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OPAQUE ALLOMORPHY IN OT: CANDIDATE CHAINS VS. DERIVATIONAL OPTIMALITY THEORY

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ABSTRACT

This article investigates the opacity in allomorphic processes in the masculine nominative plural of Polish nouns. It is shown that the discussed cases of allomorphy are opaque. Subsequently, it is examined whether Optimality Theory can account for the opacity in the Polish data and concluded that parallel evaluation is unable to handle the relevant examples. Next, the problem is reanalyzed within the theory of candidate chains in order to determine whether the theory is capable of providing a non-derivational account. However, this version of Optimality Theory fails to achieve the attested output. It is concluded that candidate chains are unable to handle the opaque generalizations. Finally, the non-derivational account is juxtaposed with Derivational Optimality Theory in order to prove that Optimality Theory must admit derivational levels.

KEYWORDS: Optimality Theory; Polish phonology; opacity; candidate chains; allomorphy.

0. Introduction

Optimality Theory (Prince and Smolensky 1993, 2004; and McCarthy and Prince 1995) offers new insight into allomorphy processes. Given the universality principle, allomorphs, whose distribution is language-specific, are evaluated by universal constraints. The idea of universality dispenses with allomorphy rules for the sake of the aforementioned constraints. Nevertheless, the input-output relation of Optimality Theory (henceforth, OT) proves to be an inadequate mechanism for opaque alternations. OT cannot handle the cases which require an insight into the intermediate stages of evaluation. Thus, in order to maintain a parallelism in OT, various subtheories were proposed. Candidate chains (McCarthy 2007) circumvents the necessity for a derivational step by employing an intermediate stage in a fully parallel evaluation. However, it is shown that the subtheory, which strongly relies on faithfulness violations, is unable to tackle the problematic allomorphs as they do not incur the necessary violations of faithfulness.

The consequence is that the problem cannot be handled without the recourse to derivational stages.

This article is organized as follows. Section 1 presents the relevant examples of polish masculine nominative plurals of nouns and their analyses in a rule-based framework as well as in the standard version of OT. Section 2 attempts to recast the evaluation of the opaque allomorphs with a recourse to the theory of candidate chains. Section 3 reanalyzes the problem within Derivational Optimality Theory (Rubach 1997, 2000a,b, 2005, 2007). Section 4 offers conclusions.[1]

1. The masculine nominative plural of nouns

Polish exhibits an alternation in the masculine nominative plural of nouns. Nouns are either formed by adding the suffix *-y* [ɨ] or *-e* [ɛ]. The suffixes are arbitrary and cannot be traced back to a single underlying representation, as Polish does not have a rule deriving [ɨ] from //ɛ//[2] or vice versa, [ɛ] from //ɨ//. Therefore, the two suffixes must be allomorphs of the masc. nom. pl. and have separate underlying representations (Rubach 2007). The relevant examples are given in (1).

(1a) bu*t* [t] 'shoe' (nom.sg.) – bu*t+y* [tɨ] (nom. pl.)
no*s* [s] 'nose' (nom.sg.) – no*s+y* [sɨ] (nom. pl.)
bana*n* [n] 'banana' (nom.sg.) – bana*n+y* [nɨ] (nom. pl.)
krze*w* [f][3] 'shrub' (nom.sg.) – krze*w+y* [vɨ] (nom. pl.)

(1b) ry*ś* [ɕ] 'lynx' (nom.sg.) – ry*si+e* [ɕɛ] (nom. pl.)
goś*ć* [tɕ] 'guest' (nom.sg.) – goś*ci+e* [tɕɛ] (nom. pl.)
ko*ń* [ɲ] 'horse' (nom.sg.) – ko*ni+e* [ɲɛ] (nom. pl.)
gwóź*dź* [tɕ] 'nail (fastener)' (nom.sg.) – gwoździ+*e* [dʑɛ] (nom. pl.)

As shown in (1), the plural of masc. nouns has different inflectional paradigms. The suffix //ɨ// is added after hard stems (those that end in a [+back] consonant (1a)), whereas //ɛ// is found after soft stems (those that end in a [−back] consonant (1b)). Hence, the

[1] I would like to thank Bartek Czaplicki and the two *PSiCL* reviewers for their numerous comments and insightful criticism, which led to considerable improvement of both the content and the presentation of my analysis. Needless to say, the responsibility for this article is solely mine.

[2] I use double slashes for underlying representations, single slashes for intermediate representations and square brackets for phonetic representations.

[3] The alternation in voice between some Polish nominative singular nouns and their vocative cases, namely *krzew – krzewy* and *gwóźdź – gwóździe*, is the effect of Final Devoicing rule, which states that obstruents become voiceless at the end of words.

idiosyncratic allomorphs //ɛ// and //ɨ//[4] have predictable distribution. Given a rule-based approach, the distribution of the allomorphs in (1) is accounted for by an allomorphy rule stated in (2).

(2) ɨ/ɛ Plural Allomorphy

$$\varnothing \rightarrow \left\{ \begin{array}{l} \text{ɛ/[+cons, -back]} \\ \\ \text{ɨ/[+cons, +back]} \end{array} \right\} \_\ ]\ \text{masc.nom.pl}$$

The plural form triggers the application of the rule in (2). The vowel [ɛ] is inserted after a soft-consonant stem and [ɨ] occurs after a hard-consonant stem. In (3), I present derivations of *rysie* 'lynx' (nom.pl.) and *buty* 'shoe' (nom.pl), where //+ ∅// stands for the allomorphic suffix.

(3) Derivation of *rysie* 'lynx' (nom.pl.) and *buty* 'shoe' (nom.pl)

//but + Ø//	//rɨɕ + Ø//	
but + ɨ	rɨɕ + ɛ	ɨ/ɛ Plural Allomorphy
[butɨ]	[rɨɕɛ]	

The allomorphy rule in (2) assigns the [+back] suffix //ɨ// to *but*, which is a hard-consonant stem, whilst the soft-consonant stem, *ryś*, receives the [− back] suffix //ɛ//. Both forms are attested outputs.

The treatment of allomorphy in Optimality Theory is different than the account made available by a rule-based framework. OT dispenses with allomorphy rules such as the one in (2). The language-specific allomorphs are evaluated by a universal set of constraints, whose ranking is language specific. In order to account for the choice of the correct allomorph in OT, we use the mechanism of listing and include both suffixes in the underlying representation. Subsequently, the nom.pl. suffixes //ɨ// and //ɛ// are submitted to CON for evaluation. The allomorph that fares best on the constraint hierarchy is selected as the optimal one. Notice that allomorphs do not violate any faithfulness

[4] As a *PSiCL* reviewer points out, the phonetic status of [ɨ] is, undoubtedly, controversial. Gussmann (2007) classifies [i] and [ɨ] as two allophones, stating their complimentary distribution, as [ɨ] can never appear at the beginning of a word, whilst [i] can, for example *igła* 'needle' (**ygła*). However, I follow Rubach (1984) and Bethin (1992) and look at the phonological behavior of [ɨ], which is [+back]. Moreover, Polish nouns are generally classified as personal and non-personal. Usually, non-personal nouns form their plural by adding the [+back] suffix [ɨ], as in (1a), for example *kot* 'cat' – *koty* [tɨ] (nom.pl). Personal nouns, on the other hand, take the [− back] [i], which is also an environment for the process of Coronal Palatalization, for instance *student* 'student' – *studenci* [tɕi] (nom.pl). The use of a non-personal suffix with personal nouns would derive plural forms such as *studenty* [tɨ]. Such forms are, nevertheless, different as they have pejorative implications. This fact supports the phonological distinction in backness between the two suffixes.

constraint, as they are encoded in the underlying representation. Thus, the choice of the correct allomorph must be made on the basis of markedness constraints (McCarthy and Prince 1993), which will mandate the agreement in backness between the stem-final consonant and the vocalic suffix. The constraint that ensures the selection of the appropriate suffix preserving the agreement in backness with the stem-final consonant is given in (4).

(4) PAL-*i*:[5] Assign a violation for every sequence of a consonant and a following high vowel which do not agree in backness.

The application of the constraint in (4) may be observed on the basis of palatalization processes in Polish such as *but* 'shoe' (nom.sg.) [t] – *bucik* [tɕik] (dim.). In the process, the [+back] feature of [t] changes to [− back] in [tɕ], in agreement with the palatalizing vowel. In consequence, *bucik* emerges with prepalatal [tɕ]. Moreover, palatalization occurs also before [ɛ] as in *brat* 'brother' (nom.sg.) [t] – *bracie* [tɕɛ] (voc.sg.). The constraint that mandates the change from [+back] to [− back] before [ɛ] is stated in (5).

(5) PAL-*e*:[6] Assign a violation for every sequence of a consonant and a following mid vowel which do not agree in backness.

Furthermore, notice that during the process of palatalization[7] the vowel is unaffected; it is the consonant that changes the feature [+back] to [− back]. Therefore, the ranking ID-V([− bk]) >>ID-C([+bk]) is necessary. On the other hand, notice that the words in (1a) retain the [− back] quality of the consonant word-finally, which proves that they must be [− back] in the underlying representation. This is guaranteed by a faithfulness constraint, ID-C([− bk]), which preserves the softness on the consonant. I assume that the input submitted to CON for each evaluation consists of two inputs, each containing different allomorph: //STEM + ɨ// and //STEM + ɛ//. A candidate may be in correspondence with either input. Therefore, it is obvious that a candidate which ends in [ɨ] but corresponds to //STEM + ɛ// incurs a fatal violation of ID-V([±bk]). The same pertains to a candidate which ends in [ɛ] but corresponds to //STEM + ɨ//. This dual input is represented by the means of angled brackets encapsulating the two suffixes.[8]

I summarize the discussion by presenting the evaluation of *rysie* 'lynx' (nom.pl.) in (6) and *buty* 'shoe' (nom.pl.) in (7).

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[5] The constraints in (4) and (5) are adapted from Rubach (2000a).

[6] I assume the fixed ranking Pal-*i* >> Pal-*e*. The generalization is that if a language has palatalization before *e*, it must also have it before *i* (Chen 1973). Moreover, the ranking PAL-*i* >> PAL-*e* is considered unmarked because it is cross-linguistically more common to have palatalization before *i* than before *e*.(Rubach 2007).

[7] See Rubach (2003) for detailed discussion of palatalization processes in Polish.

[8] Thanks to a *PSiCL* reviewer for pointing this out to me.

(6) Tableau for //rɨs’+{ɨ, ɛ}// ‘lynx’ (nom.pl.)[9]

	PAL-*i*	PAL-*e*	ID-C$_{([-bk])}$	ID-V$_{([-bk])}$	ID-C$_{([+bk])}$
a. rɨs’ɨ	*!				
b. rɨsɨ			*!		
☞ c. rɨs’ɛ					
d. rɨsɛ		*!	*		

Candidates (6a) and (6d) fatally violate PAL-*i* and PAL-*e,* respectively, due to the disagreement in backness. In the former, the consonant is [−back] but the vowel is [+back], while in the latter, the values are reversed. Candidate (6b) violates ID-C$_{([-bk])}$, as the [−back] feature of //s’// has been lost. In consequence, (6c) is the optimal form.[10]

(7) Tableau for //but+{ɨ, ɛ}// ‘shoe’ (nom.pl.)

	PAL-*i*	PAL-*e*	ID-C$_{([-bk])}$	ID-V$_{([-bk])}$	ID-C$_{([+bk])}$
☞ a. butɨ					
b. but’ɨ	*!				*
c. but’ɛ					*!
d. butɛ		*!			

[9] I assume after Rubach (2007) that the underlying representation of the surface [ɕ] //s’// and I ignore the spell-out operations that derive prepalatals from palatalized alveolars, such as /s’/ → [ɕ].

[10] A *PSiCL* reviewer inquires whether PAL constraints may be at odds with the Obligatory Contour Principle (Leben 1973; McCarthy 1986) in words such as, for example, *rysie* or *buty*. In *rysie*, OCP would penalize two instances of the [− back] feature: one on the stem final consonant [ɕ] and the other on the suffix [ɛ]. In *buty*, on the other hand, two instances of [+back]: one on [t] and the other on the suffix [ɨ]. However, I assume that the [±back] feature is shared between the stem final consonant and the following vowel. Such a “sharing relation” predicts that there is only one instance of the [±back] feature, which, given OT framework, circumvents OCP violations.

Candidate (7d) violates PAL-*e* as the [+back] feature of //t// disagrees with the [−back] feature of //ɛ//. Candidates (7b) and (7c) incur a single violation of ID-$C_{([+bk])}$, whereas the former in addition fatally violates PAL-*i*. Consequently, candidate (7a) passes unscathed on constraint violations and emerges as the optimal output.

The tableaux in (6) and (7) show that the two arbitrary allomorphs, which are present in the underlying representation, are chosen by the specific ranking of the constraints. In other words, the least marked allomorph is preferred. However, the case of the Polish nom.pl. suffix is more complex. Consider the examples in (8).

(8) kalo*sz* [š] 'rubber boot' (nom. sg.) – kalo*sz+e* [šɛ] (nom. pl.)
nó*ż* [š] 'knife' (nom. sg.) – no*ż+e* [žɛ] (nom. pl.)
tłusz*cz* [šč] 'fat' (nom. sg.) – tłusz*cz+e* [čɛ] (nom. pl.)
kole*dż* [č] 'college' (nom. sg.) – kole*dż+e* [džɛ] (nom. pl.)

The strident coronals /š ž č dž/ that are hard on the surface, against the expectations, take the suffix that is associated with soft stems – //ɛ//. The fact that /š ž č dž/ follow the morphological paradigm that is typical of the nouns in (1b) enables us to assume that, underlyingly, the coronals are soft and give preference to the [−back] suffix in order to satisfy the agreement in backness. However, notice that in (8) the coronal stridents appear in a non-palatalizing context, at word boundaries and before back vowels, which, on the other hand, supports the assumption that they must be phonetically hard, for example, *szalik* [ša] 'scarf', *żaba* [ža] 'frog', *czapka* [ča] 'cap' and *dżuma* [džu] 'plague'. The problem is how to explain this abnormality.

Despite the fact that there are two allomorphs for the nom.pl. suffix, we have a set of examples that do not follow the pattern in (1). If the coronal stridents are soft underlyingly, their [+back] surface form is an effect of hardening. Therefore, we need a constraint that ensures the hardening of the coronal stridents. As pointed out in Rubach (2003), the scope of the hardening process differs among languages. Namely, Ukrainian has hard [š ž č dž] but soft [ts' dz'], Russian hard [ts š ž] but soft [č'], Upper Lusatian hard [ts] but soft [š']. Polish, on the other hand, hard [š ž č dž]. Therefore, the [+back] feature of Polish strident coronals is captured by the generalization stated in (9).[11]

(9) HARD: [š ž č dž ts dz] must be [+back]. (Rubach 2007)

In accordance with the generalization stated in (8), [š ž č dž] are soft underlyingly and their [+back] feature on the surface is the effect of HARD. Given a rule-based account of the process responsible for the words in (8), we must order HARD after the allomorphy rule in (2), as only in this way the rule selects the correct suffix. This is shown in (10) on the basis of the word *tłuszcze* 'fat' (nom. pl.).

[11] As rightly noticed by a *PSiCL* reviewer, nowadays the process does not have a phonetic motivation. Nevertheless, the constraint HARD is typologically grounded. Historically, Slavic dentals and postalveolar stridents were soft. Their contemporary surface forms result from a process of hardening, which occurred later.

(10) Derivation of *tłuszcze* 'fat' (nom. pl.)
//tłušč' + ∅//
tłušč' + ɛ   ɨ/ɛ Plural Allomorphy
tłušč + ɛ   HARD
[tłuščɛ]

In (10), ɨ/ɛ Plural Allomorphy rule correctly selects the [−back] suffix [ɛ], which is attached to the soft, stem-final [č']. Subsequently, the application of HARD removes the [−back] feature on the stem-final consonant. Consequently, *tłuszcze* emerges with a [+back] /č/, which is the attested output. Notice that if we had reversed the rule ordering and HARD applied first, the allomorphy rule would select the wrong suffix, as the environment for the selection of //ɛ// had been removed by HARD. The results of such a hypothetical reversed rule ordering are given in (11).

(11) Derivation of *tłuszcze* 'fat' (nom. pl.) (reversed rule ordering)
//tłušč' + ∅//
tłušč + ∅   HARD
tłušč + ɨ   ɨ/ɛ Plural Allomorphy
[tłuščɨ]

The analysis in (11) is wrong. The application of HARD removed the [−back] feature on the stem-final //č'//, which is now [+back]. In consequence, the allomorphy rule assigns the [+back] suffix /ɨ/ to the stem-final /č/. The result of the derivation in (11) is the unattested surface form, *tłuszczy*.

It is interesting to examine whether Optimality Theory can provide equally satisfying scenario of the allomorphy processes similarly to a rule-based account in (10).[12] Given the nature of the OT framework, the important task is to properly remodel the results from (10) in a fully parallel manner. Thus, the crucial point is to rank HARD properly in the constraint hierarchy. If [š ž č dž] are soft in the underlying representation, the reason they choose the suffix //ɛ//, we must place HARD below $\text{I}\textsc{d}\text{-C}_{([\text{-bk}])}$. In this way, we preserve the [−back] feature, which mandates the choice of this suffix, as in *tłuszcze*. The evaluation of *tłuszcze* is presented in (12).[13]

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[12] My purpose in this article is to present two competitive theories and, hopefully, evaluate their predictive powers as regards opacity. Rather than focus on formularization of the processes of allomorph selection, I aim at presenting which of the theories, OT-CC or DOT, offers a workable scenario of the opacity problem in (8), and is capable of achieving the attested output forms.

[13] In the underlying representation of *tłuszcze* //tłušč'+ɛ//, we have //s// rather than //š// due to a rule of Strident Assimilation: /s z/ → /š ž ɕ ʑ/_č dž tɕ dʑ. For further discussion of this problem, see Rubach (1984).

(12) Tableau for //tłušč’+{ɨ, ɛ}// ‘fat’ (nom.pl.)

	PAL-*i*	PAL-*e*	ID-$C_{([-bk])}$	HARD	ID-$V_{([-bk])}$	ID-$C_{([+bk])}$
a. tłušč’ɨ	*!			*		
b. tłuščɨ			*!			
☜ c. tłušč’ɛ				*		
☹ d. tłuščɛ		*!	*			

The result of the analysis in (12) is wrong. The desired winner, (12d), is eliminated as it fatally violates PAL-*e.* Candidate (12a) is eliminated because it offends PAL-*i.* Candidate (12b) incurs a faithfulness violation due to the change in [−back]. Placing HARD below ID-$C_{([-bk])}$ ensures that (12b) is not chosen as the optimal output, but it also gives preference to the undesired winner (12c). Had we reranked HARD above ID-C([−bk]), we would give preference to the unattested winner, (12b), which is the unattested output form from the hypothetical derivation in (11). The consequence of such reranking is presented in (13).

(12) Tableau for //tłušč’+{ɨ, ɛ}// ‘fat’ (nom.pl.) (HARD>>ID-C([−bk]))

	PAL-*i*	PAL-*e*	HARD	ID-$C_{([-bk])}$	ID-$V_{([-bk])}$	ID-$C_{([+bk])}$
a. tłušč’ɨ	*!		*			
☜ b. tłuščɨ				*		
c. tłušč’ɛ			*!			
☹ d. tłuščɛ		*!		*		

Due to the reranking of HARD above ID-C([−bk]), the winner from (12), candidate (13c), is eliminated as it fatally violates HARD. The desired winner, (13d), fatally offends PAL-*e.* Consequently, (13b) emerges as the optimal output, as it incurs the least costly violation of ID-C([−bk]).

To conclude, the case of the Polish nom.pl. is opaque. Classic Optimality Theory with direct input-output relations cannot account for the processes that require an insight into the intermediate stages available in the derivational approaches to opacity.

Based on Kiparsky (1973), McCarthy (1999) points out that opacity may be two-fold: non-surface-true and non-surface-apparent. A generalization is not surface-true if it is violated by some output representations. Non-surface-apparentness, on the other hand, occurs when a surface form does not provide any reasons for the operation of a given process. The former type of opacity is found in the nominative plural in (8). Normally, we expect the plural form to be //ɨ// in such words; however, they surface with //ɛ//. The latter type of opacity also pertains to the words in (8). The fact that [š ž č dž] take the suffix //ɛ// is not surface-apparent as the trigger, the [−back] feature of those segments, has been removed by HARD.

In order to account for opacity, various subtheories were proposed within OT. They are devised with a view to maintain the parallelism of the framework. In the following section, I investigate whether one of these subtheories, candidate chains (McCarthy 2007), can account for the opacity in (8). Then, I contrast the results with Derivational Optimality Theory (Rubach 1997, 2000a,b, 2005, 2007) to prove that the non-serialist account is fails to achieve the attested output, by the same token strengthening the argument for level distinction within OT.

2. Candidate chains

In this section, I examine whether the troublesome data maybe handled in a fully parallel manner, resorting to a subtheory of OT that attempts to circumvent the necessity for a derivational step: candidate chains (McCarthy 2007).

The role of candidate chains in dealing with opacity is two-fold. First, to provide access to the intermediate stages of evaluation. Second, to obviate the necessity for a derivational step. Therefore, the theory of candidate chains (henceforth, OT-CC) must differ in its architecture from standard OT. The main difference lies in the concept of level representation. The direct input–output relation distinguished by the standard version of the framework is expanded in OT-CC. Here, candidates form chains which include not only the input and the output forms, but also the intermediate stages of operations that gave rise to the final surface representation. Given that, a properly generated chain reflects, to some extent, derivation without disrupting the strict parallelism of the framework. Furthermore, OT-CC diverges form the notion of Freedom of Analysis employed in OT. A chain that is correctly constructed must meet specific requirements in order to be admitted for evaluation. Conversely to standard OT where the number of candidates is infinite, the number of chains is limited because only some chains will satisfy the chain well-formedness requirements formulated in (14) (McCarthy 2007: 62).

(14) A candidate chain associated with an input /in/ in a language with the constraint hierarchy $\mathcal{H}$, is an ordered *n*-tuple of forms $C = <f_0, f_1, ..., f_n>$ that meets the following conditions:

(a) Faithful initial form: f0 is a faithful parse of /in/.
(b) Gradual divergence: In every pair of immediately successive forms in C, < ..., f_i, f_{i+1}, ... > ($0 \leq i < n$), f_{i+1} has all of f_i's unfaithful mappings, plus one.
(c) Harmonic improvement: In every pair of immediately successive forms in C, < ..., f_i, f_{i+1}, …> ($0 \leq i < n$), f_{i+1} is more harmonic than f_i according to EVAL$_{\mathcal{H}}$.

McCarthy (2007) observes that, in order to fulfill the requirements stated in (14b), each subsequent form in a chain must increase faithfulness violations and simultaneously decrease structure markedness of its components. This is the only way to improve harmonically and satisfy the requirement in (14c). Recall from Section 1 that allomorphs do not violate faithfulness as they are encoded in the underlying representation, so it appears that the requirement in (14b) cannot be met. However, notice that the required change from //tłušč’ε// to [tłuščε] to arrive at the attested output entails a violation of the faithfulness constraint ID-C$_{([-\text{bk}])}$ on the one hand, but it also improves markedness by satisfying HARD on the other. The theory of candidate chains opens the possibility of employing evaluation stages that produce the attested output in a fully parallel evaluation. This combination dispenses with level distinction in the handling of the opaque alternations in (8). Crucially, the system must properly generate a valid chain that fulfills the requirements in (14). For the reader’s convenience, the problematic tableau is repeated in (15).

(15) Tableau for //tłušč’+{ɨ / ε}// ‘fat’ (nom.pl.) (failed evalutation)

	PAL-*i*	PAL-*e*	ID-C$_{([-\text{bk}])}$	HARD	ID-V$_{([-\text{bk}])}$	ID-C$_{([+\text{bk}])}$
a. tłušč’ɨ	*!			*		
b. tłuščɨ			*!			
☞ c. tłušč’ε				*		
☹ d. tłuščε		*!	*			

As is clear from (15), candidate (15c) is the unattested output necessary to eliminate by OT-CC. Due to the fact that in (15) there are two instances of the allomorphic suffix, the [+back] //ɨ//and the [−back] //ε//, it seems logical to construct two separate chains, one for each suffix, which are then submitted to EVAL$_{\mathcal{H}}$ for constraint evaluation.[14] More-

[14] In the case at hand, constraint hierarchy $\mathcal{H}$ reflects the ranking of the constraints in tableau (15): PAL-*i* >> PAL-*e* >> ID-C$_{([-\text{bk}])}$ >> HARD, ID-V$_{([-\text{bk}])}$ >> ID-C$_{([+\text{bk}])}$.

over, in order to enforce the selection of the appropriate candidate, McCarthy (2007) suggest that the violations of faithfulness constraints take effect in an ordered fashion, thus resembling rule ordering in rule-based frameworks. This is captured by a precedence constraint stated informally in (16).

(16) PREC(A, B)
Violations of the faithfulness constraints A and B must occur in an ordered fashion. Assign ‘*’ for every violation of B that precedes A.

Observe that in (15), the only faithfulness constraint that is violated by the attested output, candidate (15d), is ID-C$_{([-\text{bk}])}$ due to the change of the [−back] value of //č’// to the [+back] /č/. Therefore, we might expand the realm of PREC(A, B) by PAL-*e,* the constraint that takes part in the evaluation when we reverse the [± back] values in order to achieve the attested output [tłuščɛ]. Thus, the constraint ID-C$_{([-\text{bk}])}$ should be violated first, before the violation of PAL-*e* occurs. The PREC(ID-C$_{([-\text{bk}])}$, PAL-*e*) then reads: “In a given chain, while proceeding from the first to its next element, assign a violation mark whenever PAL-e is violated before ID-C([−back]).” The chains that are relevant for the analysis are given in (17).

(17)	a. <tłušč’ɨ>	Faithful parse.
	b. <tłušč’ɛ>	Faithful parse.
	c. <tłušč’ɨ, tłuščɨ>	Harmonically improving under $\mathcal{H}$ as PAL-*i* >> ID-C$_{([-\text{bk}])}$.
	d. **<tłušč’ɛ, tłuščɛ>[15]	Not harmonically improving under $\mathcal{H}$ as PAL-*e* >> ID-C$_{([-\text{bk}])}$.

The result of the analysis in (17) is wrong. Chain (17d)[16] fulfills the gradual divergence requirement by incurring a faithfulness violation while changing the [−back] value of /č’/ to [č], which is [+back]. Nevertheless, (17d) does not improve on markedness under $\mathcal{H}$ due to the disagreement in backness between the stem-final consonant and the following vocalic suffix, so it cannot be submitted for constraint evaluation not having fulfilled the requirements in (14). The only chain that does fulfill all the requirements is (17c). However, such a result is of no avail. Evaluating the valid chains in (17), we would achieve the identical result as in tableau (12), giving rise to the unattested <tłušč’ɛ>.[17]

[15] I adapt the same convention as McCarthy (2007: 61), who uses “[…] double asterisks to mark chains that are invalid, reserving single asterisks to mark chains that are valid but nonoptimal.”

[16] As a reviewer points out, <tłušč’ɛ, tłuščɛ> can be viewed as an overapplication of HARD in the sense of Wilbur (1973).

[17] A *PSiCL* reviewer would like to know whether we could salvage the analysis in (11) by introducing a perceptually motivated constraint similar to OCP effects. Given that, the chain <tłuɕtɕɛ, tłuščɛ> would improve

A *PSiCL* reviewer inquires whether it is possible to generate a valid chain under a partially corrected constraint hierarchy, where HARD dominates ID-C[(−back]). The corrected ranking would be *ℋ*: PAL-*i*, PAL-*e* >> HARD >> ID-C$_{([-bk])}$, ID-V$_{([-bk])}$ >> ID-C$_{([+bk]).}$ The relevant chains under the new hierarchy are given in (18).

(18)
- a. <tłuščʼɨ> — Faithful parse. (Violates PAL-*e* and HARD.)
- b. <tłuščʼɛ> — Faithful parse. (Violates HARD.)
- c. <tłuščʼɨ, tłuščɨ> — Harmonically improving under *ℋ* as HARD >> ID-C([−bk]).
- d. **<tłuščʼɛ, tłuščɛ> — Harmonically improving under HARD >> ID-C([−bk]). Not harmonically improving under *ℋ* as PAL-*e* >> ID-C([−bk]).

Chain (18d), improves harmonically under the partial ranking of HARD>>ID-C ([−back]) as the violation of HARD on the initial element of the chain, which includes the [−back] /čʼ/, is followed by a faithfulness violation of ID-C([−back]), due to the change of the [−back] value of /čʼ/ to [č] in <tłuščɛ>. Nevertheless, (18d) will never emerge as the optimal output due to the fatal offence of PAL-*e.* Given the parallel constraint evaluation, chains are evaluated by all the constraints simultaneously. Hence, PAL constraints, which act as allomorph selectors, can never be ordered to occur before HARD and select the appropriate suffix before the hardening of the stem-final consonant.[18] I summarize the discussion by presenting an OT-CC evaluation of *tłuszcze*, under the partial reranking of HARD >> ID-C([−back]) in (19).

(19) Tableau for //tłuščʼ+{ɨ / ɛ}// 'fat' (nom.pl.)

	PAL-*i*	PAL-*e*	PREC(ID-C$_{([-bk])}$, PAL-*e*)	HARD	ID-C$_{([-bk])}$	ID-V$_{([-bk])}$	ID-C$_{([+bk])}$
a. <tłuščʼɨ>	*!			*			
b. <tłuščʼɛ>				*!			
☞ c. <tłuščʼɨ, tłuščɨ>					*		
☹ d. < tłuščʼɛ, tłuščɛ>		*!			*		

harmonically by removing one of the two palatal elements in <tłuɕtɕɛ>. Nonetheless, I assume that the stem-final consonant and the vocalic suffix share the [−back] feature (see footnote 10). Thus, the chain could not improve harmonically, as there is one instance of [−back] in each element of the chain: one in <tłuɕtɕɛ>, and the other in <tłuščɛ>. Moreover, the "sharing relation" renders possible assimilation processes as, for example, in words *prosić* 'to ask' [prɔɕitɕ] – *prośba* 'a request' [prɔʑba]. Otherwise, OCP would ban the occurrence of the feature [+voice] on each consonant in [ʑb] cluster.

[18] Such an option, however, is possible if we adopt a derivational model of OT (see Section 3).

Chains (19a) and (19b) incur a fatal violation of PAL-*i* and HARD, respectively. In addition, the former violates HARD. Chain (19d) receives a faithfulness violation while changing the [−back] value of /č'/ to [č], which is [+back]. Nevertheless, (19d) does not improve on markedness under $\mathcal{H}$ as the stem-final consonant and the following vocalic suffix disagree in backness, which is a fatal offence of PAL-*e*. Consequently, (19c), vacuously satisfying PREC, emerges as the optimal output with a faithfulness violation of ID-C([−back]).

At this point, we may conclude that OT-CC fails to provide a fully parallel account of the opacity problem in (8). However, it is possible to assume that the issue does not concern the predictions made by the subtheory. Specifically, in order to fulfill the requirements in (14), we may reconsider the assumptions regarding the underlying representation of the problematic input. Instead of soft //č'//, we submit to GEN the hard counterpart of the postalveolar affricate, //č//, and rely on the requirements in (14) to generate a valid chain. The chains generated under the corrected UR are given in (20), with the exact constraint hierarchy $\mathcal{H}$: PAL-*i* >> PAL-*e* >> ID-C$_{([-bk])}$ >> HARD, ID-V$_{([-bk])}$ >> ID-C$_{([+bk])}$.

(20) a. <tłuščɨ> — Faithful parse.
b. <tłuščɛ> — Faithful parse.
c. **<tłuščɨ, tłušč'ɨ> — Not harmonically improving under $\mathcal{H}$ as HARD >> ID-C$_{([+bk])}$.
d. <tłuščɛ, tłušč'ɛ> — Harmonically improving under $\mathcal{H}$ as PAL-*e* >> ID-C$_{([+bk])}$.

Due to the restructuring of the underlying representation, we have eliminated (20c), the undesired winning chain from (18). Chain (20d) violated ID-C$_{([+bk])}$ by changing the [+back] /č/ to [−back] /č'/ on its last component. It also improved harmonically on PAL-*e,* as the stem-final consonant and /ɛ/ agree now in backness. Observe that, in (12d), <tłušč'ɛ> must be the last component of the chain which improves under $\mathcal{H}$. Taking the analysis one step further by adding <tłuščɛ> as the final element would not ameliorate the evaluation because then the chain would not improve under $\mathcal{H}$ violating the high-ranked PAL-*e*.

Additionally, as regards the evaluation of the candidates in (20), it is necessary to correct the PREC constraint so that it accounts for the faithfulness violation after the restructuring of the UR. In the valid chain <tłuščɛ, tłušč'ɛ>, the only faithfulness constraint that is violated now is ID-C$_{([+bk])}$ due to the change of the [+back] value of //č// to the [−back] /č'/. Therefore, it must be included in the relevant PREC constraint, which is now PREC(ID-C([+back]), PAL-*e*), which reads: "In a given chain, while proceeding from the first to its next element, assign a violation mark whenever PAL-*e* is violated before ID-C([+back])." The OT-CC evaluation of *tłuszcze* enforced by PREC(ID-C([+back]), PAL-*e*) is given in (21).

(21) Tableau for //tłušč’+$\left\{\begin{matrix} \text{ɨ} \\ \text{ɛ} \end{matrix}\right\}$// ‘fat’ (nom.pl.)

	PAL-*i*	PAL-*e*	PREC(ID-C$_{([-bk])}$, PAL-*e*)	ID-C$_{([-bk])}$	HARD	ID-V$_{([-bk])}$	ID-C$_{([+bk])}$
☜ a. <tłuščɨ>							
☹ b. <tłuščɛ>		*!					
☹ d. < tłuščɛ, tłušč’ɛ>					*!		*

The result of the evaluation in (21) is wrong. Chain (21c) vacuously satisfies PREC(ID-C$_{([+bk]}$, PAL-*e*), however it incurs a fatal violation of HARD. The desired output, (21b), fatally violates the undominated PAL-*e*, which militates against the disagreement in backness. In consequence, the unattested output (21a), <tłuščɨ>, emerges as the optimal form.[19]

To conclude, OT-CC failed to achieve the attested output. Despite the intricate process of chain selection, candidate chains cannot provide a fully parallel evaluation of the opacity problem in (8).

3. Derivational Optimality Theory

As shown in the preceding sections, the non-serialist account of OT is unable to handle opacity in allomorphic processes. The parallel evaluation runs into problems with the choice of the correct allomorph in (8). This is due to the fact that the opacity in (8) is too deep for a framework which is output-oriented. However, the problems can be overcome if we resort to a model of OT which admits level distinction.

The derivational version of OT advocated by, among others, Kiparsky (1997, 2000) and Rubach (1997, 2000a,b, 2005, 2007), pivots on three principles stated in (22).

(22) a. Level Minimalism
b. Reranking Minimalism
c. Constraint Minimalism

As pointed out in Rubach (2000b), the number of levels and constraints employed in an evaluation must be kept to the minimum. Moreover, the reranking of constraints between levels should be motivated and minimal as well, as each reranking comes at a cost and requires justification.

[19] Notice that any reranking between HARD and faithfulness constraints will not affect the final result.

Derivational Optimality Theory enables us to split the evaluation into parts. At level 1, which resembles the lexical level in Lexical Phonology (Kiparsky 1982), the suffix //ε// is attached to the soft stem, obeying the high-ranked PAL-*i* and PAL-*e* constraints. At the same time, HARD is low in the hierarchy. At level 2, which corresponds to the postlexical level, the ranking is reversed, and HARD is reranked to an undominated position, mandating the enforcement of the [+back] quality on /č'/. This is the minimal reranking of constraints between levels that is necessary.[20] It must be emphasized that, in accordance with the standard assumptions of Derivational Optimality Theory (DOT, henceforth), the input to level 2 is the optimal output of level 1. A DOT account of *tłuszcze* is given in (23) and (24).

(23) Tableau for //tłušč'+{ɨ / ε}// 'fat' (nom.pl.)

Level 1

	PAL-*i*	PAL-*e*	ID-C$_{([-bk])}$	HARD	ID-V$_{([-bk])}$	ID-C$_{([+bk])}$
a. tłušč'ɨ	*!			*		
b. tłuščɨ			*!			
☞ c. tłušč'ε				*		
d. tłuščε		*!	*			

Candidates (23a) and (23b) fatally violate PAL-*i* and PAL-*e*, respectively. Candidate (23b) incurs a fatal violation of ID-C([−back]), due to the change in [−back] on the stem-final //č'//. At level 1, HARD is low in the hierarchy and does not play a role in the evaluation, therefore its violation is permitted as it is the least costly alternative. Consequently, (23c) is chosen as the optimal output. This is the undesired winner in the analysis presented in section 2. However, in DOT, the winner form level 1 is not the ultimate output, but it constitutes the input to level 2.

(24) Tableau for /tłušč'ε/ → [tłuščε]

Level 2

	HARD	PAL-*i*	PAL-*e*	ID-C$_{([-bk])}$	ID-V$_{([-bk])}$
a. tłušč'ε	*!				
☞ b. tłuščε			*		*

[20] Thanks to a *PSiCL* reviewer for drawing my attention to this fact.

At level 2, which is the domain of HARD, the hierarchy is changed, and, consequently, the winner from level 1, candidate (24a), fatally violates the high-ranked HARD. As a result, candidate (24b), which changed the [−back] /č'/ to [+back] [č], satisfies HARD and emerges as the optimal output, which is the attested surface form.

To conclude, Derivational Optimality Theory correctly predicts the choice of the correct allomorph. By admitting the existence of levels in the analysis, it can overcome the opacity processes in (8), which are beyond the scope of OT-C. Therefore, Derivational Optimality Theory is superior in its power of predicting the attested output, which also proves that OT must admit derivational levels.

4. Conclusion

This article has discussed opacity in allomorphic processes on the basis of the Polish masculine nominative plural of nouns, in words such as *tłuszcze*. It has been shown that the process is problematic for standard OT as the framework is unable to handle the allomorphic alternation. The analyses presented in Sections 1–2 attempted to maintain a parallel evaluation of the framework. OT-CC, with its intricate process of chain selection, offers an insight into the intermediate stages of evaluation. However, the theory failed to achieve the attested output despite the fact that the underlying representation had to be restructured in order to proceed with the evaluation. The idea of level distinction in OT proves to be the only viable alternative. Derivational Optimality Theory correctly predicts the choice of the correct suffix. The existence of levels in the analysis renders possible the interaction of the constraints HARD and PAL-*e*. The reason is that each level has a different constraint ranking. The mutually exclusive HARD and PAL-*e* can only be satisfied when ranked to the undominated position within their specific levels. Therefore, the prediction made by DOT regarding derivational levels is correct.

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