How to generate saltations in a classical Optimality Theory grammar

Charles Reiss *

November 18, 2021

Abstract

Saltations can be generated in a classical OT grammar by using underspecified inputs and MAX and DEP faithfulness constraints.
Keywords: *phonology, feature logic, saltation, Optimality Theory, underspecification*

The solution given by Reiss (2021b) to the problem of generating chain shifts in a 'classic' Optimality Theory grammar, one without constraint conjunction, sympathy or harmonic serialism also provides a correction to another mistaken notion in the literature, the idea that an OT grammar using only mechanisms posited up until about 1995 cannot generate saltations. Like chain shifts, saltations have driven OT practitioners to propose radical enhancements to the framework, most prominently the version proposed by White (2013); Hayes and White (2015) and White (2017) involving the P-Map (Steriade, 2008, 2001) and *MAP constraints (Zuraw, 2007).

The apparent inability of classic OT models to generate saltations was presented in Reiss (1994, 1995, 1996) under the rubric of set theoretically defined 'target-output closeness' as a potential *virtue* of OT, under the assumption that saltations do not exist. The explanation, rediscovered by several phonologists (e.g., Łubowicz, 2002; Ito and Mester, 2003) who have argued fairly convincingly that saltations *do* exist, is repeated in the recent work by Hayes and White. These authors believe that saltations are real phonological processes, and I assume here that they are correct. Perhaps more important than the question of their existence is the fact that all of these authors, including the early papers by Reiss, make a fundamental error by assuming that saltations must be derived from input segments that sometimes surface unchanged. For example, in describing data from Campidanese Sardinian, White (2017, 3) says that "In this language, voiceless stops are realized as voiced fricatives in intervocalic contexts"—he assumes that the segment /p/ must underlie the [p]∼ [β] surface alternation. In other words, in discussion of saltations we have all been misled by an antipathy to positing 'abstract' underlying representations.[1] We will see that by overcoming this unjustifiable bias, at least some saltations can be generated in a classic OT model very straightforwardly.

*Thanks to Björn Köhnlein and David Ta-Chun Shen.

[1] In light of the cogent arguments for underspecified representations provided by Sharon Inkelas' (1994; 1995) early OT work, this error is all the more mystifying.

Reiss (2021b) shows that the surface pattern that characterizes chain shifts can be modeled by positing underlying segments equivalent to the intersection of neighboring segments in the chain. For example, in a *p*-*b*-*β* chain shift, the segment underlying the *p,b* alternation is the intersection of the two, $p \cap b = P$, which is a bilabial stop containing all the valued features common to *p* and *b*, and unspecified for VOICE. Similarly, the segment underlying the *b,β* alternation is $b \cap \beta = B$, a voiced bilabial unspecified for CONTINUANT. Markedness constraints and DEP and MAX constraints for each of the unspecified features allow a classic OT grammar to yield a chain shift in a straightforward fashion.The same simple mechanism of intersection also solves the problem of generating (at least some) saltations.

Consider a simplified version of the Sardinian case discussed by Hayes and White (2015) where some morphemes show [β] intervocalically, but [p] elsewhere. Other morphemes show [b] in both environments. Informally, it looks like the *p* of the first set saltates or 'leaps over' the *b* to become *β*. If we mechanically apply the intersection method mentioned above, we can try to model this alternation by posting a segment ב (Hebrew *beth*, because Reiss 2021b uses P,B,V for other purposes) = $p \cup \beta$, which is a bilabial obstruent unspecified for both VOICE and CONTINUANT. Now, we just need to show that a single constraint ranking can map /ב/ to [p] in some environments X, and /ב/ to [β] in other environments Y, but map /b/ to [b] in both environments X and Y.

Section 5.1 of Hayes and White's paper is entitled *Why saltation cannot be derived in classical Optimality Theory*, so it is clear that they understand this as a logical issue of classical constraint interaction. My goal here is not to provide a complete analysis of every putative saltation those authors discuss, but rather to clarify the conditional validity of the logical claim inherited from earlier scholars. Hayes and White define 'classical' Optimality Theory as "Prince and Smolensky (1993) as modified by the Correspondence Theory of McCarthy and Prince (1995)". Apparently, the logical claim is valid (as realized by the authors cited above) with this stipulative characterization of classical OT. However, it is more interesting to note that other work that was already in circulation in 1995 made saltations possible, but that nobody seems to have realized that. The crucial move is to allow the MAX and DEP faithfulness constraints for individual features proposed by Lombardi (1995/2001) and discussed by (McCarthy, 2011, 200).

The relevant faithfulness constraints are divided into two classes:

(1) MAX and DEP Constraints

- MAX-F constraints penalize deletion of +F or −F for a given feature in the mapping from input to output
- DEP-F constraints penalize insertion of +F or −F for a given feature in the mapping from input to output

In order to ensure that underspecified ב does not surface, I assume an undominated markedness constraint against surface specification, SURFACE-SPEC. Since this constraint is undominated, I leave it out of all the tableaux below. In other words, all outputs are fully specified in the language, so an input with ב must surface with a fully specified bilabial replacing that segment (unless it is deleted completely).

I also assume these markedness constraints:

(2) Markedness constraints

- *VTV: no stops between vowels
- *VSV: no voiceless obstruents between vowels

- Stop-Vless: Stops should be voiceless
- Stop-Onset: Onsets should contain stops

As noted above, I posit ℶ, a bilabial stop unspecified for VOICE and CONTINUANT as the segment underlying the *p/β* alternation. Since ℶ has no specification for VOICE and CONTINUANT, candidates for inputs with ℶ will not incur violations of MAX constraints for those features. On the other hand, DEP constraints are violated when a feature value is 'inserted', when a valued feature that is not present in the input form appears in a candidate. For morphemes with non-alternating [b], I assume fully specified /b/ in the input. Constraint ranking is given in the tableaux below.

Tableaux (3) and (4) show the outcome of a /b/ in initial position in a phonological word, and in intervocalic position, respectively. MAX and DEP constraints are violated by candidates that differ in specification with the underlying /b/. The fully faithful candidate wins in (3)—note that the *VTV and *VSV constraints are irrelevant for differentiating candidates here. In (4), the MAX-CONT violation is fatal to the candidate with [β], and the winning candidate is again maximally faithful.

(3) b →b / # ___

/ba/	MAX-VOICE	MAX-CONT	*VTV	*VSV	DEP-VOICE	DEP-CONT	STOP-ONS	*VOI-STOP
☞ a. ba								*
b. pa	*!				*			
c. βa		*!				*	*	
d. ɸa	*!	*			*	*	*	

(4) b → b / V ___V

/aba/	MAX-VOICE	MAX-CONT	*VTV	*VSV	DEP-VOICE	DEP-CONT	STOP-ONS	*VOI-STOP
☞ a. aba			*					*
b. apa	*!		*	*	*			
c. aβa		*!				*	*	
d. aɸa	*!	*		*	*	*	*	

In (5) the input contains ℶ, and now MAX constraints are irrelevant, because there are no values to delete for VOICE and CONTINUANT. On the other hand, every candidate violates the DEP constraints—each inserted valued feature incurs a violation (and we have left out the forms with surface underspecification that would be eliminated by SURFACE-SPEC). The constraints that favor stops in onsets (over fricatives) and that favor voiceless stops over voiced ones in general, ensure that the winning candidate has [p].

(5) ℶ →p / #___

/ℶa/	MAX-VOICE	MAX-CONT	*VTV	*VSV	DEP-VOICE	DEP-CONT	STOP-ONS	*VOI-STOP
a. ba					*	*		*!
☞ b. pa					*	*		
c. βa					*	*	*!	
d. ɸa					*	*	*!	

When ℶ occurs between vowels, as in (6), the faithfulness constraints still play no role. The candidates with [b] and [p] are excluded by a violation of *VTV, and the candidate with the voiceless fricative is excluded by *VSV. The 'leap' to [β] can surface.

(6) ℶ →β / V ___V

/aℶa/	MAX-VOICE	MAX-CONT	*VTV	*VSV	DEP-VOICE	DEP-CONT	STOP-ONS	*VOI-STOP
a. aba			*!		*	*		*
b. apa			*!	*	*	*		
☞ c. aβa					*	*	*	
d. aɸa				*!	*	*	*	

I have shown how a version of classical OT available by 1995 can indeed generate 'saltations'. Local constraint conjunction, assumed by several authors, and the radical revisions to

OT suggested by Hayes and White and their sources, proposals that build perceptibility considerations into grammar, thus cannot be motivated by the existence of saltations. To model saltations, it is sufficient to accept MAX and DEP constraints, as well as the possibility of underspecified representations in input forms. As argued by Reiss (2012), allowing underspecification *streamlines* a model of UG by removing a stipulation that all segments be specified for all features, so positing underspecified representations is not theoretically 'costly'. Of course, many analyses within OT and other frameworks have used underspecification in exactly the fashion advocated here. In fact, Sharon Inkelas' OT work from the early 1990's, cited in fn. 1, is the primary inspiration for the use of underspecification in this work.

In addition to the demonstration here concerning saltations, Reiss (2021b) has shown that chain shifts also cannot be used to motivate fundamental revisions to classical OT, and arguments for these elaborate mechanisms must be re-examined. It is important to reiterate that the standard characterization of saltations, for example of *p* 'leaping over' *b*, is misleading. We should be reminded to look beneath the surface, since the "relation between a phonemic system and the phonetic record . . . is remote and complex" (Chomsky, 1964, 38). This observation holds whether we are using OT or any other approach to phonological computation that recognizes the complexity of human language.

This discussion and that in Reiss (2021b), like the ideas in the cited OT papers by Inkelas, basically involve expressing an analog of the feature-filling vs. feature-changing rule distinction of derivational phonology. The contrast between presence vs. absence of an underlying specification is also insightfully handled in some of Inkelas' pre-OT work (e.g., Inkelas and Cho, 1993), and continues to be exploited in the contemporary Logical Phonology derivational framework (e.g., Bale et al. 2014; Bale and Reiss 2018; Bale et al. 2020; Reiss 2021a; Leduc et al. Forthcoming; Reiss 2021c). Theory comparison between OT and such derivational approaches can be more fruitful if we understand better the scope and limits of the various models. We now know that the capacity to generate chain shifts and saltations does not distinguish the two.

References

Bale, Alan, Maxime Papillon, and Charles Reiss. 2014. Targeting underspecified segments: A formal analysis of feature changing and feature filling rules. *Lingua* 148:240–253.

Bale, Alan, and Charles Reiss. 2018. *Phonology: A formal introduction*. Cambridge, MA: MIT Press.

Bale, Alan, Charles Reiss, and David Ta-Chun Shen. 2020. Sets, rules and natural classes: { } *vs.* [ ]. *Loquens* 6.

Chomsky, Noam. 1964. Formal discussion in response to W. Miller and S. Ervin. In *The Acquisition of Language*, ed. Ursula Bellugi and Roger Brown, 35–39. Chicago: University of Chicago Press.

Hayes, Bruce, and James White. 2015. Saltation and the P-map. *Phonology* 32:267–302.

Inkelas, Sharon. 1994. The consequences of optimization for underspecification. Ms, Department of Linguistics, UC-Berkeley (ROA 40-1294).

Inkelas, Sharon, and Young-mee Yu Cho. 1993. Inalterability as prespecification. *Language* 69:529–574.

Inkelas, Sharon, and Cemil Orhan Orgun. 1995. Level ordering and economy in the lexical phonology of Turkish. *Language* 71:763–793.

Ito, Junko, and Armin Mester. 2003. On the sources of opacity in ot: Coda processes in german. In *The syllable in optimality theory*, ed. C. Féry and R. van de Vijver, 271–303. Cambridge University Press Cambridge.

Leduc, Marjorie, Charles Reiss, and Veno Volenec. Forthcoming. Votic vowel harmony in Substance Free Logical Phonology. In *Oxford Handbook of vowel harmony*. Oxford: Oxford University Press.

Lombardi, Linda. 1995/2001. Why place and voice are different: Constraint-specific alternations in optimality theory. In *Segmental phonology in optimality theory: Constraints and representations*, ed. Linda Lombardi, 13–45. Cambridge: Cambridge University Press. First circulated in 1995. Available on Rutgers Optimality Archive, ROA-105.

Łubowicz, Anna. 2002. Derived environment effects in optimality theory. *Lingua* 112:243–280.

McCarthy, John, and Alan Prince. 1995. Faithfulness and reduplicative identity. In *University of massachusetts occasional papers in linguistics, vol. 18*, ed. Jill Beckman, Laura Walsh Dickey, and Suzanne Urbancyk, 249–384. Amhert, MA: GLSA, University of Massachusetts at Amherst.

McCarthy, John J. 2011. *Doing optimality theory: Applying theory to data*. John Wiley & Sons.

Prince, Alan, and Paul Smolensky. 1993. *Optimality Theory: Constraint interaction in generative grammar (technical report)*. New Brunswick, NJ: Rutgers Center for Cognitive Science.

Reiss, Charles. 1994. Deriving a phonological universal from optimality theory. *Harvard Working Papers in Linguistics* 4:220.

Reiss, Charles. 1995. Stepwise assimilation and optimality theory. Talk at the Tilburg conference on the derivational residue in phonology.

Reiss, Charles. 1996. Deriving an implicational universal in a constrained OT grammar. In *Proceedings of the northeast linguistics society*, ed. Kiyomi Kusumoto, 303–317. Amherst, MA: UMass Graduate Linguistics Association.

Reiss, Charles. 2012. Towards a bottom-up approach to phonological typology. In *Towards a biolinguistic understanding of grammar: essays on interfaces*, ed. Anna Maria Di Sciullo, 169–191. John Benjamins Publishing.

Reiss, Charles. 2021a. Priority union and feature logic in phonology. *Linguistic Inquiry* .

Reiss, Charles. 2021b. Solving optimality theory's chain shift problem. *Submitted* .

Reiss, Charles. 2021c. Towards a complete Logical Phonology model of intrasegmental changes. *Glossa* 6:107.

Steriade, Donca. 2001. Directional asymmetries in place assimilation: A perceptual account. In *The role of speech perception in phonology*, ed. Elizabeth Hume and Keith Johnson, 219–250. San Diego: Academic Press.

Steriade, Donca. 2008. The phonology of perceptibility effects: the p-map and its consequences for constraint organization. In *The nature of the word: Studies in honor of Paul Kiparsky*, ed. K. Hanson and Sharon Inkelas, 151–180. MIT press.

White, James. 2017. Accounting for the learnability of saltation in phonological theory: A maximum entropy model with a p-map bias. *Language* 93:1–36.

White, James Clifford. 2013. Bias in phonological learning: Evidence from saltation. Doctoral Dissertation, UCLA.

Zuraw, Kie. 2007. The role of phonetic knowledge in phonological patterning: corpus and survey evidence from tagalog infixation. *Language* 277–316.