"The importance of being voiced": cluster formation in dialectal variants of Greek

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1. Introduction

Cluster formation is one aspect of examining a language's prosodic phonology. Variety in cluster formation is widely attested in developmental data of language acquisition (L1) and language learning (L2) as well as a language's standard form and its dialectal variants (cf. Tzakosta 2004 and more references therein). The basic principles underlying cluster formation is that, first, the sonority scale (hereafter SS) needs to be satisfied in a rightward direction, i.e. cluster members have to be selected from left to right so that segments rise in sonority, and, second, the bigger the distance between the members of a cluster on the SS is the better structured this cluster is (Clements 1984, 1988). To give an example, /kl/ is a better formed cluster compared to /kn/ because of the bigger distance holding between /k/ and /l/ (4) as opposed to /k/ and /n/ (3). This is the reason why CL[72] rather than CC clusters are considered to be perfect and, consequently, they emerge more frequently in various aspects of a language and cross-linguistically. The classical sonority scale is depicted in figure 1.

S	F/Sib	Affr	N	L	G	V
1	2	3	4	5	6	7

Figure 1: *The sonority scale (Selkirk 1982, Steriade 1984)*

Given the above assumptions, it is easy to gather that from a phonological, a phonetic and a psycholinguistic point of view, a well-formed, and, ideally, a perfect cluster has more chances to remain intact in its surface/ phonetic realization. In other words, big sonority distance among cluster members leads to 'clear' cluster perception; in turn, this clarity drives easy production. Tzakosta & Vis (2009) reach the same conclusions based on developmental L1 data. They argue that the phonetic gap existing between members of a perfect cluster facilitates perception and production. The smaller the distance between cluster members the more difficult it is for these clusters to be accurately perceived and produced. The theoretical connotation of this claim is that different clusters are characterized by different phonological representations. Perfect CL clusters tend to be characterized by a more 'loose' phonological representation, whereas CC clusters are characterized by a more coherent and 'tight' representation. These theoretical differences are demonstrated in schemas (a) and (b) in figure 2 below, respectively.

a. **CL clusters** b. **CC clusters**

[72] C stands for obstruent consonants (stops and fricatives), L for liquids and rotics, N for nasals.

(cf. Tzakosta 2009, Tzakosta & is 2009)
Figure 2: *Differences in the phonological representations of different consonant clusters*

However, dialectal data illustrate that non-perfect clusters not existing in the standard language emerge in dialectal variants. Such non-perfect clusters may be acceptable or non-acceptable/ non-existing. In the remainder of the paper, by non-acceptable/ non-existing clusters we will be referring to consonantal sequences disallowed by the phonotactic constraints of the standard language. In Greek, for example, sequences /pk/, /tk/ and /pθ/ do not emerge in the norm - being mainly, the result of vowel loss -, though they emerge massively in dialects of both the northern and southern dialectal zone. We assume that this flexibility is attributed to the fact that dialects are less strict regarding their phonotactic constraints. The major characteristic of acceptable and non-acceptable/ non-existing clusters is that their members are highly adjacent on the SS, and, therefore, they do not rise in sonority. As a result, non-existing clusters are highly coherent; consequently, they are not easy to be perceived and produced.

Recent studies have proposed more refined factors that determine cluster well-formedness except for the rightward satisfaction of the SS and sonority distance. More specifically, Tzakosta & Karra (in press) suggested, based on indexed dialectal data from all major dialectal zones of northern and southern Greece, that the SS needs to be distinguished in two scales, a scale representing place of articulation (PoA) and a scale corresponding to manner of articulation (MoA). These two scales facilitate a thorough and an in depth assessment of cluster well-formedness. Tzakosta & Karra (in press) demonstrated that this scale distinction succeeds in providing a more detailed and accurate description of the phonotactics of (a) perfect clusters, like /kl/ and /pl/, (b) acceptable clusters, like /vγ/ and /fθ/, and (c) non-acceptable clusters, like /tf/ and /tk/. In sequence to the above, Tzakosta & Karra claim that the (vacuous) satisfaction of the PoA and MoA scales leads to distinct degrees of well-formedness. More specifically, if clusters *satisfy* the scales of *both* manner and place, they are perfect. If they *respect* the sonority of *either* place or manner, they form *acceptable clusters*, whereas if clusters *do not respect at least one* scale, they constitute *'wrong' i.e. non-acceptable* clusters. In other words, perfection or (non-)acceptability in cluster formation is an example of gradient satisfaction of the MoA and PoA scales. The prediction following the above claims is that clusters non-existing in the standard language may emerge in dialectal variants as long as they are theoretically acceptable. However, wrong clusters are not expected to emerge.

In this paper, we add to the above claims by challenging the role of voicing in cluster formation. We prove that the dissatisfaction of the suggested voicing scale is enough for a cluster to be characterized as non-acceptable. The rest of the paper is organized as follows; section 2 elaborates on the idea of Tzakosta & Karra (in press) discussing some representative results. Section 3 develops this idea by proposing that voicing should also comprise a distinct scale which evaluates cluster well-formedness on a par with the place and manner scales. Finally, section 4 concludes the paper and poses issues for future research.

2. The linguistic evidence

Let us now turn to the data that provide evidence for the claims promoted above. The data in (1) give some representative examples of the clusters which are attested both in standard Greek and in indexed dialectal data from the major Greek dialectal zones, namely the dialects of Northern Greece (e.g. Epirus, Meleniko, Lesvos, Pontos, Thassos, Corfu, Thessalia, Kozani, Trikala, Samothraki, Thessaloniki) and of Southern Greece (e.g. Cyprus, Crete, Dodekanese, Ikaria). The examined clusters are the major CL and CC types. The data in (1) present the possible Greek cluster combinations. More specifically, except for well-formed CL and CR sequences, [voiceless stop + voiceless stop], [voiceless stop + voiceless/

voiced fricative], [voiced fricative + voiced fricative], [voiceless fricative + voiceless fricative], [voiceless fricative + voiceless stop] clusters are allowed, as shown in (1c). Interestingly, [voiced stop + voiced stop], [voiced obstruent + voiceless obstruent] and [voiceless obstruent + voiced obstruent] clusters are not attested in Greek, except for CN clusters.

(1a) **CL** => a**pl**ós, **γl**áros,[73]
(1b) **CR** => á**kr**i, é**θr**ios
(1c) **CC** => a**kt**í, o**pt**ikós, té**fx**os, **xθ**és, **fθ**inós, **vγ**ázo, a**vγ**ó, é**kθ**esi, é**kδ**osi, pé**fk**o, **xt**ízo
(1d) **CJ** => **δj**o, á**δj**os
(1e) **CN** => a**km**í, é**θn**os
(1f) **NN** => a**mn**esia

In (2) we provide some more dialectal data. The clusters in (2a-b) are attested only in dialectal data, whereas (2c) emerges in dialectal data but only in one word of the standard language, namely 'ατθίς'. Finally, /tθ/, in (2d), being a perfect cluster which satisfies sonority rising and sonority distance, occurs both in the norm and the dialects because it is a perfect cluster.

(2a) /**k**u.**f**á.θi.ce/ → [**kf**á.θce] 'become deaf – 3SG. PAST' (T,hessalia, Tzartzanos 1909)
(2b) /**p**i.**θ**a.mí/ → [**pθ**a.mí] 'span-FEM.NOM.SG.' (Thessalia, Tzartzanos 1909)
(2c) /**t**u.**f**é.ci/ → [**tf**é.ci] 'gun-NEUT.NOM.SG.' (Thessalia, Tzartzanos 1909)
(2d) /ma.**θ**é.no/ → [ma.**tθ**é.no] 'learn-1SG.PRES.' (Cyprus, Kodosopoulos 1994)
(2e) /**t**u.**l**ú.pa/ → [**tl**ú.pa] 'wool-FEM.NOM.SG.' (Margariti-Roga 1990-1991)

According to the theoretical proposal made by Tzakosta & Karra (in press), the type of clusters which emerge massively in dialectal data but not in the norm are the ones they call *acceptable clusters*. As already mentioned, this preference for acceptable rather than perfect clusters is attributed to the fact that dialects are more flexible regarding their phonotactics compared to the standard language. Moreover, acceptable clusters do not demand absolute scale satisfaction. However, the massive surface realization of acceptable clusters led Tzakosta & Karra to the assumption that the SS does not suffice in evaluating cluster well–formedness. They suggested a refined version of the sonority scale signaled by two distinct scales, the scale of PoA and the scale of MoA. Depending on the degree of satisfaction of these two scales, clusters are perfect, acceptable or non-acceptable. Figures 3 and 4 depict the scales of PoA and MoA, respectively. Like in the case of the classical SS in figure 1, both scales are satisfied as long as the selection of cluster members is rightward. Cluster well-formedness also depends on distance; the bigger the distance between cluster members the better-formed the cluster. To give some examples, /kt/ is a better cluster compared to /pt/ on the place scale. The distance of the /kt/ cluster members is 2, while the distance for /pt/ is 1. On the other hand, /kl/ is considered a better cluster compared to /xl/ on the manner scale because the distance for /kl/ is 4 whereas the distance for /xl/ is 3.

Velars	Labials	Coronals
1	2	3

Figure 3. The PoA scale

[73] In this set of examples, **C** stands for an obstruent, i.e. a voiceless or voiced stop or fricative, **L** represents a liquid, **R** stands for a rhotic, **J** represents a glide and **N** is a nasal.

S	F(/Sib)	Affr	N	L	G	V
1	2	3	4	5	6	7

Figure 4: *The MoA scale*

Such data further display that cluster well–formedness - no matter whether it refers to perfection or acceptability - is a gradient phenomenon. In other words, /kl/ is a 'better formed cluster' than /xl/ because of the bigger distance among the members of /kl/. Another important contribution of Tzakosta & Karra's theoretical proposal is that scales are vacuously satisfied in case cluster members share the same PoA, as in /pf/ or /tθ/ and/ or MoA, as in /pt/ or /xθ/.

Cluster perfection and (non-) acceptability are further schematized in tables 1-3. More specifically, tables 1 and 2 illustrate the sets of perfect, acceptable and non-acceptable clusters at the level of PoA and MoA, respectively. In both tables, we observe that clusters whose members are selected from left to right, with a relative distance among them, are perfect. To give an example, LAB + COR, VEL + LAB and VEL + COR are perfect clusters at the level of place of articulation, whereas STOP + L, FRIC + L, STOP + FRIC are perfect clusters at the level of manner of articulation. It is important to mention that the scales are vacuously satisfied when cluster members share the same PoA and/or MoA. As a result, LAB + LAB, VEL + VEL, COR + COR clusters are acceptable at the level of PoA and STOP + STOP, FRIC + FRIC and AFFR + AFFR clusters are acceptable at the level of MoA. Leftward selection of cluster members leads to the formation of non-acceptable clusters. Therefore, STOP + VEL and LAB + VEL are non-acceptable with respect to PoA and FRIC + STOP or FRIC + AFFRIC are non-acceptable clusters regarding MoA.

Clusters are acceptable under three conditions: a) if they satisfy one of the two scales and vacuously satisfy the other, b) if they vacuously satisfy both scales, and c) if they satisfy one but violate the other scale. In table 3, which displays the combined effects of tables 1 and 2, all acceptable clusters are written in square brackets. Clusters appearing in white backgrounds emerge both in standard Greek as well as its dialects; whereas acceptable clusters appearing in grey backgrounds emerge only in dialectal data. Underlined acceptable clusters appearing in white backgrounds signal rarely emerging clusters.

Vacuous satisfaction of one of the scales of PoA or MoA and violation of the other is a sufficient criterion in order to characterize a cluster as non-acceptable. Non-acceptable clusters may also violate both scales. The latter are the worst among non-acceptable clusters. This fact further supports the notion of gradience in cluster well-formedness. Gradience appears at all levels of cluster well-formedness, i.e. perfect, acceptable and non-acceptable clusters. Non-acceptable clusters appear in brackets in table 3. Underlined non-acceptable clusters emerge in morpheme boundaries, whereas non-acceptable clusters appearing in grey backgrounds emerge only in dialects.

The difference between acceptable and non-acceptable clusters is in most cases very subtle. This observation supports the claim that, not only are clusters gradient regarding the category they belong to, i.e. whether they are perfect, accept and non-acceptable; gradience characterizes each level of acceptability. In other words, there are perfect clusters which are 'better' than other perfect clusters or clusters which are more acceptable than other acceptable clusters. In addition to that, there are clusters which are, as already mentioned, the worst among non-acceptable clusters.

Table 1: *Gradience in cluster formation (PoA)*

Types	Perfect	Accept	Non-accept
Lab + Lab		√ /pf/	
Lab + Cor	√ /pt/		

Lab + Vel			√ /pk/
Cor + Cor		√	
Cor + Lab			√
Cor + Vel			√
Vel + Vel		√	
Vel + Cor	√		
Vel + Lab	√		

Table 2: *Gradience in cluster formation (MoA)*

Types	Perfect	Accept	Non-accept
Stop + L	√ /pl/		
Fric+ L	√		
Stop + Stop		√ /pt/	
Fric + Fric		√	
Stop + Fric	√		
Fric + Stop			√ /ft/
Stop + Affr	√		
Affr + Stop			√
Fric + Affr	√		
Affr + Fric			√

Table 3 combines the effects of tables 1 and 2 and displays the sets of perfect, acceptable and non-acceptable clusters. Perfect clusters clearly satisfy both scales of PoA and MoA; they emerge in perentheses in table 3. Perfect clusters appearing in white backgrounds are clusters which emerge both in standard Greek as well as its dialects, whereas perfect clusters appearing in grey backgrounds emerge only in dialects. Perfect clusters appearing in angle brackets emerge only in morpheme boundaries.

Table 3: *Gradience in cluster formation (combined)*

Types	Stop Lab	Fric Lab	Stop Cor	Fric Cor	Stop Vel	Fric Vel	L
Stop Lab	GEM	√ (pf)?	√ (pt)	√ (pθ)!!!	√ (pk)	√ (px)	√ (pl)
Fric Lab	√ (fp)	GEM	√ (ft)	√ (fθ)	√ (fk) ?	√ (fx)	√ (fr)
Stop Cor	√ (tp)	√ (tf)	GEM	√ (tθ)?	√ (tk)	√ (tx)	√ (tr)
Fric Cor	√ (θp) ?	√ (θf)	√ (θt)	GEM	√ (θk) ?	√ (θx)	√ (θl)

Stop Vel	√(kp)	√ (kf)?	√ (kt)	√ (kθ)?	GEM	√ (kx)	√ (kr)
Fric Vel	√(xp)	√ (xf)	√ (xt)	√ (xθ)	√ (xk)	GEM	√ (xl)

3. The current proposal

The theoretical claims discussed in this section develop the ideas promoted in the previous section and are supported by the same indexed data set from dialects of northern Greece (Epirus, Meleniko, Lesvos, Pontos, Thassos, Corfu, Attica, Thessalia, Kozani, Trikala, Samothraki, Thessaloniki, Koutsovlahika) and southern Greece (Cyprus, Crete, Dodekanese, Ikaria) investigated by Tzakosta & Karra (in press). In the present study, following the line of Tzakosta & Karra (in press), we focus on CL and CC clusters but we do not consider CJ clusters because we believe that [j] is the product of vowel raising. More specifically, the goals of the paper are, first, to discuss the surface realization of CL and CC clusters in Greek dialects, second, to investigate whether clusters have the same 'survival chances' across dialects, third, to evaluate the 'importance' of voicing in cluster formation and, finally, to make a typological account of the 'strength' of CL and CC clusters with respect to the three dimensions of place, manner and voicing.

Voicing has primarily been dealt with at the level of voicing vs. devoicing alternations (cf. Oostendorp 2004, 2006, among others) and to the extent (de)voicing is involved in assimilatory processes (cf. Al-Ahmadi Al-Habi to appear, Arvaniti 1999, Baroni 1997, Grijzenhout 2000). At the theoretical level, voicing has been accounted for in OT terms by means of the *NC, ND, *ND constraints (cf. Borowsky 2000, Grijzenhout 2000, Lombardi 1996, 1999, Pater 1999). The current research questions are related to the following: a) if voice assimilation applies to non-adjacent consonants, b) if voice assimilation applies within consonant clusters, and, c) if [-voi] + [+voi] clusters, like, /kδ/ are acceptable, given that [+voi] + [-voi] clusters, like /δk/, are not acceptable at least in Greek.[74]

The hypothesis underlying the current theoretical proposal is that, in addition to the PoA and MoA scales, the dimension of voicing should also be considered in cluster formation. In other words, all three dimensions of PoA, MoA and voicing need to be taken into account. More specifically, the PoA scale which corresponds to the fixed place hierarchy (cf. Prince & Smolensky 1993) an the MoA scale, which roughly corresponds to the classical sonority, as already proposed by Tzakosta & Karra (in press). In this paper, we propose the introduction of the voicing scale which completes cluster well-formedness. Before we elaborate on this idea, let us turn to some representative examples. The data in (3) and (4) display cases in which clusters emerge either due to consonant medial vowel loss, as shown in (3b-f) and (4a-e), or due to intra-dialectal, social or stylistic reasons, as demonstrated in (3a).[75]

(3a) /cí.**p**os/ → [cí.**pf**os] 'garden-MASC.NOM.SG.' (Cyprus, Kodosopoulos 1994)
(3b) /ta.ra.tu.ró.**p**i.**t**a/ → [ta.ra.tu.ró.**pt**a] 'pie- FEM.NOM.SG.' (Thassos, Tombaidis 1967)
(3c) /**p**i.**θ**a.mí/ → [pθa.mí] 'span-FEM.NON.SG.' (Thessalia, Tzartzanos 1909)
(3d) /**p**u.**ká**.**m**i.**s**o/ → [**pká**.**ms**u] 'shirt-NEUT.NOM.SG.' (Meleniko, Andriotes 1989)
(3e) /velo**no**θíci/ → [velu**n.θ**íci/ 'needle case-FEM.NOM.SG.' (Meleniko, Andriotis 1989)
(3f) /**tu**.**f**é.ci/ → [**tf**é.ci] 'gun-NEUT.NOM.SG.' (Thessalia, Tzartzanos 1909)

(4a) /**ku**.**b**á.ros/ → [**kb**a.ré.ls] 'bestman-MASC.NOM.SG.' (Thassos, Tombaidis 1967)
(4b) /**ku**.**v**á.ri/ → [**gv**ár] 'ball-NEUT.NOM.SG.' (Kozani, Roga 1989)*
(4c) /**ku**.**δ**ú.ni/ → [**kδ**u.nél] 'bell-NEUT.NOM.SG.' (Thassos, Tombaidis 1967)
(4d) /tra.**γ**u.**δ**á.i/ → [tra.**γδ**á.i] 'sing-3SG.PRES.' (Thessalia, Tzartzanos 1909)

[74] [+voi] + [-voi] combinations are subject to voicing assimilation (cf. Pater 1999).
[75] cf. Blaho & Bye (2006) for equivalent results.

(4e) /**t**i.**γ**á.ni/ → [**tγ**án] 'frying pan-NEUTR.NOM.SG.' (Samothraki, Katsanis 1996)

In most examples, except for (3d) and (3e), it is either both cluster members that are voiceless (3a-c, 3f,) or voiced (4a-b) or the leftmost member is a voiceless segment, whereas the rightmost is a voiced one (4c-e). Such data designate that there is a third scale, the voicing scale, which is responsible for cluster completeness. Like the scales of PoA and MoA, the voicing scale needs to be satisfied in a rightward direction, i.e. the first segment is voiceless and the second is voiced, and is vacuously satisfied in case both cluster members are either voiced or voiceless. This is illustrated in the data in (5). Given that the majority of clusters appearing in dialectal variants of Greek belong to the 'acceptable clusters' type, most clusters undergo (de)voicing assimilation, a common process cross-linguistically (cf. Al-Ahmadi Al-Habi to appear, Arvaniti 1999, Baroni 1997, Grijzenhout 2000).

Crucially, the voicing scale is violated if cluster members are selected in a leftward direction. In other words, leftmost voiced segments are prohibited, as displayed in (5e) and (5f), where the leftmost voiced segments undergo devoicing. The condition of rightward satisfaction of all scales is violated in case the leftmost segment is a nasal, as shown in (3d) and (3e) above. However, [nasal + voiceless obstruent] sequences are heterosyllabic, therefore, such cases are by definition excluded from the set of cases examined here. The voicing scale is depicted in figure 6 below.[76]

(5a) /**p**i.**δ**ó/ → [**bδ**ó] 'jump-1SG.PRES.' (Thessalia, Tzartzanos 1909)
(5b) /**p**e.**δ**í/ → [**vδ**í] 'child-NEUT.NOM.SG.' (Thessalia, Tzartzanos 1909)
(5c) /pa.**t**i.**m**a.sjá/ → [pa.**tm**a.súδ] 'footmark-FEM.NOM.SG.'(Thassos, Tombaidis 1967)
(5d) /s**k**ou.**d**ó/ → [**gd**ó] 'push-1SG.PRES.' (Samothraki, Katsanis 1996)
(5e) /po.**d**i.**k**ós/ → [pu.**tk**ós] 'mouse-MASC.NOM.SG.' (Samothraki, Katsanis 1996)
(5f) /**δ**i.**c**é.li/ → [**θc**él] 'grub hoe-NEUT.NOM.SG.' (Thassos, Tombaidis 1967)

[-voi]	[+voi]
1	2

Figure 6: *The voicing scale*

It is important to note that the voicing scale is violated in one more case, i.e. in morpheme boundaries' blending which is the product of vowel loss and results in the emergence of word final clusters. This is displayed in the data in (6). In these cases, the consonantal segments which make up the newly formed clusters retain their featural characteristics, consequently, the first segment is voiced and the second is voiceless. Again, these cases are excluded from the set of data examined here because the newly formed clusters are the product of surface processes rather than true phonological representations.

(6a) /léjis/ → [lé**γ+s#**] 'say-2nd.PRES.IND.SG.'
(6b) /bakális/ → [baká**l+s#**] 'grocer-MASC.NOM.SG.' (Drimos, Katsanis 1983)

Table 4, like the equivalent tables in 1 and 2, summarizes cluster perfection and/ or (non)acceptability as well as gradience in cluster formation. A fundamental question underlying our thoeretical proposal would be why to consider a distinct voicing scale and not assume the latter as being part of the classical sonority or MoA scale. A first potential answer would be that it is difficult to deal with CC cluster internal 'voiceness' without a distinct scale. More specifically, the data discussed in (3)-(6) exemplified that if the voicing scale is not satisfied clusters are not acceptable. As a result, and, in order to form

[76] Cf. also Grijzenhout & Kraemer (2000).

acceptable clusters, cluster segments undergo cluster assimilation. In addition, the data showed that the voicing scale is essentially one of the two scales that should be satisfied, given that violation of the conditions posed by the voicing scale is enough for clusters to be characterized as non-acceptable.

Table 4 : *Gradience in cluster formation (voicing)*

Types	Perfect	Accept	Non-accept
[-voi] + [-voi]		√	
[-voi] + [+voi]	√ /kδ/		
[+voi] + [+voi]		√ /gδ/	
[+voi] + [-voi]			√ /δk/

In section 2, we discussed gradience in cluster formation in detail. The discussion was summarized in table 3. In this section, we elaborate on table 3 by incorporating voicing in figure 7 below. In all boxes of figure 7, the leftmost cluster is the best of the category and the rightmost is the worst of this specific category. In the PC1 uppermost box, the most perfect among perfect clusters are provided. More specifically, we refer to clusters whose initial segment is voiceless and a second is (inherently) voiced. Given the above the most perfect among perfect clusters is /kl/ represented by [-voi]SV+L. It is important to remember that the most perfect cluster satisfies the place and manner scales; moreover, the distance among its members is the biggest possible, 4. The least perfect cluster, on the other hand, satisfies both scales of manner and place but the distance among its members is 1. Two of the least perfect clusters, /kθ/ and /kf/, appear in standard Greek but only in morpheme boundaries. In addition, /pθ/, the least perfect cluster, appears only in dialects. Similar hierarchies hold for acceptable and non acceptable clusters. AC1 represents acceptable clusters which are better formed compared to the leftmost AC2 clusters. Finally, non-acceptable clusters appear in the N-AC box. It is interesting to point out that two of the 'worst' non-acceptable clusters, /fk/ and /fx/, appear in standard Greek, though only in morpheme boundaries, as in 'ef + kolos' "easy" or 'ef + xaristos' "pleasant".

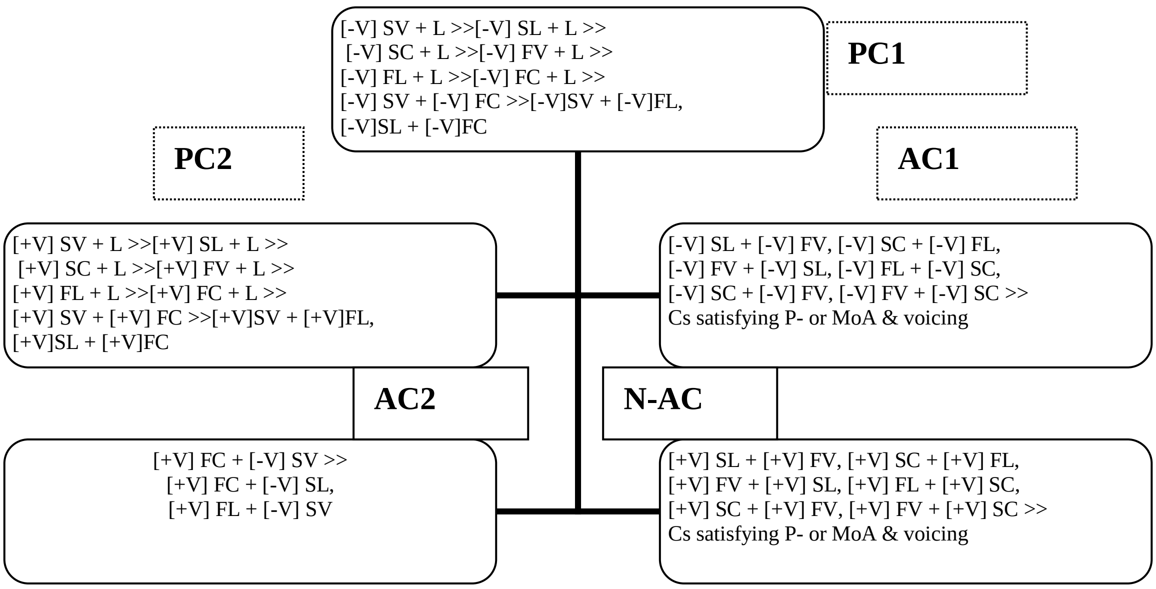

Figure 7: *gradience in cluster perfection*

4. Concluding remarks and issues for future research

This paper assesses cluster well-formedness in a parallel fashion. More specifically, we evaluate cluster acceptability at the levels of, first, sonority, and, second, the distinctive features that determine segmental composition, namely, manner, place and voicing. Previous studies (Tzakosta & Karra in press) in combination with the present one have shown that clusters are divided in three categories of well-formedness, i.e. they are perfect, acceptable and non-acceptable. This categorization depends on the degree of satisfaction of the sonority scale as well as the scales of place and manner of articulation and voicing. Perfect clusters are sequences which respect the rightward direction of the sonority and the place, manner and voicing scales. Moreover, members of perfect clusters hold the biggest possible distance among them. To give an example, considering the sonority scale in figure 1, /pl/ and /pn/ are both perfect clusters, because they both respect the rightward direction of all scales. However, /pl/ is better-formed than /pn/ because /pl/ is characterized by sonority distance 5 while /pn/ is characterized by sonority distance 3. In other words, the bigger the distance among cluster members the better formed the cluster.

Acceptable clusters, on the other hand, are mainly CC clusters, i.e. sequences of segments highly adjacent on the sonority scale, like /pf/, or sequences of segments landing exactly on the same site on the sonority scale, like /fθ/. Adjacent segments, for example combinations of stops and fricatives, are maximally characterized by a sonority distance 1, while segments landing on the same sonority site, i.e. if both cluster members are stops or fricatives, are characterized by zero sonority distance. Consequently, acceptable clusters are characterized by coherence among their members. Put differently, acceptable clusters may violate one of the scales of place and/ or manner or vacuously satisfy one or both of these scales. It is interesting that, although place and manner may not be essentially or necessarily satisfied, voicing completes acceptable and/ or perfect cluster formation; therefore, it always needs to be satisfied. If the voicing scale is violated, the emergent cluster is non-acceptable.

The data reveal that, in theory, coherence is crucial for cluster survival, although, perception-wise, coherent – acceptable- clusters are not 'true' clusters (cf. Tzakosta & Vis 2009). Apparently, cluster coherence is responsible for the fact that acceptable clusters are the most frequent patterns which, in turn, drives the prediction that the latter are also dominant cross-linguistically.

Finally, non-acceptable clusters are consonantal sequences which violate the sonority scale and/ or one of the scales of place/ manner and voicing, i.e. its members are selected on a leftwards rather than a rightwards fashion. Non-acceptable clusters are the fewest in theory, a fact verified empirically by the data.

A final summarizing point in the discussion is that cluster formation, in general, and cluster perfection, in particular, is gradual in the sense that not all perfect or acceptable clusters are perfect or acceptable to the same extent. We still need to investigate our prediction that clusters acceptable in theory, like /fp/, /θf/, or /θt/, but not attested in the data are expected to emerge. More data need to be tested and classified.

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