Many Hands or Many Cooks?
The Functional Load of Tone in Tonal Languages

Nicholas Rolle

slides at **nicholasrolle.com/output** (at top)

Pitch – Different roles in different systems

1. Mandarin → Contrast different lexical items
2. Yaitepec Chatino → Inflectional tone
3. English → Intonation

Pitch – Different roles in different systems

1. **Mandarin** → **Contrast different lexical items**
   1. T1 mā 'mother'
   2. T2 má 'numb'
   3. T3 mǎ 'horse'
   4. T4 mà 'curse'
2. Yaitepec Chatino → Inflectional tone
3. English → Intonation

3

Pitch – Different roles in different systems

1. Mandarin → Contrast different lexical items
2. **Yaitepec Chatino → Inflectional tone** (Rasch 2015)
3. English

a.	*xnu* 'leave behind'			*swi* 'choose'		
	1st	2nd	3rd	1st	2nd	3rd
HAB	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{3}	nswi^{31}	nswi^{43}
POT	xnu^{21}	xnu^{31}	xnu^{1}	swi^{3}	swi^{31}	swi^{43}
CPL	nwxnu^{21}	nwxnu^{31}	nwxnu^{1}	nwswi^{3}	nwswi^{31}	nwswi^{1}
PROG	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{2}	nswi^{31}	nswi^{1}

b.	1st	2nd	3rd	1st	2nd	3rd
HAB						43
POT	21	31	1	3	31	
CPL						1
PROG				2		

4

Pitch – Different roles in different systems

1. Mandarin → Contrast different lexical items
2. **Yaitepec Chatino → Inflectional tone** (Rasch 2015)
3. English

a.	*xnu* 'leave behind'			*swi* 'choose'		
	1st	2nd	3rd	1st	2nd	3rd
HAB	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{3}	nswi^{31}	nswi^{43}
POT	xnu^{21}	xnu^{31}	xnu^{1}	swi^{3}	swi^{31}	swi^{43}
CPL	nwxnu^{21}	nwxnu^{31}	nwxnu^{1}	nwswi^{3}	nwswi^{31}	nwswi^{1}
PROG	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{2}	nswi^{31}	nswi^{1}

b.	1st	2nd	3rd	1st	2nd	3rd
HAB						43
POT	21	31	1	3	31	
CPL						1
PROG				2		

5

Pitch – Different roles in different systems

1. Mandarin → Contrast different lexical items
2. **Yaitepec Chatino → Inflectional tone** (Rasch 2015)
3. English

	xnu 'leave behind'			swi 'choose'		
a.	1st	2nd	3rd	1st	2nd	3rd
HAB	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{3}	nswi^{31}	nswi^{43}
POT	xnu^{21}	xnu^{31}	xnu^{1}	swi^{3}	swi^{31}	swi^{43}
CPL	nwxnu^{21}	nwxnu^{31}	nwxnu^{1}	nwswi^{3}	nwswi^{31}	nwswi^{1}
PROG	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{2}	nswi^{31}	nswi^{1}

	1st	2nd	3rd	1st	2nd	3rd
b.						
HAB	21	31	1	3	31	43
POT						
CPL						1
PROG				2		

Pitch – Different roles in different systems

1. Mandarin → Contrast different lexical items
2. **Yaitepec Chatino** → **Inflectional tone** (Rasch 2015)
3. English

	xnu 'leave behind'		
a.	1st	2nd	3rd
HAB	nxnu^{21}	nxnu^{31}	nxnu^{1}
POT	xnu^{21}	xnu^{31}	xnu^{1}
CPL	nwxnu^{21}	nwxnu^{31}	nwxnu^{1}
PROG	nxnu^{21}	nxnu^{31}	nxnu^{1}

	swi 'choose'		
	1st	2nd	3rd
HAB	nswi^{3}	nswi^{31}	nswi^{43}
POT	swi^{3}	swi^{31}	swi^{43}
CPL	nwswi^{3}	nwswi^{31}	nwswi^{1}
PROG	nswi^{2}	nswi^{31}	nswi^{1}

b.	1st	2nd	3rd
HAB	21	31	1
POT			
CPL			
PROG			

1st	2nd	3rd
3	31	43
2		1

Pitch – Different roles in different systems

1. Mandarin $\rightarrow$ Contrast different lexical items
2. **Yaitepec Chatino $\rightarrow$ Inflectional tone** (Rasch 2015)
3. English

	xnu 'leave behind'			*swi* 'choose'		
a.	1st	2nd	3rd	1st	2nd	3rd
HAB	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{3}	nswi^{31}	nswi^{43}
POT	xnu^{21}	xnu^{31}	xnu^{1}	swi^{3}	swi^{31}	swi^{43}
CPL	nwxnu^{21}	nwxnu^{31}	nwxnu^{1}	nwswi^{3}	nwswi^{31}	nwswi^{1}
PROG	nxnu^{21}	nxnu^{31}	nxnu^{1}	nswi^{2}	nswi^{31}	nswi^{1}

	1st	2nd	3rd	1st	2nd	3rd
b.						
HAB						43
POT	21	31	1	3	31	
CPL						1
PROG				2		

8

Pitch – Different roles in different systems

1. Mandarin   →   Contrast different lexical items
2. **Yaitepec Chatino** →   **Inflectional tone** (Rasch 2015)
3. English

a.	*xnu* 'leave behind'			*swi* 'choose'		
	1st	2nd	3rd	1st	2nd	3rd
HAB	$nxnu^{21}$	$nxnu^{31}$	$nxnu^{1}$	$nswi^{3}$	$nswi^{31}$	$nswi^{43}$
POT	xnu^{21}	xnu^{31}	xnu^{1}	swi^{3}	swi^{31}	swi^{43}
CPL	$nwxnu^{21}$	$nwxnu^{31}$	$nwxnu^{1}$	$nwswi^{3}$	$nwswi^{31}$	$nwswi^{1}$
PROG	$nxnu^{21}$	$nxnu^{31}$	$nxnu^{1}$	$nswi^{2}$	$nswi^{31}$	$nswi^{1}$

b.	1st	2nd	3rd	1st	2nd	3rd
HAB						43
POT	21	31	1	3	31	
CPL						1
PROG				2		

9

Pitch – Different roles in different systems

1. Mandarin $\rightarrow$ Contrast different lexical items
2. Yaitepec Chatino $\rightarrow$ Inflectional tone
3. **English** $\rightarrow$ **Intonation**

- <u>Imperative with the 'calling contour'</u> Jeong & Condoravdi (2018)
- Felicitous with mnemonic: *Remember to feed the cats!*

$$H^* \, ^{\downarrow}H\text{-}L\%$$

- Infelicitous with command: *Hand in the assignment by Friday!*

$$cf. \, \# \, H^* \, ^{\downarrow}H\text{-}L\%$$

10

Pitch – Different roles in different systems

1. Mandarin → Contrast different lexical items
2. Yaitepec Chatino → Inflectional tone
3. English → Intonation

- **How do languages balance these competing needs, especially in tone languages where it is common that all three functions can operate simultaneously**

11

Massive neutralization - Orungu [mye]
(Bantu: Gabon - Maniacky & Ambouroue 2014)

- For example, the interactional of lexical tone and inflectional tone in the Bantu language Orungu

- Negative past
/à-é-ɾè-rìɣⒽ-è   àwáná áŋkà   ɣó ìŋkòlò/
[èɾé⁺tíɣ   àwán ⁺áŋkà ɣó ⁺ŋkólò]
's/he did not leave the children alone tonight'

12

Massive neutralization - Orungu [mye]
(Bantu: Gabon - Maniacky & Ambouroue 2014)

- Negative present
  /à-é-ɾè-Ⓛ-rìɣⒽ-a àwáná áŋkà   ɣó   ìŋkòlò/
- [èɾétìɣ   àwàn àŋkà   ɣò   ŋkòlò]
  's/he does not leave the children alone tonight'

- Negative subjunctive
  /à-á-Ⓗ-lwàn-àɣ-a ɣó ìɗyànjà   kwáŋgá   òɣwèɾà néŋgénéŋgé/
- [àlwánáɣá   ɣ íɗyánjá   kwáŋg   óɣwéɾá néŋgénéŋgé]
  'that s/he usually do not stay late at work'

13

Massive neutralization – FAKE Orungu

- (FAKE) Negative present
  /à-é-ɾè-**[-BACK]**-rìɣⒽ-a   àwáná áŋkà   ɣó   ìŋkòlò/
- [èɾétìɣ   **æ̀wǽn ǽŋkæ̀ ɣǿ   ŋkø̀lø̀**]
  's/he does not leave the children alone tonight'

Many hands or many cooks?

1. "Many hands make light work."
   Viele Hände machen bald ein Ende
   Viele Hände machen der Arbeit bald ein Ende
   Viele Hände – schnelles Ende
   Viele Hände, rasches Ende
   Viele Hände, leichte Arbeit

2. "Too many cooks spoil the broth."
   Viele Köche verderben den Brei

Questions – The nature of phonological systems

1. How do phonological contrasts contribute to intended meaning of utterance? This is the question of the **Functional Load** of a phonological contrast.

2. How much functional load does linguistic **tone** have in tonal languages, e.g. diverse as Zulu and Chinese (and Navajo, Cherokee, Japanese, Vietnamese, Swedish, Serbian, Punjabi, Hausa, Yoruba, Somali, Luganda, Enga, Ticuna, …)

Questions – The nature of phonological systems

1. How do phonological contrasts contribute to intended meaning of utterance? This is the question of the **Functional Load** of a phonological contrast.

2. How much functional load does linguistic **tone** have in tonal languages, e.g. diverse as Zulu and Chinese (and Navajo, Cherokee, Japanese, Vietnamese, Swedish, Serbian, Punjabi, **Hausa**, Yoruba, Somali, Luganda, Enga, Ticuna, ...)

Functional Load

Definition of Functional Load

- Quantifying the <u>lexical function</u> of tone can be done by assessing its '**functional load**'

- Definition of **Functional Load** [Hall et al. 2016]
  - "a measure of the "work" that any particular contrast does in a language, as compared to other contrasts"

- "The idea that different phonemic contrasts may have different degrees of functional load in the overall phonemic system goes back to the Prague School (*inter alia* Mathesius 1929; Jakobson 1931)" [Konnerth 2014:76]

Definition of Functional Load

- In English, "the difference between [d] and [t] is used to distinguish between many different lexical items, so it has a <u>high functional load</u>; there are, on the other hand, very few lexical items that hinge on the distinction between [ð] and [θ], so its <u>functional load is much lower</u>" [Hall et al. 2016]

Definition of Functional Load

- Frequent minimal pairs indicate a high functional load
- /i/ vs. /ɪ/
  - *leave* vs. *live, read* vs. *rid, bean* vs. *bin, heat* vs. *hit, least* vs. *list,* etc.
- cf. /ʊ/ vs. /ʌ/
  - *put* vs. *putt, could* vs. *cud, look* vs. *luck, ...?*   ← much harder

Nucleus \ Coda	p	b	m	**f**	v	**k**	g	ŋ	θ	ð	**t**	**d**	n	s	z	tʃ	dʒ	**ʃ**	ʒ
ʊ	(*)	*	*		(*)		(*)	*	*	*			*	(*)	*	(*)	*		(*)
ʌ									*	*									*

21

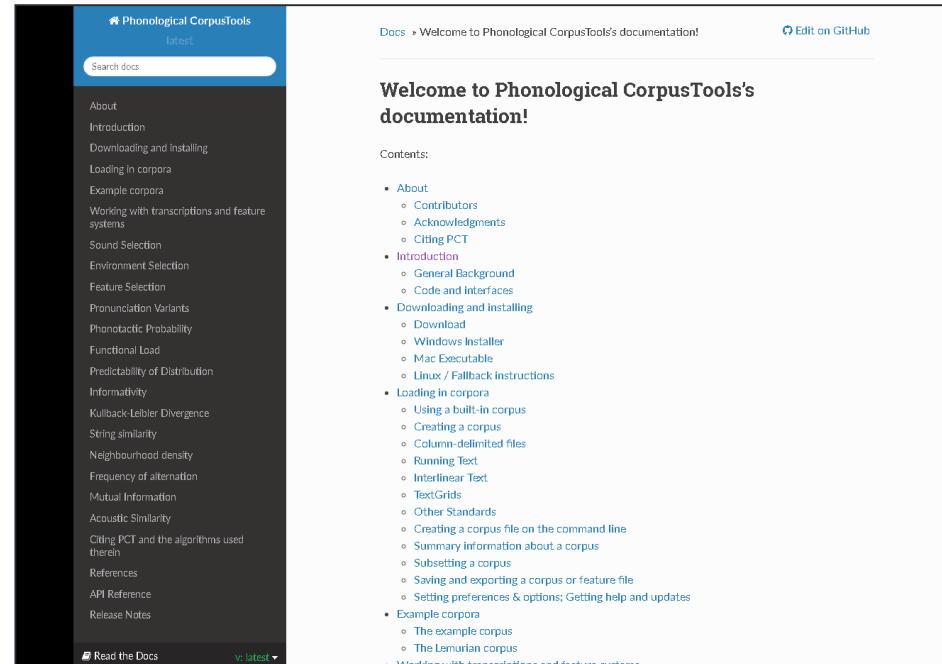# Previous statements on Functional Load of tone

- "Tone has a **high functional load** in Supyire. Boys cowherding in the bush often communicate with each other by whistling." [*Supyire* - Carlson 1994:32]

- "Seenku vocabulary is largely monosyllabic with almost exclusively open syllables, resulting in a **high functional load for tone**." [*Seenku* - McPherson 2016:43]

- "**Tone carries a high lexical functional load in Ganza**." [*Ganza* - Smolders 2016:129]

- "Unlike some African tone languages, tone is not affected by consonants, tone is stable—it does not shift from one syllable to another, and tone does not down-step or down-drift. **The functional load of tone is very high**, both in the distinction of words and in the expression of grammatical functions." [*Gaahmg* – Stritz 2011:43]

Previous statements on Functional Load of tone

- "The most intriguing aspect of Karbi phonology is the tone system, which carries a **low functional load**." [*Karbi* - Konnerth 2014:iv]

- "...[P]itch accents are contrastive, and other minimal pairs occur (tecénoo 'door' vs. técenoo 'roll it out!'...). However, such pairs are comparatively rare, and it is **extremely difficult to find minimal pairs of nouns based on pitch accent**, so the pitch accent system is certainly not equivalent to tonal systems in languages such as Mandarin Chinese, where such minimal pairs are pervasive." [*Arapaho*- Cowell & Moss 2008:23]

- "**Only a small list of minimal pairs has been recorded for the verbs**:...The rarity of verb stem contrasts, in some cases its total absence, has long since been reported for the Mande languages" [Mande Family - Manyeh 1983:184, Welmers 1971: 12, Green 2017:8]

- "Tone is contrastive both grammatically and lexically in Kifuliiru. Lexical roots which differ only in tone can be found in both nouns (**roughly 1%**) and in verbs (**between 1 and 2%**)." [*Kifuliiru* – van Otterloo 2011:127]

Quantifying Functional Load

- Hall et al. (2016) discussion of 'Functional Load'
  - **Phonological CorpusTools**
  - http://corpustools.readthedocs.io/en/latest/index.html
- [Hockett 1955, 1966; Martinet 1955, 1977; Kucera 1963; King 1967; Surendran 2003; Surendran and Niyogi 2006; Wedel et al. 2013a,b; Oh et al. 2013, 2015]

Quantifying Functional Load

- Hall et al. (2016) discuss two primary ways of calculating functional load
- 1) **Change of entropy**
  - "Entropy is an Information-Theoretic measure of the amount of uncertainty in a system" [Shanon 1949]
  - What is the change in entropy in a system upon merger of a segment pair or set of segment pairs [Surendran 2003]
- 2) **Minimal pair count**
  - "the other is based on simply counting up the number of minimal pairs (differing in only the target segment pair or pairs) that occur in the corpus"

Change in Entropy

- Entropy: $H = -\sum_{i \in N} p_i * log_2(p_i)$

- We get a baseline of the entropy by first running this measurement for the corpus as a whole
  - H_1

- We then merge a category and see how much this changes the baseline entropy
  - $H_1 - H_2$

- p is the probability of a word
  - Token-based: multiple by frequency in a corpus
  - **Type-based: multiple by 1 (all equally frequent in a dictionary)**

Change in Entropy – Toy example

A Word (n=6) Baseline	B Meaning	C No tone (n=4)	D No Cons (n=5)	E No Vowel (n=5)	F No s vs. z (n=6)
sálì	eat	sali	tátì	sálà	sálì
sàlí	talk	sali	tàtí	sàlá	sàlí
zìlá	sleep	zila	tìtá	zàlá	sìlá
zàrá	know	zara	tàtá	zàrá	sàrá
zárá	be nice	zara	tátá	zárá	sárá
zàlá	tow away	zala	tàtá	zàlá	sàlá

Change in Entropy – Toy example

A Word (n=6) *Baseline*	B Meaning	C No tone (n=4)	D No Cons (n=5)	E No Vowel (n=5)	F No s vs. z (n=6)
sálì	eat	sali	tátì	sálà	sálì
sàlí	talk	sali	tàtí	sàlá	sàlí
zìlá	sleep	zila	tìtá	zàlá	sìlá
zàrá	know	zara	tàtá	zàrá	sàrá
zárá	be nice	zara	tátá	zárá	sárá
zàlá	tow away	zala	tàtá	zàlá	sàlá

Change in Entropy – Toy example

A Word (n=6) *Baseline*	B Meaning	C No tone (n=4)	D No Cons (n=5)	E No Vowel (n=5)	F No s vs. z (n=6)
sálì	eat	sali	tátì	sálà	sálì
sàlí	talk	sali	tàtí	sàlá	sàlí
zìlá	sleep	zila	tìtá	zàlá	sìlá
zàrá	know	zara	tàtá	zàrá	sàrá
zárá	be nice	zara	tátá	zárá	sárá
zàlá	tow away	zala	tàtá	zàlá	sàlá

Change in Entropy – Toy example

A Word (n=6) *Baseline*	B Meaning	C No tone (n=4)	D No Cons (n=5)	E No Vowel (n=5)	F No s vs. z (n=6)
sálì	eat	sali	tátì	sálà	sálì
sàlí	talk	sali	tàtí	sàlá	sàlí
zìlá	sleep	zila	tìtá	zàlá	sìlá
zàrá	know	zara	tàtá	zàrá	sàrá
zárá	be nice	zara	tátá	zárá	sárá
zàlá	tow away	zala	tàtá	zàlá	sàlá

Change in Entropy – Toy example

A Word (n=6) *Baseline*	B Meaning	C No tone (n=4)	D No Cons (n=5)	E No Vowel (n=5)	F No s vs. z (n=6)
sálì	eat	sali	tátì	sálà	sálì
sàlí	talk	sali	tàtí	sàlá	sàlí
zìlá	sleep	zila	tìtá	zàlá	sìlá
zàrá	know	zara	tàtá	zàrá	sàrá
zárá	be nice	zara	tátá	zárá	sárá
zàlá	tow away	zala	tàtá	zàlá	sàlá

Case study: Functional load of tone in the Hausa language

The Hausa Language

- Afroasiatic phylum →
- Chadic family
  ↓

Berber
Chadic
Cushitic
Egyptian
Semitic

Biu-Mandara
East Chadic
Masa
West Chadic
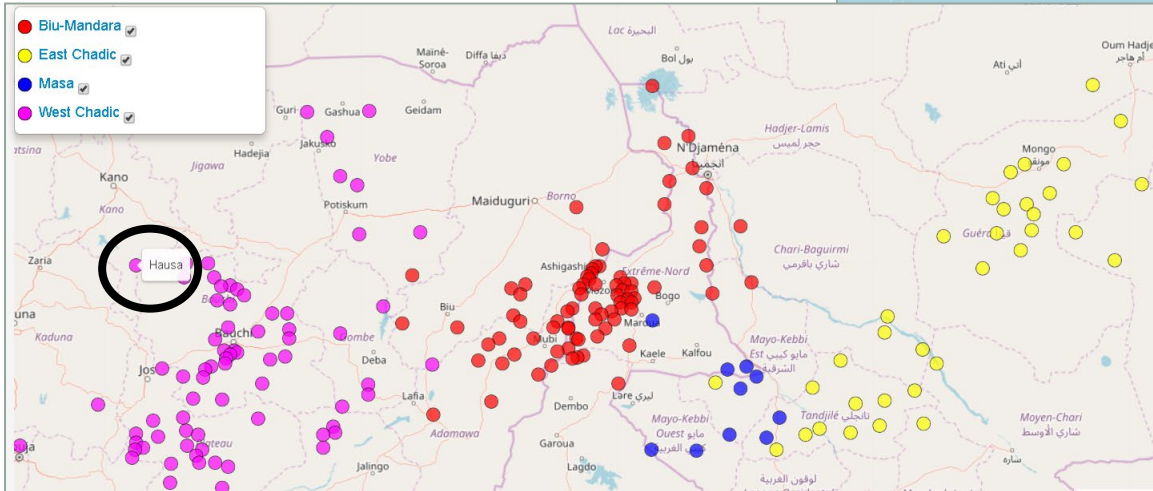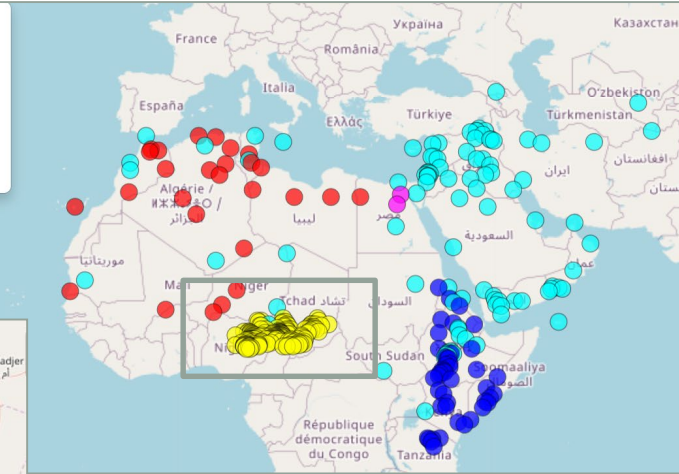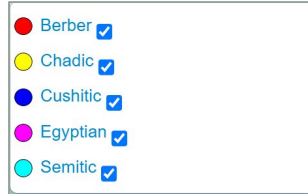
The Hausa Language

- Major lingua franca of West Africa, with tens of millions of 1st and 2nd language speakers

Hausa speakers:
- First language
- Second language
- Second language within the Muslim community

© 2008 Encyclopædia Britannica, Inc.
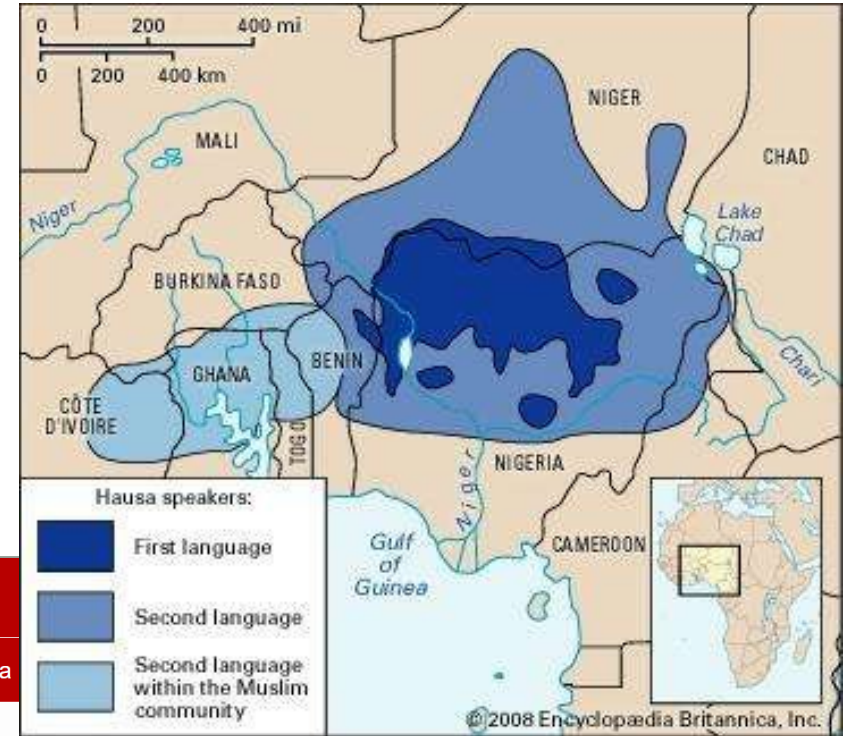
BBC NEWS | HAUSA

Labaran Duniya   Wasanni   Nishadi   Cikakkun Rahotanni   Bidiyo   Shirye-shirye na

Sabon sarkin Zazzau Ahmed Nuhu Bamalli ya shiga fada

Sakon da aka wallafa a shafin gwamnatin jihar na Twitter, ya ce "Gwamnatin jihar Kaduna ta sanar da nada Alhaji Ahmed Nuhu Bamalli a matsayin sarkin Zazzau na 19."

Sa'o'i 2 da suka wuce

Tone in the Hausa Language

- /H/ , /L/ , and /HL/ tonemes in Hausa [Newman 2000:597]
  - H   <shā> /ʃá:/   'drink'   <maza>   /mázá/   'quickly'
  - L   <dà> /dà/   'with, and'   <àkwầtì>   /àkʷà:tì/   'box'
  - HL <shâ> /ʃáà/ 'drinking'   <ƙâttā>   /k'âttá:/   'huge' (pl.)
- "Although tone does not have a functional load comparable to that of many West African languages like Igbo or Yoruba, it does serve to distinguish a number of lexical items" [Newman 2000:599]
- < ràinā > / ràìná: / LH   look after a baby
- < rainầ > / ráínà: / HL   despise, have comtempt for

Functions of tone in Hausa

- **Lexical:** i.e. contrastive, underlying tone
- nouns, ideophones, functional words, adverbs, among others...

Functions of tone in Hausa

- **Grammatical**: expressing grammatical categories

- Part of plural inflection on nouns
  - LH <rǐgā> /rì:gá:/ gown → HL <rīgunà̀> /rí:gúnà:/ gowns

- Marking tense/aspect/mood
  - HL <tāshì> /tá:ʃì/ get up → LH <tà̀shí> [tà:ʃí] Get up! (imperative)

- Different verb grades (~= verb classes)
  - HL <arà̀>   /árà:/ (gr 1) lend   vs.
  - LH <àrā>   /àrá:/ (gr 2) borrow (not money)

Functions of tone in Hausa

- The balance between Hausa employing tone for a **Lexical function** (underlying contrasts on morphemes) versus a **Grammatical function** (changes in default tone to cue certain grammatical categories)
- And how do these two 'get along' with one another?
  - *many cooks vs. many hands...*
- Specifically, we want to quantify
  - To what degree is tone used in its **lexical** function
  - To what degree is tone used in its **grammatical** function

Functions of tone in Hausa

- <u>Across Afro-Asiatic tone languages…</u>
- Where tone plays a small role in distinguishing morphemes, tone is said to have a low **functional load**
  - claimed for Chadic languages Makary Kotoko [mpi] (Allison 2012:38) and Goemai [ank] (Tabain & Hellwig 2015:91), and for Cushitic as a whole (Mous 2009), e.g. Awngi [awn] (Joswig 2010:23-24).
- However, statements do not provide clear statistics to support their position

Hausa lexicon

- Use a digitized Hausa lexicon of 10,768 lexemes taken primarily from Newman's 2007 dictionary

- Not possible (yet) to get token counts/frequency of individual words – no corpus readily available

- Input into a R-readible spreadsheet by research assistants to Stephanie Shih (Univeristy of Southern California) and Sharon Inkelas (UC Berkeley)

- Help with python from my research assistants Daniel Getter and Frank Lin

Hausa lexicon

id	Word	Distilled Tone	POS	Gender (n)/ Grade (v)	Definition	total
348	ts'oohoo	H.H	adj	NA	adj Old (psn or thing). — m 1. Old man.	ts'oohoo_H.H
10481	ts'allakaa	H.L.H	v	v1	Cross over, go from one side to the other.	ts'allakaa_H.L.H
483	jeere	L.H	adv	NA	In a row, in succession	jeere_L.H
2648	fants'aree	L.L.H	noun	m	Coarsely ground corn or the grinding process	fants'aree_L.L.H
3548	jadawalii	H.H.L.H	noun	m	Multiplication table; Class schedule	jadawalii_H.H.L.H
4348	k'arau	H.H	noun	m	Glass bangle	k'arau_H.H
4480	k'ungurgumaa	L.H.L.H	noun	f	Kind of wingless beetle.	k'ungurgumaa_L.H.L.H

Hausa lexicon

- From this 10,768 lexeme set, we took out:
  - Words which were transcribed with spaces (phrases) or dashes (compounds)
  - All exclamations
  - Feminine versions which were not defined clearly separately from the masculine counterpart
  - Variants which appears to be predictable phonological variants
  - Verbal nouns which appear to be predictable meanings from verbs
  - Predictable plural forms
  - Predictable ethnonyms
  - Words only found in a certain collocation

Hausa lexicon

- Result was a set of **9164 words** as our baseline starting point

s vs. z, …	b vs. ɓ, …	i/u vs. e/o	r vs. ɽ	k vs. kʸ vs. kʷ	tʃ vs. kʸ	f vs. h	f vs. w	h vs. Ø
noVoice	**noGlot**	**noHMVowel**	**noR**	**noVelSecond**	**noPostAlv**	**noFvsH**	**noFvsW**	**noH**

	no merger		H vs. L	b vs. t vs. d vs. ɗ …	i vs. e vs. a …	a vs. a:	
id	**total**		**noTone**	**noCons**	**noVowel**	**noVLength**	**...**
1	aajizii_H.L.H		aajizii	aaxixii_H.L.H	aajazaa_H.L.H	ajizi_H.L.H	...
2	algashii_H.L.H		algashii	axxaxii_H.L.H	algashaa_H.L.H	algashi_H.L.H	...
3	angajeejee_H.H.H.L		angajeejee	axxaxeexee_H.H.H.L	angajaajaa_H.H.H.L	angajeje_H.H.H.L	...
4	askakkee_L.H.H		askakkee	axxaxxee_L.H.H	askakkaa_L.H.H	askakke_L.H.H	...

All words (*n*=9164)	Merger	Unique	H	ΔH	% less compared to tone	
total		8913	13.12170			
noAlvPostA	tʃ vs. kʸ	8912	13.12153	0.00016	0%	0
noR	r vs. ɽ	8909	13.12105	0.00065	1%	0
noH	h vs. Ø	8901	13.11975	0.00194	2%	0
noFH	f vs. h	8899	13.11943	0.00227	3%	0
noFW	f vs. w	8896	13.11894	0.00275	3%	0
noVel	k vs. kʸ vs. kʷ	8875	13.11553	0.00616	7%	0
noGlot	b vs. ɓ, ...	8800	13.10329	0.01841	21%	1/5
nuHMV	i/u vs. e/o	8780	13.10001	0.02169	25%	1/4
noVoic	s vs. z, ...	8746	13.09441	0.02729	31%	1/3
noVL	a vs. a:	8701	13.08697	0.03473	40%	2/5
notone	**H vs. L**	**8393**	**13.03497**	**0.08672**	**100%**	1
noV	i vs. e vs. a ...	7770	12.92370	0.19800	228%	2.3 x
noC	b vs. t vs. d...	2912	11.50779	1.61390	1861%	18.6 x

Nouns (*n*=5781)	Merger	Unique	H	ΔH	% less compared to tone	
total		5674	12.47015			
noAlvPostA	tʃ vs. kʸ	5673	12.46990	0.00025	1%	0
noR	r vs. ɽ	5671	12.46939	0.00076	2%	0
noH	h vs. Ø	5670	12.46913	0.00102	3%	0
noFH	f vs. h	5668	12.46862	0.00153	5%	0
noFW	f vs. w	5665	12.46786	0.00229	7%	0
noVel	k vs. kʸ vs. kʷ	5658	12.46608	0.00407	13%	1/8
nuHMV	i/u vs. e/o	5651	12.46429	0.00586	18%	1/5
noGlot	b vs. ɓ, ...	5633	12.45969	0.01046	33%	1/3
noVL	a vs. a:	5632	12.45943	0.01072	34%	1/3
noVoic	s vs. z, ...	5602	12.45173	0.01842	58%	4/7
notone	**H vs. L**	**5550**	**12.43827**	**0.03188**	**100%**	**1**
noV	i vs. e vs. a ...	5251	12.35838	0.11177	351%	3.5 x
noC	b vs. t vs. d...	2291	11.16176	1.30839	4104%	41 x

Findings

- **Hierarchy of functional load [Highest to Lowest]:**
  - Consonantal contrast
    - Vocalic contrast
      - **Tonal contrast**
    - Major oppositions

(Voicing, Length, Glottalization, Vowel Height, Secondary Articulation)
  - Phoneme contrasts

(f vs. h, r vs. ɽ, etc.)

Discussion point 1:
Functional Load of Tone (FLT) hypothesis

Findings for the functional load of lexical tone

- Hausa language tone system
- **Hierarchy of functional load [Highest to Lowest]:**

  - ...

    - Vocalic system contrast
    - **Tonal system contrast**

      - ...

FL of a contrast as a system-specific property

- Functional load is system-specific (language-specific)

- It is not identical to perceptual or articulatory pressures, although it interacts with them

- We therefore expect to see some cross-linguistic variation across prosodic systems (tone systems or stress systems)

Null FL of stress – Oh et al. 2015 (Token & Inflected)

	Cantonese	Mandarin	English	French	German	Italian	Japanese	Korean	Swahili
FL_{Cons}	10.64	13.09	20.82	19.41	15.45	11.12	9.39	11.5	20.0
FL_{Vowel}	4.55	3.24	6.7	14.83	4.37	7.61	3.76	3.3	4.11
FL_{Tone}	4.48	4.13							
FL_{Stress}			.005		.01	.24			

Null FL of stress – Oh et al. 2015 (Token & Inflected)

	Cantonese	Mandarin	English	French	German	Italian	Japanese	Korean	Swahili
FL_{Cons}	10.64	13.09	20.82	19.41	15.45	11.12	9.39	11.5	20.0
FL_{Vowel}	4.55	3.24	6.7	14.83	4.37	7.61	3.76	3.3	4.11
FL_{Tone}	4.48	4.13							
FL_{Stress}			.005		.01	.24			

Null FL of stress – Oh et al. 2015 (Token & Inflected)

	Cantonese	Mandarin	English	French	German	Italian	Japanese	Korean	Swahili
FL_{Cons}	10.64	13.09	20.82	19.41	15.45	11.12	9.39	11.5	20.0
FL_{Vowel}	4.55	3.24	6.7	14.83	4.37	7.61	3.76	3.3	4.11
FL_{Tone}	4.48	4.13							
FL_{Stress}			.005		.01	.24			

Large functional load of lexical tone in Chinese

- In contrast to Hausa, previous research in tonal languages Mandarin and Cantonese has shown that the functional load of vowels is largely equivalent to that of tone, showing their equal lexical importance

  [Surendran & Niyogi 2003, 2006; Surendran & Levow 2004; Oh et al. 2013, 2015]

- cf. Hausa Nouns

notone	H vs. L	5550	12.43827	0.03188	100%	1
noV	i vs. e vs. a …	5251	12.35838	0.11177	351%	3.5 x

Functional Load of Tone (FLT) hypothesis

- We can put forward the **Functional Load of Tone (FLT)** hypothesis ← **A hypothesis which remains to be tested**

- States that in languages where the functional load of lexical tone is low (e.g. Hausa), the use of grammatical tone is relatively high, and vice versa

- This hypothesis is (anecdotally) supported by the large role grammatical tone plays in Afroasiatic tone systems (Mous 2009, Schuh 2017), and its diminished role in these Chinese languages

Functional Load of Tone (FLT) hypothesis

- In short, in many languages little to no lexical information is lost if tone is completely wiped out/replaced   (…Swahili?)

- Communication-based bias preserves and enhances grammatical exponence along 'underutilized' phonological dimensions when lexical contrast would not be significantly compromised, i.e. inflectional, grammatical, intonational uses of tone

- Builds off of Hall et al.'s (2016) functionalist **Message Oriented Phonology** program, compatible with formalist OT implementation

  - Remains to be properly tested…

Functional Load of Tone (FLT) hypothesis

- **Notable aspect**: Lexical heads' tone is neutralized, but inflectional tone is not, often assigned from/co-occurring with affixes

- Negative present
  /à-é-ɾè-Ⓛ-rìɣⒽ-a   àwáná   áŋkà   ɣó   ìŋkòlò/
  [èɾé**tìɣ**   **àwàn**   **àŋkà**   **ɣò**   **ŋkòlò**]
  's/he does not leave the children alone tonight'

- Negative subjunctive
  /à-á-Ⓗ-lwàn-àɣ-a   ɣó ìɗyànjà kwáŋgá   òɣwèrà   néŋgénéŋgé/
  [à**lwánáɣá**   **ɣ íɗyánjá   kwáŋg**   **óɣwɛ́ɾá**   **néŋgénéŋgé**]
  'that s/he usually do not stay late at work'

Functional Load of Tone (FLT) hypothesis

- This contradicts the oft-cited preference for **root faithfulness** over **affix faithfulness**

  [McCarthy & Prince 1995; Beckman 1998; Ussishkin & Wedel 2002; Krämer 2006; Urbanczyk 2011; Hall et al. 2016, a.o.; however cf. Hargus & Beavert 2004]

Discussion point 2:
Towards better documentation and description of tonal systems

Segmental Bias

- Well known that the current sample of human language suffers from under-documentation and under-description
  - "Not more than 10-15 per cent of languages have been described comprehensively" [Comrie et al. 2005:3]

- **The state of prosodic documentation is much worse!**

Documentation levels [Hammarström 2014:16]

Nearly all "undocumented" families/isolates (∼ 30) are to be found in the New Guinea area

Laos & Nigeria are the countries with the lowest avg documentation level

Country	Avg Doc	# lgs
Laos	1.64	47
Nigeria	1.77	489
Bhutan	1.82	22
Papua New Guinea	1.94	850
Indonesia (Papua)	1.99	690
Viet Nam	2.07	69
Philippines	2.27	168
Benin	2.30	37
Liberia	2.30	23
Cameroon	2.35	240
Chad	2.35	113

points	type
5	long grammar
4	grammar
3	grammar sketch
2	dictionary
2	text
2	specific feature
1	wordlist
0	minimal
0	overview

Documentation levels [Hammarström 2014:16]

Nearly all "undocumented" families/isolates ($\sim$ 30) are to be found in the New Guinea area

Laos & Nigeria are the countries with the lowest avg documentation level

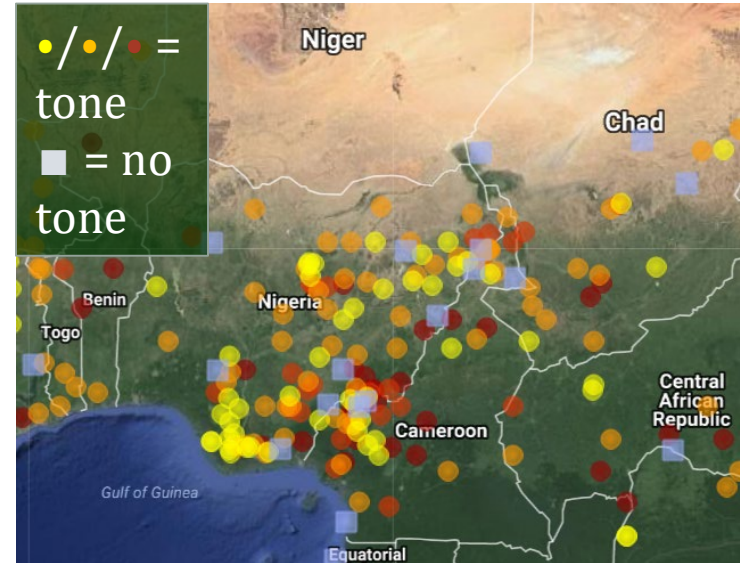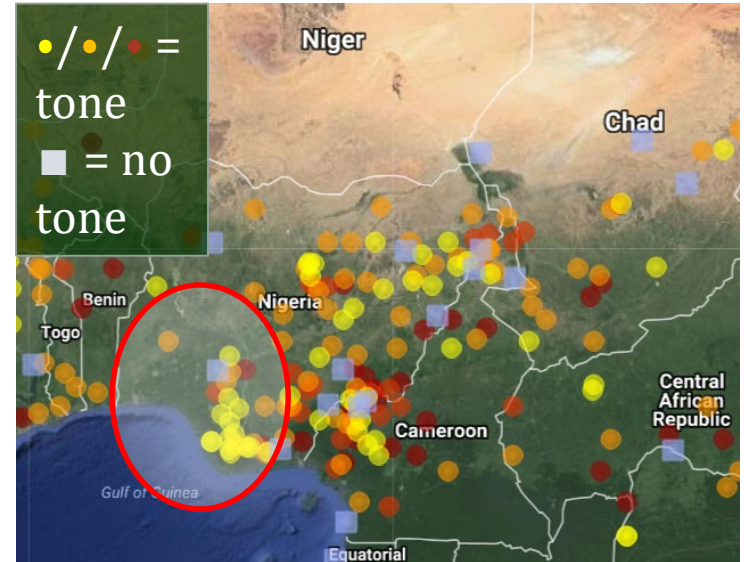| Country	Avg Doc	# lgs
Laos	1.64	47
Nigeria	1.77	489
Bhutan	1.82	22
Papua New Guinea	1.94	850
Indonesia (Papua)	1.99	690
Viet Nam	2.07	69
Philippines	2.27	168
Benin	2.30	37
Liberia	2.30	23
Cameroon	2.35	240
Chad	2.35	113

• / • / • = tone

■ = no tone

- World phonotactics database [Donohue et al. 2013]

Documentation levels [Hammarström 2014:16]

Nearly all "undocumented" families/isolates ($\sim$ 30) are to be found in the New Guinea area

Laos & Nigeria are the countries with the lowest avg documentation level

Country	Avg Doc	# lgs
Laos	1.64	47
Nigeria	1.77	489
Bhutan	1.82	22
Papua New Guinea	1.94	850
Indonesia (Papua)	1.99	690
Viet Nam	2.07	69
Philippines	2.27	168
Benin	2.30	37
Liberia	2.30	23
Cameroon	2.35	240
Chad	2.35	113

- World phonotactics database [Donohue et al. 2013]

Documentation levels [Hammarström 2014:16]

Nearly all "undocumented" families/isolates ($\sim$ 30) are to be found in the New Guinea area

Laos & Nigeria are the countries with the lowest avg documentation level

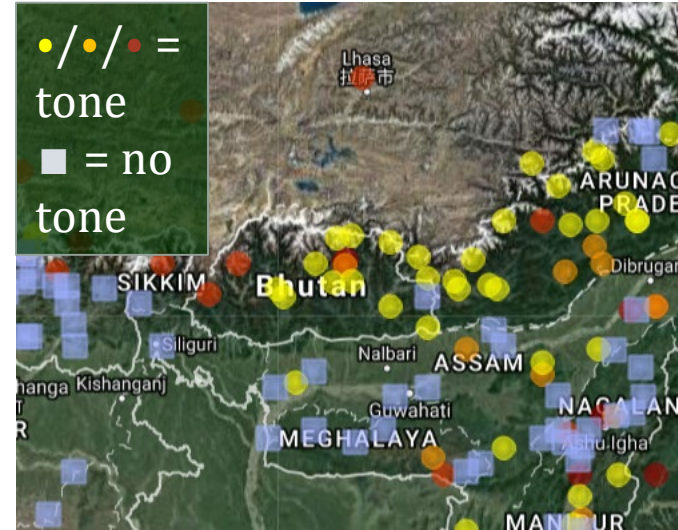| Country	Avg Doc	# lgs
Laos	1.64	47
Nigeria	1.77	489
Bhutan	1.82	22
Papua New Guinea	1.94	850
Indonesia (Papua)	1.99	690
Viet Nam	2.07	69
Philippines	2.27	168
Benin	2.30	37
Liberia	2.30	23
Cameroon	2.35	240
Chad	2.35	113

• / • / • = tone

■ = no tone

- Rolle fieldsites 2009/2014/2015/2017/2019
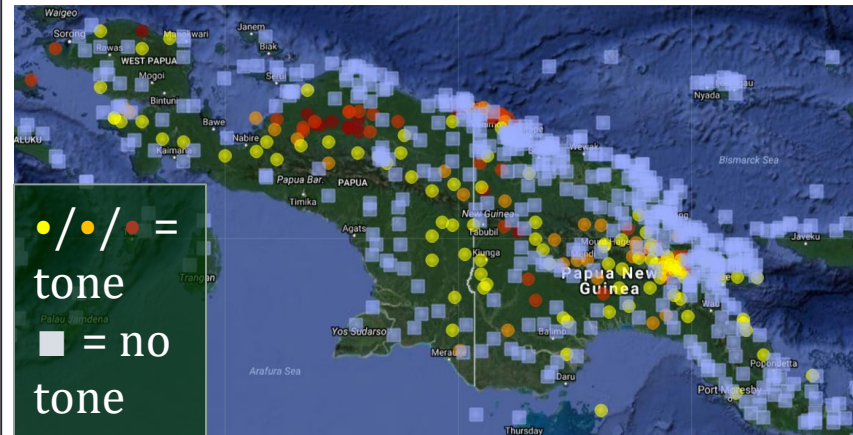- description/ analysis of grammatical tone (see Thesis)

63

Documentation levels [Hammarström 2014:16]

Nearly all "undocumented" families/isolates (∼ 30) are to be found in the New Guinea area

Laos & Nigeria are the countries with the lowest avg documentation level

Country	Avg Doc	# lgs
Laos	1.64	47
Nigeria	1.77	489
Bhutan	1.82	22
Papua New Guinea	1.94	850
Indonesia (Papua)	1.99	690
Viet Nam	2.07	69
Philippines	2.27	168
Benin	2.30	37
Liberia	2.30	23
Cameroon	2.35	240
Chad	2.35	113

● / ● / ● = tone

■ = no tone

- World phonotactics database [Donohue et al. 2013]

Documentation levels [Hammarström 2014:16]

Nearly all "undocumented" families/isolates ($\sim$ 30) are to be found in the New Guinea area

Laos & Nigeria are the countries with the lowest avg documentation level

Country	Avg Doc	# lgs
Laos	1.64	47
Nigeria	1.77	489
Bhutan	1.82	22
Papua New Guinea	1.94	850
Indonesia (Papua)	1.99	690
Viet Nam	2.07	69
Philippines	2.27	168
Benin	2.30	37
Liberia	2.30	23
Cameroon	2.35	240
Chad	2.35	113

● / ● / ● = tone

■ = no tone

- World phonotactics database [Donohue et al. 2013]

65

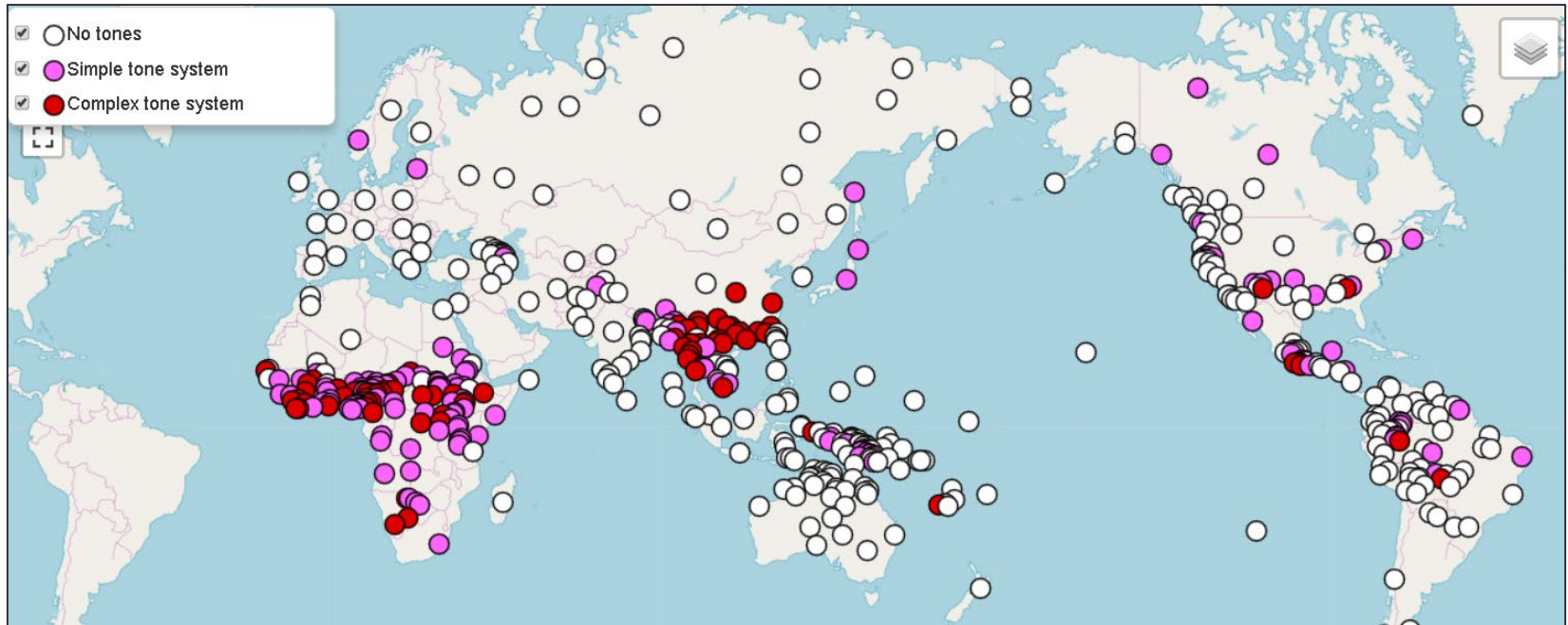# Lack of largescale typologies of tone

- PHOIBLE – **Only segments**
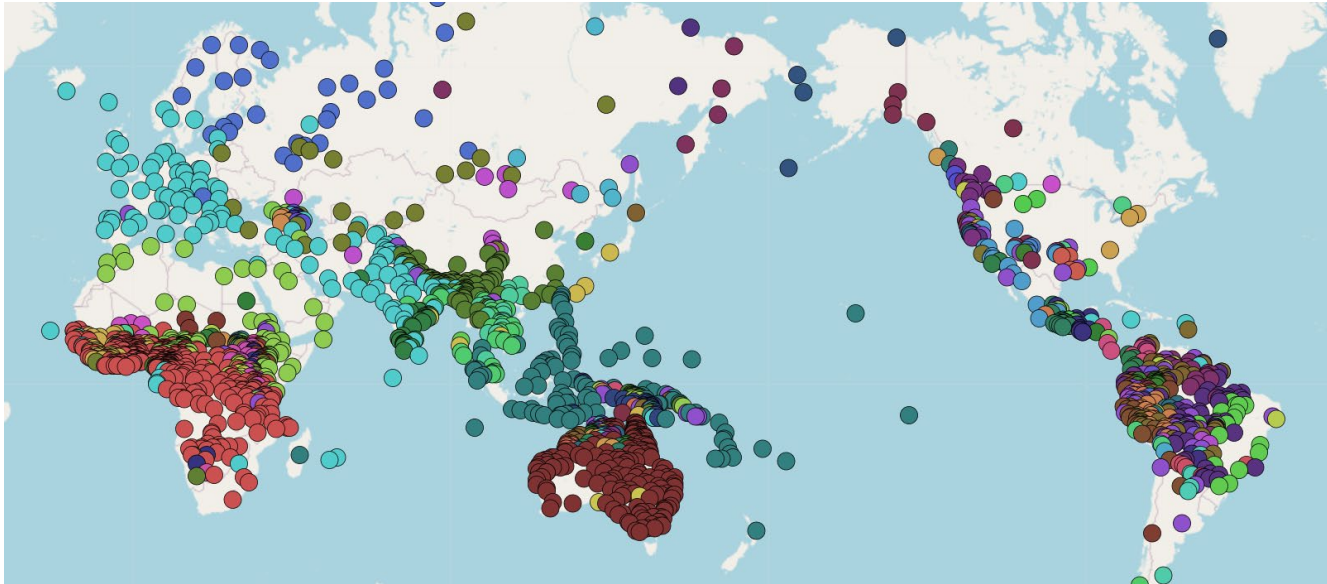
Lack of largescale typologies of tone

- WALS – Almost nothing on tone [Maddieson 2013]

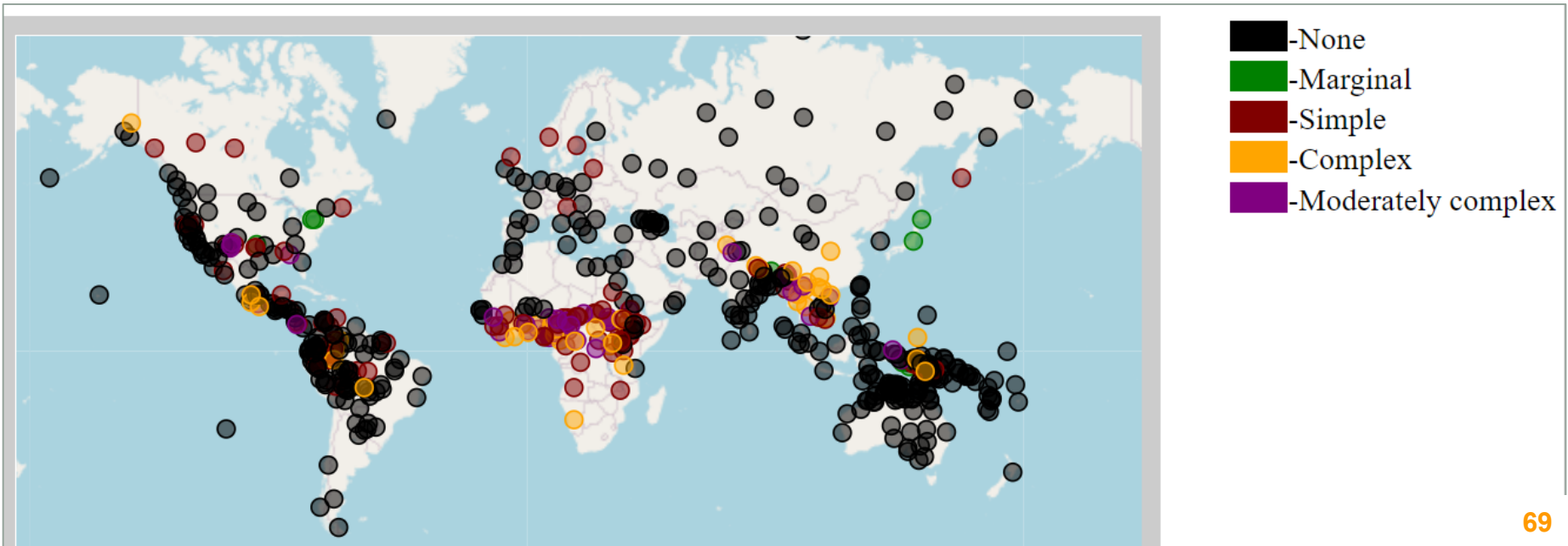|					
10A	Vowel Nasalization	John Hajek	Phonology	244	Values
10B	Nasal Vowels in West Africa	John Hajek	Phonology	40	Values
11A	Front Rounded Vowels	Ian Maddieson	Phonology	562	Values
12A	Syllable Structure	Ian Maddieson	Phonology	486	Values
13A	Tone	Ian Maddieson	Phonology	527	Values
14A	Fixed Stress Locations	Rob Goedemans and Harry van der Hulst	Phonology	502	Values
15A	Weight-Sensitive Stress	Rob Goedemans and Harry van der Hulst	Phonology	500	Values
16A	Weight Factors in Weight-Sensitive Stress Systems	Rob Goedemans and Harry van der Hulst	Phonology	500	Values
17A	Rhythm Types	Rob Goedemans and Harry van der Hulst	Phonology	323	Values
18A	Absence of Common Consonants	Ian Maddieson	Phonology	567	Values
19A	Presence of Uncommon Consonants	Ian Maddieson	Phonology	567	Values

Lack of largescale typologies of tone

- WALS – Almost nothing on tone [Maddieson 2013]

Lack of largescale typologies of tone

- LAPSyD – Lyon-Albuquerque Phonological SYstems Database

Legend:
- -None (black)
- -Marginal (green)
- -Simple (dark red)
- -Complex (orange)
- -Moderately complex (purple)

Lack of clear terminology for inflectional/grammatical use of tone

- tonal morpheme
  [Welmers 1969, 1973; Yip 2002:106]
- tonal affix/affixal tone [Yip 2002:115]
- tonal particle
  [Yip 2002:114]
- tonal suprafix
  [Remijsen 2010: 289-290]
- tonal overlay

[McPherson & Heath 2016]
- inflectional tone
  [Palancar & Léonard 2016]
- replacive tone
  [Welmers 1973:132-133]
- semantic-tonal process [Kam 1980]
- meaningful tone
  [Ratliff 2010]
- morphological tone

[Palancar 2016; Zimmermann 2016]
- morphosyntactic tone [Palancar 2016:113]
- melodic tone
  [Odden & Bickmore 2014]
- floating tone
  [Voorhoeve 1971; Hyman & Tadadjeu 1976]
- …

Lack of clear terminology for inflectional/grammatical use of tone

- ...
- phrasal grammatical tone

  [McPherson & Heath 2016]
- grammatical use of tone

  [Ladefoged & Johnson 2011]
- morphological use of tone [Gussenhoven 2004:46]

- syntactic use of tone

  [Gussenhoven 2004:46]
- tonosyntax

  [Heath & McPherson 2013]
- construction tonology

  [Harry & Hyman 2014]
- melody replacement

  [Rodewald 1989]

- construction-specific tonology

  [Yip 2002:107]
- compacité tonale

  [Green 2018]
- tone perturbation

  [Pike 1948:25; Mak 1950]
- tone change (Chinese: bianyin; cf. biandiao 'tone sandhi') [Chen 2000:30-31]

71

Conclusion & future work

- Lexical tone in Hausa is not as important as in other tonal languages, e.g. Cantonese and Mandarin, but is far more important than in (European) stress languages (lexically at least)

- The next step is to quantify the functional load of grammatical tone in Hausa

- There is a healthy body written Hausa which could be examined to determine frequency counts ← For TOKEN rather than TYPE

  - However, the majority of which is not toke marked...

- Spoken language corpus of Hausa? ← An idea from Nollywood...

Kannywood

Top 10
Kannywood actresses in 2016
w w w . p r e m i u m t i m e s n g . c o m

Kano
KANO

NIGERIA

Abuja

BAYELSA

Kannywood

- "Badariya 1&2 latest Hausa film with English subtitle"

(https://www.youtube.com/watch?v=9CkfZsp6q5k)

Acknowledgments

- Audience of 46th NACAL 2018 (Long Beach, CA)
- Stephanie Shih and Sharon Inkelas for access to their materials and discussions
- For crucial assistance:
  - Frank Lin, Daniel Getter, and all the assistants with this project

- **References are available by request**

75

EXTRA

Change in Entropy

- We look at **Change in Entropy**

- NOTE: "if raw minimal pair count is used, or minimal pairs relativized to the size of the corpus, these will be perfectly analogous to the (non-standard) calculation of functional load based on change in entropy using word types (rather than tokens)." [Hall et al. 2016]

Low number of tonal minimal pairs

- In Chadic (interpreted from Schuh 2017:90)

| **Lang**	**ISO**	**n = (approx.)**	**Distinguished by tone**	
Bole	bol	2000	139	6.95%
Bura	bwr	600	30	5%
Ngizim	ngi	1900	76	4%
Miya	mkf	670	6	0.9%
Gude	gde	800	4	0.5%

Need for a larger typology of GT

- Contributions of (grammatical) tone to linguistic inquiry outside of phonology are less apparent, e.g. across morphological theories of different stripes
  - [Paradigm Function Morphology - Stump 2001; Distributed Morphology - Halle & Marantz 1993; Construction Morphology - Booij 2010a,b]
- GT has long been ignored in morphology textbooks
  - [Matthews 1974, Booij 2005, Lieber 2009, Haspelmath & Sims 2010, Aronoff & Fudeman 2011]
- GT only marginally discussed in morphology handbooks and overviews
  - [Spencer & Zwicky 1998, Hippisley & Stump 2017]
- Limited discussion even in books dedicated to tone
  - [Fromkin 1978, Chen 2000, Yip 2002, Wee forthcoming – an exception is Palancar & Leonard 2016]

Major generalizations

- **Non-dominant is symmetrical:**
  - **i.e. Concatenative (~ Neutral)**
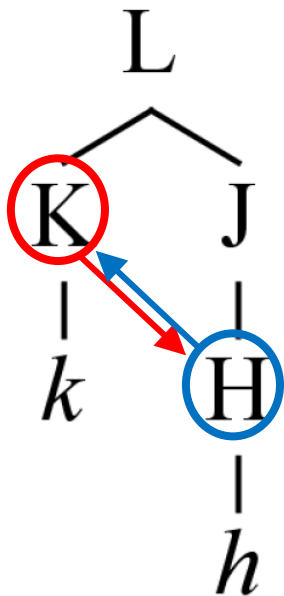
- **Dominant is asymmetrical:**
  - **i.e. Additive-dominant/ Replacive**
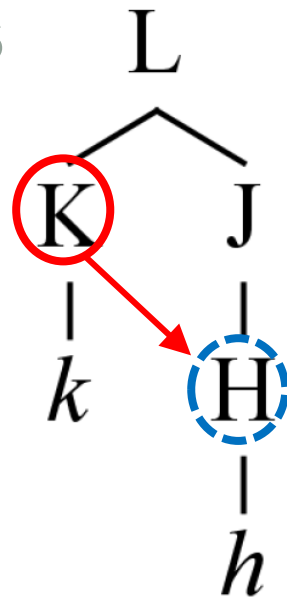
Dominant tone asymmetry

Trigger → Target / Tone pattern			Non-dominant (e.g. docking)	Dominant (e.g. replacive)
Grammatical/ Dependent	→	**Lexical head**	✓ **Yes**	✓ **Yes**
a. Affix	→	Root	✓ Yes	✓ Yes
b. Modifier	→	Noun	✓ Yes	✓ Yes
c. Object	→	Verb	✓ Yes	✓ Yes
Lexical head	→	**Grammatical/ Dependent**	✓ **Yes**	* **No**
d. Root	→	Affix	✓ Yes	* No
e. Noun	→	Modifier	✓ Yes	* No
f. Verb	→	Object	✓ Yes	* No

Anatomy of GT

GT with / mí ⓁⒽ / 'this' (neut.)				
/HH/	/námá/	'meat'	\mí **nàmá**\	'this meat'
/LL/	/pùlò/	'oil'	\mí **pùló**\	'this oil'
/HL/	/bélè/	'light'	\mí **bèlé**\	'this light'
/LH/	/gàrí/	'garri'	\mí **gàrí**\	'this garri'
/H˅H/	/ɓá˅rá/	'hand'	\mí **ɓàrá**\	'this hand'

- *Kalabari* (Ijoid: Nigeria - Harry & Hyman 2014)
- **Trigger**: demonstrative *mí* /H/ 'this'
- **Target:** noun
  - (the undergoing of the tonological process)
- **Tune**: ⓁⒽ
  - (covaries with demonstrative)

Segmental Bias, or why grammatical prosody is important

- Grammatical Prosody Domains can be **<u>Wide</u>**...
  - Ideal for testing locality, triggers/targets, syntax/phonology interface, e.g. phase theory, etc...

- Izon [ɪjɔ] (Ijoid: Nigeria – Rolle fieldnotes, from thesis in production)

- /L L ^{LH}/   /H H /   /L L /   /L L ^{LH}/
  /ìnè/ 'my'   /tárá/ 'three'   /dị̀bà/ 'big'   /bùrù/ 'yam'

- [L L   L L   H H   H H]
  [ìnè   tàrà   díbá   búrú]
  my   three   big   yam   ([ej]pples and ban[ej]n[ej]s tonology)
  'my three big yams'

Segmental Bias, or why grammatical prosody is important

- ... and at the same time, Grammatical Prosody Domains can be **Compact & Competitive**
  - Ideal for studying root vs. affix faithfulness, stratal OT, theories of representational 'weight', etc.

- Dinka [din] (Nilotic: South Sudan – Anderson 1995, Trommer 2011:133)

- /H/   / HL /   /L/
          /wêc/   ..^{μ}

   2sg   'kick'   hither

-          [H   ]
           [wé̤é̤c]

        'kick it hither!'