Reduplication and Tone Interaction in Fongbe

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University of Delaware, March 17, 2000

- The purpose of this poster is to present an analysis of Fongbe, a member of the Kwa language family spoken in Benin and Togo, within Optimaity Theory (Prince and Smolensky 1993, McCarthy and Prince 1995).
- The OT analysis that is developed here has two major implications:
  (1) *Richness of the Base* and *Lexicon Optimization* place contradictory demands on OT grammars.
  (2) The language wide inventory of tonal patterns can not be defined without considering the tonal patterns in reduplicated forms. This affects the typological claims made by Alderete et al 1999.

1.0 Tonal patterns on roots in Fongbe

- Fongbe demonstrates properties of tone being affected by preceding consonants (see Bradshaw 1999 for an in depth discussion of this phenomenon).
- Every vowel in Fongbe has one of four tonal patterns associated with it: low (à), high (á), low-high (rising, ǎ), or high-low (falling, â).
- The falling (HL) pattern is dervied from a rule of the phrasal phonology in Fongbe that spreads high tones rightward (Brousseau 1991). This process and tonal pattern will be ignored for the purposes of this poster.
- The distribution of the remaining three tonal patterns interacts with the viocing system to restrict the appearance of some tones. This distribution is presented in (1).

(1) Distribution of root tonal patterns in Fongbe (Brousseau 1991, Gormley 1999)

	voiced consonant	voiceless consonant	sonorant
high	*bá	pá	*má
low	bà	pà	mà
rising	bǎ	*pǎ	mǎ

- With this distribution of tonal patterns we can now develop an OT analysis.

2.0 An OT analysis of Fongbe—language wide inventory

- "A major claim of Optimality Theory is that lexical contrast, and the lack of lexical contrast, are both derivable from surface constraints. ...allowing all possible inputs to be considered (*Richness of the Base*). (Keer 1999:28)
- The analysis that will be developed here will respect *Richness of the Base* and use the following universal constraints.

(2) Language Universal Constraints

*TONELESS	(*TLESS) All TBUs (moras) must have a tone {H,L} associated.
*COMPLEXTONE	(*CPX) Only a single tone is associated with a TBU.
DEP TONE	(DEP) Every tone associated with the root in the output has a corresponding tone in the input.
MAXTONE	(MAX) Every tone associated with the root in the input has a corresponding tone in the output.
*HIGH	(*H) No high tones.
*LOW	(*L) No low tones.

- Constraints that will describe the consonant/tone interaction in Fongbe are presented in (3).

(3) Tone/consonant interaction constraints

*[+voiced] H	(*+H) No voiced segment-high tone sequences. (Analogous to DEPRESSOR constraint in Bradshaw 1995:264)
*[sv]H	(*svH) No sonorant segment-high tone sequences.

- Sonorants and voiced consonants pattern together so our analysis will only focus on the voiced consonant forms. Sonorant forms will behave in the same manner.
- A conjoined constraint, DEPTONE & MAXTONE (D&M), will also be required in order to correctly define the surface language wide inventory of tones.
- Defining this inventory will begin with considering inputs without tones. This is presented in (4) and (5).
- Basic constraint rankings in Fongbe:
  —Tone Faith (MAX, DEP) >> Tone Markedness (*H, *L)-there are tones at the surface
  —*CPX >> Tone Faith- there are no complex tones at the surface in general
  —*TLESS, *+H, D&M >> *CPX- causes HL tones at the surface in a special environment
  —*TLESS, *+H are undominated because they are never violated

(4) Toneless input-voiced consonant root

/ba/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
a L ☞ bà						*		*
b H bá		*!				*	*	
c ba	*!							
d LH bă				*!		**	*	*
e HL bâ		*!		*		**	*	*

(5) Toneless input-voiceless consonant root

/pa/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
a L ☞ pà						*		*
b H pá						*	*!	
c pa	*!							
d LH pă				*!		**	*	*
e HL pâ				*!		**	*	*

- In (5), an arbitrary decision to rank *HIGH above *LOW makes low tones the default tones in Fongbe.
- Both voiceless and voiced consonant roots map inputs without tones to L toned outputs but for different reasons. The [+v] roots map to L tone because of the *+HIGH constraint while the [-v] roots map to L tone because it is the 'default' tone in Fongbe.
- Considering inputs with tones allows other rankings of constraints to be evidenced. Consider the following tableaux.

(6) H tone input-voiced consonant root

H /ba/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
a L bà			*!		*	*	*	*
b H bá		*!					*	
c ba	*!				*			
d LH ☞ bă				*		*	*	*
e HL bâ		*!		*		*	*	*

- A voiced consonant root with H tone in the input provides the ranking argument for D&M >> *CPX. Candidate (4d) with a LH tone is optimal here because it has retained the H tone from the input and inserted a L tone to satisfy *+H.
- An alternative analysis which allows voiced consonant roots with an input H tone to map to a L tone either by removing D&M or ranking *CPX above D&M is untenable because this ranking will have voiced consonant roots with an input rising tone (LH) map to L also (see (7)).

(7) Alternative analysis 1

LH /ba/	*TLESS	*+H	*CPX	D&M	MAX	DEP	*H	*L
a L ☞ bà					*			*
b H bá		*!			*		*	
c ba	*!				**			
d LH bă			*!				*	*
e HL bâ		*!	*				*	*

- (7) shows that if *CPX is ranked above D&M then LH input tones will map to L. This is very problematic because if both H and LH input tonal patterns map to L then there is no way to produce the occuring voiced consonant LH tone roots in the output.
- A different possibility is to rank MAX above *CPX. This will allow the LH input tone to map to LH.

(8) Alternative analysis 2

LH /ba/	*TLESS	*+H	MAX	*CPX	DEP	*H	*L
a L bà			*!				*
b H bá		*!	*			*	
c ba	*!		**				
d LH ☞ bă				*		*	*
e HL bâ		*!		*		*	*

- The problem with the ranking in (8) is that now all input contour tones will persist to the output. This is problematic for two reasons:
  (1) *Richness of the Base*is no longer achieved. Restrictions on the inventory of input tones would have to be posited in order to block non-occuring contour tones.
  (2) Contour tones are disfavored in Fongbe in general and are only created in specific environments. Because of this, there will be little evidence to demote the *COMPLEXTONE Markedness constraint below the MAXTONE Faithfulness constraint. This does not follow recent proposals on learnability in OT (Prince and Tesar 1999)
- Tableaux (9) and (10) show the problems with the MAX >> *CPX ranking.

(9) MAX >> *CPX problems (voiced consonant roots)

HL /ba/	*TLESS	*+H	MAX	*CPX	DEP	*H	*L
a L bà			*!				*
b HL bă		*!		*		*	*
c LHL ☛ bâ				*	*	**	**

- HL input tone patterns are reasonable hypotheses for infants learning Fongbe since forms do exist with these patterns due to a rule in the phrasal phonology.

(10) MAX >> *CPX problems (voiceless consonant roots)

LH /pa/	*TLESS	*+H	MAX	*CPX	DEP	*H	*L
a L pà			*!				*
b LH ☛ pă				*		*	*

- Since LH can appear on voiced consonant roots, it is plausible that an infant acquiring Fongbe may entertain a voiceless root with this tonal pattern as a possible input.
- Tableaux (6) through (10) provide arguments for the ranking of:

  *TLESS, *+H, D&M >> *CPX >> MAX, DEP >> *H >> *L

  Tableaux (11) through (16) show that this ranking correctly defines the output inventory of tonal patterns on roots in Fongbe.

(11) L tone input-voiceds consonant roots

L /ba/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
a L ☞ bà								*
b H bá			*!		*	*	*	*
c ba	*!				*			

(12) HL input-voiced consonant roots

HL /ba/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
a L ☞ bà					*			*
b H bá		*!			*		*	
c HL bâ		*!		*			*	*
d LHL bǎ̂				*!		*	*	**

(13) LH input-voiced consonant roots

LH /ba/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
a L ☞ bà					*			*
b H bá		*!			*		*	
c LH bǎ				*!			*	*

(14) L input-voiceless consonant roots

L /pa/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
a L ☞ pà								*
b H pá			*!		*	*	*	
c pa	*!				*			

(15) H input-voiceless consonant roots

H /pa/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
L pà			*!		*	*		*
☞ H pá							*	
pa	*!				*			

(16) Contour input-voiceless consonant roots

HL /pa/	*TLESS	*+H	D&M	*CPX	MAX	DEP	*H	*L
☞ L pà					*			*
H pá					*		*!	
HL pă				*!			*	*

- Changing the input to LH in (16) will produce the same output, a L tone because of the *CPX >> MAX ranking.
- The output tonal inventory is now defined by the ranking of constraints presented here. This analysis follows *Richness of the Base* in that any possible input pattern of tones is mapped to an occuring output pattern. (17) presents a summary of these mappings.

(17) Input-Output mappings of tones

input	*output*
voiced root H	LH
voiceless root H	H
all roots-single tones	L
all contour tones	L

3.0 Richness of the Base vs. Lexicon Optimization

- The input/output mappings in (17) preserve *richness of the base* but they violate *lexicon optimization*.
- The analysis here claims that only H tones are lexically contrastive and that all contour tones result from phonological processes in Fongbe.
- *Lexicon optimization* favors an analysis where surface LH tones are stored as LH tones. As pointed out in (9) and (10), if input contour tones are allowed to map faithfully to the output then *richness of the base* must be abandoned because there are now possible inputs that will map to non-occuring outputs.
- If *richness of the base* is lost, then the language wide surface inventory of tones in Fongbe can not be described using OT.
- Conclusion here is that *lexicon optimization* and *richness of the base* place contradictory demands on OT grammars and at least one of these principles should be abandoned. See Reiss 2000 for arguments against *richness of the base*.

4.0 An OT analysis of Fongbe—reduplication

- In Fongbe, deverbal nouns or adjectives are created by reduplicating the first C of a root. This causes epenthesis of a vowel /i/ between the created consonant cluster (Brousseau 1991).
- An important 'side effect' of reduplication is that H toned voiced consonant roots are added to the language wide tonal inventory (in violation of *+HIGH).

(18) Reduplication in Fongbe (Brousseau 1991, Gormley 2000)

a) ɖà > ɖì-ɖà	'to prepare'	f) ɖǒ > ɖì-ɖó	'to taste'
b) gbà > gbì-gbà	'to destroy'	g) blǒ > bì-bló	'to make'
c) xà > xì-xà	'to read, count'	h) sɔ́ > sí-sɔ́	'to take'
d) lì > lì-lì	'to iron'	i) nă > nì-ná	'to give'
e) yì > yì-yì	'to leave'	j) wă > wì-wá	'to come'

- The shape of the reduplicant (along with the 'fixed segmentism' of the /i/) can be produced following proposals by Spaelti 1999, Raimy and Idsardi 1997, and Alderete et al 1999. This is not crucial to the present analysis so it will be left aside.
- Tones are not copied in the reduplicated forms in (18). This is evidenced by the voiced consonant root forms with LH tonal patterns on the root form. These forms have a tonal pattern in reduplicated forms that 'unpack' the contour tone (see (18f,g,i,j)).
- This interaction between reduplication and tonal patterns can be captured by using a single conjoined constraint that combines *CPX and the reduplication specific constraint in (19).

(19) Reduplication specific constraint

DEPTONEIR	(DTIR) All tones associated with RED in the output correspond with tones in the input.

- DEPTONEIR & *COMPLEXTONE (DTIR&*CPX) will automatically be ranked above *CPX according to proposals by Smolensky. This constraint needs to be promoted above *+HIGH to account for the data.
- BR Faithfullness(Tone) constraints will all be ranked very low because there is no evidence to indicate that tones are copying in Fongbe (low ranked Faithfulness constraints follows Prince and Tesar 1999).

(20) Reduplicated voiced consonant H toned input

	H RED-ba	*TLESS	DTIR& *CPX	D& M	*+H	*CPX	MAX	DEP	*H	*L	DTIR
a	H bí-bá				**!				*		
b ☞	L H bì-bá				*				*	*	*
c	L H bì-bă		*!			*		*	*	*	*
d	L bì-bà			*!			*	*		*	*
e	LHLH bĭ-bă		*!			**		*	**	**	*
f	H L bí-bà			*!	*		*	*	*	*	

- Candidate (20b) is the most optimal because it preserves the input H tone and inserts a L tone on the reduplicant to satisfy *TONELESS.
- Note that this reduplication pattern allows a ranking between D&M and *+H to be determined (D&M >> *+H). This presents a case where reduplication helps determine a non-reduplication specific ranking of that affects the language wide tonal inventory.
- Other candidates in (20) are less harmonic for the following reasons:
  —(20a) spreads the input H tone and this adds violations of *+H
  —(20c) inserts an L tone and allows it to create a complex tone in the root (violating *CPX but satsifying *+H). This violates DTIR&CPX.
  —(20d) deletes the H tone and inserts and spreads a L tone. This violates D&M.
  —(20e) reduplicates the H tone and thus adds *+H violations.
  —(20f) creates a LH on the root and copies this pattern to the reduplicant. This violates DTIR&CPX.
  —(20g) associates the input H tone with RED and inserts an L tone on the root. This violates both MAXTONE (because the H associated with the root in the input is not associated with the root in the output) and DEPTONE (because an L tone is added to the root in the output) thus violaing D&M.
  —(20h) inserts an L tone on the root and copies it to RED. This violates D&M because the input H tone is not associated with the root in the output.
  —(20i) inserts an L tone on the root and copies it to RED. This violates DTIR&*CPX (because a contour tone exists in the output).
- The tableaux in (21-23) show the other possible inputs for voiced consonant roots. All of them map to roots and reduplicants with L tones (just as the root phonology does).

(21) Reduplicated voiced consonant L toned input

	L RED-ba	*TLESS	DTIR& *CPX	D& M	*+H	*CPX	MAX	DEP	*H	*L	DTIR
a	H bí-bá				**!				*		
b	L H bì-bá			*!	*		*	*	*	*	
c	L H bì-bă					*!		*	*	*	
d	L ☞ bì-bà									*	
e	H L bí-bà				*!				*	*	*
f	L L bì-bà									**!	

(22)Reduplicated voiced consonant LH toned input

	LH RED-ba	*TLESS	DTIR& *CPX	D& M	*+H	*CPX	MAX	DEP	*H	*L	DTIR
a	H bí-bá				*!*		*		*		
b	L H bì-bá				*!		*		*	*	
c	L H bì-bă					*!			*	*	
d	L ☞ bì-bà						*			*	
e	H H bí-bá				*!*		*		**		
f	LHLH bĭ-bă					*!*			**	**	
g	H L bí-bà				*!		*		*	*	
h	L L bì-bà						*			**!	
i	L LH bì-bă					*!			*	**	

- A voiced consonant root with a HL tone input will behave the same as (22).
- Voiceless consonant roots will map input/ouput as the root phonology. Representative tableaux are presented in (23-25).

(23)Reduplicated voiceless consonant H toned input

	H RED-pa	*TLESS	DTIR& *CPX	D& M	*+H	*CPX	MAX	DEP	*H	*L	DTIR
a	H ☞ pí-pá								*		
b	L H pì-pá								*	*!	*
c	L pì-pà			*!			*	*		*	*
d	H H pí-pá								**!		
f	LHLH pĭ-pă		*!			**		*	**	**	*
g	H L pí-pà			*!			*	*	*	*	

(24)Reduplicated voiceless consonant L toned input

L RED-pa	*TLESS	DTIR& *CPX	D& M	*+H	*CPX	MAX	DEP	*H	*L	DTIR
a H pí-pá			*!			*	*	*		*
b L ☞ pì-pà									*	
c H L pí-pà								*!	*	*
d L L pì-pà									**!	
e L LH pì-pă					*!		*	*	**	

(25)Reduplicated voiceless consonant LH toned input

LH RED-pa	*TLESS	DTIR& *CPX	D& M	*+H	*CPX	MAX	DEP	*H	*L	DTIR
a H pí-pá						*		*!		
b L H pì-pá						*		*!	*	
c L ☞ pì-pà						*			*	
d LHLH pĭ-pă					*!*			**	**	
e L L pì-pà						*			**!	

- The analysis of reduplicated forms in Fongbe is completed. The input-output mapping for tones for reduplicated forms is presented in (26).

(26) Input-Output mappings of tones-reduplicated forms

input	*output*	
	RED	Root
voiced root H	L	H
voiceless root H	H	H
all roots-single tones	L	L
all contour tones	L	L

- The mappings in (26) are very similar to the mappings for root forms in (17). The only difference (barring the presence of reduplication) is that in reduplicated forms voiced consonant roots with input H tones map to output H tones in violation of the *+H constraint.

5.0 The relationship between reduplicant and root phonology

- Alderete et al 1999 claims that there is a fixed relationship between the phonological inventory in roots and phonological inventory in reduplicants.
- The phonological inventory of a given langauge is determined through constraint ranking. Alderete et al 1999:331 claims that there are 4 possible relationships between root and reduplication inventories.

(27) Inventory relationships

a. Barring ζ from inventory of whole language (including RED)
$M(\zeta) >> F_{IO}(\zeta), F_{BR}(\zeta)$

b. Barring ζ from inventory of reduplicant only
$F_{IO}(\zeta) >> M(\zeta) >> F_{BR}(\zeta)$

c. Permitting ζ in the inventory of the whole language (including RED)
$F_{IO}(\zeta), F_{BR}(\zeta) >> M(\zeta)$

d. Barring ζ from inventory of whole language (and RED by proxy)
$F_{BR}(\zeta) >> M(\zeta) >> F_{IO}(\zeta)$

- The implication of the typology of (27) is that the inventory of the whole language is defined solely by the interaction of markedness constraints and Input-Output Faithfulness. In other words, reduplication should not impact the definition of the surface inventory of a whole language.
- Alderete et al 1999:332 qualify their claims by admitting that *underapplication* in reduplication can affect the inventory of the whole language but explain this anomaly as a decrease of markedness in the reduplicant.
- Fongbe presents a case that does not fit into the typology of (27). The interaction of different markedness constraints, the addition of IR Faithfulness (McCarthy and Prince 1995), and conjoined constraints to the typology adds new posibilities. This ranking is presented in (28).

(28) Fongbe typological ranking

$M(\alpha)$ & $F_{IR}(\zeta) >> M(\beta) >> F_{IO}(\zeta) >> M(\zeta) >> F_{BR}(\zeta)$
*CPX & DTIR >> *+H >> MAXTONE >> *TONE >> MAXTONE_{BR}

- The ranking in (28) does not fit into the typology of Alderete et al 1999 and instantiates a more complicated interaction between language wide and reduplication specific inventories.
- The presence of voiced consonant-high toned roots (bá) in violation of *+HIGH is only caused by the behavior of tones in reduplication. The langauge wide inventory of tonal patterns can not be defined without considering reduplication specific constraints (and their participation in conjoined constraints).
- The inventory expansion caused by the tone/reduplication interaction in Fongbe does not appear to improve markedness of the inventory. A surface form that violates a high ranked constraint emerges in this particular context with no decrease in reduplication markedness.

- The effect of DTIR&*CPX is to arbitrarily increase the overall markedness of the surface forms because it causes a surface form which violates *+H (otherwise highly ranked) to surface.
- There is no reduction of markedness due to DTIR&*CPX; DTIR is a Faithfulness constraint and it is violated in the occuring surface form, *CPX is not violated by the surface form but violations of *CPX in surface forms already exist (so there is no reduction of markedness in the language wide inventory).

6.0 Conclusion

- Fongbe presents an interesting case of reduplication and tone interaction with the following implications for OT:
  (1) *Richness of the Base* and *lexicon optimization* place contradictory demands on OT grammars
  (2) A new typological pattern of inventory expansion (Alderete et al 1999) is discovered. This inventory explansion adds markedness to the inventory of Fongbe so it calls into question claims that reduplication never adds markedness to a phonological system.

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