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The Sonority Sequencing Generalization and the Structure of Consonant Clusters with Trapped Sonorants in Polish

Abstract: This paper discusses the structure of consonant clusters in Polish involving so-called trapped sonorants in syllable onset, i.e. consonantal sonorants that appear between two consonants of lower sonority, as in *krwi* 'blood' (gen. sg.) and *brwi* 'brow' (gen. sg). It is argued that their structure is much more restricted than would be expected from the application of the phonotactic generalizations of Polish identified so far. It is further argued that the patterning of trapped sonorants sets them apart from other sonorants violating the Sonority Sequencing Generalization (SSG) in Polish, revealing much greater influence of the SSG on the makeup of word-initial three-term consonant clusters than required by the phonotactic constraints of Polish described in the phonological literature. The structure of the paper is as follows: In Section 1 the principle of the SSG is discussed. In Section 2 data that show how consonant clusters in Polish appear to violate the SSG are presented. Section 3 shows how this lack of conformity with the SSG has been explained in the existing phonological literature. Section 4 offers new observations about the unexpectedly restricted structure of consonant clusters involving trapped sonorants. Section 5 provides a tentative explanation for the generalizations presented in Section 4.

This paper addresses the problem of consonant clusters in Polish involving so-called trapped sonorants in syllable onset, i.e. consonantal sonorants that appear between two consonants of lower sonority, as in (for example) *krwi* [krf^{j} i] 'blood' (gen. sg.) and *brwi* [brv^{j}i] 'brow' (gen. sg).[1] It is argued that their structure is much more restricted than would be expected from the application of the phonotactic generalizations of Polish identified so far. It is further argued that the patterning of trapped sonorants sets them apart from other sonorants violating the Sonority Sequencing Generalization (SSG) in Polish, revealing much greater influence of the SSG on the makeup of word-initial three-term consonant clusters than required by the phonotactic constraints of Polish described in generative phonological literature.[2]

[1] The term is more often used specifically with reference to a sonorant between two obstruents, such as the [r] in *grdyka* 'Adam's apple,' than to a sonorant in either this position or between an obstruent and a sonorant of lower sonority, e.g. the first [r] in *krnąbrny* 'unruly.'

[2] For earlier studies of the structure of Polish onsets see (for example) Kuryłowicz (1952), referring to the 'functional' theory of syllable structure presented in Kuryłowicz (1948). (For an in-

The theoretical framework assumed in this paper is the Derivational Optimality Theory (Kiparsky 1997; 2000; Rubach 1997; 2000a; 2000b; 2003; 2005; 2008), although the new observations presented in Section 4 are about facts and should maintain their relevance regardless of the theoretical interpretation.

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1. The Sonority Sequencing Generalization

The Sonority Sequencing Generalization (SSG) is a principle which connects syllable structure with the Sonority Hierarchy. Although the name Sonority Sequencing Generalization comes from Selkirk (1980), the idea of associating syllable well-formedness with sonority-related ordering of the classes of sounds is much older and can be found as early as Jespersen (1904).[3] The SSG says that in a well-formed syllable, as we move from the nucleus to the edges of the syllable, the sonority of segments decreases.

The principle refers to the concept of the Sonority Hierarchy, which is used to measure the relative sonority of different classes of segments. That idea is even older, dating back to works by Whitney (1865) and Sievers (1881). In the Sonority Hierarchy, the order of main segment classes, arranged from the most to the least sonorous, is as follows:

vowels — glides — liquids — nasals — fricatives — affricates — stops

The Sonority Sequencing Generalization is considered part of the universal component underlying the phonotactic constraints of any particular language, which means that it is expected to apply to all languages. Consequently, before anything is known about the language-specific phonotactic constraints of a given language, it can be assumed that a hypothetical word such as [klʌmp] is more likely

sightful discussion of Kuryłowicz's 1952 solution see Gussmann and Cyran 1998). For more recent works, outside the generative phonology-OT line of development, see Gussmann and Cyran (1998), Scheer (2004), Gussmann (2007), Bloch-Rozmej (2008), Kijak (2008), Cyran (2010). I do not follow this line of analysis, as it assumes a highly controversial idea of syllables with empty nuclei, an assumption not shared by the framework adopted in the present paper (OT, DOT).

[3] The Sonority Sequencing Generalization, with its reference to the Sonority Hierarchy, is not the only way offered in phonological literature to account for the structure of consonant clusters by means of an independent hierarchy of classes of segments. For an overview of other scales, evoking the idea of so-called segmental strength, see (for example) Bloch-Rozmej (2008: 118–128).

to be a possible word of that language than hypothetical words such as *[lkʌmp], *[klʌpm] or *[lkʌpm].[4]

Without some principle indicating the preferred ordering of segments (in a word or in a syllable) such an expectation is hard to justify. All four words are monosyllabic, all have the same vowel, the same number of consonants and even the same consonants. The Sonority Sequencing Generalization provides an elegant way to explain why one of the four strings of segments is more likely to be a word than the other three: it is better-formed as a syllable. The crucial difference is that in [klʌmp], the segments adjacent to the nucleus, i.e. [l] and [m], are sonorants, which are high on the sonority scale, and the segments in the position further away from the nucleus, i.e. [k] and [p], are voiceless stops, which are the lowest in the sonority scale, whereas in the other three words this ordering is reversed — either in the syllable onset (*[lkʌmp] and *[lkʌpm]) or in the syllable coda (*[klʌpm] and *[lkʌpm]) or in both syllable margins (*[lkʌpm]). When a segment adjacent to the syllable nucleus is a sonorant and the segment further away from the nucleus is an obstruent, as in [kl-] and [-mp] in [klʌmp], the sonority of the syllable margin decreases with the distance from the nucleus — in other words, the syllable structure adheres to the Sonority Sequencing Generalization. When a syllable margin is made up of a voiceless stop (or, for that matter, any obstruent) adjacent to the nucleus and a sonorant separated from the syllable nucleus by that stop (as in [lk-] in *[lkʌmp] and *[lkʌpm] and in [-pm] in *[klʌpm] and *[lkʌpm]), the sonority of the syllable margin increases with the distance from the nucleus, which means that the syllable structure violates the Sonority Sequencing Generalization, either unilaterally or bilaterally. Consequently, it is not a well-formed syllable.

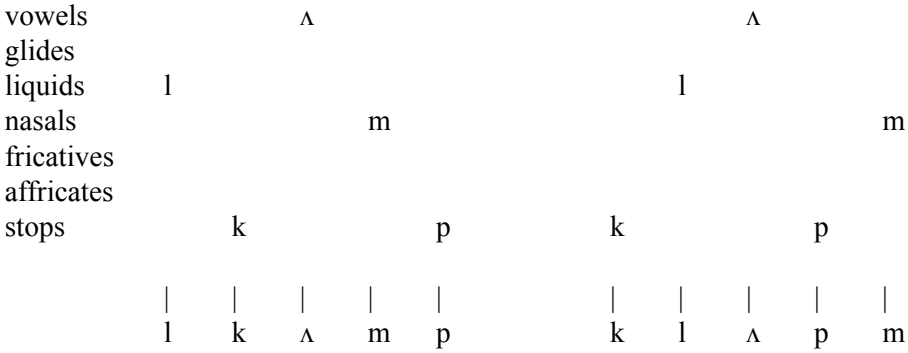
Graphically, the difference between the structure of a well-formed syllable, in terms of the SSG, and the structure of faulty syllables can be demonstrated in a simple diagram where the horizontal axis shows the order of sounds and the vertical axis shows their sonority. Consider the diagrams in (1) and (2).

(1) Sonority diagrams for [klʌmp] and *[lkʌpm]

vowels			ʌ						ʌ		
glides											
liquids		l					l				
nasals				m							m
fricatives											
affricates											
stops	k				p			k		p	
	|	|	|	|	|		|	|	|	|	|	
	k	l	ʌ	m	p		l	k	ʌ	p	m

[4] Incidentally, this particular expectation is confirmed for English: *clump* [klʌmp] is an actual word in English, while **lkump* [lkʌmp], **clupm* [klʌpm] and **lkupm* [lkʌpm] are not.

(2) Sonority diagrams for *[lkʌmp] and *[klʌpm]



In terms of the graphic presentation above, it can be said that the sonority diagram of a well-formed syllable resembles the shape of a gable roof, with no trough-like areas or plateaus. The presence of any such troughs or plateaus reveals a structure that violates the Sonority Sequencing Generalization and shows that the syllable is not well-formed, regardless of any other more specific phonotactic constraints that apply in any given language.

2. The case of Polish: consonant clusters violate the SSG

It might be tempting to use the observation that syllables tend to adhere to the Sonority Sequencing Generalization across languages as a starting point for a stronger claim: that the SSG constitutes an obligatory, inviolable condition of syllable structure in all languages, which can only be further restricted, but never relaxed, by language-specific phonotactic constraints. However, such a claim is challenged by data from Polish, among other languages.

Polish is known to abound in consonant clusters that violate the SSG in various ways. The chart in (3) provides some examples of such unruly structures.

(3) Examples of violation of the SSG in Polish consonant clusters

a) sonority plateau among obstruents: two segments in a syllable margin have the same sonority (two stops, two fricatives, two affricates):

i. two voiceless stops
ptak [pt-] ‘bird,’ *kto* [kt-] ‘who,’ *tkać* [tk-] ‘weave,’ *kpić* [kpʲ-] ‘mock’

ii. two voiced stops
gdy [gd-] ‘when,’ *gbur* [gb-] ‘boor,’ *dbać* [db-] ‘care’

iii. two voiceless fricatives
wszystko [fš-] 'everything,' *szwy* [šf-] 'seams,' *chwalić* [xf-] 'praise'

iv. two voiced fricatives
wrzask [vž-] 'cry,' *żwawy* [žv-] 'lively,' *wziąć* [vʑ-] 'take'

v. two voiced affricates
dżdżownica [dᶾdᶾ-] 'earthworm,' *dżdżysty* [dᶾdᶾ-] 'rainy'

vi. two voiceless affricates
czcić [tᶴtᶜ-] 'worship,' *czcionka* [tᶴtᶜ-] 'font,' *czczy* [tᶴtᶴ-] 'empty'

b) 'sonority trough': sonority increases towards the edges, instead of decreasing:

i. involving two obstruents: a fricative further from the nucleus than a stop
wtorek [ft-] 'Tuesday,' *stać* [st-] 'stand,' *szpital* [šp-] 'hospital'

ii. involving two sonorants: a liquid further from the nucleus than a nasal
lnu [ln-] 'flax' (gen. sg.), *lniany* [lɲ-] 'linen' (adj.)

iii. involving an obstruent and a sonorant:
1. CC-clusters
a. with a liquid
rtęć [rt-] 'mercury,' *rdest* [rd-] 'knotgrass'
rwać [rv-] 'tear,' *rżeć* [rž-] 'neigh'
lwa [lv-] 'lion' (gen. sg.), *lżyć* [lž-] 'insult'

b. with a nasal
mchu [mx-] 'moss' (gen. sg.), *msza* [mš-] 'mass'

2. CCC-clusters: sonorant + obstruent + sonorant
a. with a liquid in the outermost position
lśnić [lɕɲ] 'shine'

b. with a nasal in the outermost position
mdleć [mdl-] 'faint,' *mgle* [mgl-] 'mist' (loc. sg.)

Given the data in (3), which show how Polish consonant clusters egregiously violate the SSG, we are faced with the question of whether the Polish phonological system as whole is not an exception to the general character of the principle or,

alternatively, whether the application of the Sonority Sequencing Generalization in Polish is not obscured or limited in some way. Both options are outlined in (4).

(4) a) Polish syllable structure does not obey the SSG — anything goes.
b) Polish syllable structure does obey the SSG, but either
i) in an opaque way, or
ii) in a restricted manner, to some extent only.

If hypothesis (4a) is correct, we should observe no sonority-related restrictions on the shape of syllable margins in Polish, and this should be true for all positions — word-initial, word-final, word-medial — and for consonant clusters of any length allowed by the phonotactic constraints of Polish. If, on the other hand, hypothesis (4b) is correct, it remains to be clarified how the SSG is obeyed in spite of appearances to the contrary (4bi), or to what extent it is obeyed and when it is suspended (4bii). These issues are discussed in the following section.

3. The opaque and restricted functioning of the SSG in Polish

As shown by Rubach and Booij (1990b), there is evidence in favour of (4b) rather than (4a). The details are presented below.

The experiments reported in Rubach and Booij (1990b: 126) show that when native speakers are asked to divide words with medial clusters into syllables, they treat clusters of two obstruents differently from clusters beginning with a sonorant. With clusters of obstruents only, native speakers divide words into syllables as if the SSG did not exist, freely putting two obstruents in the syllable onset, regardless of their sonority. In the case of clusters beginning with a sonorant, however, they always syllabify words in a manner conforming to the SSG. Thus, words with medial clusters of obstruents, such as [-tk-] in, e.g., *matka* 'mother,' are syllabified by some native speakers as *ma-tka* and by others as *mat-ka.* On the other hand, words with medial clusters beginning with a sonorant, such as [-rt-] or [-ln-] in, e.g., *karta* 'card' or *walny* 'general,' are always syllabified as *kar-ta* and *wal-ny* and never as **ka-rta* or **wa-lny.* This is especially interesting if we remember that there are words like *rtęć* [rt] 'mercury' and *lnu* [ln] 'flax' (gen. sg.), where the same clusters occur word-initially. Naturally, words such as *mokry* 'wet' can be syllabified as either *mo-kry* or *mok-ry*, as neither option involves a violation of the SSG.

This observation led Rubach and Booij to the following two conclusions about the way the Sonority Sequencing Generalization works in Polish:

(5) a) In Polish the SSG is observed, but not at word edges.
b) In Polish the SSG is not observed among obstruents.

The observations in (5) are now better known in the following form:

(6) a) At word edges, sonorants that violate the SSG cannot be syllabified and are extrasyllabic.
b) With obstruents, there is no requirement for sonority distance.

Rubach and Booij (1990a: 431) call hypothesis (6b) the Obstruent Sequencing Principle (OSP).

Thus, Rubach and Booij (1990a) demonstrated that in Polish both (4bi) and (4bii) are true: the application of the Sonority Sequencing Generalization is opaque at word edges, because the consonantal sonorants that appear to violate the SSG are extrasyllabic, hence they are not part of the syllable structure and do not constitute a violation of the SSG (4bi). Also, the application of the Sonority Sequencing Generalization in Polish is restricted in that it does not apply in clusters of obstruents — hypothesis (4bii).

However, as will be shown in the next two sections, there are other, hitherto unaccounted for, restrictions on the structure of consonant clusters in Polish, which under certain assumptions can be interpreted in a way that sheds new light on the scope of the application of the Sonority Sequencing Generalization in Polish. These restrictions concern clusters involving so-called trapped sonorants.

4. Unexpected regularities in the structure of consonant clusters with trapped sonorants

Principles (6a) and (6b) do not account for the very restricted structure of word-initial consonant clusters with a trapped sonorant, i.e. CCC-clusters with a sonorant in the position second from the nucleus, which violate the SSG. These clusters are discussed below.

List (7) shows all word-initial consonant clusters with trapped sonorants in Polish. It has been compiled on the basis of the list of homomorphemic clusters in Pawelec (1989) and checked against the lists in Bargiełówna (1950).

(7) Word-initial consonant clusters with trapped sonorants in Polish
a) two obstruents separated by a sonorant
i. voiceless obstruents
pwt^{c}- *płciowy* ‘sexual’
plf- *plwocina* ‘spit’

trf- *trwały* ‘lasting’
krf- *krwawy* ‘bloody’
krf^{j}- *krwinka* ‘blood cell’
krt- *krtań* ‘larynx’

ii. voiced obstruents
brv^{j}- *brwi* ‘eyebrows’
drg- *drgać* ‘twitch,’ *drgawki* ‘convulsions’
drv- *drwal* ‘lumberjack’
drv^{j}- *drwina* ‘mockery’
drž- *drżeć* ‘tremble’
grd- *grdyka* ‘Adam’s apple’
brd- *Brda* (the name of a river)

b) a consonantal sonorant between another consonantal sonorant and an obstruent
krn- *krnąbrny* ‘unruly’
brn- *brnąć* ‘flounder’
brɲ- *brnie* ‘flounders’

The list in (7) shows that consonant clusters involving trapped sonorants display regularities that are not accounted for by the generalizations in (6a) and (6b). They could be spelt out as follows:

(8) a) There are no clusters of a voiced obstruent and a voiceless obstruent separated by a sonorant, so the following (for example) are not possible:
*krd- , *drf- , *grt-

b) All clusters involving trapped sonorants begin with a stop.

c) In word-initial clusters only liquids occur as trapped sonorants (and in most cases the sonorant is [r] rather than [l]).

In view of the existing generative phonological literature, there is an important difference between observation (8a) on the one hand, and observations (8b) and (8c) on the other.

The regularity expressed in (8a) is a consequence of the fact that trapped sonorants are transparent to voice assimilation. This observation is not new, and it is well-described in phonological literature (see, e.g., Rubach 1997, see also the next section). Another well-known observation, connected with it but not listed in (8), is that nonsyllabic sonorants between voiceless obstruents are voiceless too.

However, the generalization captured in (8b) — that in CCC-clusters with a trapped sonorant, the consonant furthest from the nucleus is invariably a stop

— is by no means an expected pattern. Not only is it not justified by either (6a) or (6b) above, but it is contrary to what might be predicted about the structure of such clusters.

Recall that stops are the class of consonants which have the lowest sonority in the Sonority Hierarchy. There is no *a priori* reason, even if the Sonority Sequencing Generalization were assumed to apply here, why a consonant positioned further away from the nucleus than a consonantal sonorant should be a stop and not a fricative. In both cases the sonority decreases. The observation is even more unexpected when we consider that there are no CCC-clusters with a nasal in the first position and a liquid in the second position, where sonority would also decrease, in agreement with the SSG.

Before offering a tentative account of the patterning of CCC-clusters with trapped sonorants, let us return to the issue of extrasyllabicity.

Notice that the generalizations in (6) predict that at word edges only sonorants are extrasyllabic. The non-compliance of obstruent clusters with the SSG is accounted for by the Obstruent Sequencing Principle. The idea of the extrasyllabicity of sonorants is not evoked merely to use a different term to say that they do not adhere to the SSG. The consequences of their status are more complex, concerning, among other things, the transparency of extrasyllabic sonorants with respect to voice assimilation rules and the instability of syllabification patterns in medial clusters containing trapped sonorants.

The hypothesis that monosyllabic sonorants at word edges are extrasyllabic raises the question of how they are accommodated in the prosodic structure. This is a much broader issue, which goes beyond the scope of the present paper. It is relevant to notice, however, that extrasyllabicity is postulated not only for word-initial and word-final sonorants, but also for sonorants in other positions where they violate the Sonority Sequencing Generalization. This view is adopted by, among others, Rubach (1997), in a study of Polish phonology within the theoretical framework of early Derivational Optimality Theory, which focuses on the problem of extrasyllabic consonants in Polish. One of the key diagnostics that a sonorant in a cluster is extrasyllabic is that it is transparent to voice assimilation rules. However, as can be seen in the cluster typology presented in (9) below, this regularity does not apply in the opposite direction: there are extrasyllabic sonorants that are not transparent to voice assimilation (see 9a).

According to Rubach (1997), in Polish there are four kinds of environment in which consonantal sonorants occur with what appears to be an SSG violation and should be regarded as extrasyllabic. They are identified in (9) below, which also indicates, for each type, how the sonorants in that position behave with respect to voice assimilation among obstruents.

(9) a) word-initial, e.g., *rtęć* ‘mercury,’ *lśnić* ‘shine’; sonorants in this position are not transparent to voice assimilation, e.g., in *brak rdzy* [-k rd^{z}-] ‘lack

of rust' there is no voicing of /k/ to /g/ before [d^z-] across the word-initial [r];

b) word-final, e.g., *łotr* 'villain,' *organizm* 'organism'; sonorants in this position are transparent to voice assimilation, e.g., in *wiatr zachodni* [-dr z-] 'west wind,' the underlying /t/ assimilates in voice to /z/ (becoming [d]) across the word-final /r/;

c) word-medial between two syllable nuclei (and not adjacent to any of them, naturally); sonorants in this position are also transparent to voice assimilation, e.g., in *mędrka* [-trk-] 'know-all' (gen. sg.), /d/ assimilates in voice to /k/ across the [r] and becomes [t];

d) in the onset of a word-initial syllable, between two consonants of lower sonority; sonorants in this position, the so-called trapped sonorants, are also transparent to voice assimilation, e.g., in *krwi* [krf^j-] 'blood' (gen. sg), /v/ assimilates to /k/ across the /r/ and becomes /f/ (progressive assimilation).

In view of the extrasyllabic status of trapped sonorants in word-initial clusters, the restriction on the structure of these clusters expressed in (8b) seems unjustified. The reasoning behind this contention can be presented as follows.

Let us designate the positions of consonants in a cluster with respect to the syllable nucleus as n-1 (the closest), n-2 (further), n-3, etc. If the consonant in position n-2 — i.e. C_{n-2} — is extrasyllabic, then it is by definition not included in the syllable structure; therefore it cannot be expected that the SSG would apply to the sequence C_{n-3} C_{n-2} and restrict the selection of the type of consonant that can appear in position n-3.

Now let us consider two options for the way the extrasyllabic status of a trapped sonorant can affect the application of the SSG to the whole cluster, which I will call Option 1 and Option 2. If Option 1 is adopted, C_{n-2} 'blocks' the application of the SSG, and the sonority-based choice of C_{n-3} is totally unrestricted. If Option 2 is assumed, C_{n-2} is transparent and 'invisible' to any rules and generalizations pertaining to the syllable structure, so a CCC-cluster with the sequence C_{n-3} C_{n-2} C_{n-1} behaves like a CC-cluster made up of consonants that in the CCC-cluster appear in positons n-3 and n-1.

Neither of these seems to be true for Polish CCC-clusters with trapped sonorants. If Option 1 were correct, C_{n-3} would be occupied by consonants of any class — stops, affricates, fricatives or even nasals and liquids[5] — but as can be seen from the data in (7) this position is only filled by stops. The restriction on the

[5] Whether liquids and nasals could be expected here depends on the definition of 'a trapped sonorant.' If trapped sonorants are only those caught between two obstruents, then by definition neither nasals nor liquids could be found in position n-3.

choice of consonants in position n-3 is so strong that not only are there no clusters like *[lmt-], where sonority would increase between C_{n-2} and C_{n-3}, but there are not even clusters like *[lrd-] or *[mnd-], where sonority would stay on the same level.

The latter is especially telling in view of the fact that there are words with 2-term CC-clusters of nasals with a sonority plateau: *mnóstwo* [mn-] 'a lot,' *mną* [mn-] 'me' (instr. sg.), *mnich* [mɲ-] 'monk,' *mniemać* [mɲ-] 'think.' There are also words with CCC-clusters with a nasal as the first element, i.e. in position n-3: *mdleć* [mdl-] 'faint' and *mgle* [mgl-] 'mist' (loc. sg.), both quoted in (3biii2b) above.

If, on the other hand, Option 2 were correct, then in a CCC-cluster, i.e. in a sequence C_{n-3} C_{n-2} C_{n-1}, the consonant in position n-3 would behave as if it were structurally adjacent to C_{n-1}, occupied by an obstruent. Given the Obstruent Sequencing Principle (6b), which lifts any restrictions imposed by the Sonority Sequencing Generalization on the possible classes of neighbouring obstruents in a cluster, position C_{n-3} could be filled by stops, affricates or fricatives indiscriminately. Instead, as we have seen, it is always filled by stops.

Section 5 offers some suggestions as to how that unexpected pattern could be accounted for.

5. A tentative solution

As noted in (8b), word-initial trapped sonorants can only be preceded by a stop. Notice that this is exactly what should be expected of the first consonant in a three-term initial cluster, if the second consonant in the cluster were a fricative and the Sonority Sequencing Generalization were observed: the SSG would require that the sonority of the segment third from the nucleus be lower than the sonority of the segment second from the nucleus, which, the latter being a fricative, would only allow for stops in the position third from the nucleus.

Thus, a possible way to account for the observation in (8b) is to note that when position n-2 (the second from the nucleus) in a CCC-cluster is occupied by an extrasyllabic sonorant, the sonorant behaves with respect to the consonants it is sandwiched between like a fricative which not only is not extrasyllabic but which requires the consonant in position n-3 to conform with the Sonority Sequencing Generalization. Let us call such segments 'functional fricatives.' Their functioning could be described as follows.

(10) a) An extrasyllabic sonorant in position n-2 (the second from the nucleus), behaves phonotactically like a 'functional fricative' with respect to any C_{n-3}.

b) In a C_{n-3} C_{n-2} C_{n-1} sequence that has a 'functional fricative' in position C_{n-2}, the Obstruent Sequencing Principle does not apply.

The Obstruent Sequencing Principle is a condition constraining the application of the Sonority Sequencing Generalization, so its non-application in a particular environment means that in that environment the SSG strictly applies. Consequently, since any segment other than a stop would have sonority equal to or greater than that of a fricative and thus would violate the SSG, only stops are possible in position C_{n-3}.

The hypothesis presented above does not explain why trapped sonorants should function like fricatives. One possibility is that sonorant transparency is a manifestation not of extrasyllabicity only, but of either extrasyllabicity or a change of class from sonorants to obstruents. When a change of class takes place, it is minimal, so the sonorants turn into fricatives, the most sonorous among obstruents.[6]

Another question is why the Obstruent Sequencing Principle does not apply to such clusters. Here a possible answer is that the OSP applies to 'true obstruents' only, but not to language-specific 'functional fricatives.' When it does not apply, the Sonority Sequencing Generalization, a universal principle, applies unconditionally.

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[6] Note that this is not tantamount to saying that they turn into obstruents and *become* fricatives in every respect (for a recent study of the latter phenomenon and of liquid-fricative alternations in Polish, see Kijak 2011).

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