Neutralization and Transparency Effects in Consonant Clusters in Polish

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ABSTRACT

In phonetic descriptions, Polish is presented as a language in which sonorants are transparent to voice assimilation (VA). In the present paper we review phonetic data on which phonological analyses of VA in Polish are based. Our analysis provides statistical data from spectrographic analysis of the occurrence of opacity, transparency, sonorant devoicing, elision and the length of relevant segments in the realization of consonant clusters. Two claims are made: 1) according to our data, opacity, regular VA and sonorant elision are more pervasive than transparency; phonological analyses do not take into account cases of sonorant devoicing or elision which, consequently, count as transparency; the high proportion of sonorant devoicing and elision is therefore too important a fact to be ignored; 2) Another parameter when analyzing Polish consonant clusters and transparency effects is the length of the sonorant, which is the basis of "*Licensing by cue*". Our results confirm that there are no regularities that relate sonorant length to voicing contrast of the preceding obstruent.

1. INTRODUCTION

Slavonic languages such as Polish and Russian are regarded as paradigmatic examples for sonorant transparency in VA processes. The fact that sonorant transparency does not take place in Russian has been widely accepted in the literature (see [7] for references and discussion. Nevertheless, there seems to be consensus in accepting sonorant transparency in Polish, even though the distribution of voice presented in phonetic descriptions prior to phonological analyses differs considerably from the descriptions of studies of the phonetic system of Polish:

(1) Consonant cluster voice distribution ([1], [2], [3])[1]

a. Word-internally in non-final position:
i. Progressive VA (regular sonorant devoicing or elision) in word-initial position: *trwać* [tr̥f], *pomyślcie* [ɕt͡ɕ], *krtań* [kr̥t], *płci* [pw̥t͡ɕ], *czosnku* [sn̥k]
#[-voice] S [+voice] → [-voice] S̥ [-voice]
→ [-voice] [-voice]

ii. Regressive VA (VA when sonorant devoices) in word-medial position: *mędrca* [tr̥t͡s]// [drt͡s], *jabłko* [pw̥k] // [bwk], *od rtęci* [drt]//[tr̥t]
[+voice]S[-voice] → [+voice]S[-voice]
→ [-voice]S̥[- voice]

b. Word-internally in word-final position:
i. regular sonorant devoicing after unvoiced obstruent: wiatr [v'jatr̥], rytm [rɨtm̥]
[-voice] S# || → [-voice]S̥
ii. Optional obstruent and sonorant devoicing: kadr [dr] / [tr̥], realizm [zm] / [sm̥], ansambl [bl] / [pl̥]
[+voice] S# || → [+voice]S
→ [-voice]S̥

c. Across word boundaries:
i. Transparency: myśl bogata [ɕlb], myśl że [ɕlż]
[-voice] S# [+voice] → [+voice] S# [+voice]

ii. Optional sonorant devoicing and VA: każń przestępcy [ɕɲn̥p], módl się [tl̥ɕ]
[+voice] S# [-voice] → [-voice]S̥[- voice]
→ [+voice]S̥[- voice]

(2) Consonant cluster voice distribution ([4], [5], [6])

Transparency to VA:
a. Word-internally in word-final position (- OS#): żubra [ʒúbra] - żubr [ʒúpr];[2]
b.Word-internally in non-initial nor final position (#-OSO-#) i. krewny [krev], krwi [krf]
ii. mę[dr]ek mę[trk]a
b. Across word boundaries (OS#O) wiatr [tr]- wiatr wieje [dr#v])

2. EXPERIMENTAL PROCEDURE AND ACOUSTIC ANALYSIS

The corpus was made up of 95 items as a list of carrier sentences which were organized into three main blocks: a) -OS## clusters and (35 items) b) -OS##O (35 items) and c)

[1] Where: O = Obstruents, S = Sonorant, ## = word edge.

[2] [7] assumes optional neutralization in this context.

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##-OSO-## clusters (25 items). At the same time each block was divided into two groups: group 1: O̥SO, group 2: OSO̥) and into 3 contexts: OLO (OrO, OlO), OGO, ONO[3]. Block 3 was also divided into two groups according to progressive and regressive assimilation patterns. O#SO clusters were ruled out since they are not expected to undergo VA or sonorant devoicing.
The corpus was read by four female and two male speakers in the anechoic cabin of the Phonetic Laboratory at the University of Barcelona. Items of the corpus were analyzed by means of the speech analysis software Praat+, and statistical data were processed by means of the SPSS software. The analysis includes the sonority specification of each consonant, the length, and elisions in the realization of these clusters.

3. RESULTS AND COMMENTARY

Four possible cases were considered: a) Sonorant elision, which implies VA; b) Sonorant devoicing which also implies VA (only possible in group 1); c) Opacity, i.e there is no VA across the sonorant; and d) Transparency, i.e. there is voice assimilation across the sonorant.
In this section, data of the distribution elision, sonorant devoicing, transparency and opacity will be presented for the whole corpus and for each block. For further discussion, elision and sonorant devoicing are considered cases of regular VA. In the contingency table they appear separately on descriptive grounds.
For each block the proportion of occurence of VA, opacity and transparency was calculated and it is presented in contingency tables.

3.1 -OS## clusters

(3) Contingency table for -OS## clusters (all consonants)

(%)	L	G	N	$Total_{-OS\#\#}$
E	0.0	13.0	13.6	10.5
SD	43.5	27.3	6.2	21.5
Op	52.4	56.5	50.2	52.0
T	4.1	3.2	30.0	15.5

(4) Statistical analysis of -OS## clusters[4]
(4a) ANOVA of $\bar{t}_S$ in SD, OP, T clusters
P = 0.042
(4b) T test of OP, T clusters
$\bar{t}_{OP} = 107.72 < \bar{t}_T = 121.71$
Standard deviation: : $\bar{t}_{S2}$=36.85, $\bar{t}_{S3}$=27.56
P = 0.032

According to the phonetic description (1b), when opacity does not occur, elision and SD are optional for all sonorants. The data obtained in this study confirm that vibrants and glides undergo SD more often than the other sonorants. Glide clusters (O[w]##), however, result in a lower proportion of SD that is compensated by sonorant elision. Nasal clusters behave differently from the other sonorants. Transparency can only be found in a relevant proportion in nasal clusters. They include a small proportion of SD and display a proportion of sonorant elision which is similar to the one of glides.
If we consider the block as a whole it can be said that results match the phonetic descriptions (1), but do not confirm statements such as (2), since transparency is less frequent than regular VA. It is important to point out that a number of cases of transparency do not result in fully voiced sonorants. As shown in (11) below, the first part of the final sonorant is often unvoiced, which could explain the obstruent devoicing (see discussion below).
The ANOVA comparing sonorant duration for all cases with groups showed that there are no major differences between groups (P=0.322). Differences were found among cases. *Post hoc* tests showed that sonorant duration in cases a b were smaller but similar to opacity, and the time mean of opacity was smaller than that of transparency. A T-test was carried out in order to determine to what extent it was smaller (5b).

3.2 -OS##O- clusters

(5) Contingency table for ##-OSO-## (groups: O̥SO, OSO̥; and consonants: L, G, N)

(%)	group 1				group 2			
	L	G	N	Total	L	G	N	Total
E	10.3	46.4	14.8	22.3	0.0	0.0	8.3	2.1
SD	33.3	10.7	0.0	17.0	1.4	0.0	0.0	1.0
Op	42.0	39.3	44.4	41.5	83.6	69.7	81.7	84.4
T	10.4	3.6	40.7	19.1	14.9	30.3	0.0	12.5

(6) Statistical analysis of -OS##O- clusters
(6a) ANOVA of $\bar{t}_S$ in SD, OP, T clusters
Sig.: 0.055
(6b) T test of OP, T clusters
$\bar{t}_{OP} = 859.09 \sim \bar{t}_T\ 968.28$
Standard deviation: $\bar{t}_{OP}$=36.85, $\bar{t}_T$=27.56
P = 0.200

-OS##O- clusters display different results depending on the group. For group 1 there is a high proportion of elision, especially relevant for the glide, which rarely allows transparency. The lateral and the vibrant often devoice before an unvoiced obstruent. Nasals show a high proportion of transparency. Before voiced obstruents (group 2) sonorants rarely elide or devoice, and they block VA instead. The percentage of transparency is similar to that of other blocks.
Statistical analyses show that different cases have different time means. *Post hoc* tests indicate that the different case is sonorant devoicing, which has a lower mean. Opacity and transparency have similar means.

[3] Where L: liquids [r], [l]; G: glide [w]; N: nasals [m], [n].
[4] t = time in ms.

3.3 ## -OSO- ## clusters

(7) Contingency table for ##-OSO-## clusters (progressive and regressive VA contexts)

(%)	regressive (only group 2)				progressive			Total
	[r]	[l]	[w]	Total	[r]	[l]	Total	
E	0.0	10.0	35.3	29.5	50.0	0.0	0.0	22.8
SD	100	0.0	8.2	17.1	50.0	85.7	54.8	26.5
Op	0.0	90.0	35.3	37.1	0.0	0.0	38.7	37.5
T	0.0	0.0	21.2	16.2	0.0	14.3	3.2	13.2

(8) Statistical analysis of ##-OSO-## clusters

(8a) ANOVA of $\bar{t}_S$ in SD, OP, T clusters for sonorants [r], [l]

For progressive contexts: P = 0.749

For regressive contexts: P = 0.113

(8b) T test of OP, T clusters for regressive contexts

$\bar{t}_{OP} = 712.08 < \bar{t}_T = 1313.81$

Standard deviation: : $\bar{t}_{S2}$=171.72, $\bar{t}_{S3}$=2115.87

P = 0.093

In ##-OSO-## clusters only sonorants [r], [l], [w] can be found, although there are few words in Polish with trapped lateral. This is the reason why the proportion of cases with the lateral has such a small relevance in the total results for this block. The liquids in almost all their occurrences undergo sonorant elision or devoicing (only one case of transparency with the lateral was found). Almost all cases with transparency correspond to regressive contexts with the glide [w] before a voiced labial or after a voiceless velar. Opacity occurs in a significant lower proportion than in other blocks.

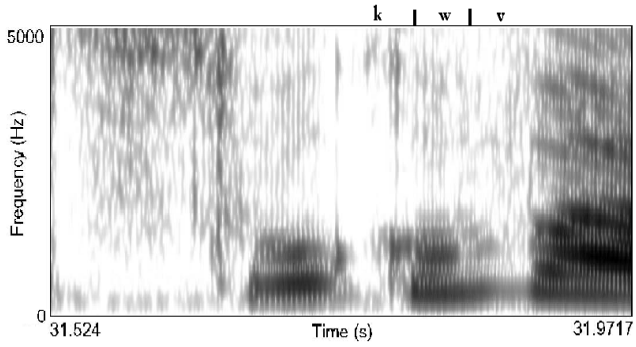
Statistical analysis of progressive contexts displays strong similarities between the time means of the different cases. This result is consistent with analyses of the other blocks, if we consider that transparency is a residual case in this context with only one case. For regressive contexts the time mean in cases of opacity is smaller than that of transparency. Sonorant means time for each consonant are very similar (P=0.749) and for cases of opacity the sonorant time mean is smaller but not significantly.

4. DISCUSSION

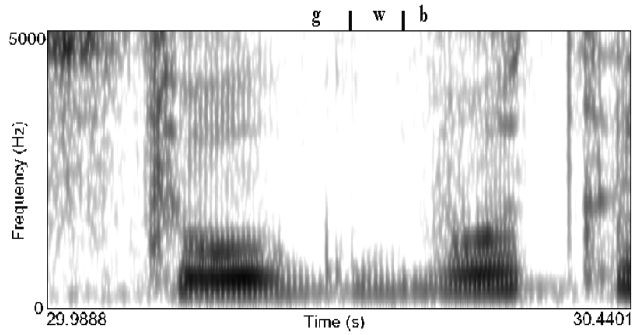
Obtained data indicate that, when taking into account sonorant transparency to VA as a regular process in Polish, probably, the cases in which opacity does not take place (sonorant elision and devoicing) are counted as transparency. It seems that the fact that sonorant elision and devoicing taken together occur twice as often as transparency is important enough to be taken into account. Sonorant devoicing and elision are cases of regular voice assimilation that depend on the quality of the sonorant. Moreover, it is difficult to establish a regular pattern for the Sonorant class as a whole, since nasals allow transparency in a high proportion whereas liquids and the glide do not.

The case of transparency in clusters with a glide is worth being analyzed thoroughly. The glide mostly allows transparency when it precedes a voiced labial or velar obstruent. Before unvoiced obstruents, however, it usually blocks VA. In these contexts the glide is reduced to labial rounding as if it triggered compensatory lengthening of the following obstruent. Spectrogram (8) and (9) illustrate opacity and transparency in glide clusters. In (8), when [w] blocks VA formantic structure is visible, and when transparency takes place (9) it loses formantic structure and there is not a big difference between the realization of the glide and the occlusive.

(9) ... *stukł wazon* [kw ## v] →[kwv]

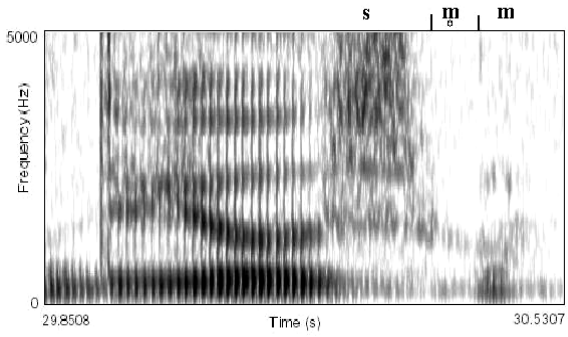


(9) ... *stukł butelkę* [kw##b] →[gwb]



Despite the fact that in the data there are some examples of clear sonorant transparency, there are also other examples that deserve special consideration. Transparent sonorants, usually nasals, partially devoice in final position (-OS##) (11) and before a voiceless obstruent (12).

(11) ... *organizm* [zm ##] → [sm̥/m]



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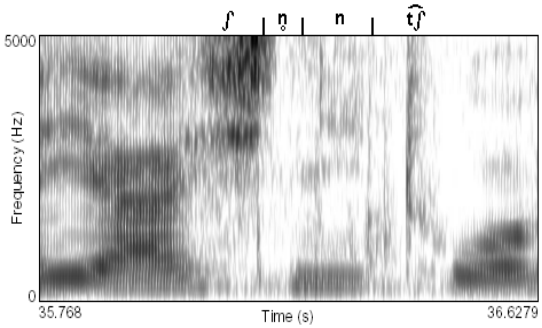
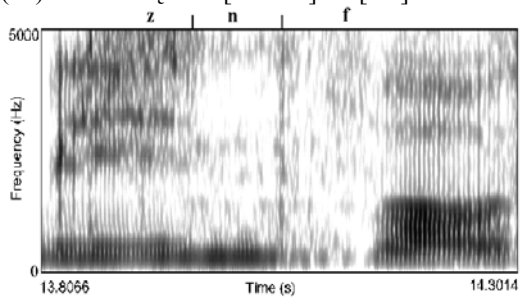
(12) ...*jaźń człowieka* [ʒn ## t͡ʃ]→ [ʃn̥/n t͡ʃ]



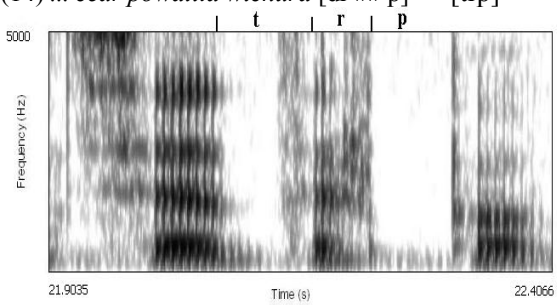
Apart from nasals, the vibrant is the only sonorant that allows transparency across the word boundary with certain regularity in group 1. With the exception of contexts with the glide and, in a lower degree, the liquids, transparency consists of the loss of [voice]. The first obstruent in the group usually devoices when the sonorant is partially devoiced (10), (11) or when it loses its formant structure (like in the case of [w]). The vibrant can also present this configuration, but the lateral is normally fully voiced (12).

A loss in the sonority of the whole cluster has also been observed in all blocks. In extreme cases, usually with the labiodental, it leads to devoicing of the obstruent in the strong position (O̥SO→O̥SO̥) (13).

(13) ... *blizn wąskich* [zn ## v] → [znf]



(14) ... *cedr powaliła wichura* [dr ## p] → [trp]



Data confirm that the duration of the sonorant do not differ in cases of opacity and transparency. In -OS##O- clusters sonorant duration is similar to that in consonant clusters with opacity and transparency. However, in -OS## and -OS#O clusters sonorant time means are bigger in cases of transparency than opacity, as opposed to what is suggested in [5].

5. CONCLUSIONS

Data presented suggest that transparency effects on voice assimilation in Polish should neither be analyzed by taking into account the Sonorant class as a whole nor by taking all the possible positions of sonorants within the word as one single pattern. In phonological analyses transparency cannot be taken as a regular process in Polish either, unless sonorant devoicing and elision are regarded as cases of transparency which are explained by phonetic implementation. If that were the case, there should be some phonetic parameters that explain why the sonorant sometimes blocks and sometimes triggers voice assimilation. One explanation to this issue is based on Licensing by Cue [6], according to which distribution of features is controlled by phonetic cues. As far as Laryngeal features are concerned, duration of the cues to voicing (sonorants for Polish), plays a role in the perceptibility of contrast. Therefore, in contexts like -OS##O- and ##-OSO-##, where the sonorant is overlapped on both sides, voicing is neutralized; in contexts like -OS##, with a sonorant overlapped on only one side, neutralization depends on the temporal reduction of the sonorant; and in contexts where the sonorant is syllabic, i.e followed by a vowel or an obstruent and a vowel, contrast is maintained. Our data are not consistent with this approach, since no regularities between duration and cluster configurations could be found. Although sonorant partial devoicing can be considered as a shortening of the phonetic cue to sonority, there are a number of cases that present fully voiced long sonorants which allow transparency.

Taking into account that OSO clusters undergo lenition, especially when the second obstruent is unvoiced and that these clusters violate the Sonority Sequencing Principle, it is reasonable to consider for phonological analyses approaches that are based on the minimization of the articulatory effort. In non-accurate or fast speech, the difficulty in maintaining contrast increases and the repair strategies apply, such as sonorant devoicing, elision or obstruent voice agreement.

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