Underlying representation in geminates: from an OT perspective*

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Hong, Sung-Hoon, and Chang-Kook Suh. 2004. Underlying representation in Geminates: from an OT perspective. *Studies in Phonetics, Phonology and Morphology*. 10.1. 129–144. This research has examined the status of Underlying Representation (UR) in Optimality Theory focusing on the representation of consonant geminates. For this purpose, we have examined geminate/singleton alternation in Ponapean employing Lexicon Optimization (LO), an algorithm proposed to select a UR among multiple inputs. We have seen that simple application of LO is problematic in singling out a UR for the case of alternation. This leads us to the version of LO that is performed on the paradigms, rather than on an individual forms (Tesar and Smolensky 1996, 2000, Inkelas 1995, 1998). After a thorough implementation of LO, we have found that the URs are simply identical to the input forms; geminate UR for the alternating case and singleton UR for the nonalternating case. Further, it was shown that a unique underlying representation of geminates, regardless of their positions in which they occur, can account for the exceptional geminate behaviors. **(Hansung University and Cheonan University)**

Keywords: geminates, Underlying Representation, Lexicon Optimization, Richness of the base

1. Introduction

The purpose of this paper is to investigate the status of Underlying Representation (UR) in Optimality Theory (OT) focusing on the representation of geminate consonants. For this purpose, we will evaluate some of the proposed theories of Lexicon Optimization (LO), and by considering some consequences of Richness of the Base and Lexicon Optimization, we will argue that URs for geminates are different from those for singletons as has been suggested in the previous rule-based approaches.

As our empirical evidence, we will look at geminates in Ponapean, where the word-initial geminates behave differently from the geminates in other positions. That is, geminates in word-initial position become singletons on the surface; in word-medial and word-final positions, however, geminates do not become singletons.

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In this paper, we suggest that the different representations of geminates according to their positions are not necessary in our constraints-based approach of OT, but a unique underlying representation of geminates, regardless of their positions in which they occur, can account for the exceptional behaviors of word-initial geminates. This implies that constraints and their interaction play a more important role than UR in OT, which is an advantage over previous rule-based approaches which assume different URs for the initial geminates (Hume *et al.* 1997, Davis 1999).

This paper is laid out as follows. Section two provides a general survey of UR in theories of phonology. This section will mainly confirm the need for UR in general, and in OT. Here we will also try to clarify the difference between input and UR with respect to Richness of the Base and Lexicon Optimization.

Section three turns to the detailed focus on UR of geminates since formal representation is considered important to distinguish singletons from geminates, both in rule-based theories and OT (McCarthy and Prince 1986, Hayes 1989, Suh 1997).

Section four is an exemplification of our analysis of geminates in different positions of a word: initial, medial and final. We provide a sample Optimality Theoretic analysis of the initial, medial and final geminates in Ponapean, including the relevant constraints, ranking, and tableaux for relevant input forms. We will also consider the case of geminate/singleton alternation in Ponapean in connection with LO.

Finally, section five summarizes the paper and provides theoretical and empirical implications of our approach to the proper underlying representation of geminates.

2. Backgrounds: the "Base" of OT

One of the fundamental assumption of OT is that the input component is not constrained and all inputs are possible for deducing the possible outputs of a grammar (Prince and Smolensky 1993: 191). Such an assumption is formulated into the now well-known Richness of the Base (ROB).

(1) Richness of the Base (ROB):
"The set of possible inputs to the grammar of all languages is the same. The grammatical inventories of languages are defined as the forms appearing in the structural descriptions that emerge from the grammar when it is fed the universal set of all possible inputs." (Tesar and Smolensky 1998: 252)

The major goal of ROB is to attribute all systematic cross-linguistic variation entirely to constraint ranking (Prince and Smolensky 1993, Smolensky 1996, Tesar and Smolensky 1996, 1998, 2000). When cast into an actual analysis, this means that a correct output is guaranteed without hinging on any particular input, if provided with proper constraint ranking.

It was noted, however, that ROB may pose a serious computation problem on learnability. Since any input can be posited for a given output, learning a grammar, whose basic function is to map an input to an output, may become a burden on the part of a learner. The basic stance of OT on this issue is to "distinguish possible inputs, which are drawn from the universal pool of possible linguistic structures, from the URs of the morphemes of a particular language (Benua 1997: 14)," and to posit that the input space is infinite (thus unrestricted) but the lexicon is finite.[2]

The important claim in this regard is that a learner's construction of lexical representation or UR is guided by LO. The basic function of LO is to track down the 'optimal' inputs ('optimal' in terms of learnability) among the potential inputs, given proper constraint ranking (Prince and Smolensky 1993, Inkelas 1995, Itô *et al*. 1995, Tesar and Smolensky 2000).

(2) Lexicon Optimization

> "Suppose that several different inputs $I_1, I_2, ..., I_n$, when parsed by a grammar G lead to corresponding outputs $O_1, O_2, ..., O_n$, all of which are realized as the same phonetic form Φ--these inputs are all *phonetically equivalent* with respect to G. Now one of these outputs must be the most harmonic, by virtue of incurring the least significant violation marks: suppose this optimal one is labelled O_k. Then the learner should choose, as the underlying form for Φ, the input I_k." (Prince and Smolensky 1993: 192)

In plain terms, this means that of several potential inputs whose outputs all converge on the same phonetic form, the particular UR is chosen whose mapping to phonetic form incurs the fewest violations of highly

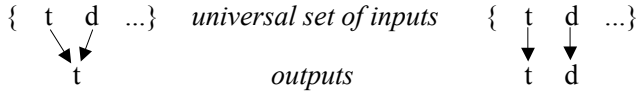
[2] The basic view of UR in OT is inherited from the traditional generative grammar. It's the view of UR that is evident from the following quotation: "Orthodox generative phonology is mentalist, in that it implies mental storage of underlying representations... Chomsky and Halle speak of 'mental construction' by speaker and hearer (1968: 14). And in connection with access to underlying representation in the process of reading aloud and with the development of such representation in children's acquisition of language, they refer to the 'fundamental importance of the question of psychological reality of linguistic constructs' (1968: 49-50) ... The ... underlying level ... corresponded to the speaker's storage of phonological representations..." (Clark and Yallop 1995: 156)

ranked grammatical constraints.

One important point of notice is that LO shows a discernible effect only when multiple inputs converge on a single phonetic form. In other words, LO is significant only in the cases where contrasts are neutralized, i.e. where markedness dominates faithfulness. In the cases where faithfulness outranks markedness (thus, underlying contrasts are expressed at surface), each input maps to its own output and the role of LO is trivial. Here, URs are simply determined to be the forms identical to their respective output forms.

To illustrate this point, let us compare the cases where underlying voice contrasts are neutralized at surface and those where underlying voice contrasts are expressed at surface.

(3)



In a standard OT account, these systems would be made distinct via different constraint ranking. In the first case (neutralized voice contrast), a markedness constraint such as Obs/*Voice (obstruents must be voiceless) outranks a faithfulness constraint, Ident-IO(voice). By contrast, faithfulness dominates markedness in the second case, where underlying voice contrast is expressed at surface.

The constraint tableaux for each system are given below. In accordance with ROB, the possibilities of inputs being /t/ and /d/ are both considered.

(4) a. voice contrast neutralized

Input: /t/	Obs/*Voice	Ident(voice)
☞ t		
d	*!	*

b. voice contrast expressed

Input: /t/	Ident(voice)	Obs/*Voice
☞ t		
d	*!	*

Input: /d/	Obs/*Voice	Ident(voice)
☞ t		*
d	*!	

Input: /d/	Ident(voice)	Obs/*Voice
t	*!	
☞ d		*

LO is significant in (4a), where different inputs converge on a single output form, [t]. Here, LO chooses /t/ as the UR since the mapping from this form to [t] is more harmonic than the mapping from /d/ to [t]. This harmonic evaluation is shown on the "tableau des tableaux", adopted by Itô *et al* (1995).

(5) Tableau des tableaux for LO (4a)

Inputs	Outputs	Obs/*Voice	Ident(voice)
☞ /t/	[t]		
/d/	[t]		*!

LO for (4b), however, is trivial since each input maps to its own output. In this case, URs are identical to output forms.

The important consequence of LO is then those input forms which are most faithful to the outputs are stored in the lexicon as the URs, both in the cases of neutralized and expressed contrasts. In the above illustration of neutralized contrast, /t/, which is more faithful to the output, is selected as UR; and in the case of expressed contrast, the input form that is identical to each output is simply chosen as UR.

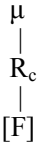
3. UR in Geminates

To account for the special behaviors of consonant geminates, attention has focused on representational properties that distinguish geminates from singletons. This suggests that proper phonological representation of geminates plays an extremely important role in capturing those phenomena known as geminate *integrity* and *inalterability*.[3] This seems to be true even in OT, but interaction of the constraints plays a more crucial role in OT as can be seen later in the discussion of Ponapean initial geminates.

In this paper, the representation of geminates in the lexicon follows that of McCarthy and Prince (1986) and Hayes (1989) in that a geminate is represented in the lexicon as *a simple consonant with a mora* (cf. Suh 1997). Thus, according to this assumption, geminates versus singletons are represented as underlying moraic versus nonmoraic, respectively, as shown in (6):

(6) Underlying Representation

a. Geminate Consonant

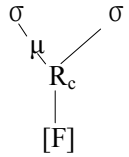


b. Singleton Consonant

[3] The reader is referred to Suh (1997) for a detailed analysis of geminate *integrity* and *inalterability* within the framework of Optimality Theory.

In the case of consonant geminate, there is only one root node preassociated to a mora, as in (6a). On the surface, however, underlying moraic C gets additional prosodic structure (i.e. double-linking) through syllabification as shown in (7) (Suh 1997).

(7) Surface Representation of Geminates



In addition to that, the underlying representation of geminates has also been proven to be quite effective in explaining compensatory lengthening (Hayes 1989) and reduplication phenomena (McCarthy and Prince 1986).

With this theoretical background, we now turn to the Optimality Theoretic analysis of Ponapean geminates, which behave differently according to the positions in which they occur.

4. What does LO say about UR in geminates?

4.1 Distribution of Geminates in Ponapean

In Ponapean, there is a notable generalization regarding the distribution of geminates on the surface as shown in (8) (Rehg and Sohl 1979, McCarthy and Prince 1986, Itô 1989, Levin 1989, Suh 1997).

(8) Distribution of Geminates in Ponapean

a. Initial position: no geminates (only singletons on the surface: CVC, *CCVC)
   - [was] ‘obnoxious’
   - [ŋar] ‘see’
   - [met] ‘full’

b. Medial position: both geminates and singletons (CVCV and CVCCV)
   - [arawella] ‘to return to the wild’
   - [kemmad] ‘to change into dry clothing’
   - [urenna] ‘lobster’

c. Final position: both geminates and singletons (CVC and CVCC)
   - [kull] ‘roach’
   - [rom^{w}m^{w}] ‘calm’
   - [ŋar] ‘see’

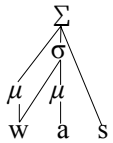
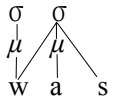
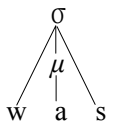
For an OT account, the following four key constraints are proposed. Specifically, PROSHIER will play an important role in the analysis of Ponapean initial geminates.

(9) Proposed Constraints for Ponapean (Suh 1997)

a. PEAK: Every syllable has a vowel (Archangeli 1997)
b. PROSHIER: All instances of a prosodic category must be dominated by an immediately higher prosodic category, if there is any (cf. Selkirk 1984)
c. DEP-IO(μ): Every segment/mora of the output has a correspondent in the input (cf. McCarthy and Prince 1993, 1995; Prince and Smolensky 1993)
d. MAX-IO(μ): Every segment/mora of the input has a correspondent in the output (cf. McCarthy and Prince 1993, 1995; Prince and Smolensky 1993)

Based on these constraints, we will look at an analysis deriving degemination of geminates in word-initial position.

(10) Initial position: [was] 'obnoxious'

	μ μ | | /w a s/	PEAK	PROSHIER	DEP-IO(μ)	MAX-IO(μ)
a.	 [wwas]		*!		
b.	 [wwas]	*!			
c. ☞	 [was]				*

Candidate (a) is first eliminated due to the fatal violation of the constraint PROSHIER. Here, PROSHIER violation is incurred because the prosodic category mora (*μ*) is directly dominated by the prosodic

category foot (Σ), not by the syllable node (σ). Candidate (b) is also eliminated by the crucial violation of PEAK. The reason is that the first syllable does not have a vowel. Accordingly, candidate (c) is chosen as the optimal output since it violates only lowest ranked MAX-IO(μ). In this way, we have singleton consonants in word-initial position on the surface in Ponapean.[4]

Now, let us turn to medial and final positions, in which the contrast between geminates and singletons is maintained.

(11) Medial position: [urenna] 'lobster'[5]

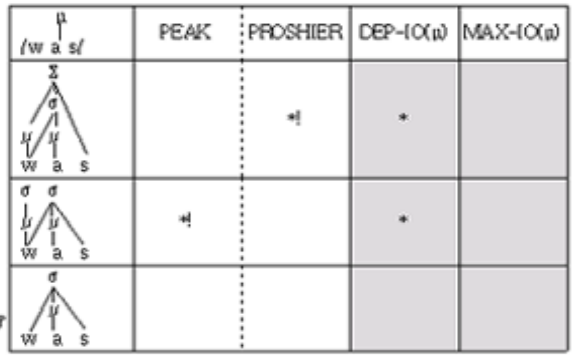
	/urenna/	PROSHIER	DEP-IO(μ)	MAX-IO(μ)
☞	a. urenna			
	b. urena			*!

In (11), candidate (b) shows that degemination of geminate consonants in word-internal position causes MAX-IO(μ). On the other hand, candidate (a) which is faithful to the input form will be considered as the optimal output form. It is important to note that in medial position PROSHIER violation is not incurred because geminates can be syllabified both onset and coda of the syllables at the same time.

(12) Final position: [kull] 'roach'

	/kull/	PROSHIER	DEP-IO(μ)	MAX-IO(μ)
☞	a. kull			
	b. kul			*!

[4] Note that the initial singleton consonants are also guaranteed if the other input (i.e. the singleton input) is assumed, confirming ROB.



[5] For space limitation, PEAK will not be considered and only segmental representation (not moraic representation) will be shown hereafter.

Candidate (b) is eliminated by crucially violating MAX-IO(μ) by degemination of the geminate consonants. On the other hand, candidate (a) does not violate any constraint. Thus, word-final geminate (a) is produced as the optimal output form.

Summarizing thus far, we have observed that in Ponapean, geminates are neutralized in word-initial position due to the strong effect of PROSHIER. As a result, degemination occurs as the best option. On the other hand, in medial and final positions, geminates occur on the surface. Accordingly, contrast between geminates and singletons can be expressed. The reason is that in these positions PROSHIER is not effective at all. Geminates can be syllabified properly without violating the PROSHIER constraint in those positions.

According to our approach to the geminates, we do not need to posit different URs for the geminates as the rule-based approaches have done to deal with exceptional behaviors of initial geminates (cf. Hume et al. 1997, Davis 1999). We have illustrated that a unique UR of geminates, regardless of the languages and their positions in which they occur, can account for the exceptional behavior of word-initial geminates through the universal phonological constraints and their interactions, which is an advantage over previous rule-based approaches.

4.2 Geminate/singleton alternation and LO in Ponapean

We have discussed above the distribution of Ponapean geminates in relation to their URs. In this section, we focus on the alternation between geminates and singleton consonants and examine how it bears on the issue of URs in geminates.

In Ponapean, there is alternation between word-medial geminates and word-initial singleton consonants (Rehg and Sohl 1979, Levin 1989, Suh 1997). As seen below, singleton consonants appear in word-initial position, but when they occur in word-medial position by morphological operation, geminate consonants occur instead.

(13) Alternations between geminates and singleton consonants

causative (medial)	stem (initial)	gloss
[ka-mmet]	[met]	‘full’
[ka-ŋŋet]	[ŋet]	‘pant’
[ka-m^{w}m^{w}us]	[m^{w}us]	‘vomit’

If we apply LO to determine UR here, we find that LO encounters a potential problem: the URs chosen by LO are most faithful to their output forms as discussed in section 2; thus, when it deals with an allomorphy

case such as Ponapean geminate/singleton alternation, there arises a situation where words in morphologically related paradigm do not share the same UR, contra the standard view of UR. The morpheme for 'full', for example, is represented as /met/ word-initially, but as /-mmet/ word-medially.

(14) URs determined by LO

causative (medial)	stem (initial)	gloss
/ka-mmet/	/met/	'full'
/ka-ŋŋet/	/ŋet/	'pant'
/ka-$m^w m^w$us/	/m^wus/	'vomit'

To properly deal with this situation, Prince and Smolensky (1993: 194) suggested 'global' optimization, instead of usual form-by-form optimization.

(15) "The deficiency in the formulation ... of Lexicon Optimization is that it attempts a form-by-form optimization, without taking into consideration, for example, the optimization (minimization) of the number of allomorphs associated with an affix .... It seems clear that Lexicon Optimization must reformulated so that, instead of form-by-form optimization, a more global optimization of the lexicon is achieved, in which more deep/surface disparities are accepted in order to minimize the constraints on allowed morphological combination ..."

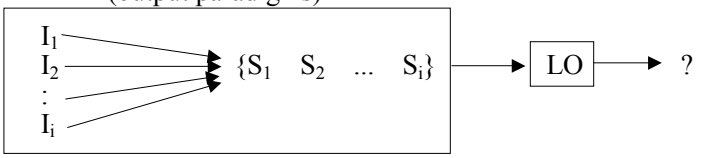
Such global optimization is formulated as Paradigm-level LO by Tesar and Smolensky (1996, 2000), by which optimization does not apply to individual forms but to the entire paradigm. As noted by Tesar and Smolensky (2000: 131, footnote 3), this form of optimization is essentially equivalent to Alternation-sensitive LO proposed by Inkelas (1995, 1998), defined as follows.

(16) Alternation-sensitive Lexicon Optimization (Inkelas 1995: 289)
"Given a set of $S=\{S_1, S_2, ..., S_i\}$ of surface phonetic forms for a morpheme M, suppose that there is a set of inputs $I=\{I_1, I_2, ..., I_i\}$, each of whose members has a set of surface realizations equivalent to S. There is some $I_i \in I$ such that the mapping between I_i and the members of S is the most harmonic, i.e. incurring the fewest marks in grammar for the highest ranked constraints. The learner should choose I_i as the underlying representation for M."

According to this version of LO, mapping to the entire allomorphy

paradigm, rather than to a single output form, is fundamental to the computation of a UR. Further, it is crucial to this version of LO that multiple inputs *converge* on an alternation paradigm. The following diagrams, which schematizes (16), demonstrates that LO performs on the entire paradigm, rather than on individual surface forms, only when inputs converge on an output paradigm.

(17) Inputs Surface phonetic forms (output paradigms) UR



Tesar and Smolensky (1996: 43, 2000: 80) show how their Paradigm-level LO works, centering on the data of German syllable-final devoicing, *tak* 'day' and *tag+ə* 'days'. The 'paradigm' tableau for German syllable-final devoicing that they present is shown below.

(18) Paradigm-level LO for German syllable-final devoicing[6]

	Inputs	Outputs	IDENT-ONS (voice)	*VOICE	IDENT-IO (voice)	IDENT-OO (voice)
☞	/tag +	ø / ə →	[tak] [ta.g-ə]	*	*	*
	/tak +	ø / ə →	[tak] [ta.g-ə]	*!	*	*

Here, LO compares two mapping relations (one from the input /tag/ and the other from /tak/) on the assumption that they converge on the output paradigm [tak] [tag-ə].

If we assume that Paradigm-level LO applies to the Ponapean geminate/singleton alternation in a similar fashion, we would get the following 'paradigm' tableau, which suggests that geminate is the UR for geminate/singleton alternation.

[6] The constraints adopted in this tableau are those proposed by Lombardi (1995, 1999). What the constraints, *VOICE, IDENT-IO(voice), and IDENT-OO(voice), do is self-evident: *VOICE disallows the specification of [voice], while IDENT-IO (voice) and IDENT-OO(voice) ensure faithful [voice] between input and output, and between output forms, respectively. IDENT-ONS(voice), a constraint of positional faithfulness, demands that consonants in the syllable onset position be faithful to underlying [voice] specification.

(19) Paradigm-level LO for Ponapean geminates

	Inputs		Outputs	PROSHIER	DEP-IO(μ)	MAX-IO(μ)
☞	/ ø / ka + mmet/	→	[met] [ka-mmet]			*
	/ ø / ka + met/	→	[met] [ka-mmet]		*!	

Close examination, however, shows that Paradigm-level LO cannot apply as in (19). As seen below, the inputs /mmet/ and /met/, do not converge on the output paradigm, but each input maps to the different output paradigms, [mmet] [ka-mmet] and [met] [ka-met], respectively.[7]

(20) a. Input: /mmet/

	/ ø / ka + mmet/	PROSHIER	DEP-IO(μ)	MAX-IO(μ)
☞	[met] [ka-mmet]			*
	[mmet] [ka-mmet]	*!		
	[mmet] [ka-met]	*!		*
	[met] [ka-met]			*!

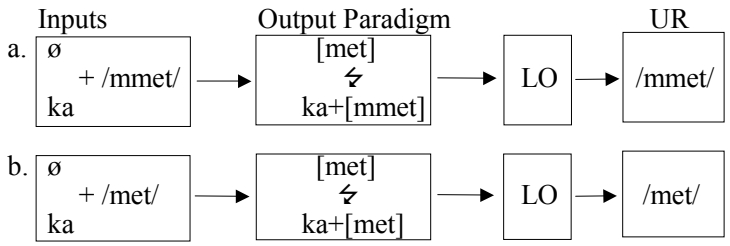
b. Input: /met/

	/ ø / ka + met/	PROSHIER	DEP-IO(μ)	MAX-IO(μ)
	[met] [ka-mmet]		*!	
	[mmet] [ka-mmet]	*!	*	
	[mmet] [ka-met]	*!	*	
☞	[met] [ka-met]			

Since the inputs here are related to different output paradigms, the application of LO is trivial and the URs are simply identical to the input forms, as diagrammed below.

[7] Although we do not show in detail for space limitation, a similar conclusion was drawn regarding German syllable-final devoicing. See Hong (2001) for details.

(21)



What this suggests for the Ponapean case is that geminate URs are selected when alternation is observed as [met] [ka-mmet], but that singleton URs are apparent when there is no alternation and only singleton consonants appear.

To summarize so far, we have seen that simple application of LO is problematic in the case of alternation, since it posits different URs for a single morpheme. To effectively deal with the alternation cases, Tesar and Smolensky (1996, 2000) and Inkelas (1995, 1998) propose that LO be performed on the paradigms, rather than on an individual forms. Whether LO is defined on paradigms or individual forms, the prerequisite for LO to exhibit a meaningful effect is that multiple inputs must converge on the same output. In the Ponapean geminate/singleton alternation, however, multiple inputs map to different output paradigms: the geminate input maps to the alternating paradigm, and the singleton input to the nonalternating case. In this parallel mapping, the URs are simply identical to the input forms; geminate UR for the alternating case and singleton UR for nonalternating case.

Note that this conclusion is not new. It is entirely in accordance with Alternation Condition proposed by Kiparsky (1968, 1973) in the traditional generative framework. Alternation Condition posits that UR is deviant from the surface form only if there is alternation involved; if there is no alternation, UR is identical to the surface form.

5. Conclusion

In this paper, we have investigated the issue of UR of geminates in OT through the analysis of Ponapean geminate data. We have shown that URs for geminates are different from those for singletons, assuming that geminates are uniformly represented in the lexicon as a simple consonant with a mora.

To account for the exceptional behavior of initial geminates, Hume et al. (1997) provide evidence for the non-moraicity of initial geminates in Leti, while Davis (1999) presents evidence showing that initial geminates

are underlyingly moraic in such languages as Trukese. According to them, geminates are represented differently according to the languages and their positions in which they occur. This line of explanation clearly lacks generalization in accounting for the same structure of consonant geminates of the world languages. The current analysis, however, can be extended to account for the above problematic cases regarding the proper representation of geminates. The different representations of word-initial geminates in Leti and Trukese are not necessary in our constraints-based approach of OT, but a unique underlying representation of geminates, regardless of the languages and their positions in which they occur, will be able to account for the exceptional behaviors of word-initial geminates. This implies that constraints and their interaction play a more important role than UR in OT, which is an advantage over previous rule-based approaches.

Finally, we have examined Ponapean geminate/singleton alternation case employing LO. We have seen that simple application of LO is problematic in the case of alternation, since it posits different URs for a single morpheme. So we have tested against the proposals of Tesar and Smolensky (1996, 2000) and Inkelas (1995, 1998) which argue that LO be performed on the paradigms, rather than on an individual forms. Through this parallel mapping, we have found that the URs are simply identical to the input forms; geminate UR for the alternating case and singleton UR for the nonalternating case.

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