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A BEATS-AND-BINDINGS ACCOUNT OF ITALIAN PHONOTACTICS

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Abstract

In this contribution I make an attempt to account for Italian phonotactics in the framework of *Beats-and-Binding phonology* (B&B henceforth), a syllable-less theory proposed by Dziubalska-Kołaczyk (2002) and later developed in Dziubalska-Kołaczyk 2009, Dziubalska-Kołaczyk & Zielińska 2010 and Marecka & Dziubalska-Kołaczyk 2012. The theory itself is part of the more general framework of *Naturalness Theory* (Dressler et al. 1987) which finds its origins in *Natural Phonology* (Stampe 1969, Donegan 1978). I show that B&B is better suited than sonority hierarchy-based theories (SH henceforth) to explain some aspects of Italian phonotactics: (1) the special status of /s/C clusters word-initially, (2) the ban on /tl, dl/ clusters and, (3) the distribution of the definite masculine article allomorphs *il* and *lo* before /j/ and /w/. Besides the calculation of the *Net Auditory Distance* (NAD) proposed by Dziubalska-Kołaczyk, I argue for the importance of the *relative salience* of a segment within its natural phonological class. As a matter of fact, phenomena that could not be handled by former phonotactic theories are easily explained by B&B.

In questo articolo cerco di rendere conto della fonotassi dell'italiano nel quadro della *Beats-and-Binding phonology* (B&B), una teoria "senza sillaba" proposta da Dziubalska-Kołaczyk (2002) e sviluppata successivamente in Dziubalska-Kołaczyk 2009, Dziubalska-Kołaczyk & Zielińska 2010 e Marecka & Dziubalska-Kołaczyk 2012. Questa teoria fa a sua volta parte della più ampia *Teoria della Naturalezza* (Dressler et al. 1987), che trova le sue origini nella *Fonologia Naturale* (Stampe 1969, Donegan 1978). Il mio intento è dimostrate che B&B è più adatta a spiegare alcuni aspetti della fonotassi dell'italiano rispetto ad altre teorie basate sulla scala di sonorità (*sonority hierarchy*, SH). Affronterò principalmente tre questioni: (1) lo statuto particolare dei gruppi /s/+C a inizio di parola, (2) l'assenza dei gruppi /tl, dl/ e, (3) la distribuzione degli allomorfi *il* e *lo* dell'articolo determinativo maschile singolare prima di /j/ e /w/. Oltre a sostenere l'importanza del calcolo della *Net Auditory Distance* (NAD) proposto da Dziubalska-Kołaczyk, propongo di considerare la *salienza relativa* di un segmento all'interno della sua classe naturale. Dall'analisi appare evidente come fenomeni che non potevano essere risolti dalle teorie fonotattiche precedenti vengano spiegati con relativa facilità da B&B.

1. The framework[1]

Natural Phonology is a functionalist, phonetically grounded model of phonology developed by David Stampe and by his collaborators (Stampe 1979, Donegan & Stampe 1979, Hurch & Rodes 1996) and basically consists in the following tenets:

- processes are natural, rules are learned;
- phonological acquisition mainly consists in the suppression of natural processes;
- rules can be phonological, morphological or morphophonological;
- phonological naturalness is often, if not always, in contrast with morphological naturalness;
- each language solves the conflict between phonological and morphological naturalness differently.

For example, the devoicing of obstruents in final position is a natural process, since voicing, which is already relatively hard for obstruents, becomes even harder word-finally:

(1) /d/ → [t] / _#

Anyway there are languages, e.g. English, that want obstruents to maintain voicing word-finally. Therefore an English child, who would spontaneously devoice all final obstruents, has to learn to maintain voicing when an obstruent is underlyingly voiced. Conversely, a German child does not have to suppress process (1).

(2) (a) English *bide* /baɪd/ → [baɪd] vs. *bite* /baɪt/ → [baɪt]

1

Conventions and Abbreviations

←	binds with the preceding segment	L	Liquid
→	binds with the following segment	MOA	Manner of Articulation
<	is worse-formed/less salient than	n	Non-beat
>	is better-formed/more salient than	NAD	Net Auditory Distance
B	Beat	NBB	New Beats-and-Bindings
b	Weight unit	O	Obstruent
B&B	Beats-and-Bindings phonology	POA	Place of Articulation
C	Consonant	Lx	Voicing
F	Fricative	S	Stop
iff	if and only if	SH	Sonority Hierarchy
		V	Vowel

(b) German *Bund* /bʊnd/ → [bʊnt] 'federation' vs. *bunt* /bʊnt/ → [bʊnt] 'colourful'

Stampe's work inspired a group of linguists in Europe to give birth to Natural Morphology (Dressler et al. 1987), Natural Syntax (Mayerthaler & Fliedl 1993), Natural Text Linguistics (Dressler 1989) and Beats-and-Binding Phonology (Dziubalska-Kołaczyk 2002). In this contribution I aim to expand the latter, modifying some aspects of the theory in the process.

1.1 Beats-and-Binding Phonology

As Dressler (2009:34-35) points out, Natural Phonology does not consider phonetics the only non-linguistic factor influencing phonology. The phonological make up of a language is generally affected by:

- the rhythmic organization, as a characteristic of any motor activity, of which prosody is just a special case;
- the semiotic principle of figure and ground which predicts that figures tend to be foregrounded, grounds tend to be backgrounded. Put differently, what is salient tends to be even more salient, what is not salient tends to be even less salient;
- the semiotically and neurologically-based preference for binary contrast.

B&B phonotactics implements "the principles of figure and ground and perceptual contrast [by] formulating phonotactic preferences (constraints) which undergo strictly phonetic processing involving as much phonetic detail as necessary" (Dziubalska-Kołaczyk 2009:55). Compared to previous approaches to phonotactics, B&B is somewhat innovative inasmuch as it is a syllable-less theory, or better, it considers the syllable as an epiphenomenon of higher level relationships between single segments.

In B&B, what is traditionally called nucleus corresponds to the *beat* (B) and everything else is just a *non-beat* (n). Relationships between beats and non-beats are called *bindings.* Phonotactics is governed by the NAD (Net Auditory Distance), which involves three factors: Manner of Articulation (MOA), Place of Articulation (POA) and voicing (Lx). In its original form, NAD is defined in the following way: |MOA| + |POA| + |Lx|, "where |MOA|, |POA| and |Lx| are the absolute values of difference in the Manner of Articulation, Place of Articulation and Voicing of the neighboring sounds, respectively" (Dziubalska-Kołaczyk 2009:56). B&B makes finer predictions than traditional Sonority Hierarchy-based theories (SH henceforth), e.g., it shows that /brV/, /grV/ are better formed than, say, /drV/, because the NAD of the former is greater than the NAD of the latter:

(3) C1C2V is well-formed iff NADC1C2 ≥ NADC2V

The way NAD is calculated relies on the fact that, in general, it is better for neighboring sounds to differ maximally in MOA, POA and Voicing.

(4) Example of the representation in B&B of the English word *cat* (Dziubalska-Kołaczyk 2009:58):

n	**B**	**n**	**Timing tier**
| n→B	| B←n	|	Bindings
|	|	|	
k	æ	t	Segmental tier
	|	|	
	|	|	
	b	b	Weight tier

(5) Example of calculation of NAD of the sequence /trV/, where V = any vowel (Dziubalska-Kołaczyk 2009:60-61):
C1 = (MOA1, POA1, Lx1) = /t/
C2 = (MOA2, POA2, Lx2) = /r/
V = (MOA3, Lx3).

The following values are assigned to each sound according to MOA and POA:

4	3	2	1	0	
obstruent		Sonorant			
Stop	fricative	sonorant stop	approximant	V	
affricate			semiV		1
p b	ɸ β f v	m ɱ	w	Labial	2
t̪ d̪ t d ʈ ɖ	θ ð sibilants	n̪ n	r l	Coronal	3
k g c ɟ	ɕ ʑ x ɣ	ɲ ŋ	j	Dorsal	4
				Radical	5
ʔ	h			Glottal	6

/t/ = (4, 2, 0), /r/ = (1, 2, 1), V = (0, 0, 1)
NAD(C1, C2) = |4 -1| + |2 – 2| + |0 – 1| = 3 + 0 + 1 = **4**
NAD(C2,V) = |1 – 0| + |1 – 1| = **1**
4 > 1 = OK

2. Revised B&B or New Beats-and-Bindings (NBB)

Anyway, (1) some phenomena that could not be handled by SH are not solved by B&B either, e.g., the frequency of /s/C clusters word-initially compared to other obstruent clusters or the rarity of /tl, dl/ compared to other C/l/ sequences, and (2), the model does not assign a POA to vowels, i.e., treats all vowels as they were the same, so it is unable to make important predictions, such as /pa/ > /pu/, /pi/ > /ti, ki/ (Ohala 1992). In this contribution I modify the model in order to enhance its predictive power, always trying to motivate the proposed changes with phonetic and statistic factors. In particular, I will introduce the concept of relative salience of a segment within its natural class, in order to show why specific segments are more likely to be found in consonant clusters than others.

(6) *Values for MOA and POA in NBB*

4			3	2		1	0	**MOA**		
Obstruents			**Sonorant**							
Stop	Affricate	Fricative	Nasal	Liquid		Glide	Vowels		**POA**	
				Lat	Rh					
p b	pɸ bβ	ɸ β	m			ɥ	y	Bilabial	**Labial**	3
	pf bv	f v	ɱ			ʋ		Labio-dental		
t d	ts dz tθ dð	s z θ ð	n	l	r		a	Dental Alveolar	**Coronal**	0
c ɟ	cç ɟʝ	ç ʝ	ɲ	ʎ		j	i	Post-alveolar/ Palatal		1
k ɡ	kx ɡɣ	x ɣ	ŋ			ɰ	ɯ	Velar	**Dorsal**	2
						w	u	Labio-velar		2.5

2.1 Place matters (for vowels too)

In B&B, the numeric values assigned to the different possible manners of articulation seem to be grounded in the degree of openness of the vocal tract: the more open it is, the lowest the numeric value. Basically this coincides with what was traditionally called *sonority*. Therefore, the MOA for vowels is 0 and for stops is 4.

Nevertheless, it is not clear which criteria are taken into account to assign a numeric value to the different places of articulation. If the values assigned to the MOA reflect somehow physical reality, that should be the case also for the POA. I therefore argue that these values should be modified. According to Paradis & Brunet (1991), coronal is the unmarked POA. However, in order to make finer predictions, it would be better to consider dental/alveolar as the default (the most frequent POA according to Maddieson 1984). I therefore assign 0 to dental/alveolar, 1 to palatal and 2 to velar. These numeric values are able to predict that palatal sounds are disfavored both after dental/alveolar and velar sounds since 1 is equidistant from 0 and 2. Dental, alveolar and velar sounds can be palatalized, so it would be somehow problematic to group palatal sounds together with either dental/alveolar (as coronal) or velar (as dorsal). Labial sounds are assigned 3. This might seem in contradiction with the actual shape of the vocal tract (the lips are closer to the teeth than to the velum) but a series of universal facts (velar vowels tend to be rounded, labiovelar co-articulations are the most frequent, labial sounds are less likely to undergo assimilation, etc.) justify this choice. Labiovelar sounds are assigned a value between 2 and 3, i.e., 2.5.

These values are applied to vowels too, so that POA/i/ = 1, POA/u/ = 2.5. Central vowels, such as /a/ and /ə/, tend to be transparent to phonotactics, i.e., they are not particularly disfavored before/after any consonant, so their value is 0. This allows the consonant to maintain its inherent salience without being modified by the adjacent vowel. NBB can therefore account for the fact that, for example, sequences of labial consonant + labiovelar vowel (pu, bu) are universally disfavored, as well as sequences of dental/alveolar consonant and palatal vowel (ti, di) (Ohala 1992:320-326).

(7) For Italian vowels, I propose the following values:

Semivowel/glide	**Vowel**	**Value**	**POA**
/w/	/u/	2.5	Back, rounded
	/o/	2.25	
	/ɔ/	2	
	/a/	0	Central
	/ɛ/	0.25	Front, unrounded
	/e/	0.5	
/j/	/i/	1	

(8) As a demonstration, consider: dental consonant /t/: (4, 0, 0), labial consonant /p/: (4, 3, 0); velar consonant /k/: (4, 2, 0), labiovelar glide /w/ (1, 2.5, 1), palatal glide /j/ (1, 1, 1), front vowel /i/ (0, 1, 1), back rounded vowel /u/ (0, 2.5, 1).
NAD(ti): $|4 – 0| + |0 – 1| + |0 – 0| = 4 + 1 + 0 = 5$
NAD(tu): $|4 – 0| + |0 – 2.5| + |0 – 0| = 4 + 2.5 + 0 = 6.5$
$6.5 > 5$.
NAD(pi): $|4 – 0| + |3 – 1| + |0 – 0| = 4 + 2 + 0 = 6$
NAD(pu): $|4 – 0| + |3 – 2.5| + |0 – 0| = 4 + 0.5 + 0 = 4.5$
$6 > 4.5$
NAD(ji): $|1 – 0| + |1 – 1| + |1 – 1| = 1 + 0 + 0 = 1$
NAD(ju): $|1 – 0| + |1 – 2.5| + |1 – 1| = 1 + 1.5 + 0 = 2.5$
NAD(wi): $|1 – 0| + |2.5 – 1| + |1 – 1| = 1 + 1.5 + 0 = 2.5$
NAD(wu): $|1 – 0| + |2.5 – 2.5| + |1 – 1| = 1 + 0 + 0 = 1$
$2.5 > 1$

The model predicts the following ranking (where > stays for "is better-formed than"):
(9) tu > pi > ti > pu > ju, wi > ji, wu.

2.2 When it comes to distance, manner ≠ place
The model, as elaborated in its first form, does not distinguish between sonorant + obstruent clusters and obstruent + sonorant clusters. The latter are universally preferred but the model does not predict it because what counts is the absolute distance of MOA. Considering the absolute distance makes sense for the POA, in which adjacent segments with the same POA tend to be avoided and adjacent segments which differ maximally in POA are favored. It also makes sense for voicing, in which the value is binary (a segment is either voiced or voiceless). But when it comes to MOA, not only is it better for two segments to differ maximally in MOA, but the difference (in mathematical terms) of MOA1 and MOA2 can even be a negative number. This is simply because *sonority* (openness of the vocal tract) tends to increase word-initially. Not considering the difference between MOA1 and MOA2 in absolute terms allows us to demonstrate that obstruent + sonorant clusters are universally preferred to sonorant + obstruent clusters.

(10)

<table>
<tr><th>B&B</th><th>NBB</th></tr>
<tr><td>NAD/lk/: |1 – 4| + |2 – 3| + |1 – 0| = 3 + 1 + 1 = 5
NAD/kl/: |4 – 1| + |3 – 2| + |0 – 1| = 3 + 1 + 1 = 5
To determine which cluster is better, a vowel is necessary (but any vowel, since B&B does not distinguish POA of vowels).
With a vowel, e.g. /u/
/lku/ vs. /klu/
NAD/ku/: |4 – 0| + |3 – 0| + |0 – 1| = 4 + 3 + 1 = 7
NAD/lu/: |1 – 0| + |2 – 0| + |1 – 1| = 1 + 2 + 0 = 3
NAD(lku) = -2
NAD(klu) = 2</td><td>NAD/lk/: (2 – 4) + |0 – 2| + |1 – 0| = -2 + 2 + 1 = 1
NAD/kl/: (4 – 2) + |2 – 0| + |0 – 1| = 2 + 2 + 1 = 5
Even without a vowel, it is already possible to see that kl > lk.
With /u/ = (0, 2.5, 1)
NBB considers POA also for Vs.

NAD/ku/: (4 – 0) + |2 – 2.5| + |0 – 1| = 4 + 0.5 + 1 = 5.5
NAD/lu/: (2 – 0) + |0 – 2.5| + |1 – 1| = 2 + 2.5 + 0 = 4.5
NAD(lku) = -4.5
NAD(klu) = 0.5</td></tr>
</table>

From the comparison between B&B and NBB it is evident that the latter makes finer predictions because, (1), can determine if a cluster is well-formed even without a vowel, (2) takes into consideration also the phonotactics of C+V (in NBB /lku/ is disfavored not only for the /lk/ cluster but also for the /ku/ sequence), and (3) shows that liquid + obstruent clusters are disfavored more effectively than B&B (-2 vs. -4.5).

2.3 Does voicing always matter?

The design of B&B assumes that it is always a good thing for two adjacent segments to differ in voicing (|1 – 0| and |0 – 1| = 1 whereas |0 – 0| and |1 – 1| = 0, thus only difference in voicing contributes to a greater NAD). This is true in many cases and reflects the universal preference for CV (with C being voiceless). But an important fact is neglected here: voicing is hard for obstruents and it is inherent for sonorants. A model that does not take these facts into account ends up predicting absurdities, such as /zpa/ > /spa/. We must then assume that, given C1C2, if both consonants are obstruents, they must agree in voicing, otherwise they will certainly not bind. A problem of this analysis could be the existence in some Germanic languages of initial /kv/ (German *Quelle* ‘spring’, Swedish *kvinna* ‘woman’), but in these cases there are good reasons to consider /v/ an approximant rather than a fricative (Maddieson 1984:49, Anderson 2002:274). Adjacent sonorants must agree in voicing too, but this is less problematic due to the extreme rarity of phonological voiceless sonorants. When calculating the NAD of obstruent clusters, henceforth, voicing will not be considered anymore[2].

2.4 Plateaux

As we anticipated in the first paragraph, classical problems of phonotactics such as /s/C and /tl, dl/ sequences are not solved by B&B, but a model that claims to be grounded in natural tendencies must be able to account for them.

First of all, one should modify slightly the way sounds are classified. B&B, as well as classical SH, relies on the fact that before a beat, sounds tend to go from the least sonorous (maximal occlusion of the vocal tract) to the most sonorous (maximal openness of the vocal tract) and traditionally, stops (S) and fricatives (F) are treated differently, considering the latter as more sonorous.

(11) Sonority Scale according to Selkirk (1984):

Voiceless Stops < Voiced Stops < Voiceless Fricatives < Voiced Fricatives < Nasals < Liquids < High Vowels < Mid Vowels < Low Vowels.

I follow Morelli (1999:6) who argues that the class of obstruents (O) should be treated as a whole, without finer distinctions. Put differently, a sequence of two obstruents is a *plateau*[3] in any case, when it comes to sonority, so SF is not better than FS, as both B&B and SH would predict. The ideal sequence is the following:

(12) O (S or F) → (L or N) → (G) → V

[2] Some languages are reported to allow clusters of obstruents that do not agree in voicing. For example, the Khasi language seems to prefer /pd, tb, td, kd/ to /pt, tk/ (Henderson 1976:53). Hebrew is said to allow them (Morelli 1999:205) but it seems that uniformity of voicing is now becoming compulsory even for sequences that resisted to it some years ago (Bolozky 2006:4). Dubious cases are Georgian and Tsou.

[3] A sequence of consonants, in order to be optimal, is expected to increase in *sonority* (openness of the vocal tract) before a beat and decrease after a beat. In case two adjacent consonants do not differ in sonority, that is called a *sonority* (or *manner*) *plateau*. Adjacent consonants are also expected to differ in POA and in voicing (unless they have the same MOA). In case they do not differ, that is called a *POA plateau* and a *Voicing plateau*, respectively. In general, the word *plateau* indicates that there is lack of alternance at some level.

O, L, N and G are typically non-beats, V is typically a beat[4]. The beat is the only compulsory component. The preferred sequence is OV but also other sequences are possible. L or N tend to be in complementary distribution. The maximal well-formed sequence is O L/N G V as in French /krwa/ *croit*, for example. Any inversion in this sequence is to be considered ill-formed.

Of course there are cases of inverted order (in many Slavic languages, e.g. Ukrainian city *Lviv*, Czech *rty* 'lips', etc.) or cases of *plateaux*. In this chapter I am interested in accounting for the latter, because, even when it comes to *plateaux*, some *plateaux* are better ('more natural, less marked') than others.

2.4.1 Manner plateau

B&B implies that Stop (S) + Fricative (F) is a better sequence than FS. This prediction is very far from the truth, though, because if a language allows FS, then it allows SF too, but not vice versa, compare: Ancient Greek /ps/yché 'soul', /ks/enos 'stranger' vs. /sp/anis 'scarcity', /sk/afé 'basin', /st/adion 'race; Italian /ps/icologia 'psychology', /ks/ilofono 'xylophone' vs. /sp/azio 'space', /sk/udo 'shield', /st/ella 'star'; French /ps/ychologie, /ks/ylophone vs. /sp/ort, /sk/i, /st/yle; English */ps/, */ks/, */ts/ but /sp/ort, /sk/y, /st/yle. According to Morelli (1999:42), if a language allows a sequence of obstruents word-initially, then it surely allows FS sequences. Therefore, in NBB all obstruents are assigned the same MOA value, i.e., 4. Considering stops and fricatives equal in sonority does not solve the issue. NAD, at this point, can only tell us that an OO sequence is worse than, say, an OL sequence, but still treats all OO as the same.

(13) NAD of sonority plateaux

NAD /sp/ = (4 – 4) + |0 – 3| = 0 + 3 = 3.
NAD /ps/ = (4 – 4) + |3 – 0| = 0 + 3 = 3.
NAD /tp/ = (4 – 4) + |0 – 3| = 0 + 3 = 3.

According to the NAD calculation, /sp/, /ps/ and /tp/ are equally good (or equally bad) as word-initial non-beats bindings but statistically we know that /sp/ is much more likely to occur than /ps/ and both are more likely to occur than /tp/.

[4] There are obviously many languages in which nasals and/or liquids can act as beats (Slavic languages, English, German, etc.) and sometimes even obstruents can (Tashlhyit Berber, Nuxalk, Semai, etc.). A consonantal beat is represented as "N" in B&B.

I claim that NAD is an optimal tool to calculate well-formedness of sonority-optimal sequences, i.e., sequences in which the values of MOA decrease, but it is useless when two segments have the same MOA. Something else has to be considered.

One of the basic tenets of most phonological theories, and of B&B too, is that the optimal sequence (syllable in traditional terms, binding of a non-beat and a beat in B&B) is OV, in which the constriction degree of the vocal tract is maximally different. Constriction must decrease, sonority must increase. It is well-known, anyway, that OV can be expanded, but maintaining the pattern: constriction decreases, sonority increases. Any sequence that does not respect the pattern is ill-formed, i.e., potentially banned from the phonological system.

That is exactly what happens in the many languages that do not allow plateaux, i.e., obstruent clusters (or sonorant clusters). Anyway, I am now dealing with languages that do allow them and I intend to show that, in order to survive, they have to meet certain requirements. These requirements are based on what I suggest to call *salience.*

Salience, as much as sonority, markedness, strength, etc. is a tricky term in phonology and phonetics and has often been used without specifying its nature and function. I argue that salience is grounded in acoustic factors, i.e., salient segments are relatively more easily audible. But with such a definition, salience would end up coinciding with sonority, since we all know that a vowel is more audible that an obstruent, etc. Therefore, I propose to define salience in the following way:

- *Salience is the capacity of a non-beat to have its MOA and POA discriminated independently from its distance from a beat*. Obstruents, in order to be recognized, rely on two kinds of cues: contextual cues and internal cues. Contextual cues are audible only if they are followed or preceded by a vowel. If this is not the case, the listener can only rely on internal cues, that are much harder to identify (Steriade 1997, Morelli 1999:149). Salient segments, anyway, maintain a certain degree of recognizability even if not followed or preceded immediately by a vowel.
- *Segments belonging to different natural classes cannot be compared for salience.* Therefore, obstruents pattern with obstruents, nasals with nasals, liquids with liquids, glides with glides. Put differently, SH already implies that the most sonorous segments are more salient than the less sonorous ones, so salience is a useful device only when it comes to plateaux (MOA plateau, as in this case, and POA plateau, as I will show later).

- *The function of salience is to allow sequences of consonants with the same MOA to survive.*

2.4.1.1 Salience scales

Obstruents: s > f > θ > k > p > t (cf. Ladefoged & Maddieson 1986, Hume et al. 1999, Wright 2004, Jun 2005)

- fricatives > stops
- Within Stops: k > p > t
- Within Fricatives: s > f > θ

For sake of simplicity, I will not consider affricates.

It is well-known that /s/-like sounds (stridents or sibilants) display a great amount of acoustic energy at very high frequencies. Non-strident fricatives, such as /f, θ/ are much less loud and easily confusable with each other (Safford Harris 1958:5). Fricatives are nonetheless more salient than stops since their internal cues consist mainly in a protracted friction noise, whereas the only internal cue for stops is the release burst. Among stops, an experiment conducted by Hume et al. (1999) showed that the velar POA is recognized more easily than the labial and both are recognized more easily than the dental/alveolar. This is due to the fact that the movements implied in the production of the velar stop are slower and require a greater effort than the ones implied in the production of the labial stop, and the movements implied in the production of the labial stop are slower and require a greater effort than the ones implied for the dental/alveolar stop. Not surprisingly, /t, d/ are often used as epenthetic segments, e.g., in French, Korean, Maru, Axininca, etc. (cf. Vaux 2002, McCarthy 1999, Bakovic 1998).

Nasals: m > n > ŋ.

Greenlee & Ohala (1980:286), citing Ferguson (1975), report that nasals are "astonishingly stable" and they resist changes better than other consonants. Anyway, among them, the velar nasal seems the weakest one since it is easily confused with a nasalized vowel. /ŋ/ "has the shortest – often negligible – oral branch and any anti-formant it does have (…) appear[s] (…) much attenuated" (Greenlee & Ohala 1980:290). On the contrary, /m/ has very long oral branch and the perceptually most evident anti-formant. /n/ is in the middle.

Liquids: r > l.

/r/ is generally treated as more sonorous than /l/ (van der Hulst 2004). Moreover, it appears that it is more likely for a rhotic to trigger assimilation of lateral, rather than the opposite (Zuraiq & Zhang 2006), although it is not always the case. Note that if it is licit to say that /r/ is more sonorous and/or more salient than /l/, one cannot say that one is more or less marked than the other, at least for their occurrence in world's languages, since there are languages with /r/ without /l/ and languages with /l/ without /r/, one does not imply the other (Rice 2005). If one looks at phonological acquisition, though, /r/ is generally learned later than /l/ since its production requires greater effort and precision. For example, Spanish children can master /r/ up to 2 years after /l/ (Bedore 1999).

2.4.1.2 Requirements on OO clusters:

- In a O1O2 sequence, O1 and O2 must differ maximally in salience;
- Salience must decrease from O1 to O2;
- The salient O is preferably the most salient of its category.

Put differently,

- in a OO sequence, one must be a stop and one must be a fricative;
- a OO sequence must be a FS sequence
- F is preferably a /s/-like sound, i.e., a strident.

Therefore, /sk/ > /fk/ > /θ/ and /sk/ > /ks/ > /kt/.

What about a sequence of stops? Salience must decrease, so /kt/ > /pt/ > /tp/ > /tk/[5].

The well-known issue of /s/O clusters is not an issue anymore because stops and fricatives are not assumed to differ in something like sonority or strength but in salience. In a sequence of sounds that belong to the same sound class, salience must decrease. Therefore, stridents, being the most salient segments within the category of obstruents, are the best candidate to occupy the initial position. My analysis differs from that of Morelli (1999:129), since she argues that /s/ is the optimal obstruent as the first segment of an obstruent cluster because it is the unmarked fricative (coronal) but then she has to explain why /s/ is preferred to other coronal fricatives, such as /θ/. In her Optimality Theory analysis, /s/ is less marked than /θ/ because the constraint *[+distributed] is ranked higher than *[-distributed] but I think that this ranking, without grounding the constraints in phonetic factors, appears rather ad hoc.

3. Requirements on OL sequences

Another issue that neither SH or B&B seem able to explain satisfactorily is the scarcity of languages that allow /tl, dl/ sequences as opposed to frequency of other OL clusters. An OL sequence is generally well-formed, since it obeys the sonority sequencing: the MOA value of the first segment is

[5] Of the 26 languages analyzed by Morelli (1999) that allow obstruent clusters, all permit FS clusters and only 11 have SS clusters. Of these 11, all permit SS clusters in which the first S is a labial or a velar the second is a dental/alveolar. Cambodian only allow an aspirated stop to precede another stop. Serbo-croatian, Dakota, Hebrew, Khasi, Nishga and Tsou allow /tk/.

4, the MOA value of the second segment is 2, so the MOA value decreases towards the beat (0). As a matter of fact, clusters such as /pr, pl, kr, kl, tr, etc./ are found in a great number of languages, but many of them do not allow /tl, dl/ sequences word-initially, e.g. English, German, French, Spanish, Italian, Hungarian, Marathi, Thai, etc. Nevertheless, there are languages that allow them (e.g. Russian, Hebrew), but they are the minority[6]. It is true that /l/ is less sonorous than /r/, but then, why are /pl, kl/ allowed? It is also true that /t, d/ and /l/ have the same POA, but then, why are /tr, dr/ allowed?

I argue that the answer lies again in salience. /l/ in post-obstruent position is weaker (more likely to undergo reduction) than /r/ in the same position. For example, Latin words containing O/l/ sequences became O/j/ in Italian, /ʎ/~/j/ in Spanish, /ʃ/ or O/r/ in Portuguese. The same did not occur with O/r/ clusters.

(14)

Latin	*Italian*	*Spanish*	*Portuguese*
pluwja(m)	pjoddʒa	ʎubja	ʃuvɐ
plagia(m)	spjaddʒa	plaja	prajɐ
klamare	kjamare	ʎamar	ʃɐmar
primu(m)	primo	primero	primeiru
kruk(em)	krɔtʃe	kruθ ~ krus	kruʃ ~ krus

In English /tl, dl/ are banned word-initially; word-medially and word-finally /l/ is realized as its syllabic allophone (Oda 2012), as in *middle, little*. An experiment conducted on French speakers (Hallé et al. 2003) showed that /tl, dl/ sequences were very likely to be perceived as /kl, gl/ instead.

It is reasonable to think that after an obstruent /r/ is more easily perceptable than /l/ because of its inherent salience and is therefore preferred in this position. But again, the issue is not the ban on O/l/ sequences but specifically on /tl, dl/. I suggest that these clusters are disfavored because, besides not having /r/ as a liquid, they are a POA plateau, since /t, d/ and /l/ are dental/alveolar. If a POA plateau is bad, as the general theory of B&B predicts, /tr, dr/ sequences should be somehow worst than /pr, br, kr, gr/ sequences and in fact in English /t, d/ before /r/ tend to affricate into /tʃ/ and

[6] Flemming (2007) reports that in Haroi and in Katu dialects /kl, gl/ are banned whereas /tl, dl/ are allowed and in Mong-Njua there is free variation between velar and dental stops before a liquid. However, these data do not change the fact that, cross-linguistically, /tl, dl/ are the least frequent combinations of stop + liquid.

/dʒ/, so much that Read (1986) reports children's misspellings such as <chree> for *tree* and <jream> for *dream*.

It appears then that salience not only plays a role within a class of segments but also across different classes when there are non-optimal situations, i.e., *plateaux*. In the specific case of OL clusters, NAD and salience together make the following predictions:

(15) pr, kr > br, gr > pl, kl > bl, gl > tr, dr > tl > dl.

4. Syllabification without the syllable

B&B is a model that refuses to consider syllabic structure as the reason why consonants group in a certain way before and after vowels, because it is somehow circular: since there is the syllable, segments are organized in syllables; segments are organized in syllables because there is the syllable. B&B does not talk about the syllable as something we already know about, but as the product of the interaction between beats and non-beats. It is important to point out that B&B does not deny the existence of the syllable, it simply wants to explain why syllables emerge in the way they do. So far I have dealt mainly with initial clusters, showing which ones are well-formed and ill-formed according to the theory. Using traditional terms, I have been talking about complex onsets. The formula for initial clusters is the one in (3) that I report here:

(16) C1C2V is well-formed iff NADC1C2 ≥ NADC2V

The constraints on complex onsets are not given in a stipulative way but are justified by the values formerly assigned to each segment. Quite reasonably, one could assume that what applies to initial clusters applies to final clusters in an opposite fashion, but final clusters do not seem to be a simple mirror of initial clusters. For example, if difference in POA is preferable word-initially, e.g. /pra/ > /tra/, word-finally there seems to be a tendency towards the unmarked and the POA plateau, e.g. /nt/ > /mt/. I will not discuss here possible requirements on the well-formedness of final clusters; I will concentrate instead on medial clusters, or better, how to predict if, in a C1V1C2C3V2 sequence, C2 binds with the preceding vowel and the following consonant, only with the preceding vowel or only with the preceding consonant. I propose the following formula:

(17) given C1V1C2C3V2, C2 binds with C3 iff [NAD(C2C3V2) – NAD(C1V1)] is closer to 0 than [NAD(C3V2) – NAD(C1V1C2)], otherwise binds with V1.

The formula in (17) calls for an explanation: a hypothetical “perfect word” would be composed of an alternation of beats and non-beats. The auditory distance between a beat and a non-beat should be maximal, i.e., the non-beat should be an obstruent, the beat should be a vowel and they should have a different POA. At this point, imagine a nBnB sequence (CVCV), where each nB (CV) pair has the greatest NAD possible = *x*. The difference of the NAD of C1V1 and C2V2 would thus be = 0, because (*x* – *x* = 0). A C1V1C2C3V2 sequence should be as close as possible to a C1V1C2V2 sequence and therefore, C2 binds with V1 if C1V1C2 – C3V2 is closer to 0 than C1V1 – C2C3V2 and binds with C3 in the opposite case. I will show this more clearly through two examples, the Italian words *capra* ‘goat’ and *costo* ‘cost’. Note that nothing would change if we made the subtraction in the inverse order, e.g.

(18) C2 binds with C3 iff [NAD(C1V1) – NAD(C2C3V2] is closer to 0 than [NAD(C1V1C2) – NAD(C3V2)]

because if the result is, e.g., -3 instead of 3, the distance from 0 is the same. Once made this clear, for the rest of the paper I will stick to the formula in (17) for the sake of simplicity.

(19) Example 1: *capra*
Possibility (a): /p/ binds with /r/

n **B** **n** **n** **B** **Timing tier**
| n→B | ? | n→n | n→B | **Bindings**
| | | | |
k a p r a **Segmental tier**

NAD/pr/ = 6, NAD/ra/ = 2, NAD/pra/ = 6 – 2 = **4**
NAD/ka/ = **7**
(NAD/pra/ – NAD/ka/) = (4 – 7) = **-3**

Possibility (b): /p/ binds with /a/, does not bind with /r/

n **B** **n** **n** **B** **Timing tier**
| n→B | B←n| | n→B | **Bindings**
| | | | |
k a p r a **Segmental tier**

NAD/kap/ = /ka/ = 7, /ap/ = 0, NAD/kap/ = 7 – 0 = **7**
NAD/ra/ = **2**
(NAD/ra/ - NAD/kap/) = (2 – 7) = -5.
Since -3 is closer to 0 than -5, /p/ binds with /r/.

(20) Example 2: *costo*

Possibility (a): /s/ binds with /t/

```
n       B       n       n       B               Timing tier
|  n→B  |   ?   | n→n   |  n→B  |               Bindings
|       |       |       |       |
k       o       s       t       o               Segmental tier
```

NAD/st/ = 0, NAD/to/ = 7, NAD/sto/ = 0 – 7 = **-7**
NAD/ko/ = **5**
(NAD/sto/ **-** NAD/ko/) = (-7 – 5) = **-12**

Possibility (b): /s/ binds with /o/, does not bind with /t/

```
n       B       n       n       B               Timing tier
|  n→B  |  B←n  |       |  n→B  |               Bindings
|       |       |       |       |
k       o       s       t       o               Segmental tier
```

NAD/ko/ = 5, NAD/os/ = -1, NAD/kos/ = 5 – (-1) = 5 + 1 = **6**
NAD/to/ = **7**
(NAD/to/ - NAD/kos/) = (7 – 6) = **1**
Since 1 is closer to 0 than -12, /s/ binds with /o/.

(21) Does C2 binds with V1 too?
- In *capra*, NAD/pra/ - NAD/kap/ = NAD/pra/ - NAD/ka/, so, YES:

```
n       B       n       n       B               Timing tier
|  n→B  | B ← n | n→n   |  n→B  |               Bindings
|       |       |       |       |
k       a       p       r       a               Segmental tier
```

- In *costo*, NAD/sto/ - NAD/ko/ = -12 and NAD/to/ - NAD/kos/ = 1, so, NO.

The model shows that it is possible to explain the emergence of syllabic structure. Syllables do emerge as rhythmic patterns during speech, but not because of some abstract structure: segments tend to link with adjacent segment if the binding enhances perceptibility, otherwise they do not. NBB accounts for the different behavior of postvocalic, preconsonantal consonants in words such as *capra*, *costo* relying on the inherent characteristics of the single segments taken into account. In the next section I will use NBB phonology to describe Italian phonotactics and see how it deals with that.

5. A phonotactic account of Italian

So far B&B has dealt with languages with a quite complex phonotactic structure, such as English and Polish (Dziubalska-Kołaczyk & Zielińska 2010, Marecka & Dziubalska-Kołaczyk 2012). These two languages, to different extents, allow consonant clusters of remarkable complexity, e.g. English *strengths* /strɛŋθs/, Polish *lśnić* /lɕɲitɕ/ 'shimmer', etc. Italian, with its relatively simple phonological structure, should not pose particular challenges to any phonotactic model but it is not the case. In this section, after an overview on Italian phonological structure, I will examine some issues that so far are left unsolved in the literature: the frequency of /s/C clusters word-initially vs. the absence (or at least marginality) of other type of obstruent clusters (Bertinetto 2004); the absence of /tl, dl/ clusters vs. /tr, dr/ clusters; the selection of the definite masculine article allomorph *lo* instead of default *il* before words starting with /j/ vs. the selection of *l'* before native words starting with /w/ and *il* before loanwords starting with /w/ (Krämer 2009:86).

5.1 The phonology of the Italian word

Typically, Italian words have the following structure: CVCV, as in *cane* 'dog', or CVCCV, as in *conto* 'account', *costo* 'cost', *copro* 'I cover', *cotto* 'cooked'. Word-initially (before a beat), Italian allows sequence of /s/ + O + L + G, as in *striato* /strjato/ 'striped', /s/ + N + G, as in *smielato* /zmjelato/ 'cheesy' or /s/ + O + G, as in *svuotato* /zvwotato/ 'emptied', but the preferred initial cluster is OL. Italian phonology is also characterized by the presence of geminate consonants, although their occurrence is limited to the intervocalic position. Also note that glides /j, w/ and the voiced sibilant [z] (that in most variants is merely an allophone of /s/) are never geminate, whereas /ʃ, ɲ, ʎ, ts, dz/ always are.

5.1.1 Obstruent clusters

Among the obstruent clusters that Italian allows word-initially, there are two types: /s/O clusters and other OO clusters. Only the former belong to the native lexicon, the latter occur exclusively in words of Greek origin. Note that before a voiced consonant, /s/ becomes voiced too.

(22)

Native lexicon	**Greek loans**
/sp/ as in *sperare* ‘to hope’	/ps/ as in *psicologia* ‘psychology’
/zb/ as in *sbattere* ‘to beat’	/ks/ as in *xenofobia* ‘xenophobia’
/st/ as in *stendere* ‘to lay’	/pt/ as in *pterodattilo* ‘pterodactyl’
/zd/ as in *sdentato* ‘toothless’	/kt/ as in *ctonio* ‘chthonic’
/sk/ as in *scherzo* ‘joke’	/ft/ as in *ftalato* ‘phthalate’
/zg/ as in *sgattaiolare* ‘to slink’	/bd/ ad in *bdellio* ‘bdellium’
/sf/ as in *sfera* ‘sphere’	
/zv/ as in *svelare* ‘to reveal’	
/stʃ/ as in *scervellarsi* ‘to rack one’s brains’[7]	
/zdʒ/ as in *sgelare* ‘to thaw’	

It is apparent that words belonging to the core lexicon only allow /s/O cluster in initial position and this perfectly follows the predictions on obstruent clusters made in section §2.4.1.2.

(23) An obstruent cluster is composed of a fricative and a stop; the fricative is a sibilant and precedes the stop.

Even though the obstruent clusters in Greek loanwords are less well-formed, they still follow the universal preferences on salience: in /ps/ and /ks/ salience does not decrease because the fricative is in second position but there is a great difference in salience between the two obstruents. /ft/ is worse than /st/ but at least salience decreases from the first to the second segment. The very rare clusters /pt, kt, bd/ are composed of two stops, which is bad on the MOA dimension, but on the POA dimension they respect the

[7] /stʃ/ is often reduced to /ʃ/.

salience decrease, i.e., the first stop is a labial or a velar and the second one is a dental. The requirements on obstruent clusters in Italian can therefore be formulated as such:

(24) Italian allows obstruent clusters word-initially in the following cases:
- one of the two obstruents is the most salient of its category;
- salience decreases from the first obstruent to the second.

/s/O clusters, since they meet both requirements, are the preferred ones. O/s/ and /pt, kt, ft, bd/ clusters only meet one requirement and thus are rarer.
One might wonder why the palato-alveolar sibilant /ʃ/ is left out of the game. The answer is probably linked to the fact that the distribution of /ʃ/ in Italian is limited to two positions: intervocalic and initial before a vowel. It never occurs before another consonant, not even nasals or liquids. If we accept that /ʃ/ is inherently long, this should suffice to explain its dispreference for preconsonantal position.
Also note that many /s/C clusters are not tautomorphemic but bimorphemic, since *s-* is one of the commonest prefixes in Italian. Clusters such as /zb, zd, zg, zv, stʃ, zdʒ/ are never tautomorphemic.

5.1.2 OL clusters
In Italian OL clusters are the commonest type of clusters and they occur both word-initially and word-medially. Traditionally, they have been described to be tautosyllabic, as opposed to /s/O clusters that are heterosyllabic. In B&B words, word-internally, an obstruent between a vowel and a liquid binds with both, whereas /s/ in the same position only binds with the preceding vowel (I showed this in section §4, *k→a←p→r→a* vs. *k→o←st→o*). However, not all the possible OL clusters have the same occurrence in Italian and some of them are not allowed.
Typically, affricates /ts, dz, tʃ, dʒ/ are excluded from pre-liquid position, as well as inherently geminate segments such as /ʃ, ɲ, ʎ/ but these sounds display a very limited distribution and are somehow marginal in the system.
/vl, vr/ are quite rare too. /vl/ is only found in the proper name *Vladimiro*, of Slavic origin, whereas /vr/ never occurs word-initially. Word-internally, besides the French loans *scevro* 'devoid' and *piovra* 'octopus', /vr/ appears in the future tense and in the conditional mood of the very common verb *avere* 'to have', in the forms *avrò, avrai, avrà* etc. and *avrei, avresti, avrebbe*, etc.
/zr, zl/ never occur in tautomorphemic sequences with the exception of *slavo* 'Slav' and even in bimorphemic sequences are quite marginal.

The core OL clusters are of the type stop (and /f/) + /r/. In fact, as I showed in (15), Latin stop + /l/ clusters became, in most cases, stop + /j/ sequences. All stop+/l/ clusters now belong to the Latinate/Greek/Germanic lexicon.

(25)

Core Lexicon	**Foreign Lexicon**
/pr/ as in *primo* 'first'	/pl/ as in *plico* 'envelop' (Latinate)
/br/ as in *bravo* 'good, talented'	/bl/ as in *blu* 'blue' (Germanic)
/kr/ as in *credere* 'to believe'	/kl/ as in *cloro* 'chlorine' (Greek)
/gr/ as in *grande* 'big, great'	/gl / as in *glicine* 'Wistaria flower' (Greek)
/tr/ as in *tre* 'three'	
/dr/ as in *dritto* 'straight'	
/fr/ as in *fronte* 'forehead'	/fl/ as in *flagellare* 'to flog' (Latinate)

Among the simple stop+liquid sequences, it is easy to notice that /tl, dl/ clusters are not attested even in foreign words. To be more precise, /dl/ is completely absent and /tl/ is present only word-internally in the words of Greek origin *atleta* 'athlete' and *atlante* 'atlas' and their derivatives *atletica* 'athletics', *Atlantico* 'Atlantic', etc.
Even in this respect, Italian seems to follow the general pattern of OL clusters described in section §3:

(26) Among OL clusters, O/r/ clusters are preferred to O/l/ clusters

(27) Among OL clusters, O and L should have a different POA

(28) in a C1C2 sequence, |Lx1 – Lx2| should be equal to 1 (they should differ in voicing).

Given (26, 27, 28) one obtains the following predictions for Italian (excluding /vr, vl, zl, zr/):

(29) /pr, kr, fr/ > /br, kr/ > /tr/ > /dr/ > /pl, kl, fl/ > /bl, kl/ > /tl/ > */dl/

/tl, dl/ clusters are excluded because they do not meet either of the two requirements on OL clusters: the liquid is not the most salient of its category and they have the same POA (dental/alveolar). /tl/ occurs in few Greek loanwords word-internally but at least it does not violate (28) because /t/ is voiceless. On the contrary, /dl/ is completely banned, because it does not meet the requirement on salience and implies two plateaux: the POA plateau and the voicing plateau.

(30)

Cluster	Least salient liquid	POA plateau	Voicing plateau
/pr, kr, fr/			
/br, gr/			✓
/tr/		✓	
/dr/		✓	✓
/pl, kl, fl/	✓		
/tl/	✓	✓	
/dl/	✓	✓	✓

5.1.3 Article allomorphy

One problem I have not touched upon so far is definite masculine article allomorphy before glides. In Italian the definite masculine article has three allomorphs: *il*, *l* and *lo.* All previous analyses have considered *lo* as the non-default form (Dressler 1985, Boyd 2006, McCrary 2004) and I agree with that. As of *il* and *l* I prefer to consider both allomorphs default but for reason of space I will not elaborate on this further. The distribution of the three allomorphs is clear, although the conditions that trigger the selection of *lo* are quite complex.

(31)

Allomorph	Context	Example
Il	CV OL OG OLG /w/ in loanwords	*il cane* /ilkane/ ‘the dog’ *il treno* /iltrɛno/ ‘the train’ *il piano* /ilpjano/ ‘the plan’ *il triangolo* /iltrjangolo/ ‘the triangle’ *il weekend* /ilwikɛnd/ ‘the week-end’
L	V /w/ in native words	*l’amico* /lamiko/ ‘the friend’ *l’uomo* /lwɔmo/ ‘the man’
Lo	OO	*lo spirito* /lospirito/ ‘the spirit’ *lo psicologo* /lopsikologo/ ‘the psychologist’ *lo pterodattilo* /lopterodatːilo/ ‘the pterodactyl’

		lo bdellio /lobdɛlːjo/ ‘the bdellium’
	O/n/	*lo pneumatico* /lopneumatiko/ ‘the tire’
	/ts/	*lo zucchero* /lotːsukːero/ ‘the sugar’
	/dz/	*lo zaino* /lodːzaino/ ‘the backpack’
	/ʃ/	*lo sciame* /loʃːame/ ‘the swarm’
	/ɲ/	*lo gnomo* /loɲːɔmo/ ‘the gnome’
	/ʎ/	*lo gliommero* /lo ʎːomːero/, a poetic genre
	/j/	*lo ione* /lojone/ ‘the ion’
	/zw/ in loanwords	*lo Swatch* /lozwɔtʃ/, a brand of watches

Traditionally, *il* is said to occur before a tautosyllabic onset, *l* before an onsetless syllable and *lo* before a heterosyllabic onset. The latter definition includes obstruent clusters, obstruent + nasal clusters and inherently geminate sounds. The occurrence of *lo* before *Swatch* might be due to an orthographic bias, as well as the different treatment of /w/ in *uomo* and in *weekend.*
How does B&B account for that? I argue that in B&B the selection of *lo* can be described as, (1) the preference for a non-beat to bind with a beat rather than with another non-beat and (2), the preference, in a C1C2V sequence, for the NAD of C1C2 to be equal or greater than the NAD of C2V. As a matter of fact, the NAD of an obstruent cluster is never greater than the NAD of an obstruent and a vowel and the NAD of a geminate is always equal to 0. Phonology by itself, though, cannot always correct ill-formed sequences. In this particular case, the solution is offered by morphology that provides three different allomorphs:

(32)

(a)	i ← l k → a ←n → e	*il cane* ‘the dog’
(b)	l→a←m→i←k→o	*l’amico* ‘the friend’
(c)	i←l t→r→ɛ←n→o	*il treno* ‘the train’
(d)	l→o←s p→i←r→i←t→o	*lo spirito* ‘the spirit’
(e)	l→o←ʃ ʃ→a←m→e	*lo sciame* ‘the swarm’

(32a) and (32b) are not problematic at all. The crucial point is the difference between (32c) and (32d), or specifically, between /trɛ/ and /spi/.

(33) NAD/trɛ/
NAD/tr/ = (4 – 2) + |0 – 0| + |0 – 1| = 2 + 0 + 1 = 3

NAD/rɛ/ = (2 – 0) + |0 – 0.25| + |1 – 1| = 2 + 0.25 + 0 = 2.25
3 > 2.25 → well-formed.

(34) NAD/spi/
NAD/sp/ = (4 – 4) + |0 – 3| = 0 + 3 = 3
NAD/pi/ = (4 – 0) + |3 – 1| + |0 – 1| = 4 + 2 + 1 = 7
3 < 7 → ill-formed.

/trɛ/ is a well-formed sequence, /spi/ is not, although we know that, among obstruent clusters, /sp/ is relatively well-formed. By selecting *lo* instead of *il*, /s/ can bind to the preceding beat (vowel) /o/, so that there are no ill-formed sequences anymore. The same applies to geminates, see /ʃʃa/ in *sciame:*

(35) NAD/ʃʃa/
NAD/ʃʃ/ = (4 – 4) + |1 – 1| = 0
NAD/ʃa/ = (4 – 0) + |1 – 0| + |0 -1 | = 4 + 1 + 1 = 6
0 < 6 → ill-formed.

Exactly like in syllable-based theories, the selection of *lo* instead of *il* can be explained as a repair strategy for sequences that are somehow ill-formed. However, we need to explain why *lo* is regularly selected in front of words beginning with /j/. In fact, glides are never long in Italian and the labiovelar glide, /w/, selects either *il* or *l* (only marginally *lo*, e.g. *lo uadi* ‘the wadi’). In B&B, the reason lies in the degree of well-formedness of the sequence. Compare, e.g., the NAD of /ljo/ in *l'ione* and of /lwɔ/ in *l'uomo.*

(36) NAD/ljo/
NAD/lj/ = (2 – 1) + |0 – 1| + |1 – 1| = 1 + 1 + 0 = 2.
NAD/jo/ = (1 – 0) + |1 – 2.25| + |1 – 1| = 1 + 1.25 + 0 = 2.25
2 < 2.25 → ill-formed.

(37) NAD/lwɔ/
NAD/lw/ = (2 – 1) + |0 – 2.5| + |1 – 1| = 1 + 2.5 + 0 = 3.5
NAD/wɔ/ = (1 – 0) + |2.5 -2| + |1 – 1| = 1 + 0.5 + 0 = 1.5
3.5 > 1.5 → well-formed.

Therefore, before /w/-initial words there is no need to select the non-default allomorph *lo*, whereas before /j/-initial words *lo* gives the possibility to correct an ill-formed sequence. Even in a sequence like /lja/ (found potentially in *l'iato* ‘the hiatus’), the NAD would be just 0 (NAD/lj/ = 2 =

NAD/ja/ = 2), which would not imply ill-formedness but is certainly not optimal.

(38)

(a) l → w → ɔ ← m → o

(b) l → o ← j → o ← n ← e.

6. Conclusion

The phonotactic model proposed by Dziubalska-Kołaczyk (2002) and developed here by the author has proven so far to be able to account for many of the phenomena that former theories explained taking the notion of syllable for granted. Moreover, since the theory considers place of articulation relevant for phonotactics, unlike classical Sonority Hierarchy, is able to make finer predictions. In order to explain the preference, among obstruent clusters, for /s/O clusters and for the rarity, among obstruent + liquid clusters, of /tl, dl/, the author introduced the concept of relative salience. When two consonants have the same manner of articulation, the first one is preferably more salient than the second; when a liquid follows an obstruent, the obstruent should not share the same place of articulation of the liquid and the liquid is preferably a rhotic. I tested my predictions on Italian phonotactics and proved that NBB provides a satisfactory analysis. Moreover, I have shown how NAD is responsible for the selection of the article *lo* before words beginning with /j/, instead of default *il* or *l*. However, there are some important issues that still need to be investigated, e.g., which criteria define the well-formedness of final clusters.

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