of strident coronals. To account for the deletion of [l], a constraint must be applied specifically targeting geminates. Following the work by Pająk (2009b), I suggest constraints regulating geminate adjacency.

As already discussed in section 2, geminates crosslinguistically are well-attested in intervocalic position yet their distribution is inconsiderable in one-side consonantal adjacency and most rare interconsonantly. These observations are translated into constraints in (16).

- (16)  $*\text{Gem}/V\_V$  ‘Geminates flanked by vowels are not allowed.’  
 $*\text{Gem}/1\_VA$  ‘Geminates adjacent to exactly one vowel are not allowed.’  
 $*\text{Gem}/NVA$  ‘Geminates not adjacent to any vowel are not allowed.’

To express the frequency of occurrence a ban against interconsonantal geminates must crucially dominate a constraint against single vowel adjacency. This in turn must outrank a ban on intervocalic geminates, which needs to be placed low in the hierarchy for Polish. The constraint interaction is shown in (17).

- (17)  $*\text{Gem}/NVA \gg * \text{Gem}/1\_VA \gg * \text{Gem}/V\_V$

To ensure the selection of the optimal output for /sevilla + ski/, the rankings (15) and (17) need to interact. This is shown in the following evaluation in (18). I omit the constraints referring to strident coronals as they do not participate in selecting the degeminated output.

(18) Tableau for /sevilla + ski/

/sevilla + ski/	*Gem/NVA	*Gem/1 VA	DEP	MAX (ROOT)	*Gem/V_V	MAX
a. sevillaški		*!				
b. sevilski				*		*
c. sevillaški			*!		*	
d. sevilški			*!			

The selection of the winning candidate (18b) shows that deletion is a more optimal solution than leaving a geminate intact, as is the case in candidate (18a). Vowel insertion as a strategy is also rejected, as shown in the evaluation of candidates (18c-d). Importantly, epenthesis turns out to be more costly than deletion, which is indicated by a solid line between Dep and MAX (ROOT).

To summarise, the tableaux in (15) and (18) show how different mechanisms employed within OT can handle the phenomenon of cluster reduction. The advantage of the model is that it makes an explicit distinction between the phonological and phonetic types of deletion. It also bases its constraints on phonetic facts. To this end, it makes crucial use of the theory of Articulatory Phonology. However, the implementation of the theory of local constraint conjunction complicates the analysis, which initially attempted to impose a limit on abstractness by means of the idea of alignment. Consequently, it remains a research topic whether phonostylistic cluster reduction can be expressed without the need to resort to any subtheories within OT. It is also interesting to explore the potential of C-centre metric in designing constraints, especially in articulating phonotactic restrictions.

## 5. Conclusions

This article has attempted to illustrate that segmental context plays an important role in cluster simplification processes in Polish. On the basis of denominal adjectives formed by the suffix *-ski*, there has been shown a distinction between the rule of degemination and phonostylistic cluster reduction of sequences of affricates followed by homorganic fricatives. To account for the latter process, a solution has been sought within the theory of Articulatory Phonology. Faced with inefficiency of the standard approach, an alternative has been suggested by making use of the theory of local constraint conjunction. Finally, a constraint hierarchy has been designed within Optimality Theory to account for the lack of length distinction in consonantal adjacency.

## NOTES

\* I would like to thank two anonymous reviewers of this journal for their remarks and criticism, which led to improvement of both the content and the presentation of my analysis.

<sup>1</sup> Polish is said to have a ban on word-final geminates (Rubach – Booij 1990, Pająk 2009b, Baković – Pająk 2010).

<sup>2</sup> High front vocalic segments trigger the process of Surface Palatalisation, as a result of which the preceding consonants receive a secondary articulation of tongue body raising (Wierzchowska 1971, Gussmann 1980a, Rubach 1984). I will ignore this process in this paper as it is irrelevant for my analysis. By the same token, I will omit stress in the transcriptions throughout the article.

<sup>3</sup> For discussion of geminates in Polish, see Rubach (1986a, 1986b), Rubach – Booij (1990), Sawicka (1995).

<sup>4</sup> The form [ranni] contains two morpheme boundaries since the final vowel is an inflectional ending. Likewise, [lækki] and [nišši] should have two morpheme boundaries each. Yet I choose not to separate inflectional endings for expository purposes.

<sup>5</sup> The morpheme *-ski* contains a ‘yer’, a vowel without a timing slot. This vowel never surfaces but it triggers the process of palatalisation, which, among others, changes [n] to [ɲ]. For more information on palatalisation, see Gussmann (1973, 1980a, 2007), Rubach (1977, 1984, 1994).

<sup>6</sup> Polish in fact simplifies consonantal clusters before suffix *-ski*, as shown in the following examples: /bidgɔʂʂi + ski/ → [bidgɔski] ‘place name adj.’, /ʂɛfts + ski/ [ʂɛfski] ‘shoemaker’s’, /malbɔrk + ski/ [malbɔrski] ‘place name adj.’. Although the sequences of consonants in the coda are in accordance with sonority hierarchy, they are simplified by deleting the final consonant of the stem (Gussmann 1980b). Hence, extrasyllabicity cannot be the trigger for cluster reduction. This matter falls out of the scope of this article, yet it requires further research.

<sup>7</sup> Polish has a productive rule of Final Devoicing and Voice Assimilation (Rubach 1984). I ignore this issue since it has no bearing on the structure of argument.

<sup>8</sup> Rubach (1994) refers to this process of obligatory assimilation as Dental Spreading. As will be shown later, also affricates are in the input to the rule.

<sup>9</sup> Word-initial geminates are resistant to reduction. For more information, see Pająk (2009b) and Pająk – Baković (2010).

<sup>10</sup> I omit here the analysis of stems which end in stops, such as *pirat – piracki* ‘pirate’ adj., *Szwed – szwedzki* ‘Swedish’, *kozak – kozacki* ‘Cossack’. The adjectives also surface with affricates as in (6) but it is done due to palatalisation rules (Gussmann 1973, 1980, 2007, Rubach 1977, 1984, 1994), which I do not wish to discuss in this article.

<sup>11</sup> For more information on derived and underlying affricates, see Krajewska (2012).

<sup>12</sup> For further information on gestural structure, see Gafos (2002).

<sup>13</sup> A potential candidate for local conjunction could be gestural OCP (Gafos 2002: 26). Unlike its standard version, it could target adjacent fricative portions in [tss] cluster. Both constraints, Align and OCP, would have to be ranked low in the hierarchy to allow /sk/ sequences and geminates respectively. However, their conjunction ranked high would penalise clusters of [tssk].

<sup>14</sup> For more information on the nature of these assimilatory processes, see Rubach (1994).

<sup>15</sup> As a matter of fact, the input form should contain a yer and thus take the shape of /grujɛts + Eski/. The elimination of an unparsed vowel would be due to the violation of a constraint PARSE(SEG), which mandates parsing underlying segments into syllable structure. Since candidates containing yers are less optimal, one could choose forms that



either parse these vowels or delete them. The former strategy would result in the violation of DEP( $\mu$ ) since a new syllable would be created, whereas the latter would be at the cost of violating MAX(V). The interaction between all of the above mentioned constraints should ensure the selection of a candidate without the problematic vowel. This issue is, however, non-essential for this article as it casts no light on consonantal interactions between affricates and fricatives. Therefore, I shall not include it in the discussion.

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