

# THE INTERACTION OF YER DELETION AND NASAL ASSIMILATION IN OPTIMALITY THEORY<sup>1</sup>

**KAROLINA IWAN**

Uniwersytet Warszawski  
iwan.karolina@gmail.com

## **Abstract**

The problem of opacity presents a challenge for generative phonology. This paper examines the process of Nasal Assimilation in Polish rendered opaque by the process of Vowel Deletion in Optimality Theory (Prince & Smolensky, 1993), which currently is a dominating model for phonological analysis. The opaque interaction of the two processes exposes the inadequacy of standard Optimality Theory arising from the fact that standard OT is a non-derivational theory. It is argued that only by introducing intermediate levels can Optimality Theory deal with complex cases of opaque interactions.

**Key words:** Optimality Theory, Derivational Optimality Theory, opacity

## **1. Introduction**

This paper investigates the process of Nasal Assimilation in Polish rendered opaque by the process of Vowel Deletion in the framework of Optimality Theory (Prince & Smolensky, 1993). The opaque interaction of the two processes exposes the inadequacy of standard OT as a model serving for phonological analysis. It will be demonstrated that only by introducing intermediate levels can Optimality Theory deal with complex cases of opaque interactions. Section 1 presents an overview of vowel-zero alternations in Polish. Section 2 presents an Optimality-Theoretic analysis of transparent instances of Nasal Assimilation and shows that standard Optimality Theory cannot deal with the opaque form *Irenka* [irenka] ‘Irene’ (dimin.), where the non-application of Nasal Assimilation is inexplicable by surface facts. The opaque cases are further analyzed in terms of Derivational Optimality Theory (section 3). Section 4 offers conclusions.

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<sup>1</sup> The author would like to thank Jerzy Rubach for his invaluable advice on the preparation of this work.

## 2. Yers in Optimality Theory

This section provides an overall picture of vowel-zero alternations in Polish. Section 1.1 presents basic generalizations. Section 1.2 provides a review of the theories concerning the representation of yers in phonology. Section 1.3 offers an OT account of the basic yer vocalization and deletion patterns which are relevant for the discussion.

### 2.1 Vowel-zero alternations in Polish

Vowel-zero alternations are a well-known problem of Slavic phonology. In Polish, the vowels alternating with zero involve /ɛ/, /i/, /ɨ/, and /ɔ/.<sup>2</sup> They are known as fleeting vowels or yers. It has traditionally been assumed that yers are present underlyingly.<sup>3</sup> Indeed, the deletion of the underlying vowels in some contexts rather than the epenthesis seems to be the correct analysis for Polish fleeting vowels.<sup>4</sup> First of all, it is impossible to define the context for epenthesis. Consider the following examples.

(1) Representative paradigms

	<i>nom.sg.</i>	<i>gen.sg</i>	<i>gloss</i>
a	skuter	skuter+a	‘scooter’
b	sweter	swetr+a	‘sweater’
c	metr	metr+a	‘meter’

The data in (1) cannot be accounted for by an analysis based on epenthesis. First, the same consonantal cluster /tr/ is always separated by /ɛ/ in *skuter* (1a), in *sweter* (1b) – only in some cases, and in *metr* (1c), it is left unaffected. Therefore, it has to be concluded that words with a non-alternating /ɛ/ contain a regular vowel underlyingly, those with an alternating /ɛ/ must be represented as containing a yer, while those with an invariably undivided clusters have no intervening vowel in the underlying representation.

Second, epenthesis interpreted as a strategy employed to break up consonant clusters cannot be proposed for Polish as the language is notorious for tolerating

<sup>2</sup> The emergence of the alternating /i/ and /ɨ/ is limited to one morphological category: the Derived Imperfective verbal forms. The fleeting /ɔ/ appears in only four roots: *kocioł* ‘boiler’ (nom.sg.), *koziół* ‘goat’ (nom.sg.), *osioł* ‘donkey’ (nom.sg.) and *ciesioł+k+a* ‘carpentry’ (compare: *kotł+a* (gen.sg.), *kozł+a* (gen.sg.), *osł+a* (gen.sg.) and *cieśl+a* ‘carpenter’(nom.sg.)). In this paper, I focus exclusively on fleeting /ɛ/ and the phonological processes in which it is involved.

<sup>3</sup> This idea goes back to Lightner (1963).

<sup>4</sup> Describing Polish vowel-zero alternations in terms of epenthesis has been attempted by Laskowski. For details, see Laskowski (1975, pp. 44-67).

clusters of as many as five consonants. Suffice it to mention words such as *źdźbło* [zdźbɔ] ‘blade of grass’, *pstrąg* [pstrɔŋk] ‘trout’, *łgarstw* [wgarstf] ‘lie’ (gen.pl.), or *zastępstw* [zastɛmpstf] ‘substitution’ (gen.pl.).<sup>5</sup>

Another fact of Polish that may present a serious problem for an epenthesis analysis is that some fleeting /ɛ/'s palatalize preceding consonants while others do not.

## (2) Palatalizing and non-palatalizing yers

### a. Palatalizing yer:

wi[ɛ]ś ‘village’ (nom.sg.)	–	ws+i (gen.sg.)
dzi[ɛ]ń ‘day’ (nom.sg.)	–	dni+a (gen.sg.)

### b. Non-palatalizing yer:

w[ɛ]sz ‘louse’ (nom.sg.)	–	wsz+y (gen.sg.)
d[ɛ]n ‘bottom’ (gen.pl.)	–	dn+o (nom.sg.)

It is clear that the arbitrariness of alternation sites as well as the existence of two distinctly behaving alternating vowels exclude epenthesis as a viable proposal and serve as proof for yers being present underlyingly.

## 2.2 Yers: the representation

Let us now address the question of the representation of yers. First, it is necessary to differentiate fleeting /ɛ/'s from non-fleeting /ɛ/'s on account of their distinct phonological behavior. Second, the palatalizing fleeting /ɛ/'s must be set off from the non-palatalizing ones. Standard generative phonology expresses the differences in terms of distinctive features, representing yers as high lax unrounded vowels: front //i// and back //ɨ// (see Lightner, 1972; Laskowski, 1975; Gussmann, 1980, and Rubach, 1984). Such analysis is fairly abstract, since these segments never make an appearance in phonetic forms, thus being subject to absolute neutralization.

Yers were reinterpreted by Rubach (1986) in three-dimensional phonology as the so-called floating matrices: they have a fully specified featural content, and are represented as floating melodic segments.<sup>6</sup> Thus, they differ from regular vowels in having no representation on the moraic tier. Having placed the contrast between the regular and the fleeting vowels on the moraic tier, Rubach abandoned the idea of underlying abstract high lax vowels and posited two mid vowels instead: the front /ɛ/ and the back unrounded /ə/ (originally /ɣ/; Rubach, 1986). Thus, we have at least three underlyingly diverse vowels neutralizing to /ɛ/'s.<sup>7</sup> They are presented in (3).

<sup>5</sup> Examples quoted after Gussmann (1980).

<sup>6</sup> For alternative interpretations of yers, see Szypra, 1992; Yearley, 1995; Rowicka, 1999; Scheer, 2006.

<sup>7</sup> Rubach (1984) points to the necessity of postulating a fully fledged //ə// underlying the non-palatalizing non-fleeting /ɛ/ (compare [kɔ t] //kɔ t// 'cat' – [kɔ tɛ+ɛ] (loc.sg.) vs. [kɔ tɛ+ɛ m] (instr.sg.)).

(3) Underlying representation of three vowels surfacing as /ε/

<i>moraic tier</i>	μ		
<i>melodic tier</i>	ε	ε	ə
	regular <i>e</i>	front yer	back yer

In order to distinguish the two underlying yers, the palatalizing one and the non-palatalizing one, I will use two capital letters: //E// for the front yer and //Y// for the back yer.

### 2.3 Yer Vocalization and Deletion in OT

The pattern of Yer Vocalization is highly complex. Standard generative theory relied on a rule called Lower (Lightner, 1963; Laskowski, 1975; Gussmann, 1980 and Rubach, 1984), which states that yers are vocalized if followed by another yer in the next syllable or word-finally.<sup>8</sup> Unvocalized yers are deleted context-freely (by the rule of Yer Deletion). This is illustrated in (4).

(4) Yer vocalization pattern in Polish

<i>nom.sg.</i>		<i>gen.sg.</i>		<i>gloss</i>
sweter	[tɛr]	swetr+a	[tr]	‘sweater’
sweter+ek	[tɛɾɛk]	swetr+k+a	[tɛrk]	‘sweater’ (dimin.)
sweter+ecz+ek	[tɛɾɛčɛk]	swetr+ecz+k+a	[tɛɾɛčk]	‘sweater’ (double dimin.)

The complexity of the Yer Vocalization pattern presents a serious problem for surface-oriented Optimality Theory. However, the exact circumstances under which yers vocalize in morphologically complex forms are beyond the scope of this paper. Therefore, I will disregard such cases and focus only on Yearley’s analysis of simple forms.<sup>9</sup>

Yearley (1995) makes a significant contribution to explaining the mechanism of Yer Vocalization in the OT framework. She assumes that the vocalization of yers is based on syllable complexity, i.e. a yer vocalizes to eliminate a complex coda. Consider the word *pasek* [pasɛk] (←//pas+Yk//) ‘belt’ (dimin., nom.sg.), where the

<sup>8</sup> Lightner argues that yers appear word-finally due to the existence of desinential yers – inflectional endings which are phonetically empty, but serve as triggers for yer vocalization in the final syllable of a word.

<sup>9</sup> For an attempt to analyze yer vocalization in complex forms, see Yearley, 1995, and Jarosz, 2006.

vowel amends the syllable structure by preventing the word final complex coda [-sk].<sup>10</sup> On the other hand, in the genitive singular form *paska* [paska] (←//pas+Yk+a//), there is no need for improvement, and the system correctly predicts yer deletion.

Let us look closely at how Yearley accounts for the transparent cases of yer vocalization. The driver for the vowel-zero alternation is an undominated markedness constraint which militates against yers in surface forms, as they are not linked to any unit of weight and therefore are ill-formed vowels. The constraint can be abbreviated as \*E/Y.

(5) \*E/Y: no morales vowels.

Polish employs a twofold strategy to satisfy \*E/Y: either the vowel is repaired via mora insertion (Yer Vocalization) or it remains unparsed (i.e. not linked to a mora) and is therefore erased (Yer Deletion). Yers vocalize if they can repair a complex coda<sup>11</sup>. This, however, comes at a cost, as the vocalization is penalized by DEP-μ.

(6) DEP-μ: Don't insert moras.

For the vowel to surface, DEP-μ must be dominated by the markedness constraint \*COMPLEXCODA.

(7) \*COMPLEXCODA (\*CC): Codas must be simplex.

Additionally, when a yer deletes, it incurs a violation of the faithfulness constraint MAX-V militating against the deletion of vowels.

(8) MAX-V: Don't delete vowels.<sup>12</sup>

Since, nevertheless, yers do delete in some cases, MAX-V cannot be undominated. The ranking governing Yer Vocalization and Deletion is presented in (9).

(9) Yer Vocalization/Deletion: \*E/Y, \*CC >> DEP-μ, MAX-V<sup>13</sup>

<sup>10</sup> As mentioned before, complex codas are not foreign to Polish and words such as *kask* [kask] 'helmet' or *pisk* [p'isk] 'squeal' are well-formed members of the lexicon. The claim is that complex codas are never simplified by vowel insertion or consonant deletion, yet syllabification principles coerce the vocalization of an underlying yer to amend the syllable structure.

<sup>11</sup> There are, however, exceptions to this rule. Yer vocalization is suspended in numerous nom.sg. and gen.pl. forms: compare *szyfr* [šifr] 'code' (nom.sg.) vs. *szyferek* [šifε r+ε k] (dimin., nom.sg.), *wiatr* [vjatr] 'wind' (nom.sg.) vs. *wiaterek* [vjatε r+ε k] (dimin., nom.sg.), or *wysp* [visp] 'island' (gen.pl.) vs. *wyseпка* [visε p+k+a] (dimin., nom.sg.).

<sup>12</sup> For a formal statement of this and other constraints, see Prince & Smolensky, 1993.

<sup>13</sup> For compactness, I will ignore the fact that the [+back] yer //Y// vocalizes as the [-back] vowel [ε], and therefore, I will not include the relevant constraints in the tableaux.

The ranking is illustrated by the evaluation of the word *pasek* [pas+ɛk] ‘belt’ (dimin.) in tableau (10) below. The symbol ‘→’ indicates the most harmonious candidate. Solid lines denote ranking while dotted lines indicate that the ranking of the given constraints cannot be established.

(10) //pas+Yk// → [pasek]

	*E/Y	*CC	DEP-μ	MAX-V
→ a. pasek			*	
b. pask		*!		*
c. pasYk	*!			

Candidate (10a) incurs a violation of DEP-μ, which, however, does not prevent it from being selected as optimal, as it does not offend either of the high-ranked markedness constraints, unlike the remaining candidates.

The ranking established for yer vocalization in (10) correctly selects the actual output [pasek]. However, it makes wrong predictions about the inflected form *paska* [pas+k+a] (gen.sg.).

(11) //pas+Yk+a//: failed evaluation

	*E/Y	*CC	DEP-μ	MAX-V
→ a. paska				*
→ b. paseka			*	
c. pasYka	*!			

The ranking cannot select the optimal candidate: candidates (11a) and (11b) tie, as the constraints which they violate, namely DEP-μ and MAX-V, are not ranked with respect to each other. To ensure that a yer is not vocalized unless absolutely necessary, DEP-μ must be ranked above MAX-V. The amended ranking and the evaluation of *paska* are illustrated in (12).

(12) Yer Vocalization/Deletion: \*E/Y, \*CC >> DEP-μ >> MAX-V  
//pas+Yk+a// → [paska]

	*E/Y	*CC	DEP-μ	MAX-V
→ a. paska				*
b. paseka			*!	
c. pasYka	*!			

Tableau (12) shows that the analysis successfully handles simple cases of Yer Deletion and Vocalization.

The examples discussed thus far are straightforward. However, the interaction of Yer Deletion with other phonological processes, such as Nasal Assimilation, give rise to opacity, a phenomenon in which phonological generalizations are partially obscured at the surface level by their interactions with other phonological generalizations, which prove to be challenging for Optimality Theory.

### 3. Nasal Assimilation: standard OT account

This section provides an overall presentation of the process of Nasal Assimilation in Polish. Section 2.1 presents basic generalizations. Section 2.2 offers an OT account of transparent instances of Nasal Assimilation. Section 2.3 presents the Optimality-Theoretic analysis of opaque cases of Nasal Assimilation and shows that standard Optimality Theory cannot account for the opacity.

#### 3.1 Basic generalizations

Polish has a well-motivated process of Nasal Assimilation, by which coronal nasals assimilate to the place of articulation of the following plosive or affricate. This is exemplified by the data in (13), where nasals appear before labial (13a), coronal (13b) and velar (13c) plosives.<sup>14</sup>

##### (13) Nasal Assimilation in Polish

a. <i>kępa</i>	//kɛnp+a//	→	[kɛmpa]	‘cluster’
<i>tępa</i>	//tɛnp+a//	→	[tɛmpa]	‘blunt’ (fem.)
b. <i>kąt</i>	//kɔnt//	→	[kɔnt]	‘angle’
<i>kołęda</i>	//kɔlənd+a//	→	[kɔlənda]	‘carol’
c. <i>ręka</i>	//rɛŋk+a//	→	[rɛŋka]	‘hand’
<i>bank</i>	//bank//	→	[baŋk]	‘bank’

As we can see in (13), the nasal preceding a plosive invariably assumes its point of articulation. One may wonder why we posit an underlying //n// in each case instead of simply assuming that the underlying nasals mirror the ones found on the surface. Indeed, in the case of [kɛmpa] ‘cluster’ or [tɛmpa] ‘blunt’ (13a), there exists no empirical evidence that the underlying nasal should be anything else but the [m] found on the surface. However, [kɔnt] ‘angle’, [kɔlənda] ‘carol’ (13b) and [rɛŋka] ‘hand’ (13c) exhibit alternations depending on the presence of the following suffix. Compare the pairs of words in (14).

##### (14) Alternations in nasals

<i>kąt</i>	[kɔnt] ‘angle’	–	<i>kącie</i>	[kɔŋtɛ+ɛ] (instr.)
<i>kołęda</i>	[kɔlənd+a] ‘carol’	–	<i>kołędzie</i>	[kɔləŋdɛ+ɛ] (instr.)
<i>ręka</i>	[rɛŋk+a] ‘hand’	–	<i>ręczny</i>	[rɛŋč+n+i] (adj.)

The above examples show explicitly that the surface shape of the nasal depends solely on the place of articulation of the following plosive.<sup>15</sup> As far as the motivation

<sup>14</sup> I follow Rubach (1984) in positing a sequence of oral vowels and nasal consonants in words such as those quoted in (13).

<sup>15</sup> It is also worth noting that the bilabial nasal /m/ is resistant to the assimilation of any places of articulation located on the roof of the mouth. The choice of underlying //n// would block the process of Nasal Assimilation in *kąt* and *ręka*. (I am indebted to the reviewer of this paper for this clarification.)

for the underlying //n// in the word [baŋk] ‘bank’ (13c) is concerned, it is not based on alternations in derived forms, but on its phonostylistic behavior: the underlying coronal nasal can actually appear as such in careful speech.

### 3.2 Nasal Assimilation: preliminaries

In terms of Optimality Theory, assimilation is the result of the interaction of faithfulness constraints and well-formedness (markedness) constraints. The markedness constraint enforcing assimilation can be formulated as follows.

(15) NasalAssimilation (NA): Nasals must agree in place with the following plosive or affricate.

The faithfulness constraint in direct conflict with NasalAssimilation is IdentPlace, which militates against corresponding segments having different places of articulation.<sup>16</sup>

(16) IdentPlace: The specification for place of articulation of an input segment must be preserved in the output correspondent of that segment.

Since nasals do assimilate, clearly it is less costly to change the place of articulation than to have a heterorganic nasal-plosive cluster. Therefore, the markedness constraint NasalAssimilation must be ranked above the faithfulness constraint IdentPlace. Tableau (17) shows the evaluation of the word *bank* ‘bank’.

(17) //bank// (failed evaluation)

	NA	IdentPlace
→ a. baŋk		*
b. bank	*!	
→ c. bant		*

The analysis in (17) shows that more specific constraints are called for. Candidates (17a) and (17c) tie as both of them satisfy NasalAssimilation at the same time offending IdentPlace by altering one of the segments in the NC cluster. However, as it is the nasal rather than the plosive that assimilates, it is clear that plosives must be protected by a more specific faithfulness constraint IdentPlace(Plosive).

(18) IdentPlace(Plosive): Correspondent plosives have the same place of articulation.

In order for forms such as \*[nt], which satisfies NasalAssimilation, to be excluded as optimal outputs from underlying //nk//, IdentPlace(Plosive) must crucially outrank the generic constraint IdentPlace. Given that, the analysis of *bank* is straightforward.

<sup>16</sup> I assume unidirectional rather than bidirectional IDENT constraints.

(19) //bank// → [baŋk]

	NA	IdentPlace(Plosive)	IdentPlace
→ a. baŋk			*
b. bank	*!		
c. bant		*!	*

The optimal candidate in (19a) violates IdentPlace. Still, it fares better than the other two candidates, (19b) and (19c), which offend the higher-ranked NasalAssimilation and IdentPlace(Plosive).

### 3.3 Opaque cases of Nasal Assimilation

As demonstrated in section 2.2, underlying //n// shows the tendency to assimilate to the following plosive. However, there is a considerable group of words in which the process does not take place and the nasal remains unassimilated. This is exemplified by the data in (20)<sup>17</sup>.

(20) Lack of Nasal Assimilation

	[nk]	<i>gloss</i>
a. Iren <u>+</u> k+a		‘Irene’ (dimin.)
b. lin <u>+</u> k+a		‘line’ (dimin.)
c. ga <u>nk</u> +i		‘porch’ (nom.pl.)
d. cien <u>+</u> k+i		‘thin’ (masc.)

Even though the words in (20) contain sequences of nasals followed by velar plosives, the process of Nasal Assimilation fails to apply. It is impossible to determine why it should be so on the basis of the surface forms. Given the data in (13) and (20), it seems that whether the nasal assimilates or fails to do so is completely arbitrary. In fact, we can find a pair of words which are identical save for assimilation. Compare *lin+k+a* [linka] ‘line’ (dimin., nom.sg.) and *link+a* [liŋka] ‘link’ (gen.sg.). The latter word is a recent borrowing from English widely used by Internet users. However, considering related forms it is clear that there is a systematic difference between the two sets of words.

(21) NC clusters: two patterns

a. bank+u	‘bank’ (gen.sg.)	–	bank	(nom.sg.)
link+a	‘link’ (gen.sg.)	–	link	(nom.sg.)
b. Iren+k+a	‘Irene’ (nom.sg.)	–	Iren+ <u>ek</u>	(gen.pl.)
lin+k+a	‘rope’ (nom.sg.)	–	lin+ <u>ek</u>	(gen.pl.)

<sup>17</sup> The lack of assimilation in these words is characteristic of standard Polish of central and northern Poland. In the south-western dialect, however, the same words exhibit Nasal Assimilation.

The problematic heterorganic NC cluster in *Irenka* and *linka* is in some grammatical cases separated by a vowel (21b), while in *bank* and *link* the cluster is left unaffected (21a).<sup>18</sup> Evidently, the fleeting vowel is responsible for the otherwise inexplicable lack of Nasal Assimilation in (21b). The heterorganic NC strings derive from underlying //nEk//<sup>19</sup> sequences, where the nasal and the plosive are separated by a vowel, while the homorganic NC strings are never separated by a vowel on any level of representation. Since the surfacing [ɛ] does not palatalize the preceding consonant, the underlying yer must be the back one. Thus, the underlying representation of *Irenka* can now be reanalyzed as //irɛn+Yk+a//, where //-Yk// is a diminutive suffix.

At this point, the question arises whether now, given this representation, OT will make the correct predictions, i.e. whether allowing for a vowel separating the NC cluster on the underlying level can account for the lack of Nasal Assimilation in the output form. The two processes coinciding here are Nasal Assimilation and Yer Deletion. The rankings warranting the processes are recapitulated below.

- (22) The rankings for Nasal Assimilation and Yer Deletion  
 a. **Nasal Assimilation:** NasalAssimilation (NA) >> IdentPlace  
 b. **Yer Deletion:** \*E/Y >> Max-V<sup>20</sup>

The rankings (22a) and (22b) are integrated in tableau (23). Since the constraints responsible for Nasal Assimilation and those responsible for Yer Deletion do not interact, it is impossible to determine their mutual ranking at this point of the analysis. The ranking in (23) presents one of the possibilities. Symbol ‘←’ denotes a candidate wrongly chosen as optimal. Symbol ‘⊕’ denotes the desired winner.

(23) //irɛn+Yk+a// (failed evaluation)

	*E/Y	Max-V	NA	IdentPlace
⊕ a. irɛnka		*	! *	
← b. irɛŋka		*	!	*
c. irɛnYka	*!		!	

The transparent candidate (23b) is wrongly chosen as optimal. Yet, no matter how we maneuver the mutual ranking of the constraints in (22a) and (22b), the opaque candidate (23a) will never win. Observe that both candidates in question offend

<sup>18</sup> In the case of *cienki* 'thin' (20d), no related form in which a vowel splits up the NC cluster can be found. However, there is compelling evidence in favor of positing an intervening yer. The word *cienki* contains an adjectival suffix [-k] present in words such as *slod+k+i* 'sweet' or *lep+k+i* 'sticky' (compare *cieni+e+ć* 'to grow thinner', *slod+ycz* 'sweetness' and *lep+i+ć* 'to stick'). Although the suffix never surfaces as [-ɛk], the presence of the underlying yer is manifested indirectly: it blocks Nasal Assimilation, and *cienki* is a case in point. Since there are no traces of palatalization in these words, the suffix must be represented underlyingly as //Yk//, that is, it contains a back yer.

<sup>19</sup> By convention, 'E' denotes the fleeting *e*.

<sup>20</sup> Irrelevant constraints have been omitted.

Max-V, and they only differ in their violation marks for NasalAssimilation and IdentPlace, whose mutual ranking is independently motivated by the assimilation in words such as *bank* ‘bank’. The reranking of the two constraints, i.e. giving higher priority to IdentPlace, would result in blocking Nasal Assimilation in all the forms. Such a situation is referred to as a ranking paradox: the ranking NasalAssimilation >> IdentPlace correctly predicts *bank* [baŋk] ‘bank’, yet, in order to generate *Irenka* [iɾɛŋka] ‘Irene’, the ranking must be reversed.

As mentioned above, it is clear that the non-application of Nasal Assimilation in *Irenka* must be attributed to the intervening vowel. In other words, when the NC cluster is split by a vowel in the input, the nasal remains unassimilated in the output. However, this insight cannot be expressed in standard Optimality-Theoretic terms. NasalAssimilation, which is a markedness constraint, refers to output forms only and is blind to the lexical input. Therefore, the only representation to which NasalAssimilation has access is the one in which the intervening vowel is not present.<sup>21</sup> Consequently, the conclusion is that standard Optimality Theory provides no means to account for the non-application of Nasal Assimilation in words such as *Irenka*.

*Irenka* is a classic case of opacity, which is notoriously problematic for standard Optimality Theory. Opaque generalizations are inexplicable unless we look at a level deeper than the output, where they are not obscured by other generalizations. An informal serial derivation of *Irenka* is presented in (24).

(24) Serial derivation of *Irenka*:

//iren+Yk+a//	underlying representation
–	Nasal Assimilation
/irenka/	Yer Deletion
[iɾɛŋka]	surface representation

By offering insight into intermediate stages of derivation, serialist analysis provides an explanation for the opacity. At the stage when Nasal Assimilation applies, the to-be-deleted yer is still present, and is thus able to block the process. In this analysis, the ordering of the rules is crucial. The issue of phonological opacity which implies the existence of intermediate stages between the input and the output presents a serious challenge for the output-oriented OT.

#### 4. Nasal Assimilation in Derivational Optimality Theory

This section presents an analysis of the opaque case of Nasal Assimilation couched within Derivational Optimality Theory. In particular, section 3.1 presents the rudiments of DOT, which are then tested against Polish data in section 3.2, particularly the problematic *Irenka*, which exhibits opacity.

<sup>21</sup> A modification to standard OT, by which markedness constraints can refer simultaneously to the input as well as output, has been proposed by Cole & Kisseberth, 1995; McCarthy, 1996; Orgun, 1996 and Archangeli & Suzuki, 1997. Yet, there is a general consensus that this mode of processing is unacceptable due to the fact that the theory would have excessive power.

## 4.1 Derivational Optimality Theory: the basics

Derivational Optimality Theory (Booij, 1997; Kiparsky, 1997, 2000; Rubach, 1997a, b, 2000a, b, 2003a, b, 2004a, b) is a development of OT introduced to deal with opacity. The motivation behind introducing derivational levels into OT is the fact that the interaction of some processes cannot be analyzed in a parallel evaluation as mandated by standard OT. Moreover, within one language, different surface forms may require contradictory rankings causing ranking paradoxes. For these reasons, DOT abandons the condition of strict parallelism<sup>22</sup>, allowing for derivational levels. The fundamental premise of DOT is that the evaluation of a given candidate “proceeds in steps and is carried out independently at each derivational level or stratum” (Rubach, 2003b, p. 601). The optimal output of one level becomes the input of the following level. The evaluation is fully parallel at each level, which is in keeping with the tenets of classic OT. A further innovation put forward by DOT is allowing for the constraint hierarchy to change at successive steps of analysis (i.e. the reranking of constraints), an idea which was not provided for by harmonic serialism. In response to the objection that DOT is not restrictive enough as it allows completely different rankings at different levels, a situation not attested in natural languages (McCarthy, 1999, p. 389), Rubach (2000b, p. 313) proposes the following principles, which stem from the universal law of parsimony (Occam’s Razor) stating that “one should not increase, beyond what is necessary, the number of entities required to explain anything.”

### (25) Principles of DOT

#### a. *Level Minimalism*

The number of derivational levels is minimal.

#### b. *Reranking Minimalism*

The number of rerankings is minimal.

#### c. *Constraint Minimalism*

The number of constraints is minimal.

Principle (25a) states that introducing a new derivational level should be argued for. The only exception is postulating separate word (lexical) and sentence (postlexical) levels, which require no additional motivation, since word phonology and sentence phonology have always been regarded as different. This assumption captures the insights of Lexical Phonology (Kiparsky, 1982), which distinguishes between the lexical and the post-lexical levels. Thus, the word level and the sentence level are an integral part of the DOT model, but additional levels require motivation. In most languages, the number of levels is limited to two; however, in some languages it is necessary to handle word phonology at two levels, which results in a three-level analysis. Notably, in DOT, the distinction between word internal levels need not coincide with morphological domains (stem and word). Here DOT differs from

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<sup>22</sup> Although, in principle, OT is not at odds with serialism (in fact, a derivational version of OT, harmonic serialism, is briefly discussed in Prince and Smolensky’s (1993) original manuscript), serialism was later criticized by McCarthy (1999). Most current work in OT embraces strict parallelism.

Kiparsky's LPM-OT (Lexical Phonology and Morphology, Kiparsky, 2000), where phonological strata have to coincide with morphological levels.

As regards principle (25b), DOT assumes that reranking should be minimal, that is, the ranking of constraints between derivational stages is altered only to the extent motivated by the analysis (Rubach, 2003b, p. 602).

Principle (25c) follows from the philosophy that only when the number of constraints is limited can constraints and their interactions be insightful (Rubach, 2000b, p. 272). Kiparsky (2000) claims that abandoning the principle of strict parallelism in favor of stratified constraint systems "has the compensating advantage of maintaining a restrictive and well-defined constraint inventory, as originally envisaged in OT" (Kiparsky, 2000, p. 1).

## 4.2 *Irenka* in Derivational Optimality Theory

Recall the failed evaluation of *Irenka* from section 2.3, repeated below as (26) for the reader's convenience.

(26) //irɛn+Yk+a// (failed evaluation)

	*E/Y	MAX-V	NA	IDENTPLACE
☹ a. irɛnka		*	*!	
← b. irɛŋka		*		*
c. irɛnYka	*!			

The candidate incorrectly chosen as the most harmonic is the transparent (26b). The standard OT's weakness lies in its inability to relate the underlying presence of the yer to the lack of Nasal Assimilation.

The traditional view is that at the time when Nasal Assimilation applies the yer is still present, thus blocking the process (see 24 in section 2.3). This, precisely, is the solution that DOT facilitates by assuming derivational levels. That is, in DOT it is possible to argue that Nasal Assimilation takes place at an inferior level while Yer Deletion is dealt with at a superior level of evaluation. At Level 1, yers are not deleted and that is when all processes sensitive to yers (that is, either blocked or triggered by them) apply. Consequently, at this level, MAX-V must outrank the constraint militating against unparsed segments \*E/Y. Also, NASALASSIMILATION must be ranked higher than IDENTPLACE in order to allow Nasal Assimilation. The necessary ranking is shown in (27).

(27) Level 1: MAX-V, NASALASSIMILATION >> \*E/Y, IDENTPLACE

The ranking in (27) coerces Nasal Assimilation in words such as *sək* [sɛŋk] 'knot (in wood)' (← //sɛnk//), i.e. in the transparent cases, and ensures that the process is blocked in *Irenka* by retaining the unparsed vowel which separates the NC cluster (see 29 and 31 below).

At the subsequent level, yers are deleted. This is achieved via the reranking of MAX-V below \*E/Y. Also, at this point, IDENTPLACE must outrank

NASALASSIMILATION. This not only ensures that Nasal Assimilation is not an active process, but also mandates that the changes that took place at Level 1 be preserved on this level. Recall that the output from Level 1 is the input to Level 2. The above reasoning is summarized in (28).

(28) Level 2: \*E/Y, IDENTPLACE >> MAX-V, NASALASSIMILATION

We have to back the above discussion with evaluations. Tableaux (29) and (30) show the computation of the transparent case of Nasal Assimilation in *sęk* [sɛŋk]. In (29) the evaluation at the inferior level is presented.

(29) Level 1: //sɛnk// → /sɛŋk/

	MAX-V	NA	*E/Y	IDENTPLACE
→ a. sɛŋk				*
b. sɛnk		*!		

The driver of Nasal Assimilation is the high-ranked markedness constraint NASALASSIMILATION, which requires all NC clusters to be homorganic. The constraint is fatally violated by candidate (29b). The optimal candidate (29a), which only incurs a violation of a lower ranked IDENTPLACE, becomes the input to the next level.

(30) Level 2: /sɛŋk/ → [sɛŋk]

	*E/Y	IDENTPLACE	MAX-V	NA
→ a. sɛŋk				
b. sɛnk		*!		*

At this level, faithfulness to the input is valued higher than Nasal Assimilation. The input, however, is no longer the underlying representation //sɛnk//, but the most harmonic candidate selected at the inferior level of evaluation, that is /sɛŋk/. Therefore, candidate (30b) violates both IDENTPLACE and NASALASSIMILATION. The desired candidate (30a) fares better in both cases and, consequently, is selected as the optimal output.

Let us now turn to the opaque *Irenka*. At the lower level of evaluation, MAX-V and NASALASSIMILATION are undominated, which causes the transparent candidate (31b) as well as the desired output (31a) to be ruled out. The most harmonic candidate at this level is the faithful (31c), which retains the yer separating the nasal and the plosive.

(31) Level 1: //irɛn+Yk+a// → /irɛnYka/

	MAX-V	NA	*E/Y	IDENTPLACE
a. irɛnka	*!	*		
b. irɛŋka	*!			*
→ c. irɛnYka			*	

The faithful /iɾɛnYka/ becomes the input to the next level of evaluation. This is illustrated in (32).

(32) Level 2: /iɾɛnYka/ → [iɾɛnka]

	*E/Y	IDENTPLACE	MAX-V	NA
→ a. iɾɛnka			*	*
b. iɾɛŋka		*!	*	
c. iɾɛnYka	*!			

Now, faithfulness to the place of articulation of the input segments and eliminating morales vowels become priorities. Therefore, the faithful candidate (32c), which contains the undesirable yer, and the transparent candidate (32b), failing to comply with the dictate of faithfulness, are rendered *hors de combat*. The desired output (32a) wins, because it preserves the unassimilated nasal of the input and gets rid of the yer. This induces the violation of MAX-V and NASALASSIMILATION. These two constraints, however, are low-ranked at this level of evaluation, therefore the violations are not fatal. Notice that the optimal candidate at Level 2 was a suboptimal candidate at Level 1. The result of the analysis is correct since the attested surface form has been generated.

## 5. Conclusions

Derivational Optimality Theory successfully accounts for the opacity in forms such as *Irenka* ‘Irene’, where the process of Nasal Assimilation is rendered opaque by the process of Vowel Deletion, which is beyond the capabilities of standard Optimality Theory. DOT accomplishes that by assigning the processes interacting opaquely to different levels of evaluation. Thus, processes sensitive to yers, such as Nasal Assimilation and Palatalization, apply on the inferior level, while Yer Deletion is dealt with on the superior level.

Criticism has been leveled against DOT for betraying OT’s fundamental principle of strict parallelism. However, as Kiparsky (2000, p. 16) points out, “the price to be paid for [saving parallelism] is the introduction of otherwise unneeded powerful new types of Faithfulness constraints, such as Output-to-Output constraints, (...) and sympathy constraints, which have turned out to compromise the OT program very severely.” By introducing levels, DOT obviates the need to multiply faithfulness relations and, consequently, faithfulness constraints. This leads to restricting the constraint inventory, which is a welcome result. Furthermore, separate levels of evaluation have independent grounding as they account for the different nature of word level phonology and sentence level phonology.

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