Morphological asymmetries by cyclic optimization: Hidatsa as an argument for Harmonic Layer Theory

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Main claim

- An analysis of the tone system of Hidatsa seemingly requires **multiple grammars** for different levels (word vs. phrase), constructions (words vs. compounds), morpheme-types (roots vs. affixes), and specific morphemes.

- I argue that all these asymmetries fall out within a **cyclic** model of phonology where phonological elements have a certain **activity** that can gradiently differ.

- 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)

Hidatsa tone

- a **single H-toned mora** in each word that can occur in any position (∼'accent')
- roots have a lexically contrastive H-tone on the non-final mora (**R_{NF}**) or on a final one (**R_F**)
- affixes either have a H-tone on any mora (**$A_{NF/F}$**), are tone-less (**ø**), or demand a H-tone on an adjacent syllable (**AP**)

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

The challenge in a nutshell

(1)

	H-tone competition	Nonfinality?
Words (R+A)	leftmost	yes
	dominance	
Compounds	leftmost	yes
	rightmost	
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. buʔáàʔii
buʔéè-ø-íí
smoky-CONT-INTENS, 230
R_{NF} - A_F

b. nácaagic
ná-cáàgic
2.SG-mourn, 73
A_F - R_{NF}

c. abádaahaghaa
abádaa-hahgá-háà
chest-ABIL-ADV, 485
R_{NF} - A_F - A_{NF}

d. nâreeʔiic
ná-néè-îì-c
2.ACT-go-HAB.SG-DECL, 173
A_F - R_{NF} - A_{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 - A_F

b. maceeríwa
macéé-rí-wa
man-ERG-INDEF, 41
R_F - A_F -ø

c. macééwa
macéé-wa
man-INDEF, 41
R_F -ø

d. maréʔdhaaʔwa
ma-iréʔ-dhaa-ʔa-wa
1.POS-speak-NEG-PL-SIMULT, 537
ø- R_F -ø-ø-ø

Dominant suffix tones

(4) Momentaneous suffix /´hi/: H on preceding mora

a. nuwiiráhic
núwiiri-´hi-c
twist-momentaneous-DECL, 42
R_{NF} - AP -ø

b. maháá́hiwic
ma-héè-´hi-wi-c
1.ACT-do-momentaneous-1.FUT-DECL, 191
ø- RA_{NF} - AP -ø-ø

c. naraaháhiʔ
ná-néè-´hi-ʔ
2.ACT-go-momentaneous-Q, 191
A_F - RA_{NF} - AP -ø

d. oocihgiwááhiwihaʔc
óòcihgee-waa-´hi-wihi-ʔ-c
rest-1.CAUS.DIR-MOM-1.FUT.PL-PL-DECL, 194
RA_{NF} -ø- AP -ø-ø

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

(5)

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, 317
R_{F} R_{F}

3-member-compounds

(6)

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

b. abahobinuxbááàga
abá + hobí + nuxbááàga
node + hole + people, 40
[[R_F R_F] R_{NF}]

c. dahuʔihgíhsiʔaasis
dahú + ihgá + íhsi
thunder + egg + container, 316
[R_F [R_F R_{NF}]]

d. miraxubaaʔihbú
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

(7)

mihcagí(í)hdaa	awawáàga	waaragic
m-íhcagidaa	maa-waáàgi-ø	maa-naagí-c
1-PRO	1.ACT-sit.down-CONT	1.ACT-sit-DECL

'I'm sitting by myself', 46

	{ $\mathrm{Wd}_{\mathrm{NF}}$	Wd_{F} }

(8)

{irúgsidi}	{îiwagicheedhahaaba}	{iiwahgasaarí	aabi-hiwaa-c}
{irugsidi}	{îiwagichee-dhaa-háà-aba}	{ii-maa-hgi-asaarí	áàbi-hiwaa-c}
meat	distribute-NEG-ADV-COLLECTIVE	INST-1.ACT-GI-steal	with-1.CAUS.DIR-DECL

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

		{ Wd_{F}	$\mathrm{Wd}_{\mathrm{NF}}$ }

Summary of empirical facts

1. Rt+Sfx

a.	R_{NF}	A_{NF}
b.	R_{NF}	A_F
c.	R_F	A_{NF}
d.	R_F	A_F
e.	$R_{(N)F}$	AP

2. Prfx+Rt

a.	A_{NF}	R_{NF}
b.	A_{NF}	R_F
c.	A_F	R_{NF}
d.	A_F	R_F

3. Compounds

a.	R_{NF}	R_{NF}
b.	R_{NF}	R_F
c.	R_F	R_{NF}
d.	R_F	R_F

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. dominant suffixes overriding LMost
3. directionality reversal: only compounds show RMost
4. 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

2. Gradient Symbolic Representations: All linguistic symbols have **activity** that can gradiently differ and result in **gradient violations** of both markedness and faithfulness constraints (GSR, e.g. Smolensky and Goldrick, 2016; Rosen, 2016, 2019; Zimmermann, 2019, 2021; Walker, 2020)

➙ 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

The nonfinality effect 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}.

Directionality reversal in compounds

Suffixed floating H_1-compound marker which wins the competition against (weakened) RF_F. It associates to the final TBU.

No non-finality at the phrase-level

Prefixed floating H_1 always wins the competition since it is leftmost. It associates to the same TBU as the closest H - **position-overwriting**.

And the behaviour of the AH-suffixes?

They contain a **suffixed floating H_3** that always wins the competition since it is super-strong. It always associates to the final mora of the **adjacent morpheme edge**.

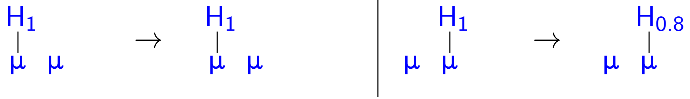
2.2. HLT account: The nonfinality effect for roots

Final H-tone decay: Constraints

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

(9) Final H-decay: Overview

a. Non-final H: retains activity | b. Final H: looses activity



(10)

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. $\text{Id}_A^{>0.2}$: 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

(11)

L1: $\mu\ \overset{H_1}{\mu}$	$Id_A^{>0.2}$ ∞	MaxH 1000	$NFin_H$ 12	Id_A 1	
a. $\mu\ \overset{H_1}{\mu}$			-1		-12
b. $\mu\ \overset{H_0}{\mu}$		-1			$-\infty$
☞ c. $\mu\ \overset{H_{0.8}}{\mu}$			-0.8	-0.2	-9.8
d. $\mu\ \overset{H_{0.7}}{\mu}$	-0.3		-0.7	-0.3	$-\infty$

Tone competition: Two competing mechanisms

- only a **single H** can be realized within a word

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

- if tones with the same input activity compete, LMost always favors the leftmost one

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

- 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

L2 optimization of R_{NF}-A_{NF}: Leftmost wins

(14) L1, R_{NF}: $\mu^{H1}\ \mu$ –> $\mu^{H1}\ \mu$

L2: $\mu^{H_1}\ \mu$ - $\mu^{H_1}\ \mu$	Max_H 1000	$NFin_H$ 12	LMost 10	Id_A 1	
☞ a. $\mu^{H_1}\ \mu$ $\mu^{H_0}\ \mu$	-1				-1000
b. $\mu^{H_0}\ \mu$ $\mu^{H_1}\ \mu$	-1		-1		-1010

L2 optimization of R_F-A_{NF}: Strongest wins

(15) L1, R_F: μ $μ^{H1}$ –> μ $μ^{H0.8}$

L2: μ μ($H_{0.8}$) - μ(H_1) μ	Max_H 1000	$NFin_H$ 12	LMost 10	Id_A 1	
a. μ μ($H_{0.8}$) μ(H_0) μ	-1				-1000
☞ b. μ μ(H_0) μ(H_1) μ	-0.8		-1		-810

L2 optimization of R_F-A_F: Strongest *input* H wins

(16) L1, R_F: $\mu\ \mu^{H1}$ –> $\mu\ \mu^{H0.8}$

L2: $\mu\ \mu^{H_{0.8}}$ - μ^{H_1}	Max_H 1000	$NFin_H$ 12	LMost 10	Id_A 1	
a. $\mu\ \mu^{H_{0.8}}$ $\mu^{H_0}\ \mu$	-1				-1000
b. $\mu\ \mu^{H_0}$ μ^{H_1}	-0.8	-1	-1		-822
☞ c. $\mu\ \mu^{H_0}$ $\mu^{H_{0.8}}$	-0.8	-0.8	-1	-0.2	-819.8

➙ 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}	A_{NF}	
ii.	R_{NF}	A_{F}	➙ LMost decides
iii.	A_{NF}	R_{NF}	
iv.	A_{F}	R_{NF}	
v.	A_{NF}	R_{F} R_{F}	➙ LMost & MaxH converge
vi.	A_{F}	R_{F} R_{F}	

2. 2nd H surfaces

iii.	R_{F} R_{F}	A_{NF}	➙ MaxH decides
iv.	R_{F} R_{F}	A_{F}	

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

2.3. HLT account: Compounding

Directionality reversal for R_F-R_F-compounds

Suffixed floating tone: compound marker /-H_1/

- added at L2 – after roots were already optimized at L1
- will loose against every R_{NF} due to LMost

➞ but the compound marker will win against weakened $H_{0.8}$ (=R_F)

Suffixed compound-H_1: looses competition against another H_1

(18)

L1, R_F:	$\mu\ \mu^{H1}$	–>	$\mu\ \mu^{H0.8}$
L1, R_{NF}:	$\mu^{H1}\ \mu$	–>	$\mu^{H1}\ \mu$

L2: $\mu\ \mu^{H_{0.8}}$ $\mu^{H_1}\ \mu$ H_1	MaxH 1000	NFin$_H$ 12	DepTS 11	LMost 10	MCont 10	
a. $\mu\ \mu^{H_{0.8}}$ $\mu^{H_0}\ \mu$ H_0	-2					-2000
☞ b. $\mu\ \mu^{H_0}$ $\mu^{H_1}\ \mu$ H_0	-1.8			-1		-1810
c. $\mu\ \mu^{H_0}$ $\mu^{H_0,\,H_1}\ \mu$	-1.8			-2	-1	-1830

Suffixed compound-H_1: wins competition against only $H_{0.8}$

(19)

L1, R_F: $\mu\ \mu^{H1}$ –> $\mu\ \mu^{H0.8}$

L1, R_F: $\mu\ \mu^{H1}$ –> $\mu\ \mu^{H0.8}$

L2: $\mu\ \mu^{H_{0.8}}$ $\mu\ \mu^{H_{0.8}}$ H_1	MaxH 1000	NFinH 12	DepTS 11	LMost 10	MCont 10	
a. $\mu\ \mu^{H_{0.8}}$ $\mu\ \mu^{H_0}$ H_0	-1.8					-1800
b. $\mu\ \mu^{H_0}$ $\mu\ \mu^{H_{0.6}}$ H_0	-1.8	-0.6		-1		-1817.2
☞ c. $\mu\ \mu^{H_0}$ $\mu\ \mu^{H_0, H_{0.8}}$	-1.6	-0.8		-2		-1629.6

→ apparent RMost is another competing H-tone

2.4. HLT account: No nonfinality at the phrase level

No non-finality at L3

Prefixed phrasal boundary tone /H_1-/

- added at L3 and precedes all other tones
- wins the competition against all other H-tones due to LMost
- associates to the closest TBU that was underlyingly associated to a H: **position overwriting**
  - predicted since (20-a) has a higher weight than (20-b)

(20) 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. Tranel (1995))

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

Prefixed phrasal boundary H_1 always overwrites closest H

(22)

L1, R_F:	μ μ^{H1}	–>	μ μ$^{H0.8}$
L1, R_{NF}:	μ^{H1} μ	–>	μ^{H1} μ
L2, R_F:	μ μ$^{H0.8}$	–>	μ μ$^{H0.6}$
L2, R_{NF}:	μ^{H1} μ	–>	μ^{H1} μ

L3: H_1 $H_{0.6}$ H_1 / μ μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. H_1 H_0 H_0 / μ μ μ μ	-1.6		-1			-1611
☞ b. H_1 H_0 H_0 / μ μ μ μ	-1.6				-1	-1610
c. H_0 H_0 H_1 / μ μ μ μ	-1.6			-2		-1620

2.5. HLT account: And other floating tones?

More floating tones in Hidatsa

Suffixed $/H_3/$: Momentaneous

- wins the competition against all other tones: a **superstrong** tone that is always realized
- is realized on the **final TBU of the preceding morpheme**
  - this violates DepTS but the **gradient** 3x violation of MCont overrides DepTS's effect

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

(23) L1, R_{NF}: $\mu^{H1}\ \mu$ –> $\mu^{H1}\ \mu$

L2: H_1 (linked to 1st μ) H_3 (floating); μ μ μ	MaxH 1000	$NFin_H$ 12	DepTS 11	LMost 10	MCont 10	
a. H_1 (linked to 1st μ) H_0 (floating); μ μ μ	-3					-3000
☞ b. H_0 (linked to 1st μ) H_3 (linked to 2nd μ); μ μ μ	-1		-1	-1		-1021
c. H_0 H_3 (both linked to 1st μ); μ μ μ	-1			-1	-3	-1040

Summary: Floating H-tone realization and activity

(24) Different behaviour of floating tones

	Realization	Position
H_1	competition	overwrites closest H
H_3	always	morpheme edge

(25) Hidatsa: Attested floating tones

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

3. Conclusion

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

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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 (26)

(26) 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’

H-assigning prefixes

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

3.poss	1.poss	2.poss	
áàci	máàci	náàci	'breasts'
aasí	maasí	n**á**àsi	'horn'
ahgúxi	mahgúxi	n**á**hgúxi	'ear'
iicagí	miicagí	n**î**ìcagi	'cane'

AP - R_{NF}

Floating tones: Final constraint

(28) 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