Morphological asymmetries as a result of cyclic optimization: Hidatsa as an argument for Harmonic Layer Theory

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Main claim

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- In such a system, **lexical activity** differences of certain tonal morphemes and predictable **activity adjustments across layers** interact.

→ a **single phonological grammar** across layers and without reference to specific morphemes predicts the complex system

1. Data: Tone in Hidatsa

Hidatsa: Background

The language

- Siouan language of North Dakota, spoken by ∼100 people
- all data from Park (2012)

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→ **competition** between different underlying H-tones

The challenge in a nutshell

(1)

	H-tone competition	Nonfinality?
Words (Rt+Afx)	leftmost	yes
	dominance	
Compounds	leftmost	yes
	rightmost final	
Phrases	leftmost	no

Roots and affixes

H-tone competition: Roots and affixes

If multiple H-tones are present in a word, only the **leftmost** H-tone that is **not on the final mora of a root** is realized.

Some suffixes are **dominant** and cause a H-tone on a preceding syllable, overriding the LMost preference.

Roots and affixes I

(2) Affixes and R_{NF}: Leftmost H-tone surfaces

a. nácaagic
ná-cáàgic
2sg-mourn, 73
AH - R_{NF}

b. buʔáàʔii
buʔéè-ø-íí
smoky-cont-intens, 230
R_{NF} - AH

c. náreeʔiic
ná-néè-îi-c
2a-go-hab.sg-decl, 173
AH - R_{NF} - AH

d. maacáàgic
maa-cáàgic
1sg-mourn, 73
ø- R_{NF}

Roots and affixes II

(3) Affixes and R_F: Final root H-tone only if no other H-tone present

a. xiibaʔíí
xiibí-ø-íí
wrinkled-cont-intens, 229
R_F - AH

b. maceeríwa
macéé-rí-wa
man-erg-indef, 41
R_F - AH -ø

c. marígusgii
ma-ní-gúʔ-sgíí
1a-2b-give-mit, 234
ø- AH - R_F - AH

d. macééwa
macéé-wa
man-indef, 41
R_F -ø

Dominant suffix tones

(4) Momentaneous suffix /-^{H}hi/: stem-final H-tone (Park, 2012, 42+191)

a. nuwiiráhic
núwiiri-´hi-c
twist-mom-decl
R_{NF} - AP -ø

b. mahááhiwic
ma-héè-´hi-wi-c
1a-do-mom-1fut-decl
ø- RA_{NF} - AP -ø-ø

c. naraaháhi?
ná-néè-´hi-?
2a-go-mom-inter
AH - RA_{NF} - AP -ø

H-assigning prefixes

(5) 2.poss prefix /n^{H}-/: stem-initial H (Park, 2012, 344)

3.poss	1.poss	2.poss	
áàci	máàci	náàci	'breasts'
aasí	maasí	náàsi	'horn'
ahgúxi	mahgúxi	náhgúxi	'ear'
iicagí	miicagí	níicagi	'cane'

AP - R_{NF}

Compounds

Tone competition: Compounds

The **leftmost non-final** H-tone is realized.

If all H-tones are final, the **rightmost** one is realized.

2-member-compounds

(6)

a. úùwihsi
úùwi + íhsi
'clay + container', 316
R_{NF} R_{NF}

b. céésiihsa
céésa + iihsá
'wolf + his.tooth',316
R_{NF} R_{NF}

c. miriwáàhdii
mirí + máàhdii
'water + vehicle', 40
R_{F} R_{NF}

d. naxbichaadí
naxbichí + aadí
'bear + his house'
R_{F} R_{F}

3-member-compounds

(7)

a. icúùwasgiidihsi
icúùwasga + iidá + íhsi
'horse his.face container', 316
[R_{NF} [R_F R_{NF}]]

b. abahobinuxbáàga
abá + hobí + nuxbáàga
'node + hole + people',40
[[R_F R_F] R_{NF}]

c. dahu?ihgíhsi?aasis
dahú + ihgá + íhsi
[R_F [R_F R_{NF}]]
'thunder + egg + container', 316

d. miraxubaa?ihbú
mirá + xubáá + ihbú
'tree sacred.tip', 40
[[R_F R_F] R_F]

Phrases

Tone competition: Phrases

Only the **leftmost** word surfaces with its tone.

Phrases

(8)

mihcagí(í)hdaa	awawáàga	waaragic
m-íhcagidaa	maa-waáàgi-ø	maa-naagí-c
1-pro	1.a-sit.down-cont	1a-sit-decl

'I'm sitting by myself', 46

{ Wd_{NF} Wd_{F} }

(9)

{irúgsidi}	{îiwagicheedhahaaba}	{iiwahgasaarí	aabi-hiwaa-c}
{irugsidi}	{îiwagichee-dhaa-háà-aba}	{ii-maa-hgi-asaarí	áàbi-hiwaa-c}
meat	distribute-neg-adv-col	inst-1a-gi-steal	with-1caus.dir-decl

'Before they passed the mat around I snuck some off', 45

{ Wd_{F} Wd_{NF} }

Summary of empirical facts

1. Rt+Sfx

a.	R_{NF}	AH_{NF}
b.	R_{NF}	AH_{F}
c.	R_{F}	AH_{NF}
	R_{F}	AH_{F}

2. Prfx+Rt

a.	AH_{NF}	R_{NF}
b.	AH_{NF}	R_{F}
c.	AH_{F}	R_{NF}
	AH_{F}	R_{F}

1

2

3

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4. Phrase

a.	Wd_{NF}	Wd_{NF}
b.	Wd_{NF}	Wd_{F}
c.	Wd_{F}	Wd_{NF}
d.	Wd_{F}	Wd_{F}

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4. Phrase

a.	Wd_{NF}	Wd_{NF}
b.	Wd_{NF}	Wd_{F}
c.	Wd_{F}	Wd_{NF}
d.	Wd_{F}	Wd_{F}

1. a nonfinality effect for roots but not for affixes
2. directionality reversal: only compounds show RMost
3. no nonfinality effect at the phrasal level

2. Theoretical account: Hidatsa in HLT

Background assumptions: Harmonic Layer Theory

(Trommer, 2019; Zimmermann and Trommer, 2021)

1. a **single grammar** (=constraint weighting) that **cyclically optimizes** at three layers
   - L1 stems
   - L2 words
   - L3 phrases

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→ elements can predictably loose/gain activity at every optimization step

→ different behaviour at different levels = different activity at these levels

→ interaction of predictable activity adjustment across layers with lexical activity differences

In a nutshell: Hidatsa in HLT

Nonfinality effect only for roots

Final H-tones are weakened in Hidatsa. And roots are optimized at L1 prior to affixation: R_F is always weaker than AH/AP/R_{NF}.

Tone-assigning morphemes

Prefixed and suffixed floating H_1: If they win the competition, the are always realized at the edgemost TBU

Rightmost in compounds

Suffixed floating H_1-compound marker wins over weakened final tones and overwrites the leftmost H

No non-finality at the phrase-level

Prefixed floating H_3 is always realized and overwrites the rightmost H

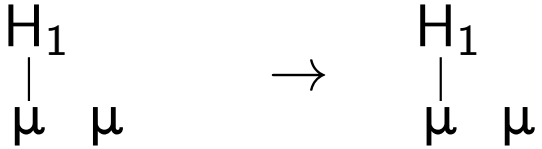
2.2. HLT account: The nonfinality effect for roots

Final H-tone decay: Constraints

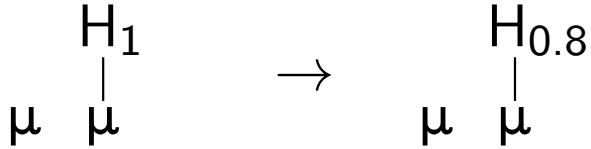
- every **final H is weakened by 0.2** at every optimization

(10) Final H-decay: Overview

a. R_{NF}



b. R_F



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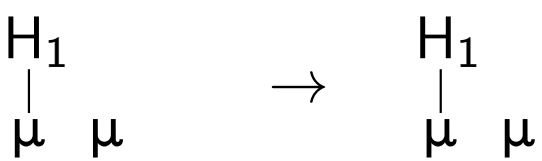

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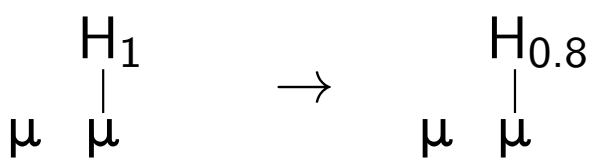

(11)

a. $NFin_H$: Assign -x violation for every H_x associated to the final mora. (W=12)

b. MaxH: Assign -x violation for every input H_x corresponding to output H_0.(W=1000)

c. Id_A: For every input output pair H_x–$H_{y\neq0}$: Assign -(x-y) violations.(W=1)

d. $Id_A{}^{>0.2}$: For every input output pair H_x–$H_{y\neq0}$: Assign -(x-y) violations if x-y>0.2.(W=∞)

Final H-tone decay: L1 root optimization

(12) Final H

H_1 μ μ	$Id_A{}^{>0.2}$ ∞	MaxH 1000	$NFin_H$ 12	Id_A 1	
a. H_1 μ μ			-1		-12
b. H_0 μ μ		-1			-∞
☞ c. $H_{0.8}$ μ μ			-0.8	-0.2	-9.8
d. $H_{0.7}$ μ μ	-0.3		-0.7	-0.3	-∞

Tone competition: Constraints

- only a single H can be realized within a word (13-a)
- if tones with the same input activity compete, LMost (13-b) always favors the leftmost one
- if tones have different input activities, MaxH favors the stronger one and this **overrides the** LMost **preference**
- since roots are optimized at L1 but affixes are not, root-final H's are always weaker than affix-H's

(13)
a. Cum: Assign -1 violation for every PrWd dominating more than one $H_{x\neq 0}$. (W=∞)

b. LMost: Assign -1 violation for every H_0 that is followed by a phonetically visible $H_{x\neq 0}$. (W=10)

Tone competition: L2 optimization of R_{NF}-AH_{NF}

L1: $[\mu^{H1}\ \mu]_{Rt}$ –> $[\mu^{H1}\ \mu]_{Rt}$

(14)

H_1 H_1 | | μ μ - μ μ	Max_H 1000	$NFin_H$ 12	LMost 10	Id_A 1	
☞ a. H_1 H_0 | | μ μ μ μ	-1				-1000
b. H_0 H_1 | | μ μ μ μ	-1		-1		-1010

Tone competition: L2 optimization of R_F-AH_{NF}

L1: $[\mu\ \mu^{H1}]_{Rt}$ –> $[\mu\ \mu^{H0.8}]_{Rt}$

(15)

$H_{0.8}$ H_1 μ μ - μ μ	Max_H 1000	$NFin_H$ 12	LMost 10	Id_A 1	
a. $H_{0.8}$ H_0 μ μ μ μ	-1				-1000
☞ b. H_0 H_1 μ μ μ μ	-0.8		-1		-810

Tone competition: L2 optimization of R_F-AH_{NF}

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L1: $[\mu\ \mu^{H1}]_{Rt}$ –> $[\mu\ \mu^{H0.8}]_{Rt}$

(16)

$H_{0.8}$ H_1 μ μ - μ	Max_H 1000	$NFin_H$ 12	LMost 10	Id_A 1	
a. $H_{0.8}$ H_0 μ μ μ μ	-1				-1000
b. H_0 H_1 μ μ μ	-0.8	-1		-1	-822
☞ b. H_0 $H_{0.8}$ μ μ μ	-0.8	-0.8	-1	-0.2	-819.8

Tone competition: L2 optimization of R_F-AH_F

L1: $[\mu\ \mu^{H1}]_{Rt}$ –> $[\mu\ \mu^{H0.8}]_{Rt}$

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→ decay for a final affix tone: doesn't influence MaxH's preference

Final tone decay: Overview of affix+root combinations at L2

(17)

1. Leftmost H surfaces

i.	R_{NF}	AH_{NF}
ii.	R_{NF}	AH_{F}
iii.	AH_{NF}	R_{NF}
iv.	AH_{F}	R_{NF}
v.	AH_{NF}	R_{F}
vi.	AH_{F}	R_{F}

2. 2nd H surfaces

iii.	R_{F}	AH_{NF}
iv.	R_{F}	AH_{F}

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- final H-tones that are weakened at L1: input $H_{0.8}$ at L2

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iii.	AH_{NF}	R_{NF}	
iv.	AH_F	R_{NF}	
v.	AH_{NF}	R_F	➙ LMost & MaxH converge
vi.	AH_F	R_F	

2. 2nd H surfaces

iii.	R_F	AH_{NF}	➙ MaxH decides
iv.	R_F	AH_F	

- final H-tones that are weakened at L1: input $H_{0.8}$ at L2

2.3. HLT account: Floating tones

Floating tones in Hidatsa

Affixed floating tones: L2

- momentaneous suffix: /-^{H}hi/
- vocative suffix: /-^{H}μ/
- 2.poss prefix: /n^{H}-/

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Affixed floating tones: L2

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- suffixed compound marker: /-^{H}/

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Affixed floating tones: L2

- momentaneous suffix: /-^{H}hi/
- vocative suffix: /-$^{H}\mu$/
- 2.poss prefix: /n^{H}-/
- suffixed compound marker: /-^{H}/

Phrasal boundary tone: L3

- Prefixed floating /H-/ added at every left edge of a phrase.

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Affixed floating tones: L2

- momentaneous suffix: /-^{H}hi/
- vocative suffix: /-$^{H}\mu$/
- 2.poss prefix: /n^{H}-/
- suffixed compound marker: /-^{H}/

Phrasal boundary tone: L3

- Prefixed floating /H-/ added at every left edge of a phrase.

→ floating tones exist with **two different activities**: H_1 and H_3

Floating H-tone realization and activity

Competition with other H-tones

H_1 participates in general competition:
realized if LMost or all others are root-final

H_3 dominant: always realized

Floating H-tone realization and activity

Competition with other H-tones

H_1 participates in general competition:
realized if LMost or all others are root-final

H_3 dominant: always realized

Position

H_1 in the position of the closest (overwritten) H

H_3 at morpheme edge: initial/final syllable

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(18) MCont: Assign -x violations for every tone T_x with morphological colour C that is associated to a syllable σ if σ is preceded and followed by syllables of a different morphological colour D. (W=10)

(19) DepTS: Assign -1 violation for every new association line between a tone and a TBU if this association line is the only one linking this TBU to a tone. (W=11) (cf. **?**)

Floating tones: Different activities and behaviour

(20) Summary: Different behaviour

	Realization	Position
H_1	competition	overwrites closest H
H_3	always	morpheme edge

Floating tones: Different activities and behaviour

(20) Summary: Different behaviour

	Realization	Position
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(21) Hidatsa: Attested floating tones

	H_1	H_3
suffixed	compound marker, L2	vocative, momentaneous, L2
prefixed	phrasal H%, L3	2.poss, L2

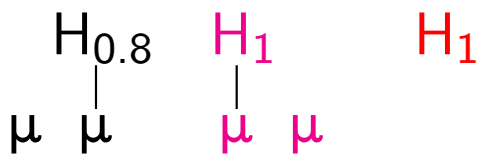
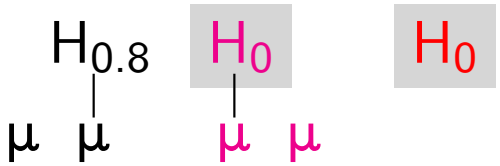
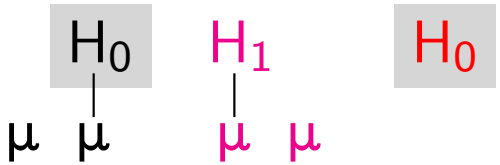
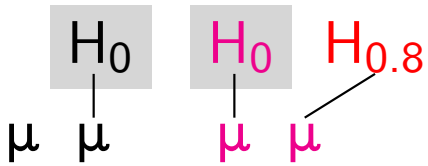
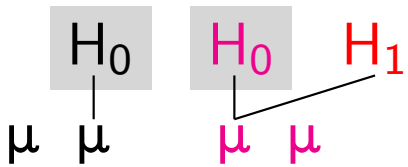
Floating tones: Final constraint

(22) H>μ: For every input H_x that is not associated to a $TBU_{y\neq 0}$ in the output: Assign -x violation. (W=2000)

- in the following: as soon as H is not associated, it has 0-activity

Floating H_1 participates in competition: Suffixed compound marker, L2

(23)

	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. 	-2					-2000
☞ b. 	-1.8			-1		-1810
c. 	-1.8	-0.8	-1	-2		-1842.8
d. 	-1.8			-2	-1	-1832.2

Floating H_1 participates in competition: Suffixed compound marker, L2

(24)

$H_{0.8}$ $H_{0.8}$ H_1 μ μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. $H_{0.8}$ H_0 H_0 μ μ μ μ	-1.8					-1800
b. H_0 $H_{0.6}$ H_0 μ μ μ μ	-1.8	-0.6		-1		-1817.2
☞ c. H_0 H_0 $H_{0.8}$ μ μ μ μ	-1.6	-0.8		-2		-1631.8

Floating H_1 participates in competition: Suffixed compound marker, L2

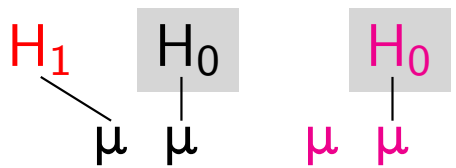
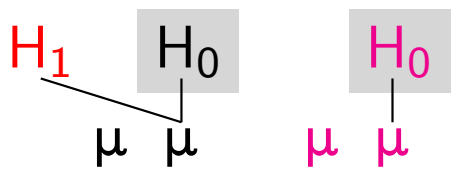
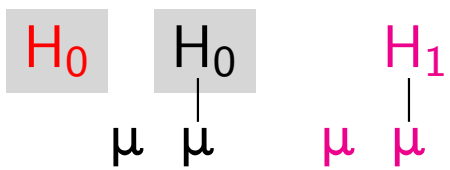
(24)

$H_{0.8}$ $H_{0.8}$ H_1 μ μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. $H_{0.8}$ H_0 H_0 μ μ μ μ	-1.8					-1800
b. H_0 $H_{0.6}$ H_0 μ μ μ μ	-1.8	-0.6		-1		-1817.2
☞ c. H_0 H_0 $H_{0.8}$ μ μ μ μ	-1.6	-0.8		-2		-1631.8

➙ apparent RMost is another competing H-tone

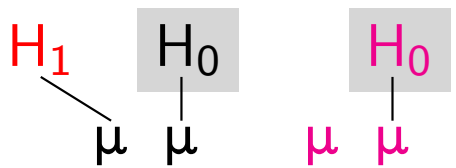
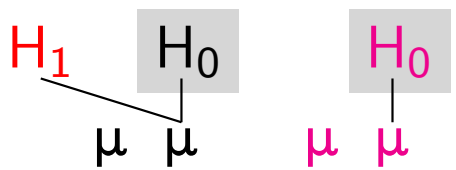
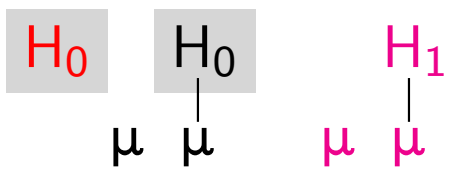
Floating H_1 overwrites closest H: Prefixed phrasal boundary H%, L3

(25)

H_1 $H_{0.6}$ H_1 μ μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. 	-1.6		-1			-1611
☞ b. 	-1.6				-1	-1610
c. 	-1.6	-1		-2		-1632

Floating H_1 overwrites closest H: Prefixed phrasal boundary H%, L3

(25)

H_1 $H_{0.6}$ H_1 μ μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. 	-1.6		-1			-1611
☞ b. 	-1.6				-1	-1610
c. 	-1.6	-1		-2		-1632

→ absence of nonfinality is another competing H-tone

Floating H_3 associates to adjacent edge: Mom.suffix, L2

(26)

H_1 H_3 | μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. H_1 H_0 | μ μ μ	-3					-3000
b. H_0 H_3 \ / μ μ μ	-1			-1	-3	-1040
☞ c. H_0 H_3 | / μ μ μ	-1		-1	-1		-1021

Floating H_3 associates to adjacent edge: Mom.suffix, L2

(26)

H_1 H_3 | μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. H_1 H_0 | μ μ μ	-3					-3000
b. H_0 H_3 \ / μ μ μ	-1			-1	-3	-1040
☞ c. H_0 H_3 | / μ μ μ	-1		-1	-1		-1021

Floating H_3 associates to adjacent edge: Mom.suffix, L2

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H_1 H_3 μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. H_1 H_0 μ μ μ	-3					-3000
b. H_0 H_3 μ μ μ	-1			-1	-3	-1040
☞ c. H_0 H_3 μ μ μ	-1		-1	-1		-1021

3. Conclusion

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Summary

- An alternative account of tone in Hidatsa apparently needs to rely on domain- and morpheme-specific grammars and root markedness.
- The HLT account presented here predicts the complex interaction of morpheme- and domain-specific effects
  - from a **single** phonological grammar
  - that optimizes **cyclically**
  - and relies on **activity** for phonological elements
- It highlights one of HLT's strength: the interaction of
  - predictable activity adjustments across layers and
  - lexical activity differences

HLT account of Hidatsa: Summary

Nonfinality effect only for roots

Roots are pre-optimized and final H-tones weakened at L1 – MaxH will always favor the strongest input tone

Tone-assigning morphemes

Prefixed and suffixed floating H_1: If they win the competition, the are always realized at the edgemost TBU since MCont >DepTS

Rightmost in compounds

Suffixed floating H_1-compound marker wins over weakened root tones and overwrites the lefttmost H since 3xDepTS >MCont

No non-finality at the phrase-level

Prefixed floating H_3 is always realized and overwrites the rightmost H since 3xDepTS >MCont

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Hidatsa tone

- a **single H-toned mora** in each word that can occur in any position
- referred to as 'accent' in the literature
- the 'accented' mora and all preceding ones: realized with a high pitch; all others with a low pitch (27)

(27) Contrastive accent (Park, 2012, 34)

HH	mahgú	'to dwell'	HL	máhgu	'cottonwood'
HHH	arawí	'to notice sth.'	HHL	aráwi	'to be bitter'
HHL	aghíri	'be lucky'	HLL	ághiri	'be tame'
HHHH	araghabí	'to walk on paws or claws'	HHHL	arahgábi	'to scratch sth. with paws or toenails'