A reassessment of Old English compensatory lengthening

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Abstract: This article investigates the explanatory capability of Optimality Theory (OT) in accounting for Old English compensatory lengthening (OECL) arising from the loss of /x/ and the avoidance of the hiatus that accompanies the loss of /x/. Our findings suggest that the constraint *h*-DROP can possibly account for the obligatory loss of /x/ in production when flanked by two inter-syllabic sonorants. We also seek to determine whether the cue constraint */n -VCF/ helps account for the perceptual absence of the nasal in the coda, such as [*finf*] (auditory form) > /*fi:f*/ (phonological surface form) 'five.' Regardless of the types of OECL, its nature appears to be controlled by a faithfulness constraint that allows for mora preservation – that is, the mora belonging to the sonorant appears to stay with the initial syllable even after the sonorants affiliate to the ultimate syllable in the genitive singular form, and when the nasal coda deletes. The constraint interactions arising from such perspectives – both in production and perception – are notably lacking in the relevant literature on the source language—we attempt to shed light on these processes.

key words: Old English, compensatory lengthening, moraic theory, resolution of vowel hiatus, cue constraints

1. Problems

There has been little work in the relevant literature characterizing OECL within the Optimality Theoretic framework (Prince and Smolensky 2004 [1993]).[1] Opalińska (2004) is probably among the first to point out that classic OT cannot account successfully for OECL at all, particularly the type which arises out of the deletion of /x/. No phonological research, particularly in OT, has been conducted into why perceptual loss of nasal should have arisen when Old High German (OHG) words entered OE in the earliest periods of the English language (cf. Ohala and Amadar 1981; Ohala and Busà 1995). Shaw (2007) shows that it is *not possible* to account for CL in any language within

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the decision-making framework of standard OT unless the underlying representation contains the moraic structure to be preserved. However, the moraic structure to be preserved stays with the underlying form in OE cases, and thus Opalińska's (2004) drawbacks actually make it possible to suggest a more refined and indeed simpler account of the target phonological events in the standard model of OT. Given such a purpose of this work, we consider *de novo* that what goes for OECL due to loss of specific consonants such as /x/ (voiceless velar fricative) and /n/ (voiced dental nasal) is accountable in the standard model of OT when supported by the moraic theory as argued for by Hayes (1989) and Skaer (1991).

First and foremost, CL is defined as a combinative phonological occurrence whereby the loss of one underlying segment leads to the lengthening of another neighboring segment at the surface (Kavitskaya 2001). By way of introduction, we will examine the data regarding OECL, which comes in two distinct forms with OECL-triggering consonants ranging through /x/ to /n/ (Jones 1989). For now, what is of interest is that the same logical pattern holds in terms of accounting for OECL regardless of whatever the consonantal loss may be. The type (1) OECL under scrutiny is generally recognized as "double flop" (Hayes 1989: 280) in the sense that the loss of /x/ in the initial stressed syllable should give rise to a synchronic lengthening of the stressed vowel across the intervening consonant. The (1a) and (1b) data indicate that a synchronic loss of [x] that is preceded by the graphic *l* and *r* respectively occurs when followed by the suffixal vowel. Similarly, the (1c) data demonstrates that the [x] that is flanked by two intra-syllabic vowels is synchronically deleted. This phonological operation is accomplished by the appendage of the suffix -*es* onto the stem-final *h*; notably, this is where the morphology interacts with the phonology (cf. McMahon 2000).

On the contrary, it is worth noting that OECL fails to apply through the suffixation of -*es* to the nominative stem ending with consonants other than [x], as with *forht* (nom. sing.) 'timid' > *forhtes* (gen.sing.) and *torht* (nom.sing.) 'bright' > *torhtes* (gen.sing.); this goes to show one important fact – [x] that is directly followed by the voiceless consonant is prevented from being deleted even if [x] is immediately preceded by the sonorant (Scragg 1970). Since OE phonology avoids [x] in between two sonorants (Scragg 1970; Dresher 1989; Hogg 2011), it can be postulated that there exists some sort of well-formedness constraint which positively encourages the [x] to be deleted in the surface form. OECL due to the loss of /x/ far outnumbers that which arises from the loss of other consonants (Hogg 2011); such a segmental loss would be considered an ultimate form of lenition (Honeybone 2012; Ringe and Eska 2013).

(1) Paradigm for OECL due to the effacement of [x]

nom.sing. gen.sing. gloss

a. *eolh* + *es* > *ēoles* ‘elk’
ealh + *es* > *ēales* ‘temple’
healh + *es* > *hēales* ‘corner’
holh + *es* > *hōles* ‘hole’
sealh + *es* > *sēales* ‘willow’
(Sievers 1903; Campbell 1959; Lass 1994)

b. nom.sing. gen.sing. gloss
mearh + *es* > *mēares* ‘horse’
fearh + *es* > *fēares* ‘pig, swine’
feorh + *es* > *fēores* ‘life’
(Sievers 1903; Campbell 1959; Lass 1994)

c. nom.sing. gen.sing. gloss
eoh + *es* > *ēos* ‘war-horse’
feoh + *es* > *fēos* ‘money’
flāh + *es* > *flās* ‘fraud’
pleoh + *es* > *plēos* ‘danger’
sǣ + *es* > *sǣs* ‘sea’
(Wright and Wright 1925)

The resyllabification found in the (1) OECL surface forms indicates that the ultimate syllable of the genitive singular invariably begins with a liquid, for an inter-vocalic consonant belonging to the second syllable in the source language (Baker 2003). This being assumed, the initial stressed syllable consists of a long diphthong at the surface, such as -*ēa* and -*ēo* (following Kuhn and Quirk 1953; Stockwell and Barritt 1955). The bimoric-ness of the stressed syllable is attributed to the lengthening, which has resulted from the retention of the mora that was previously affiliated to the sonorant coda; the initial syllable of the genitive singular maintains the same bimoraicity as the nominative singular. Though Hockett (1959) argues that the OE vowel *eo* is monophthongal – phonemically characterized as /ə/ (mid back) – rather than diphthongal, nonetheless it is not clear whether this vowel can absorb the effects of CL when it arises.

The tokens shown in (2) embody a second paradigm of OECL, which coincides with the nasal effacement in the coda; to put it in clear terms, the nasal coda in OHG words deletes when appearing before the graphic *s*, *f*, *t* and *þ* in OE. It is widely recognized that OE speakers communicated with OHG speakers without considerable difficulty

(Molencki 2014). Thus, when OHG words in (2) entered OE, they only underwent a slight alternation in the phonological structure; the environment in which the nasal coda is effaced ranges from -*ns* and -*nf* to -*nt* and -*nþ* (see (2)). Hogg (2011) among others indicates that the final coda of the words in (2c) is voiced instead of voiceless.

In order to answer *why* the nasal coda deletes in the predictable surface environment, Ohala and Busà (1995) offers us a perceptual cause of nasal deletion in the (2) paradigm. They indicate that the listeners are unable to detect a nasal sound in an ordered sequence of a nasal and a voiceless fricative. This being assumed, it can be posited that OE should have probably entailed some kind of a *cue constraint* (Boersma 2009), whose main task is to evaluate the mapping between the audio form (e.g., the input with the nasal coda) and the phonological surface form (e.g., the output without the nasal coda). This study attempts to account for the (2) paradigm in perception-based OT (Boersma 2009).

(2) Paradigm for OECL due to the loss of [n]

	OHG		OE	gloss
	OHG		OE	gloss
a.	*gans*	>	*gōs*	'goose'
	uns	>	*ūs*	'us'
	amsala	>	*ōsle*	'blackbird'
	tunst	>	*dūst*	'dust'
	hansa	>	*hōs*	'troop'
	wunsken	>	*wȳscan*	'wish'
	(Wright and Wright 1925; Bloomfield 1933; Jones 1989; Hogg 2011)			
b.	OHG		OE	gloss
	sanfto	>	*sōfte*	'softly'
	finf	>	*fīf*	'five'
	(Bloomfield 1933; Jones 1989; Wright and Wright 1925)			
c.	OHG		OE	gloss
	zant	>	*tōth*	'tooth'
	munt	>	*mūth*	'mouth'
	sunt	>	*sūth*	'south'
	(Random House Webster's College Dictionary 2001)			
d.	OHG		OE	gloss
	kunþs	>	*cūþ*	'know'
	sinþs	>	*sīþ*	'way; journey'
	anþar	>	*o:þer*	'other'
	(Hogg 2011)			

What is revealed across the (1) and (2) paradigms could indicate a robust activity of the faithfulness constraint whereby the mora count for the underlying initial syllable corresponds to the mora count for the initial syllable at the surface (Lin 1997). As we shall demonstrate later, one of the crucial drawbacks of Opalińska's (2004) approach is that her suggested constraint hierarchy does not have such a faithfulness constraint mediating between input and output in terms of mora count for the stressed syllable. Without such a constraint, she concludes that the standard model of OT does not account fully for the paradigm shown in (1). This paper attempts to rectify this shortcoming (Kobayashi and Skaer 2021).

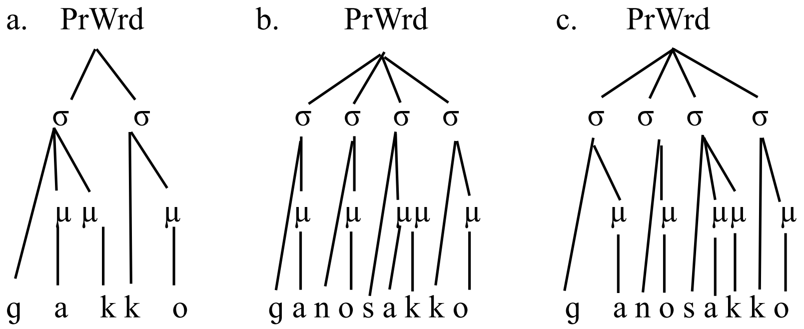
The organization of this paper is as follows. Section 2.1 assesses the performance of the moraic theory as argued for Hayes (1989), Skaer (1991), and Hyman (2003) given a range of available data in the source language. Subsequent sections consider the nature of OECL arising from the obligatory loss of [x] in the genitive singular nouns in production, and suggests necessary constraints to sufficiently account for OECL. In section 3, the standard OT model accounts well for the target phonological events, OECL due to the [x] loss, OECL that accompanies resolving the hiatus, and OECL due to the loss of nasal in perception, all of which are put forward as counterarguments to Opalińska (2004). Section 4 offers our conclusions.

2. Theoretical assumptions

2.1 Moraic theory

In formulating a full phonological operation of OECL, the theory of mora will prove instrumental in our accounting for the preservation of mora in the wake of the consonantal loss in the tautomorphemic stressed syllable. As a syllabic sub-constituent within a prosodic unit, the notion of mora refers to time spans which make up an amount of segmental length (Hock 1986; Kavitskaya 2001). The moraic theory is better equipped with the explanatory machinery for accounting for OECL than X-skeleton theory and CV theory in that the moraic theory assumes that the stranded mora in the wake of an obligatory loss of the intra-syllabic /x/ should migrate to the immediately preceding syllable (Hayes 1989; Hock 1986). The previous model suffers crossing-association lines when CL occurs across the intervening consonants in other world languages (Hock 1986; cf. Rubach 1993).

Let us consider the notion of mora in cross-linguistic perspectives so that the nature of mora in the analysis of OECL may well be better understood in cross-linguistic perspectives. Skaer (1991) adduces the synchronic existence of mora by investigating Japanese language games. Consider, for instance, the Nosago game, where a player inserts the non-lexical item *nosa* after the leftmost mora of a Japanese noun, as with *gakkoo* ‘school’ > *ganosakkoo*. The prosodic tree diagrams in (3) shows such step-by-step infixing processes. The coda consonant of the penultimate ‘gak’ in (3a) becomes moraic through Weight-by-Position (WP) (Hayes 1989), as formalized in (4). It is worth stating that the bimoraic syllable ‘gak’ receives pitch accent in Japanese. The onset consonant is underlyingly mora-less.[2] Any segment left out of the tautosyllabic sequence of CVC, as illustrated in (3b), produced by Universal Core Syllable Condition (Itô 1988), must be attached to the preceding nuclear (Skaer 1991) – that is, the mora, by its nature, is not tethered to one and only one syllable.

(3)


(Adopted from Skaer 1991)

(4) WEIGHT-BY-POSITION (WP)
Coda consonants are assigned with a mora if the language distinguishes the CVC heavy syllable from the CV light syllable. (Hayes 1989)

The post-nuclear moraic *k* in *gak* delinks from the syllable tier and re-associates to the last mora of the inserted item *sa*, as in (3c), thereby creating the bi-moraic CVC penultimate syllable in response to the stipulation of WP. This syllable in turn deserves pitch accent in the source language. The entirety of the Nosago game affirms the key notion of *moraic licensing* (Bagemihl 1991): A segment that is not linked to a mora is subject to stray erasure.

With the general architecture of the moraic theory stated above, let us consider now the nature of digraphs *ea* and *eo* which comprise the stressed syllables of the (1) data before

[2] Though the underlying consonants bear mora in Hyman’s (2003) framework, the consonant onset(s) immediately preceding the nucleus vowel loses the mora due to the onset-creation rule. Importantly, as a focus of our study, OECL does not arise through the onset loss of *r* in *sprecan* > *specan* ‘to speak’ and *spræc* > *spæc* ‘speech’ (Wright and Wright 1925), as well as through the unstressed vowel syncopation in *engel* (nom. sing.) > *engles* (gen. sing.) ‘angel’ and *ēþel* (nom. sing.) > *ēþles* (gen. sing.) ‘native land’ (Wright and Wright 1925).

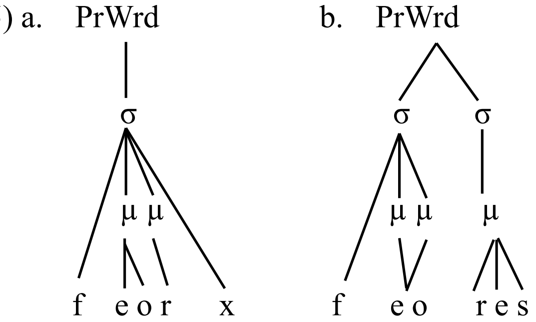
studying prosodic structure designed for (1) OECL. The present paper takes the standard position expressed by Campbell (1959) and Kuhn and Quirk (1953; 1955) among others regarding the diphthongal nature of these two vowels (cf. Hockett 1959). The traditional view maintains that the digraphs always contain two distinct vowels, with the first segment prominence placed, except when the OE orthography permits the spelling *ea* to be used instead of *a* as in *secan* ~ *secean* 'seek' (Hogg 2011). It is generally recognized that the Germanic diphthongs entered the OE linguistic sphere without substantial modifications, and subsequently developed into OE diphthongs (Hogg 2011). Thus, they are considered bimoraic since the Germanic diphthongs are phonologically equal to long vowels (Lass 1983), as in *liogan* (OHG) > *lēogan* (OE) 'lie (verb),' *fliogan* > *flēogan* 'fly (verb),' and *fao* > *fēawa* 'few.' This being assumed, on the other hand, the short diphthongs in OE are a reflex of Germanic short vowels, and hence the short diphthongs are considered mono-moraic (Lass 1983), as in *haria* (OHG) > *hearpe* (OE) 'harp,' *marg* > *mearg* 'marrow,' and *silabar* > *siolfor* 'silver' among others. It can be stated that OE is a language with an underlying contrast in syllable weight, thereby allowing CL to arise under specific environments (Hayes 1989).

2.2 Core constraints

As illustrated in (5a), the underlying form consists of a monosyllable. When this nominative form turns into genitive appended with the suffixal -*es*, resyllabification is expected to occur because, as we shall elaborate later, the graphic *h* (phonetically [x]) compulsorily deletes in OE when flanked by two sonorants in the derivation (Scragg 1970; Dresher 1989).[3] Resyllabification usually helps to block a stray segment from being removed at the surface (Lin 1997), but in this case, some sort of well-formedness pressure forces [x] out of the surface form. A natural question arises hereby as to what that constraint would be. We deal with this question in Section 2.2. The suffixed ultimate syllable should become well-formed with the onset. In this respect, it can be posited that OE has the active markedness constraint, ONSET, as formalized in (6), in the formation of the genitive singular and at the same time, the initial syllable, by receiving the orphaned mora from the previous member of the coda *r*, remains unchanged in terms of mora count (Hock 1986). This being assumed, such an interactional operation between morphology and phonology is demonstrated in (5b).

[3] The similar resyllabification of the coda to the onset of the following syllable is found in *kswenwos* 'stranger' > *kseios* (where *ei* is realized [ē]) in Greek (Steriade 1982).

(5)



(Opalińska 2004: 243)

(6) ONSET
The syllable must have an onset. (McCarthy 2008)

Note that the approach by Opalińska (2004: 239, 244), in which the underlying form *feorh* consists of two morae, as illustrated in the prosodic tree (5a), but where the underlying form in the tableau consists of one mora, is proven to be inconsistent and thus incorrect. Note importantly that the underlying coda /r/ is not assigned any mora count in standard OT (McCarthy 1998; Sprouse 1997), and accordingly it is WP that assigns mora to the coda under consideration (Kager 1997). The fact that the second member of the coda, /x/, sits at the word edge makes it extrametrical, as in (5a) (Hayes 1982). Having the monosyllabic word assigned the primary stress necessitates the syllable to become bimoraic (Benua 1995; 1997; 2000); the short diphthong *eo* contains one mora strengthened by the moraic coda /r/, as in (5a).

This being all assumed, what is crucially necessary in accounting for OECL (1) would be the undominated constraint MAX-*μ* (Lin 1997) over MAX-C (McCarthy 2008), as formalized in (7) and (8) respectively. This latter constraint is crucially dominated at the expense of the effaced consonant. The cornerstone constraint domination MAX-*μ* over MAX-C can be generalized to other types of OECL without any intermediate derivational level between the input and the output (Lin 1997). Such a constraint domination may obviate the need for DEP-*μ* as a dominated constraint in the present analysis (cf. Opalińska 2004), as we shall demonstrate later.

(7) MAX-*μ*
The mora count for the underlying representation corresponds to the mora count for the surface form. (Lin 1997)

(8) MAX-C
Each underlying consonant has its corresponding consonant at the surface.

(McCarthy 2008)

(9) DEP-μ
Every output has its own corresponding underlying mora. (McCarthy 2008)

At this juncture, it is worth adding independent evidence for a robust activity of the constraint MAX-μ (McCarthy2008) in the synchronic derivation of (1) OECL. Some evidence supporting our claim derives from a synchronic doubling of consonants in front of following liquids, which is accompanied by shortening of a preceding long monophthong or diphthong (Wright and Wright 1925); the available glossaries (10) suggest to that effect.

(10)

OE	gloss
blǣdre > blæddre	'bladder'
dēopra > deoppra	'deeper'
gelīcra > geliccra	'more like'
hwītra > hwittra	'whiter'
rīca > riccra	'more powerful'
ȳtra > yttra	'outer'

(Wright and Wright 1925)

By our analysis of (10), OE phonology should encode a robust motivation to maintain the corresponding mora count for a word in the surface environment as compared to the mora count in the underlying form; the shortening of a long monophthong or a long diphthong arises in the words is accompanied by releasing part of its mora onto the immediately following consonant. OE phonology, by making a coda consonant geminate, blocks a moraic loss from occurring so that the entire mora count for the stressed syllable will remain unaltered. This also demonstrates the activity of MAX-μ in the generative grammar of OECL.

2.3 Medial [x] in OE phonology

It is generally recognized that OE /x/ is a peripheral phoneme in that it is subject to distributional restrictions (Vachek 1976); the graphic *h* is used as [h] at the beginning of a syllable in Old English; but the graphic *h* is pronounced as either [x] or [ç] elsewhere in OE (Baker 2003). The synchronic derivation of OECL reveals that the graphic *h* plays an important role in the consideration of the phonological status of this phoneme; there exist relevant restrictions for the phonological status of *h* in OE (Wright and Wright 1925). The available data (11) is significant with respect to one of the paradigms whereby the [x] does not appear in between a vowel and a following liquid, nasal or vowel (Jones 1986). In particular, the deletion of the graphic *h*, when flanked by the vowels, "results in less of an articulatory interruption between vowels" (Ringe and Eska 2013: 83); accordingly, such a deletion of [x] should be attributed to lenition in OE (Kobayashi and Skaer 2022). The /x/ does not delete when it is flanked by the preceding vowel and the following voiceless consonant: *rihtes* (gen.sing.) 'right', *fēochtes* (gen.sing.) 'fight', and *cnihtes* (gen.sing.) 'knight'. Such a characterization is formulated in the constraint (12).

(11) Proto-Germ. OE gloss
þwahl (Gothic) > *þwēal* 'washing, bath'
lēhni (Old Saxon) > *lǣne* 'transitory'
ōheim (OHG) > *ēam* 'uncle'
ahir (OHG) > *ēar* 'ear'
fliohan (OHG) > *flēon* 'to flee'
aha (OHG) > *ēa* 'water'
(Wright and Wright 1925)

From this restriction, it can be predicted that OE phonology does not permit [x] to appear between two sonorants in the surface environment (Scragg 1970; Dresher 1989). The reason for this would be that maintaining [x] in between two sonorants at the surface would be highly marked by the "evaluation measure" (Dresher 1989: 103) of native OE speakers. This generative evaluation measure concentrates on the relative simplicity of phonological representation of a surface form (McMahon 2000). However, Opalińska (2004) suggests that *ONSET-*x*, which has a blocking effect of *h* in word-medial onsets, is at work in the derivation of (1) OECL while overlooking some variability to which the pre-consonantal [x] is subject; OE phonotactics allows for [x] to appear in a pre-sonorant onset position in the stressed syllable (Minkova 2003), for example, *hrædlic* 'hastily,' *hwīt* 'white,' *hlāfond* 'lord,' *hnot* 'bald' and *hyrian* 'to hire.'[4] This shows that *ONSET-*x* is not always enforced in OE, and hence it can be argued that positing this constraint as active may not be well advised and ad hoc (following Lin 1997). What is needed instead of *ONSET-*x* is some sort of well-formedness constraint ruling out the medial [x] flanked

[4] Cruttenden (2008: 218) indicates the word-initial *hl* in *hlæder* 'ladder' and *hlaf* 'loaf' could be either [hl] or [xl] or [l̥].

by two sonorants at the surface, as in (1). From this perspective, we are led to contend that *ONSET-*x* does not carry as much persuasive power as the constraint (12) *h*-DROP (Dresher 1989) in the consideration of (1) OECL.

(12) *h*-DROP
The voiceless velar fricative does not stand in two sonorants intra-syllabically. (Dresher 1989)

At this point, it can be further posited that when OECL (1) arises through the consonantal loss of /x/ in the tautomorphemic stressed syllable, with the liquid coda moraic licensed by WP, the faithfulness constraint MAX-*μ* is satisfied at the expense of MAX-C in the surface environment. This being assumed, as in (13), the domination of WP, MAX-*μ* over MAX-C is carried through consistently in the consideration of OECL:

(13) *h*-DROP, ONSET, WP, MAX-*μ* » MAX-C

The next section will consider constraint interactions arising from this hierarchy in the standard OT.

3. The Proposal

3.1 OECL due to the [x] loss

This section considers relevant OT constraint interactions on the basis of the theoretical assumptions, wherein the inputs *feorh* + *es* should surface as *fēores* under the constraint hierarchy (13). It is assumed the underlying coda *r* becomes moraic at the surface in response to the requirement of WP, making *feorh* bi-moraic (cf. Hayes 1989); the other underlying codas *h* and *s* are extrametrical at best because they both are at the edge of a morpheme (Hayes 1982). Tableau 1, considering all logically possible outputs, shows that the interactional activities of the suggested constraints should give rise to the legitimate output (c), whose initial syllable with the long diphthong *ēo* remains bi-moraic; the syllable has received moracity from the moraic *r*, which has been dissociated from the initial syllable in order to meet a strict requirement of ONSET; the segment in boldface shown in the output indicates the state of its being moraic as a result of WP. This is another area where the approach adopted by this study differs from Opalińska (2004: 244), which considers the underlying *feorh* mono-moraic, leaving its surface form mono-moraic, despite the fact that as illustrated in (5) the initial syllable is treated as mono-moraic. The initial syllable of the surface form should be bimoraic in that the first element of the long diphthong receives main stress in OE (Wright and Wright 1925). Furthermore, it is noteworthy that the grammatical output (c) is in accord with *syllable contact law* (Murray and Vennemann 1983; Vennemann 1988) in that it has a falling sonority profile at the syllable boundary. Those in apparent violation of *h*-DROP, such as candidates (a) and (d), prove to be sub-optimal. Candidates (b) and (c) both lack the onset in the ultimate, violating ONSET fatally. Candidate (f), with /x/ deleted, is short one mora for the initial syllable in so far as the mora that belongs to *r* has not been preserved, and accordingly the moraic status of the initial syllable violates MAX-*μ*.

Tableau 1

Input /feorx+es/	*h*-DROP	ONSET	WP	MAX-*μ*	MAX-C
a. feo**rx**.e**s**	*!				
b. feo**r**.e**s**		*!			*
c.☞ fēo.re**s**					*
d. feo.rxe**s**	*!			*	
e. feor.e**s**		*!	*		
f. feo.re**s**				*!	**

This section has confirmed that the standard model of OT is able to account for (1) OECL with relevant constraints in the tableau (cf. Opalińska 2004).

3.2 Resolving the hiatus

This section considers one case of OECL where /x/ deletes between two vowels as observed in (1c) and (14a). The coda *h* in *feoh* and *eoh* contains the element of mora in the surface environment, and thus the loss of such moraic segment leads to CL, accompanied by the removal of the suffixal vowel in the surface environment, as illustrated in (15). This section deals with the question as to why CL in (1c) and (14a) gives rise to the deletion of such a vowel. The genitive singulars *hēas* and *sǣs* in (14b) indicate that OE encompasses the constraint **μμμ* (the prohibition of a trimoraic syllable) (McCarthy 2008) in so far as CL does not result from the genitive suffixation of *-es* to the root, flanking /x/ with the vocalic segments; hence, it can be deduced that the long diphthong is considered bi-moraic (Lass 1983). This accounts for the fact that the genitive singular form *sǣs* has undergone the deletion of the suffixal vowel *-e*, which forms the hiatus with the root monophthongal long vowel, as in **sǣes*.

(14) nom. sing. gen.sing. gloss

a. *eoh* + *es* > *ēos* ‘war-horse’

feoh + *es* > *fēos* ‘money’

flāh + *es* > *flās* ‘fraud’

pleoh + *es* > *plēos* ‘danger’

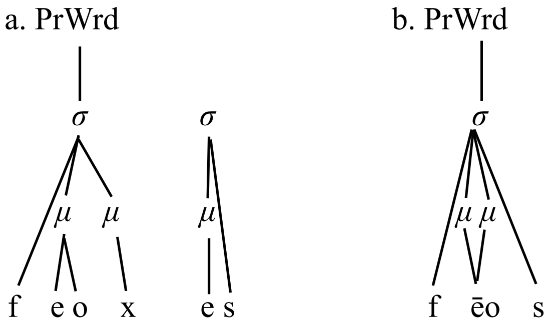
((1c) is repeated)

b. *hēah* > *hēas* ‘high’

sǣ > *sǣs* ‘sea’

(Wright and Wright 1925; Opalińska 2004; Hogg 2011)

(15)



This analysis holds that part of the (13) constraint hierarchy, i.e., *h*-DROP over MAX, sufficiently accounts for OECL when supported by the undominated constraints MAX-V_{ROOT} (Opalińska 2004) and *[V́.V] (cf. St- Amand 2012). The available data shows that the genitive singular form undergoes the medial omission of [x], as well as the deletion of the unstressed vowel in the suffix (Hogg 2012). Opalińska’s (2004) approach overlooks one important fact, namely, that OE tends to resolve the hiatus between the stressed vowel and unstressed vowel by way of loss of the latter. The present study formalizes *[V́.V], which prohibits the hiatus as in (16).

(16) *[V́.V]

A sequence of vowels with a stressed vowel followed by the unstressed vowel is not favored. (cf. St-Amand 2012)

The four-tiered constraint hierarchy suggested by Opalińska (2004: 238) could be reduced to a two-tiered one as shown in (17) (Kobayashi and Skaer 2022). Opalińska (2004: 238) remains incomplete in accounting for *feoh.es* > *fēos* as she concedes that the suggested argument ignores the issues of compensatory lengthening. In this respect, as argued for in (13), the constraint domination of MAX-μ over MAX-C plays a key role in accounting for the preservation of mora in the initial stressed syllable.

(17) MAX-V$_{\text{ROOT}}$, *h*-DROP, *[V́.V], MAX-μ » MAX-C

Tableau 2 shows that *fēos* (gen. sing.) is considered as an optimal candidate under the suggested constraint hierarchy; this outcome shows that the source language perhaps prefers to avoid hiatus, with the suffixal vowel deleted. The output candidates in (b) and (c) containing the phonetic sound which the graph *h* represents fatally violates *h*-DROP. The word-final <s> in candidate (a) represents the extrametricality of the segment in question, but the word-medial [x] in candidate (b) is not extra-metrical and nothing but moraic as stipulated by WP (Hayes 1989). The candidate in (e) violates *[V́.V] in terms of the boundary between the stressed syllable and the ultimate unstressed syllable. Candidate in (d) has the root vowel deleted, resulting in fatal violation of MAX-V$_{\text{ROOT.}}$ Resolving the hiatus requires the vowel in the unstressed syllable be deleted at the expense of MAX-C (following Hogg 2011).

Tableau 2

Input /feox+es/	MAX-V$_{\text{ROOT}}$	*h*-DROP	*[V́.V]	MAX-μ	MAX-C
a. ☞ fēo<s>					**
b. feo**x**.es		*!			
c. fēo.xes		*!			
d. fēs	*!				***
e. fēo.es			*!		*

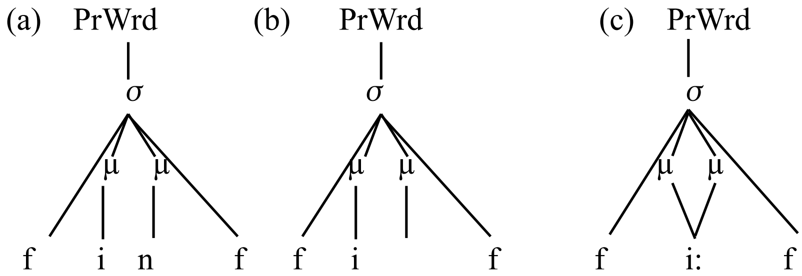
Note importantly that a major part of the constraint hierarchy (13) still arises in Tableau 2. One single constraint argument has to account for all the legitimate forms in the source language (Boersma 2009).

3.3 OECL due to the nasal loss

This section is concerned with characterizing another paradigm as illustrated in (2), where the nasal coda is subject to surface effacement in an ordered sequence of a nasal and a voiceless fricative in OE. It is assumed to have occurred when the OHG words entered into the OE lexicon. Of interest is that OECL due to the loss of /n/ is accounted for by the same logic that shows that the loss of /x/ leads to OECL in OT – that is, why omission of nasal would lead to the lengthening of the preceding vowel is well accounted for (cf. Jones 1989).

To begin with, let us consider the prosodic structure of *finf* > *fi:f* in transition as exemplified in (18). The tree in (18a) represents the mono-syllabic structure of the word in OHG. The coda consonant /f/ in (18a) is considered extrametrical because it sits at the syllable edge (Hayes 1989). It can be argued that when it was loaned into the OE lexicon, the nasal coda somehow failed to hold its position, as in coda in (18b).

(18) Prosodic structure of *finf* > *fi:f* in transition



The surviving moraic node links to the syllable nucleus /i/, which undergoes CL in order to preserve the syllable weight when the moraic nasal deletes in OE (de Chene and Anderson 1979). (18) offers an answer to why the preceding vowel would lengthen, but nonetheless does not provide a rationale behind nasal deletion in the language. In this respect, perception-based phonetics studies by Ohala and Amandar (1981) and Ohala and Busà (1995) experimentally indicate that the hearers are not capable of perceiving a nasal sound in the ordered sequence of a nasal and voiceless fricatives [s, θ, x, f]. Following this line of reasoning, the present study suggests that OE entails some sort of perception-based *cue constraints* (Boersma 2009).

At this point, let us briefly review the role of cue constraints in Boersma's (2009) prelexical perception model as relevant to the present section. They assess the mapping between the auditory form (the input) and the phonological surface form (the output). By doing so, the cue constraints interact with structural constraints, which are also known as markedness constraints in production-based OT (Prince and Smolensky 2004 [1993]). The auditory form consists of widely available continuous sounds often characterized by formants, pitches, noises and durations whereas the phonological surface form is comprised of abstract phonological structure formulated by the language users in a language. Thus, the prelexical perception model creates a phonetics-phonology interface within the decision-making framework of the standard OT model (Boersma 2009).

Resuming our analysis of the OECL, the present work suggests that the cue constraint (19) should interact with other regular constraints in the tableau. As formalized in (19), it prevents listeners from perceiving a nasal when it appears before a voiceless fricative, such as [s], [f], and [θ]. This active cue constraint prevents the listener from recognizing the nasal consonant even if the speaker has enunciated it; thus, */n -VCF/ penalizes any phonological surface form with the nasal consonant appearing before the voiceless fricative.

(19) */n -VCF/

The listener is unable to perceptually detect the nasal which appears before the voiceless fricative. (Ohala and Busà 1995)

It can be posited that one new ranking of WP, MAX-μ and */n -VCF/ (Ohala and Busà 1995) over MAX-C helps account for (2) OECL due to the perceptual inability to detect the nasal consonant in an ordered sequence of a nasal and a voiceless fricative. The fact that OE did not have a voiced fricative /v/ (Hogg 2011) precludes any output candidate containing [v] from being considered in the tableau. What is formalized in (20) is presented as the constraint hierarchy to account for the target phonological phenomenon. The constraint domination of WP and MAX-μ over MAX-C in (13) permeates through this argument, too.

(20) WP, MAX-μ, */n -VCF/ » MAX-C

Let us consider constraint interactions in Tableau 3. Note that the auditory form appears as AudF in the square brackets as compared to a range of phonological surface forms in the slashes, i.e., outputs in each row in the tableau (see Tableau 3). The output (c) straightforwardly meets the stipulation of the undominated constraints; the dominated constraint MAX-C is violated in the least fatal manner due to the loss of the nasal, though. The actuality of OECL due to loss of the nasal in perception would be impossible without the relevant cue constraint.

Let us then consider other candidates with fatal violations of at least one of the high-ranked constraints. The phonological surface forms such as (a) and (e), for instance, violate */n -VCF/ because they contain the perceptually undetectable nasal in the coda. The word-final <f> in (a) indicates the extrametricality of the segment in question (Hayes 1989). The surface form (b) is lacking in the same number of mora as what the auditory form has, resulting in violation of MAX-μ. The surface form (d) only contains one mora in the nucleus vowel inasmuch as the nasal consonant does not fill a timing slot, fatally violating WP.

Tableau 3

AudF: [fin<f>]	WP	MAX-μ	*/n -VCF/	MAX-C
a. /fi**n**<f>/			*!	
b. /fi<f>/	*!	*		*
c. ☞ /fi:<f>/				*
d. /fin<f>/	*!	*	*	

4. Conclusion and summary

Three areas of interest have been investigated within the decision mechanism of OT in this paper. First and foremost, we consider the stressed syllable of *fēores* as bi-moraic at the surface, as opposed to Opalińska's (2004: 244) approach which only sanctions one mora to it. The long diphthong in OE counts as bimoraic (Lass 1983). The constraint hierarchy (13) ensures such a bimoraic status of the grammatical syllable, with the undominated *h*-DROP accounting fully for the phonological behaviors of *h* between two sonorants, and its interactions of the two faithfulness constraints MAX-μ over MAX-C (see Section 2.2). The graphic *h* in (1) OECL is obligatorily dropped not because it is in an onset position as claimed by Opalińska (2004), but because /x/ is flanked by two sonorants (Dresher 1989; Hogg 2011). This being assumed, the constraint hierarchy (13) counter-exemplifies Opalińska (2004), which argues that the standard model of OT is not suitable for accounting for (1) OECL. Another constraint argument (17) demonstrates that the source language is predicted to rule out the hiatus which is accompanied by CL (see Section 3.2); past studies had not addressed accurate constraint interactions accounting for the avoidance of the hiatus in OE. Ultimately, the probable cause of OECL due to loss of nasal has been studied from perception perspectives (following Boersma 2009). In particular, experimentally-proven crosslinguistic findings offered by Ohala and Amadar (1981) and Ohala and Busà (1995) indicate that OE native listeners would not have detected the nasal coda when it appeared before the voiceless fricative, and thus the present paper suggests that OE entails the cue constraint */n -VCF/ for that end; with this cue constraint active as in (20), the standard OT model is capable of accounting for the target phonological event (see Section 3.3). The core ranking of constraints WP, MAX-μ over MAX-C in (13) holds for three OECL cases without an intermediate derivational step between the input and the output in the present study (following Lin 1997).

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