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Title

Phonological Opacity in Pendau: A Local Constraint Conjunction Analysis

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Journal

Proceedings of the Annual Meeting of the Berkeley Linguistics Society, 41(41)

ISSN

2377-1666

Author

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Publication Date

2015

DOI

10.20354/B4414110019

Peer reviewed

PROCEEDINGS OF THE FORTY-FIRST ANNUAL MEETING OF THE
BERKELEY LINGUISTICS SOCIETY

February 7-8, 2015

General Session

Special Session
Fieldwork Methodology

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ISSN: 0363-2946

LCCN: 76-640143

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Acknowledgments

As the Executive Committee of the 41st Annual Meeting of the Berkeley Linguistics Society, we would like to express our gratitude to the conference participants, volunteers, session chairs, faculty, and staff members for their participation. It was your contributions that made the conference a success. We are especially grateful for the patience, hard work, and support of Paula Floro and Belén Flores, without whom BLS 41 would not have been possible. We would also like to thank the following departments and organizations of the University of California, Berkeley for their generous financial support:

Department of Linguistics
Student Opportunity Fund
Graduate Assembly
Department of Philosophy
Department of Psychology
Department of Ethnic Studies
French Department
Department of Spanish and Portuguese
Berkeley Language Center
Office of Academic Affairs Vice President

Foreword

This monograph contains a number of the talks given at the 41st Annual Meeting of the Berkeley Linguistics Society, held in Berkeley, California, February 7-8, 2015. The conference included a General Session and the Special Session *Fieldwork Methodology*. The 41st Annual Meeting was planned and run by the second-year graduate students of the Department of Linguistics at the University of California, Berkeley: Kenny Baclawski, Anna Jurgensen, Spencer Lamoureux, Hannah Sande, and Alison Zerbe.

The original submissions of the papers in this volume were reviewed for style by Anna Jurgensen and Hannah Sande. Resubmitted papers were edited as necessary by Anna Jurgensen and Kenny Baclawski, and then compiled into the final monograph by Anna Jurgensen. The final monograph was reviewed by Spencer Lamoureux. The endeavor was supported by Alison Zerbe's management of the Berkeley Linguistic Society's funds for publications.

The BLS 41 Executive Committee
July 2015

Phonological Opacity in Pendau: a Local Constraint Conjunction Analysis

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1 Introduction

Phonological opacity (Kiparsky 1971, 1973) has been a challenge for Optimality Theory (henceforth, OT) in its original version (Prince & Smolensky 1993, McCarthy & Prince 1993a, b). Kiparsky (1971, 1973) defined phonological opacity as follows:

- (1) Opacity
A phonological rule $P, A \rightarrow B/C_D$ is **opaque** if there are surface structures with any of the following characteristics:
- instances of A in the environment in C_D .
 - instances of B derived by P that occur in environments other than C_D .
 - instances of B not derived by P that occur in environments in C_D .

In rule-based serialism, opacity is accounted for by rule orderings, with the application of a phonological rule R on an intermediate derived representation, rendering the effect of rule P not visible in the surface.

However, classical OT is a parallel theory of phonology. Possible output candidates generated by GEN are evaluated by CON, which has requirement on the identity of input and output forms (via faithfulness constraints) and the well-formedness of the output forms (via markedness constraints). That is, it is the pairing of input-output that is being evaluated, without making reference to intermediate derivations. As a result, while opacity is a direct product of rule ordering in rule-based approach, opacity finds no straightforward explanation in parallel OT.

This paper discusses the issue of opacity in Pendau, an Austronesian language spoken in central Sulawesi, Indonesia. Specifically, I investigate the alternations of NC² sequences observed at prefix-root boundaries. This language exhibits nasal substitution just as many other Austronesian languages do, but there is one specific case where the environment for nasal substitution is met but nasal substitution fails to apply (pattern 1a). I show that there is a synchronic chain shift in Pendau and argue that this is successfully accounted for by an Optimality Theoretic (OT) framework with Local Constraint Conjunction (Smolensky 1993, 1995, 1997).

The paper is organized as follows. Section 2 provides an overview and an analysis of nasal substitution in Pendau. Section 3 analyzes the opacity issue using Local Constraint Conjunction. Section 4 discusses the use of Local Constraint Conjunction in chain shift effect and the restrictiveness of the mechanism. Section 5 concludes the paper.

¹ I am indebted to Profs. Diana Archangeli, Michael Hammond, Andrew Wedel, and Janet Nicol, and all the people in the writing workshop (LING697A) at the University of Arizona as well as those at the 41st Berkeley Linguistics Society Annual Conference for their insightful comments. All errors are my own.

² N stands for nasal and C stands for voiceless obstruent.

2 Nasal substitution in Pendau

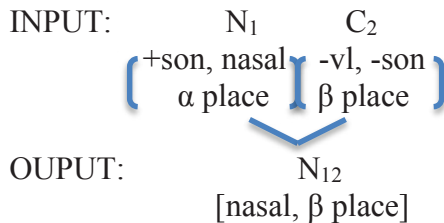
Pendau is an endangered Austronesian language spoken in central Sulawesi, Indonesia, with about 4,000 native speakers (Lewis 2009). Similar to many languages in the Austronesian language family, Pendau also exhibits what is called “nasal substitution”: a voiceless obstruent replaced by a homorganic nasal after prefixation:

(2) Nasal substitution in Pendau³

Root	Gloss	Prefixed with /moŋ-/
pareŋa	‘to check’	momareŋa
ɬuda	‘to plant’	moŋɬuda
keɬik	‘to type’	moŋkeɬik

Although nasal substitution was traditionally analyzed as place assimilation followed by voiceless obstruent deletion, Pater (1996, 2001) analyzed nasal substitution as fusion of the voiceless obstruent and the nasal.

(3) Nasal substitution as fusion of N and C: a two-to-one correspondence



This fusion account is supported by evidence from typology that post-nasal voiceless obstruent deletion accompanies place assimilation, which renders the deletion rule a “false step” (Pater 1996: 25), and the phonology of Indonesian that reduplication copies a nasal formed by coalescence (Cohn and McCarthy 1994). As shown below, Pendau offers another support for this fusion account.

In Pendau, when an consonant-final harmonic prefix is added before a vowel-initial root, there is vowel harmony, whereas when the same harmonic prefix is added before an obstruent-initial root, vowel harmony is blocked, regardless of the voicing feature of the obstruent. In fact, the coda of any consonant-final prefixes is the velar nasal /ŋ/.

(4)	/moŋ-inuŋ/	>	[meŋiŋuŋ]
	/moŋ-uraŋ/	>	[moŋuras]
	/moŋ-pareŋa/	>	[momareŋa]
	/moŋ-baŋa/	>	[mombaŋa]

The blocking of vowel harmony in [mombaŋa] can be due to the coda consonant [m], and such a blocking effect is typologically valid and seen in languages such as Lango (Archangeli and Pulleybank 1994), Yucatec Maya (Krämer 2001) and Assamese (Mahanta 2008). The singleton nasal between the prefix vowel [o] and the root vowel [a] in [momareŋa] also blocks vowel

³ All data presented in this paper is from Quick (2007), the only existing grammar of Pendau.

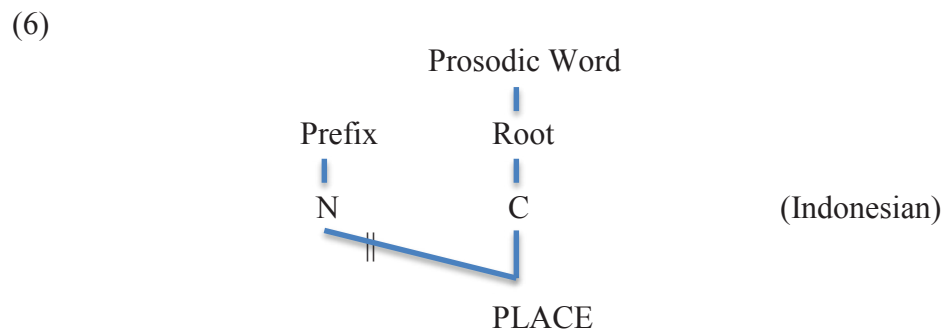
harmony. In this case, it acts like a cluster, just like [mb] in [mombaʃa]. On the contrary, the singleton nasal in [meŋiŋuŋ] and [moŋuras] does not block vowel harmony. The only explanation for this contrast is that the singleton nasal in [momareʃa] is a result of fusion, and this nasal is ambisyllabic in nature⁴. Since it is the coda of the first syllable of [momareʃa], it blocks vowel harmony. Having established this, I will use fusion to account for nasal substitution in Pendau and the substituted nasal will have the following correspondence to its input.



In correspondence-OT, fusion like (5) is violation of the faithfulness constraint Uniformity because of the many-to-one correspondence between input and output.

(6) Uniformity: No element of output has multiple correspondents in input.

This faithfulness constraint is violated in order to satisfy a higher-ranked markedness constraint. Pater (2001) argued that this markedness constraint is CrispEdge[prwd] (Itô & Mester 1999), that no element belonging to a Prosodic Word be linked to a prosodic category external to that Prosodic Word. The prerequisite for CrispEdge[prwd] is the alignment of a Prosodic Word and a root, which is demonstrated by Cohn and McCarthy (1994). The evidence is from the stress pattern in Indonesian that stress is never assigned to prefixes even if prefixation creates a disyllabic foot where the first (left) syllable can normally receive stress. This led Cohn and McCarthy to conclude that prefixes are not in the Prosodic Word domain projected by roots. CrispEdge[prwd] then disallows linkage across the Prosodic Word edge, and as a result, homorganic NC sequences do not surface.



While CrispEdge[prwd] explains the pattern in Indonesian, it faces a problem in Pendau, because the very premise that allows CrispEdge[prwd] to operate, that is, the alignment of a Prosodic Word and a root, is not supported by evidence from Pendau. The stress pattern in Pendau is simple, in the sense that stress only falls on the penultimate syllable and there is no secondary stress (Quick 2007). There is no other independent evidence suggesting that a root is a Prosodic

⁴ The representation of this proposed ambisyllabic consonant is beyond the scope of this paper. Reader is directed to Clements and Keyser (1983) and Borowsky *et al.* (1984) for analyses of the representations of ambisyllabic consonants.

Word and that prefixes are outside a Prosodic Word as in Indonesian. Therefore, instead of extending the application of CrispEdge[prwd] to Pendau, I appeal to *CC, which is more general than CrispEdge[prwd] in that it makes no reference to higher prosodic structure. *CC is also more general than *NC proposed by Pater (1996), as *CC is observed in many other languages and can cope with other NC alternation in Austronesian languages and Bantu languages (see Archangeli *et al.* 1998).

(7) *CC: Sequences of consonants are prohibited.

As a result, I propose the tableau in (9) for nasal substitution in Pendau. The crucial constraints, Uniformity and *CC, are shown here, along with the NasAssim constraint that forces place assimilation.

(8) NasAssim: A nasal must share place feature with its following consonant.

(9)

/moŋ ₁ -p ₂ areʃa/	NasAssim	*CC	Uniformity
a. moŋ ₁ p ₂ areʃa	*	*!	
b. mom ₁ p ₂ areʃa		*!	
☞ c. mom ₁ areʃa			*

The constraint hierarchy for nasal substitution is NasAssim, *CC >> Uniformity⁵. (9a) is the most faithful candidate, but it violates NasAssim and *CC. (9b) is a little bit better than (9a) as it only violates *CC. (9c) is the optimal candidate. Although it violates Uniformity, it is better than both (9a) and (9b), since Uniformity is ranked lower than *CC and NasAssim. Although NasAssim does not seem to be crucial here, as will be seen in the next section, the relative ranking of NasAssim and *CC will become crucial.

3 Underapplication of Nasal Substitution in Pendau

Glottal stop is a phoneme in Pendau and it can be the initial consonant of a word, as shown in (10).

(10) [ʔapi] ‘wing’
 [api] ‘fire’

⁵ When the post-nasal obstruent is voiced, there is no nasal substitution, as seen in the last example in (4). There is only place assimilation but no fusion: /ŋb/ -> [mb]. The constraint hierarchy in (9) will rule out the optimal candidate [mb] because [mb] incurs a violation of *CC. However, as suggested in Pater (2001), a nasal and a voiced obstruent fail to be coalesced because they have incompatible voice feature: while nasals and voiceless stops are not pharyngeally expanded, voiced stops are. In terms of OT, this means that there is a constraint about the voice feature that outranks *CC. This is also beyond the scope of this paper, but for a detailed analysis of the blocking of fusion of a nasal and a voiced obstruent, reader is directed to Pater (2001), Trigo (1991) and Steriade (1995).

When a η -final prefix is added to a ʔ -initial root, a different type of NC alternation takes place (11). This is different from the NC alternation involving the other voiceless obstruents in two ways: 1) place assimilation is progressive with $/\text{ʔ}/$, but regressive with the other voiceless obstruents; 2) there is no fusion of the nasal and the obstruent when the input contains $/\text{ʔ}/$.

(11)

Root	Gloss	Prefixed with $/\text{mo}\eta\text{-}/$
$\text{ʔomu}\eta$	‘to bring’	$\text{mo}\eta\mathbf{k}\text{omu}\eta$
ʔai	‘to call’	$\text{mo}\eta\mathbf{k}\text{ai}$
ʔour	‘to shave’	$\text{mo}\eta\mathbf{k}\text{our}$
ʔaʔar	‘to scratch’	$\text{mo}\eta\mathbf{k}\text{aʔar}$

Regressive assimilation, as seen in $[\text{mom}_{12}\text{are}\text{ʃa}] < / \text{mo}\eta_1\text{-p}_2\text{are}\text{ʃa}/$, suggests that there is a faithfulness constraint requiring the place feature of the root-initial segment be kept in the output. I formulate this constraint as *IdentPlaceOnset*, since the root-initial segment is a syllable onset in the input and its corresponding segment, the substituted nasal, is an onset in the output.

(12) *IdentPlaceOnset*: Output correspondent of an input $[\alpha \text{ place}]$ onset is also $[\alpha \text{ place}]$.

In order for $[\text{momare}\text{ʃa}]$ to be the optimal candidate, *IdentPlaceOnset* needs to outrank *Uniformity*. As seen in (13), (13b) with a substituted $/\eta/$ loses to (13a), because $/\eta/$ does not have the same place feature as $/p/$ in the input. (13c), which is the fully faithful candidate, loses because of either *NasAssim* or **CC*.

(13)

$/\text{mo}\eta_1\text{-p}_2\text{are}\text{ʃa}/$	<i>NasAssim</i>	<i>IdentPlaceOnset</i>	<i>*CC</i>	<i>Uniformity</i>
a. $\text{mom}_{12}\text{are}\text{ʃa}$				*
b. $\text{mo}\eta_{12}\text{are}\text{ʃa}$		*!		*
c. $\text{mo}\eta_1\text{p}_2\text{are}\text{ʃa}$	*!		*	

Unlike nasal substitution, where the place features of the onsets are preserved in the outputs, what is preserved in the output of $/\eta\text{ʔ}/$ is the place feature of the nasal coda, and this is presumably a result of structure preservation (Kiparsky 1985). If there is regressive assimilation in $/\eta\text{ʔ}/$, a placeless nasal surfaces as a result of the glottal stop being placeless. However, nowhere in the grammar of the language is this new segment motivated as an underlying phonological segment. Therefore, for the purpose of structure preservation, assimilation has to be progressive, forcing the glottal stop to change to a velar stop. The critical constraint motivated here is *HavePlace[nasal]* (see Padgett 1995), which penalizes the placeless nasal.

(14) *HavePlace[nasal]*: Every nasal must have some place.

This constraint should outrank *IdentPlaceOnset* in order to produce progressive assimilation. As can be seen in (15), candidate (15c) and (15d) both violate *HavePlace[nasal]*, whereas (15a) and (15b) violate *IdentPlaceOnset*. The grammar now needs to choose between (15a) and (15b).

(15)

/moŋ ₁ -ʔ ₂ ai/	HavePlace[nasal]	IdentPlaceOnset
☞ a. moŋ ₁ k ₂ ai		*
☞ b. moŋ ₁₂ ai		*
c. moN ₁₂ ai	*!	
d. moN ₁ ʔ ₂ ai	*!	

Previously I showed that the output of an input /ŋk/ is a single nasal, and that this is due to the constraint *CC outranking Uniformity. However, the output of /ŋʔ/ is exactly the NC sequence [ŋk]. One might argue that this could be a prenasalized stop [ʔk], but the data from reduplication simply rules out this possibility. The reduplicant-initial onset is [k], but not [ʔk], which indicates that [ŋk] are heterosyllabic.

(16)

Root Input	Prefixed with /moŋ-/	Reduplication Output	Gloss
/ʔomuŋ/	[moŋkomuŋ]	[moŋkomuŋ-komuŋ]	‘carry and carry’

/ŋk/ and /ŋʔ/ alternations, when put together, form what is called a ‘regular shift’ (Lubowicz 2011): /ŋʔ/ → [ŋk], /ŋk/ → [ŋ]. Each mapping is motivated independently, not as a consequence of one another. *CC forces the change from /ŋk/ to [ŋ], but the same constraint does not have an effect on /ŋʔ/. It is blocked by some other high-ranked constraint.

Let’s consider first the constraint violations incurred by the output [ŋ₁₂], shown in (17a). Fusion results in two faithfulness violations, namely, IdentPlaceOnset by the change of place from glottal to velar, and Uniformity by merging two input segments. The non-fusion candidate (17b), on the other hand, violates both IdentPlaceOnset and *CC. If the constraint hierarchy for ŋʔ- alternation is the one in (17), (17a) would be chosen as the optimal candidate. But this is not true in the language. In order for the real output (17b) to win, the ranking of Uniformity should be higher than *CC in ŋʔ-alternation, which is the opposite constraint ranking for nasal substitution. In an OT with strict constraint domination, we have two contradicting constraint rankings for NC effects across the prefix-root boundaries for a single language.

(17)

/moŋ-ʔai/	IdentPlaceOnset	*CC	Uniformity
☞ a. moŋ ₁₂ ai	*		*
☉ b. moŋ ₁ k ₂ ai	*	*!	

Another way of looking at this is that the combined violation of the faithfulness constraints IdentPlaceOnset and Uniformity is more severe, and that makes (17a) less harmonic than (17b). Smolensky (1993, 1995, 1997) propose that this scenario exists, by the interaction of two constraints in a local domain, known as Local Constraint Conjunction (henceforth LCC). The constraint is formulated as follows:

(18) *The Local Conjunction of C₁ and C₂ in domain D:*

C₁&C₂ is violated when there is some D in which both C₁ and C₂ are violated.

The assumption behind LCC is that the simultaneous violations of the constraints conjoined are more fatal than the violation of only one of them.

Now imagine there is a constraint hierarchy where constraint 1 (C1) outranks constraint 2 (C2), which in turns outranks constraint 3 (C3). Candidate 1 (Cand 1) violates C1 and C3, and Candidate 2 (Cand 2) violates C1 and C2. Given this constraint hierarchy, the optimal candidate is Cand 1:

(19)

/INPUT/	C1	C2	C3
☞ Cand 1	*		*
Cand 2	*	*!	

However, if there is a conjoined constraint of C1 and C3, which outranks all other constraints, the optimal candidate is Cand 2. This is because the simultaneous violation of C1 and C3 is more fatal than the violation of C1 and C2.

(20)

/INPUT/	C1&C3	C1	C2	C3
Cand 1	*!	*		*
☞ Cand 2		*	*	

The regular chain shift in Pendau can be obtained by the constraint hierarchy in (20), with C1 being the constraint IdentPlaceOnset, C2 being *CC, and C3 Uniformity. The conjoined constraint is then IdentPlaceOnset & Uniformity. The conjoined constraints are both faithfulness constraints and together they penalize multiple faithfulness violations.

(21) IdentPlaceOnset & UNIF:

IdentPlaceOnset & Uniformity is violated when there is some domain juncture in which both IdentPlaceOnset and Uniformity are violated.

The tableau in (22) incorporates the crucial constraints motivated so far, and in order to account for η̣-alternation, the constraint NasAssim should outrank IdentPlaceOnset and *CC in order to rule out the most faithful candidate (22a). (22b) and (22c) both satisfy IdentPlaceOnset vacuously, and do not have a violation against the conjoined constraints. However, they have a fatal violation of HavePlace[nasal]. (22d) with a substituted [ŋ] violates both IdentPlaceOnset and Uniformity, and thus it violates the conjoined constraint. (22e) is the optimal candidate. It violates IdentPlaceOnset and *CC but does not violate the higher-ranked conjoined constraint. We see from the relative ranking of IdentPlaceOnset & Uniformity and *CC that the conjoined constraint serves to prevent multiple faithfulness violations within which the violation of Uniformity is a direct result of the markedness constraint *CC.

(22)

/moŋ ₁ -ʔ ₂ ai/	HavePlace[nasal] NasAssim	IdentPlaceOnset & Uniformity	IdentPlaceOnset	*CC	Uniformity
a. moŋ ₁ ʔ ₂ ai	*! (NasAssim)			*	
b. moN ₁ ʔ ₂ ai	*! (HacePlace[nasal])			*	
c. moN ₁₂ ai	*! (HacePlace[nasal])				*
d. moŋ ₁₂ ai		*!	*		*
e. moŋ ₁ k ₂ ai			*	*	

This constraint hierarchy also accounts for nasal substitution. Since the optimal candidates never violate IdentPlaceOnset, the conjoined constraint is also vacuously satisfied. I use ŋk-alternation as an example in the following tableau.

(23) Nasal Substitution and Vacuous Satisfaction of the Conjoined Constraint

/moŋ ₁ -k ₂ etik/	HavePlace[nasal] NasAssim	IdentPlaceOnset & Uniformity	IdentPlaceOnset	*CC	Uniformity
a. moŋ ₁₂ etik					*
b. moŋ ₁ k ₂ etik				*!	

By limiting the faithfulness violations of onsets, as seen in (22), the mapping of inputs and outputs is minimized. Although alternation takes place as forced by a markedness constraint, the contrasts of the root onsets are preserved as much as possible and transformed to the contrasts in the output onsets. It can be seen from the following table that while there are contrasts among all of the input NC sequences, there are also contrasts among their outputs. If there is no penalty on multiple faithfulness violations, a substituted [ŋ] will be the output of /ŋʔ/, and contrasts are neutralized as [ŋ] can also be the output of [ŋk].

(24) Contrast in Inputs and Outputs

	Contrastive Inputs	Contrastive Outputs	Neutralized
Nasal Substitution	ŋp ŋʔ ŋk	m ŋ ŋ	
No Nasal substitution	ŋʔ	ŋk	*ŋ

One prediction following this contrast preservation and transformation is that the input onsets are highly recoverable. For example, if a speaker of this language hears a word [moŋetik], s/he will know the root verb must be [ketik]. However, if multiple faithfulness violations are possible in this language, the speaker will have a hard time deciding whether the verb root is

[ketik] or [ɲetik], as the substituted [ɲ] can be the output of either /ɲʔ/ or /ɲk/. Notice that the speaker will not posit the root verb as [ɲetik], either. That is, the speaker will not analyze the word as having a prefix /mo-/, which is also a valid harmonic prefix in Pendau. This is because if the prefix is /mo-/, there should be vowel harmony and the verb should be [meɲetik], which is not what the speaker hears. The above scenario (i.e. highly recoverable onsets) follows from Kaye (1974), that underlying representations could be recovered from the surface representations if the surface representations occur nowhere else. Since the inputs and outputs at the prefix-root boundaries in Pendau have one-to-one correspondence, there is unambiguous inversion between outputs and inputs.

4 Local Constraint Conjunction, Chain Shift, and Restrictiveness

The synchronic chain shift in Pendau (/ɲʔ/ -> [ɲk], /ɲk/ -> [ɲ]) is comparable to the chain shifts found in other languages, for example, Western Basque Hiatus Raising (/a/ -> [e], /e/ -> [i]) and Finnish vowel shift (/aa/ -> [a], /a/ -> [o]), to name a few. Kirchner (1996) proposed that only an enriched theory of faithfulness can account for the chain shift mappings in OT, and the mechanisms used to achieve the enriched theory of faithfulness is LCC. For instance, in Western Basque, a conjoined constraint of two faithfulness constraints outranks both of its component constraints, penalizing multiple faithfulness violations, and a markedness constraint, the satisfaction of which will incur a fatal violation of the conjoined constraints. As a result, while /a/ has an output [e] and /e/ has an output [i], /a/ cannot have an output correspondent [i].

(25) Western Basque Hiatus Raising (adapted from Kawahara 2002)

	Ident[low] & Ident[high]	Raising	Ident[low]	Ident[high]
/alaba-a/				
a. alabaa		**!		
☞ b. alabea		*	*	
c. alabia	*!		*	*
/seme-e/				
a. semee		*!		
☞ b. semie				*

One criticism that LCC receives is that it implies that different constraints can be conjoined and it potentially increases the expressive power of the architecture of OT. Wolf (2007) argued that LCC exhausts the way constraints can interact with each other. Several proposals have been given to promote restrictiveness of LCC (Crowhurst and Hewitt 1997, Fukuzawa and Miglio 1998, Itô and Mester 1998, etc.). For example, Itô and Mester (1998) argued that faithfulness and markedness constraints cannot be conjoined, and similarly, Fukuzawa and Miglio (1998) proposed that only constraints in the same family can be conjoined. The LCC used in accounting for Pendau chain shift and that of Western Basque is indeed restrictive, if we follow the restrictiveness proposals. First, the domain of LCC is restrictive, in that the domain for both constraints to operate is segment. Second, only constraints in the same family are conjoined. In both Pendau and Western Basque, only faithfulness constraints are conjoined, and markedness constraints do not participate in LCC. Moreton and Smolensky (2002) further shows that LCC derives a typology of impossible and possible chain shift. Again,

the LCC used in their proposal is restrictive: same family of constraints (faithfulness in this case) and the same domain (segment) for both constraints. To sum up, the chain shift in Pendau provides additional support for the use of LCC (in its restrictive form) for opacity issues such as the chain shift effect.

5 Conclusion

This paper examines a phonological opacity phenomenon at the prefix-root boundaries in Pendau, namely, the underapplication of nasal substitution. Nasal substitution is a major morpho-phonological process found in Pendau, and similar to languages like Indonesian, nasal substitution in Pendau is the fusion of the nasal and the voiceless obstruent. The blocking of vowel harmony in Pendau provides additional evidence for the fusion account, first proposed by Pater (1996). However, contrary to what Pater (2001) proposed, fusion in Pendau is forced by *CC, which prevents a two-consonant sequence. This constraint, as I have argued, is more general than Pater's (2001) CrispEdge[prwd], and there is no evidence in Pendau suggesting CrispEdge[prwd] is applicable. The underapplication of nasal substitution is accounted for by Local Constraint Conjunction. The conjunction of two faithfulness constraints, namely, IdentPlaceOnset and Uniformity, can successfully explain the chain shift /ŋʔ/ → [ŋk], /ŋk/ → [ŋ]. I have argued that this use of conjunction is restrictive, since the domain for the constraints is the same and only constraints in the same family are conjoined. The effect of this conjoined constraint is to prevent multiple faithfulness violations of the onset segments, and in so doing, the mapping of input onset and output onset is minimized, and the contrasts among inputs are preserved and transformed to outputs. Since neutralization is prevented, it is predicted that input onsets are highly recoverable because there is only one-to-one correspondence between inputs and outputs, and unambiguous inversion is possible in this language.

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