Why are three-level vowel length distinctions rare?

Insights from Luanyjang Dinka

Bert Remijsen, University of Edinburgh

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Intro

What approaches can help the linguist to discover unexpected phenomena?

While **theory** and **typology** are valuable tools, they can constrain the researcher's awareness.

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While **theory** and **typology** are valuable tools, they can constrain the researcher's awareness.

In the study of sound systems, **knowledge of articulatory / auditory phonetics** offers an additional framework of reference.

Intro – quantity

Can languages have three-level vowel length distinctions (V vs. VV vs. VVV)?

Intro – quantity

The dominant view on quantity distinctions in theoretical phonology is that they are maximally binary:

"A nuclear node may dominate at most two skeletal slots."

[Kenstowicz & Rubach 1987:476

see also e.g. Chomsky & Halle 1968, Prince 1980, Bye 1997, Odden 1997, Duanmu to appear]

Intro – quantity

Nonetheless, three-way length distinctions (V vs. VV vs. VVV) have been postulated for several languages: Estonian, certain dialects of North German, Mixe, and Dinka.

Intro – quantity

A study of quantity in Dinka (joint research with Leoma Gilley)

- Lexical & morphological quantity
- Competing analyses of phonological quantity
- Testing the competing hypotheses
- Conclusions and implications

Dinka – language situation

Dinka is:

a Nilo-Saharan language

spoken in Southern Sudan

by ± 2 million people (Ethnologue).

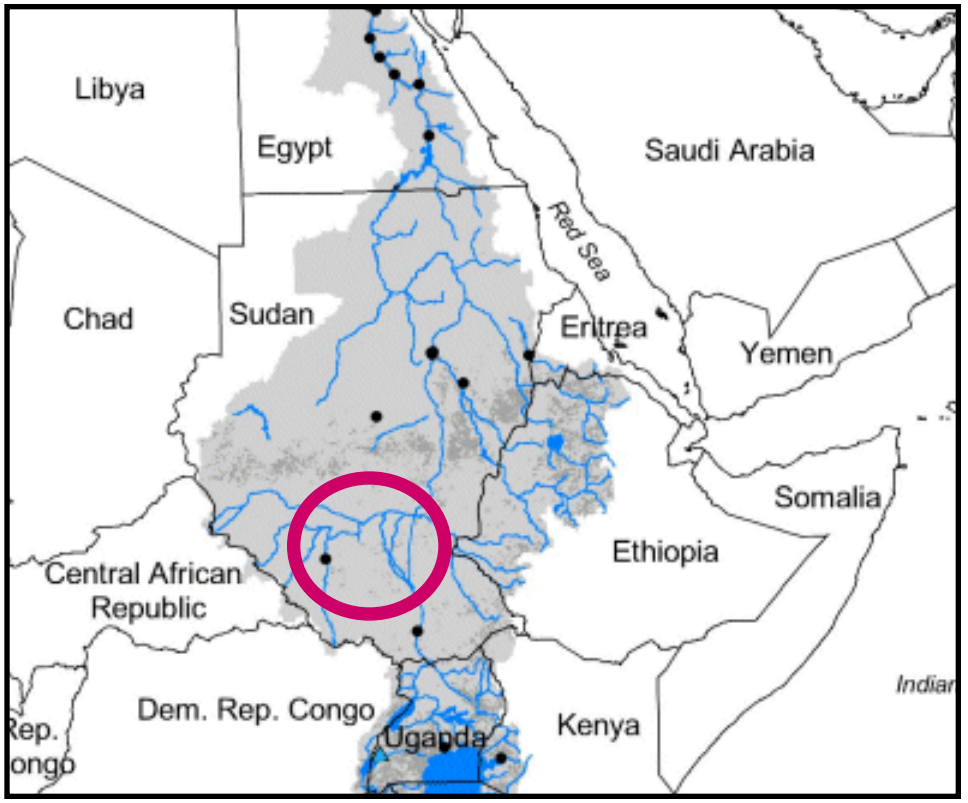


Figure 1: The Dinka language area, marked on the Nile tributary network.

Dinka – Suprasegmental inventory

- 7 vowel phonemes: /i,e,ɛ,a,ɔ,o.u/
- 4 lexical tones (High, Low, Rise, Fall)
- 2 voice qualities (modal vs. breathy)
- 3 or 4 categories of quantity

For minimal-set (sound) examples of these contrasts, you can download a pdf with embedded sound files from:
http://www.ling.ed.ac.uk/~bert/nilotic_output.html

Lexical and morphological quantity

Lexical and morphological quantity

- Quantity distinctions are important in morphological paradigms –

Example with finite verb :

2nd singular	kòow à-**kòl**	
	thorn AGR-take_out:2SG	
	You take out the thorn.	
3rd singular	kòow à-**kòol**	
	thorn AGR-take_out:3SG	
	He takes out the thorn.	

Lexical and morphological quantity

- Quantity distinctions are important in morphological paradigms –

Example with infinitive verb:

Negation	Acóol a-cìi	kòow **kól**
	A.	AGR-NEG thorn take_out:NEGATION
	Acol does not take out a thorn.	
Past	Acóol a-cí	kòow **kôol**
	A.	AGR-PAST thorn take_out:PAST
	Acol has taken out a thorn.	

Lexical and morphological quantity

- In summary, verbs can appear in a shorter grade and in a longer grade:

Morphological quantity		{kol} ‘take out’
Short grade	2nd sg.	kòl
	Negation	kól
Long grade	3rd sg.	kòol
	Past	kôol

Lexical and morphological quantity

- But there is also lexical quantity:

Morphological quantity		Lexical quantity {kol} ‘take out’	Lexical quantity {kool} ‘adopt’
Short grade	2nd sg.	kòl	kóol
	Negation	kól	kòol
Long grade	3rd sg.	kòol	kòool
	Past	kôol	kóool

Lexical and morphological quantity

In summary

- **Lexical quantity**: there are short stems (SS) and long stems (LS).

- **Morphological quantity**: both SS and LS stems appear in a short grade (SG), and in a long grade (LG).

Lexical and morphological quantity

Short Stem		Long Stem	
Short Gr.	Long Gr.	Short Gr.	Long Gr.
làŋ	**láaŋ**	**làaŋ**	**láaaŋ**
berry:PL	berry:SG	overburden	
kól	**kôol**	**kòol**	**kóool**
take out		adopt	

Competing hypotheses

Competing hypotheses

- What is the relation between lexical-morphological quantity and **phonological** quantity?
- In other words: how many **phonemic** levels of quantity does Dinka have?
- What is the most appropriate phonological representation?

Competing hypotheses

The three vowel-length hypothesis (3VL)

Torben Andersen (1987):

Agar Dinka has 3 levels of vowel length –

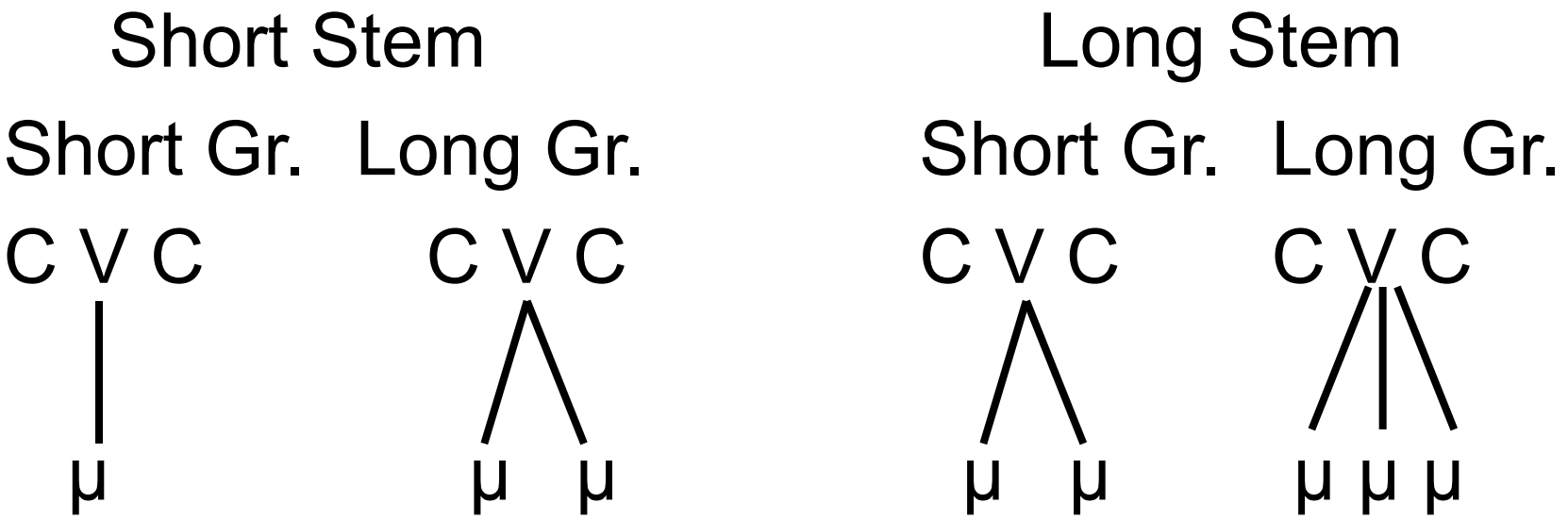
V vs. VV vs. VVV

Competing hypotheses

Short Stem		Long Stem	
Short Gr.	Long Gr.	Short Gr.	Long Gr.
làŋ	**láaŋ**	**làaŋ**	**láaaŋ**
berry:PL	berry:SG	overburden	
kól	**kôol**	**kòol**	**kóool**
take out		adopt	
V	VV		VVV

Competing hypotheses

Andersen's hypothesis in moraic theory (Hyman 1985, Hayes 1989):



NB The mora (μ) is a language-specific weight unit

Competing hypotheses

A challenge to Andersen's 3VL hypothesis:

- Nebel (1948), Tucker (1979), Malou (1989), Duerksen (1994), Gilley (2003): the grade distinction is not just about vowel duration.

- Several of these describe the nature of the very short vowels as 'stressed'.

Competing hypotheses

- Short grade (of short stems):
- centralised vowel quality e.g. /ŋ́éŋ/
- more salient coda e.g. /kʲ̀ir/
- sounds louder

- Phonologically, it could be interpreted as a distinction in coda length.

Competing hypotheses

Alternative hypothesis (2VL+2CL)

Based on Gilley (2003):

Lexical length is vowel length, but the morphological grades are marked by a separate quantity distinction. In other words, there are two binary quantity distinctions:

VCC vs. VC vs. VVCC vs. VVC

Competing hypotheses

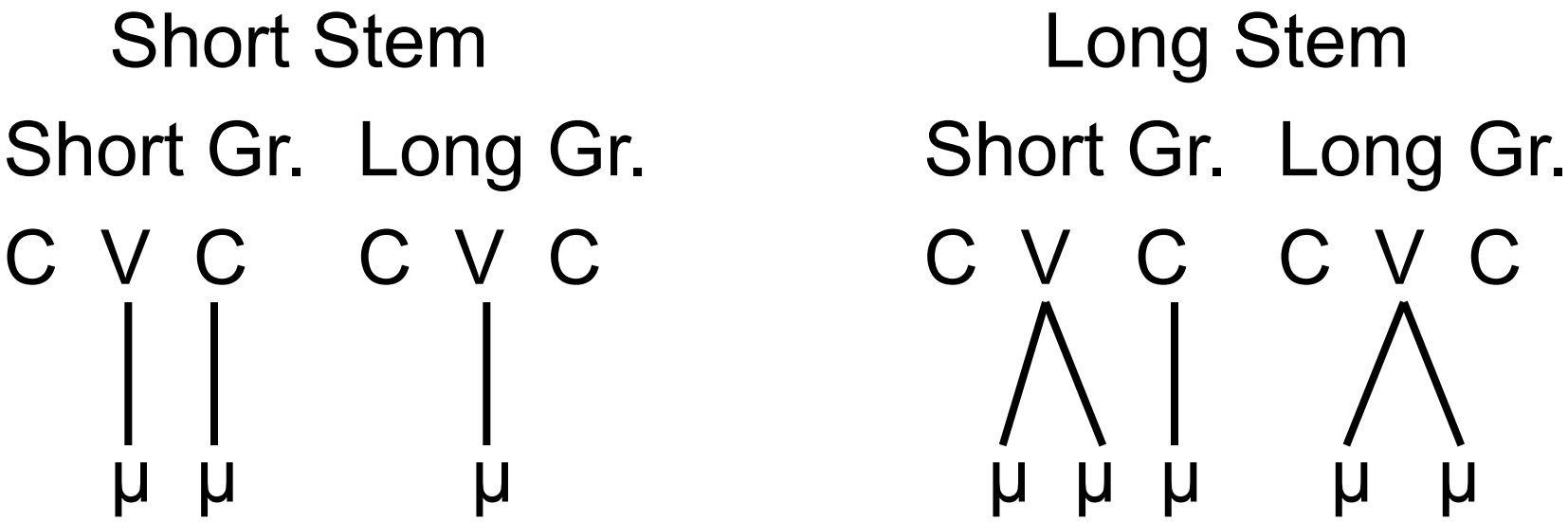
Short Stem		Long Stem	
Short Gr.	Long Gr.	Short Gr.	Long Gr.
làŋ	**láaŋ**	**làaŋ**	**láaaŋ**
berry:PL	berry:SG	overburden	
kól	**kôol**	**kòol**	**kóool**
take out		adopt	
VCC	**VC**	**VVCC**	**VVC**

Competing hypotheses

Short Stem		Long Stem	
Short Gr.	Long Gr.	Short Gr.	Long Gr.
làŋŋ	**láŋ**	**làaŋŋ**	**láaŋ**
berry:PL	berry:SG	overburden	
kóll	**kôl**	**kòoll**	**kóol**
take out		adopt	
VCC	**VC**	**VVCC**	**VVC**

Competing hypotheses

- This alternative hypothesis could be expressed in moraic theory as follows:



Competing hypotheses

Lexical/ Morphological quantity	Phonological quantity			
	3VL		2VL+2CL	
Short St.- Short Gr.	kol	CVC	koll	CVCC
Short St.- Long Gr.	kool	CVVC	kol	CVC
Long St.- Short Gr.	kool	CVVC	kooll	CVVCC
Long St.- Long Gr.	koool	CVVVC	kool	CVVC

Testing the hypotheses

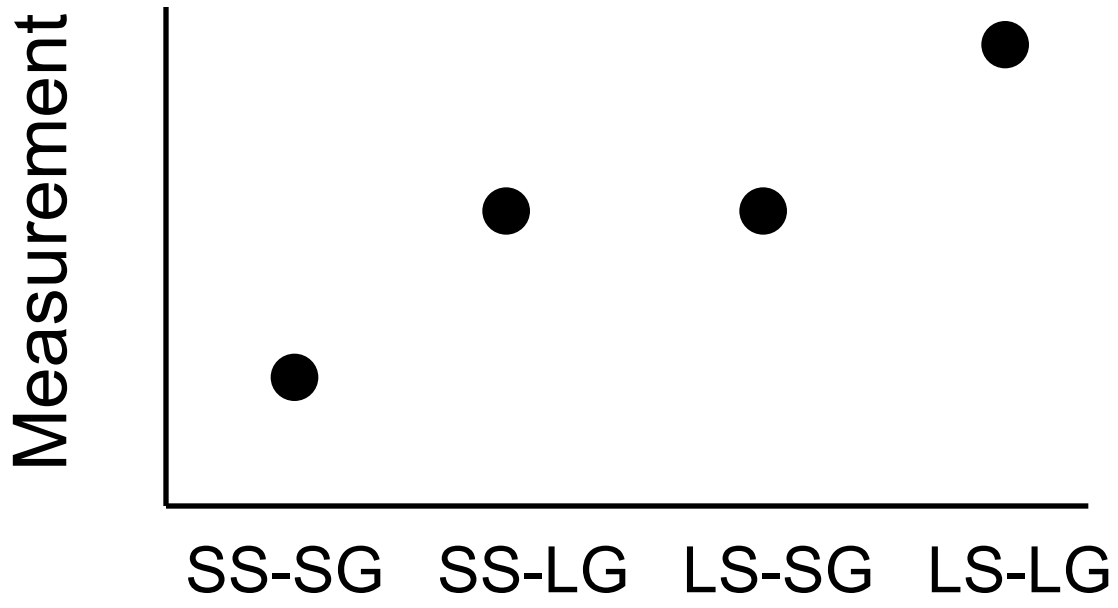
Testing the hypotheses

Assumption underlying the test:

Differences in phonetic duration
reflect differences in moraic structure
in segmentally identical material.
(Broselow, Chen & Huffman 1997)

Testing the hypotheses

- 3VL predicts:



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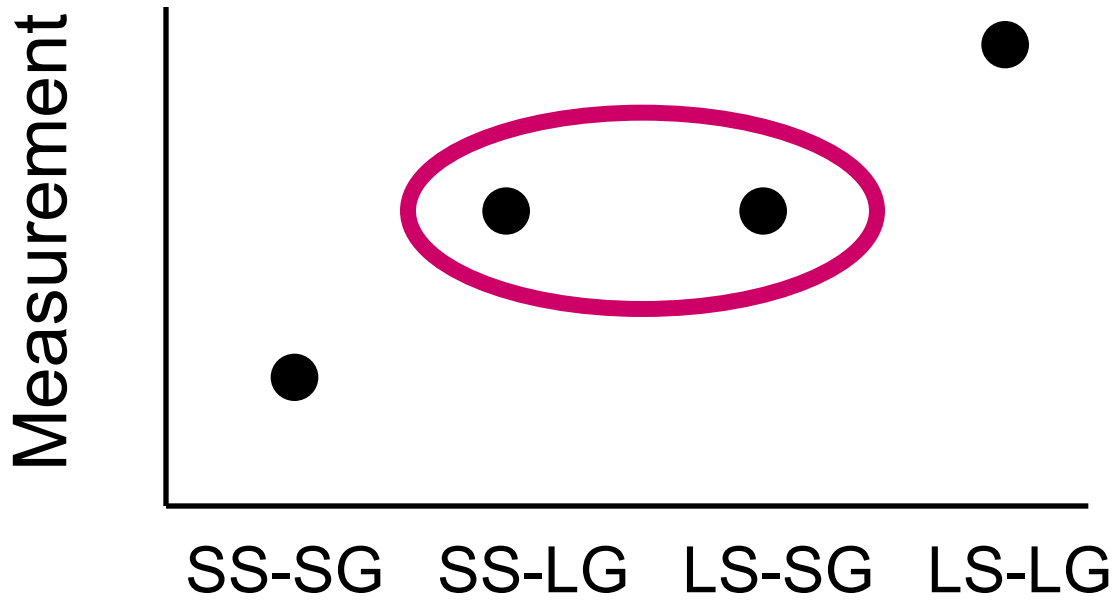

Testing the hypotheses

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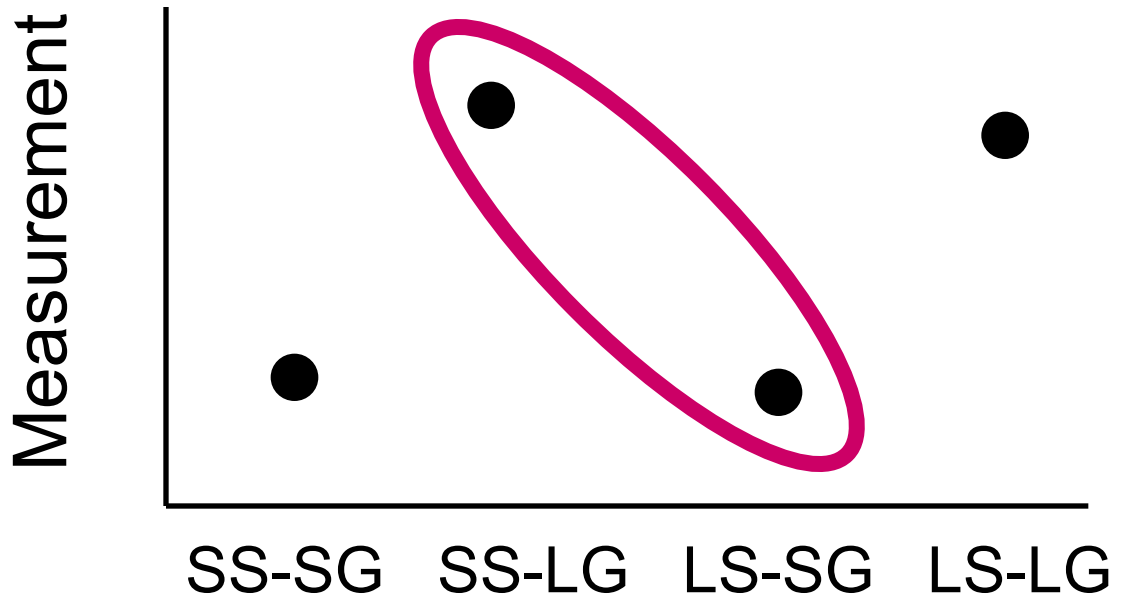


Testing the hypotheses

Methodology of the acoustic analysis

- We collected …

Testing the hypotheses

- 20 complete (four-member) semi-minimal sets

Short Stem		Long Stem	
Short Gr.	Long Gr.	Short Gr.	Long Gr.
làŋ	**laáŋ**	**làaŋ**	**láaaŋ**
berry:PL	berry:SGg	overburden	
kól	**kôol**	**kòol**	**kóool**
take out		adopt	

Testing the hypotheses

- 20 complete (four-member) minimal sets
- including six different vowels (/i,e,a,ɔ,o,u/) and of four coda types (nasal, liquid, rhotic, stop)
- elicited in medial and final contexts
- from 12 speakers of the Luanyjang (Luac) dialect

Dinka – language situation

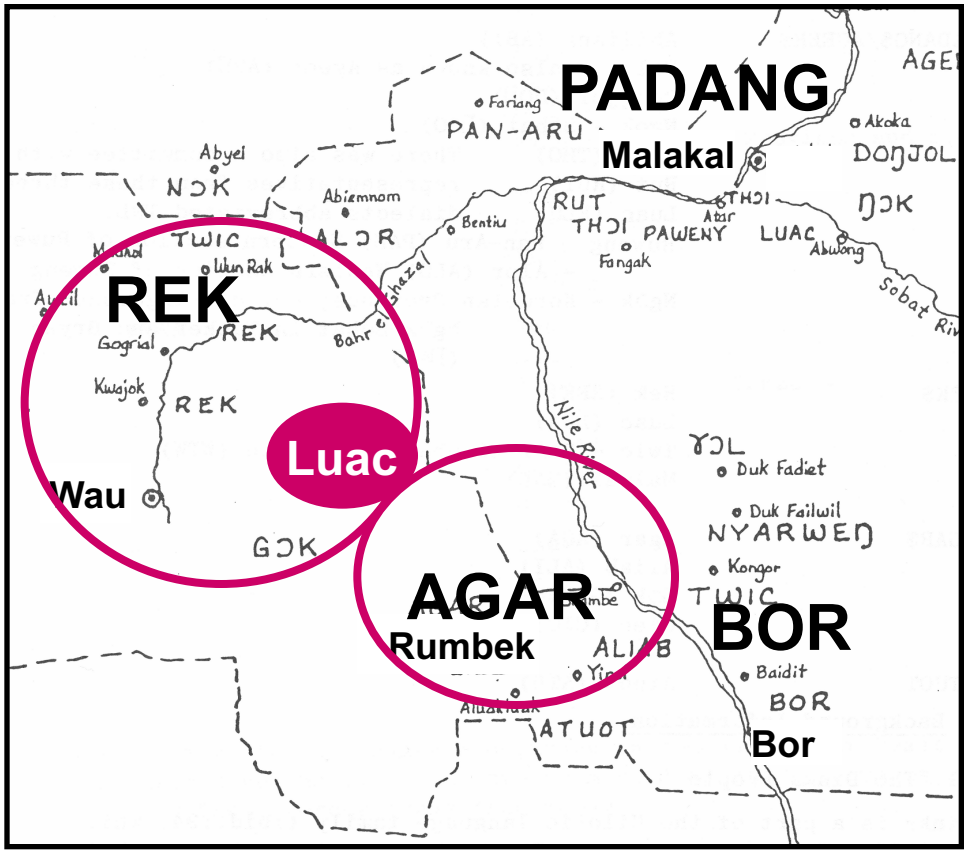


Figure 2: Map of Dinka dialects, based on Roettger & Roettger (1989).

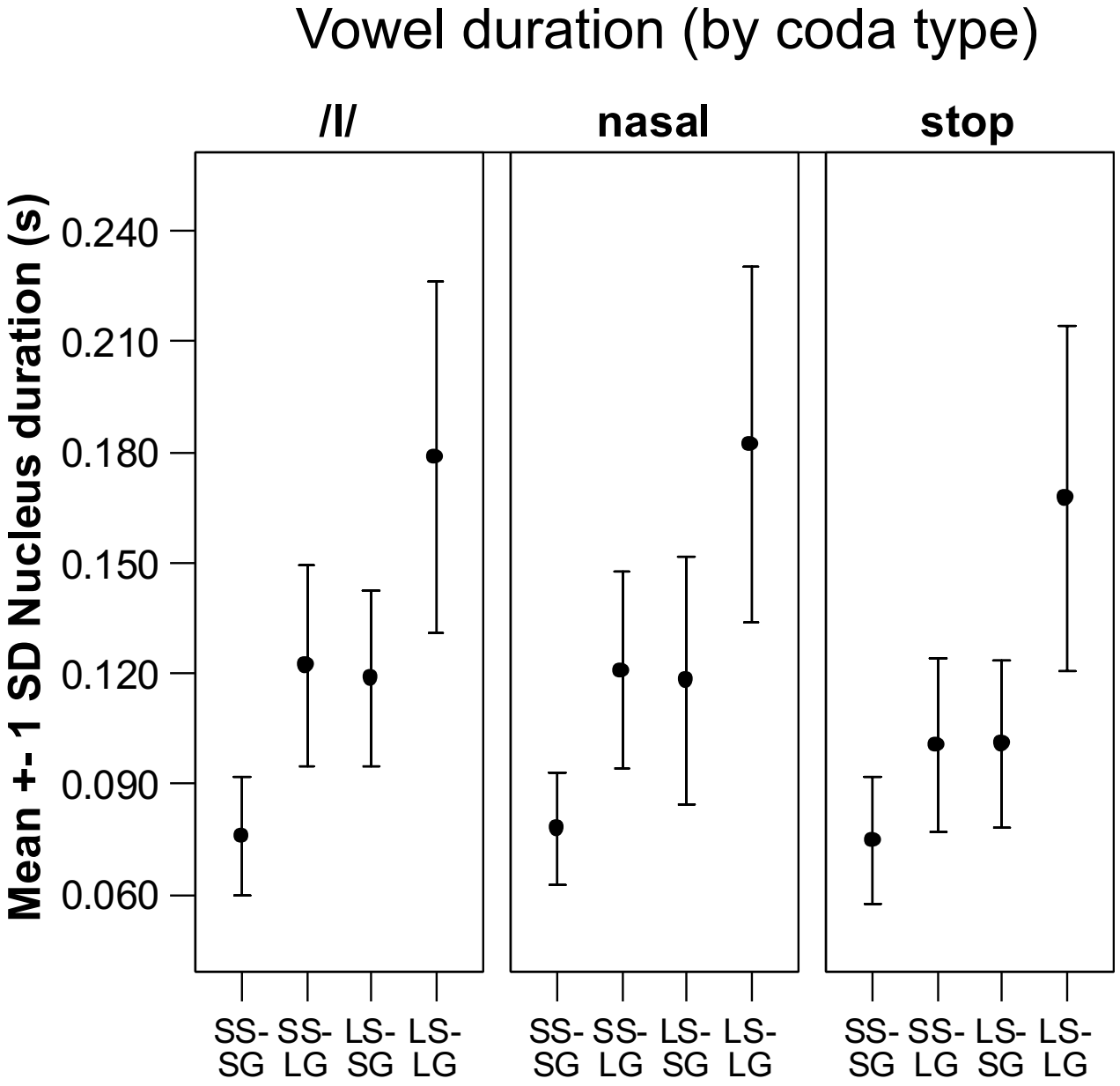
Testing the hypotheses

Measurements:

- Durations of nucleus and coda
- Vowel quality (F1 and F2)
- Several intensity-related measurements

Figure 3:

Means and standard deviations for vowel duration, across speakers. Separate graphs for coda type.



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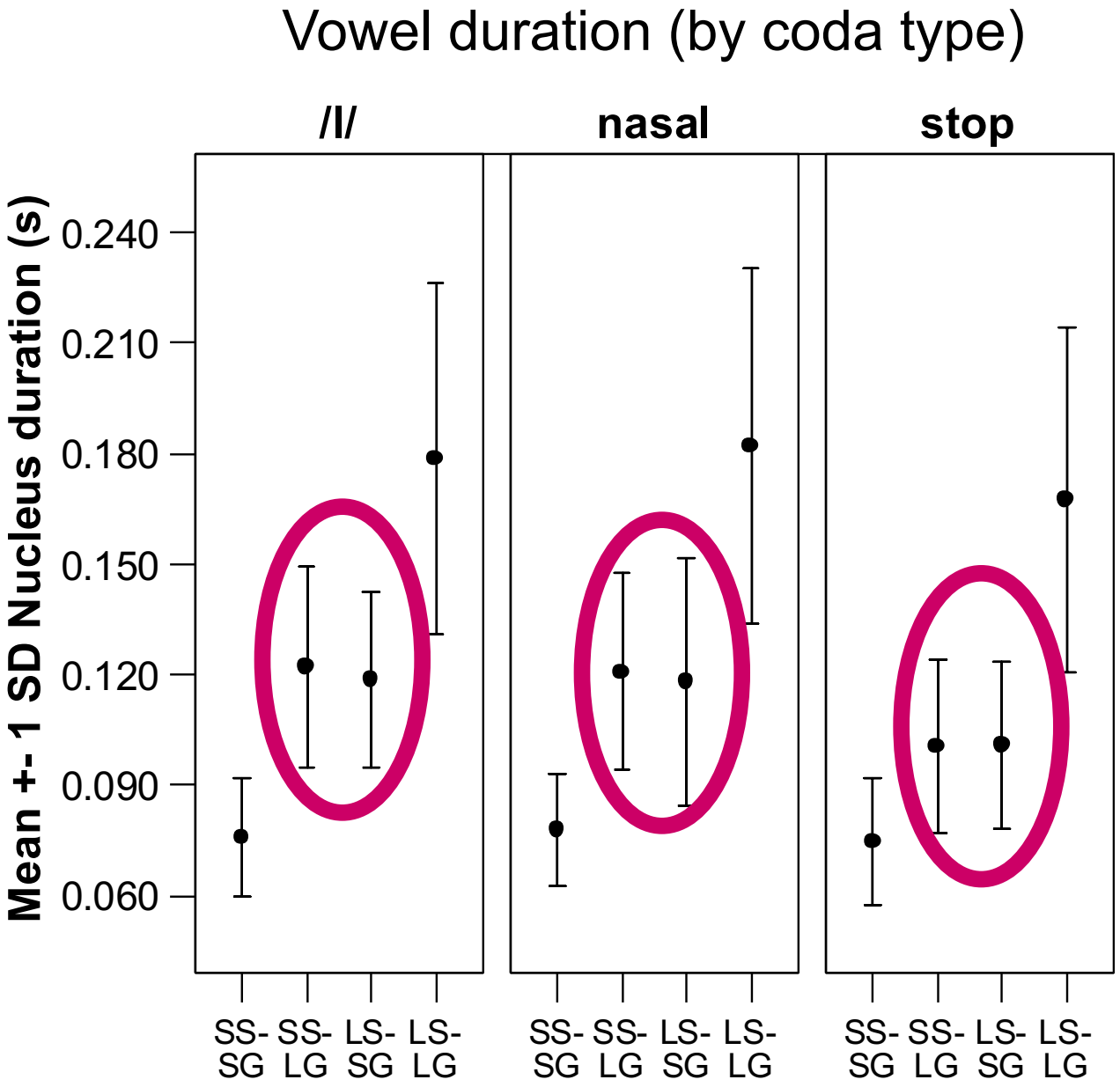


Figure 4:

Means and standard deviations for coda duration, across speakers. Separate graphs by coda type. Sentence-medial context only.

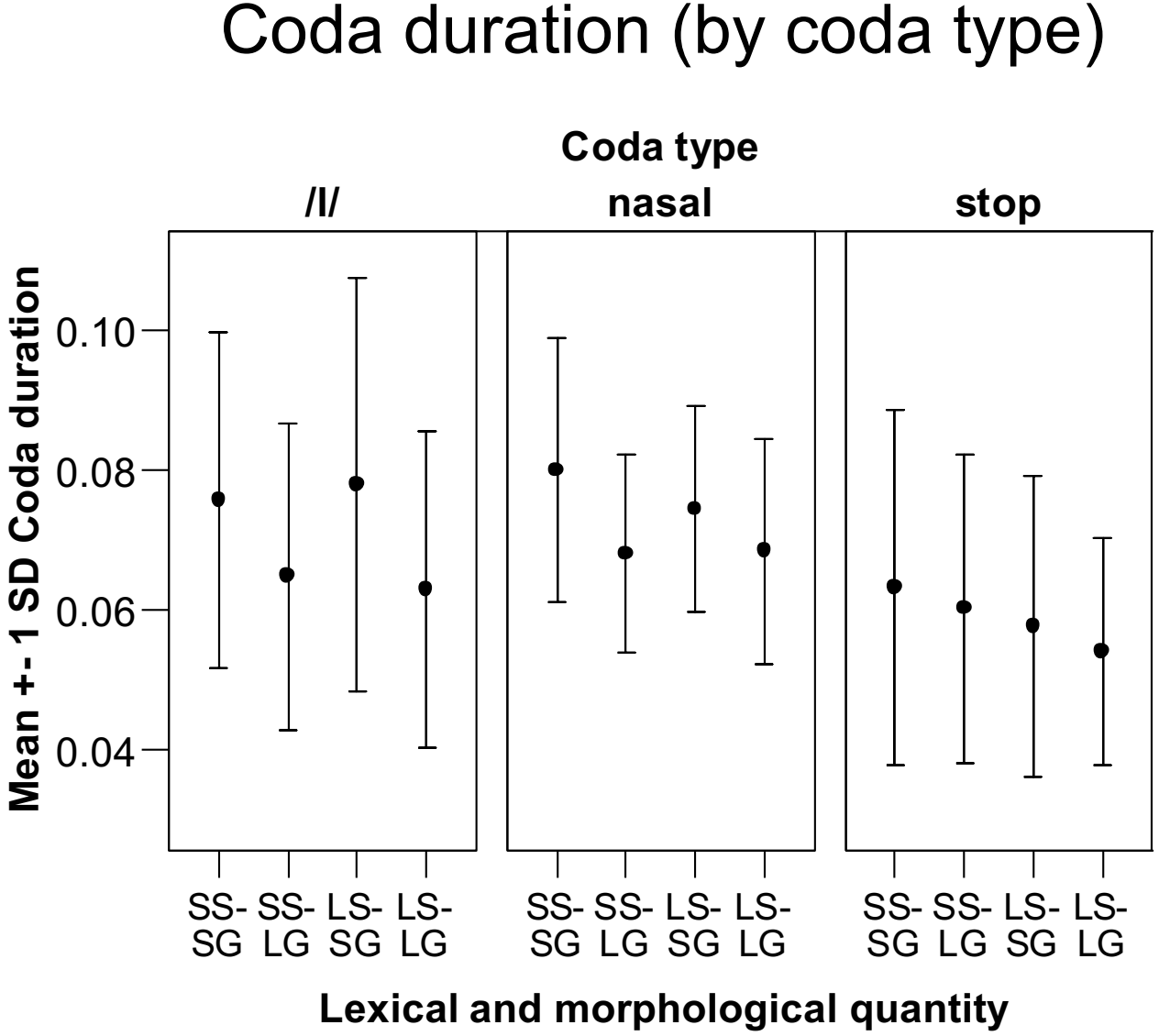


Figure 5:

Means values for first and second formant (F1 and F2), by vowel and by level of lexical / morphological quantuty. Across speakers.

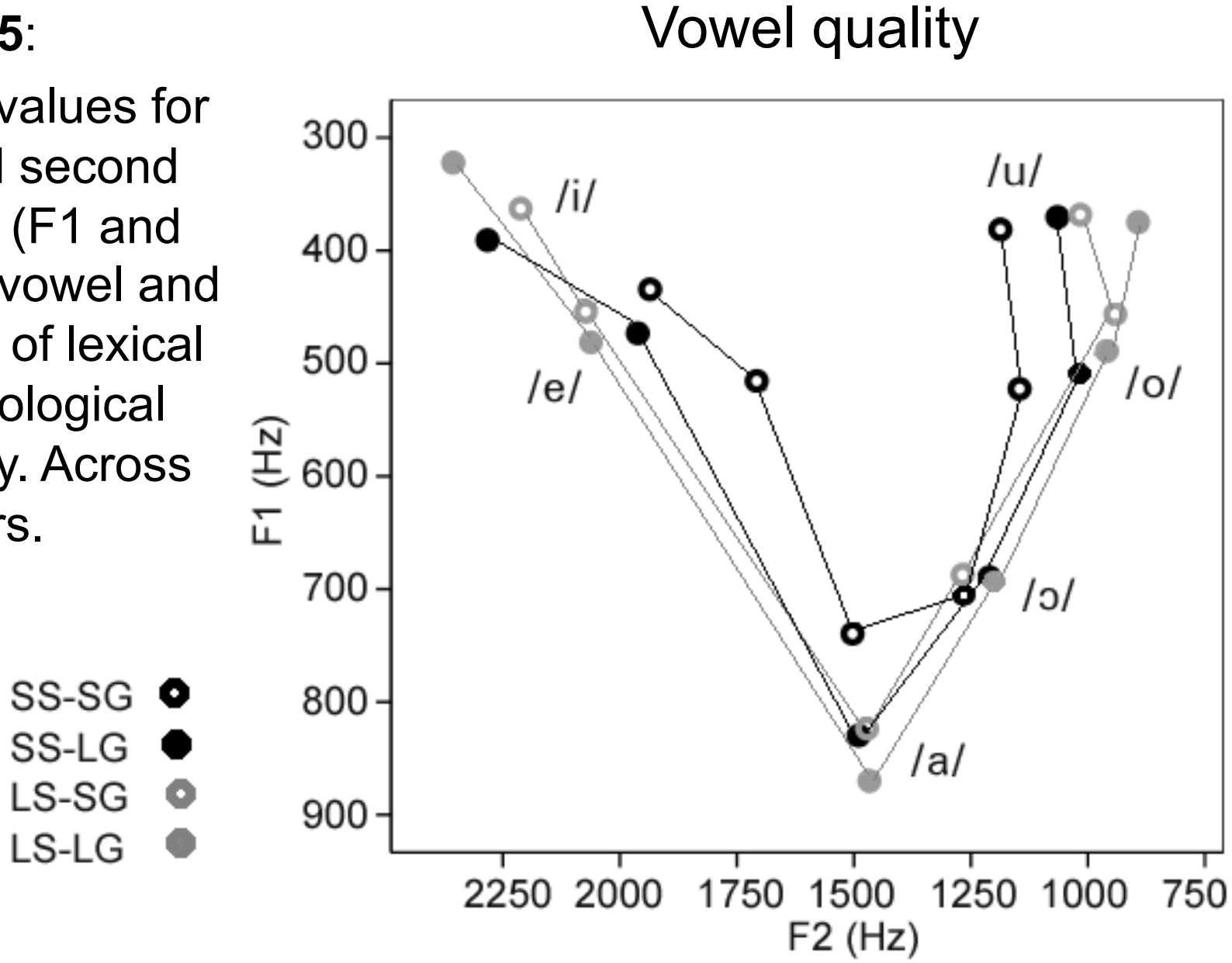
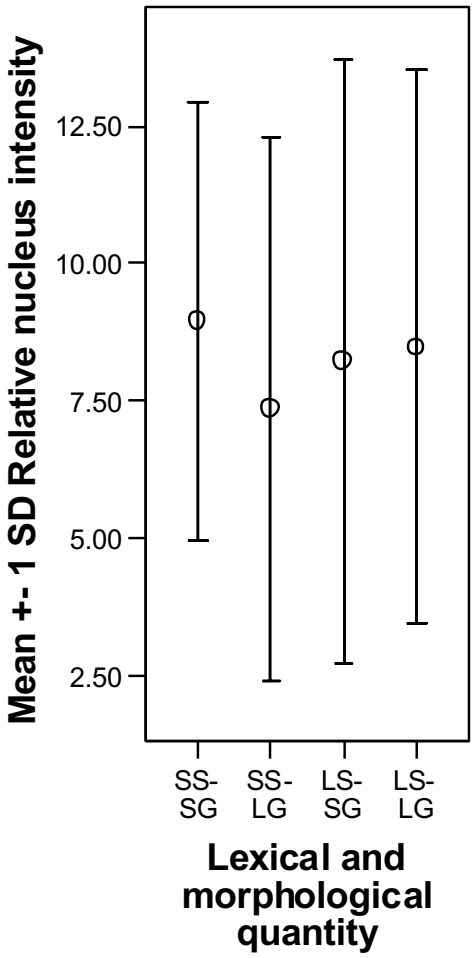
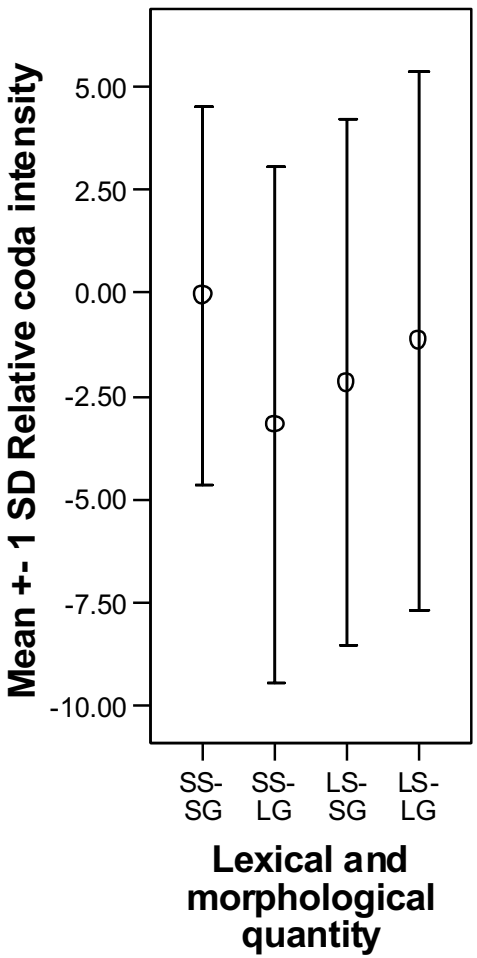


Figure 6: Three intensity-related measurements

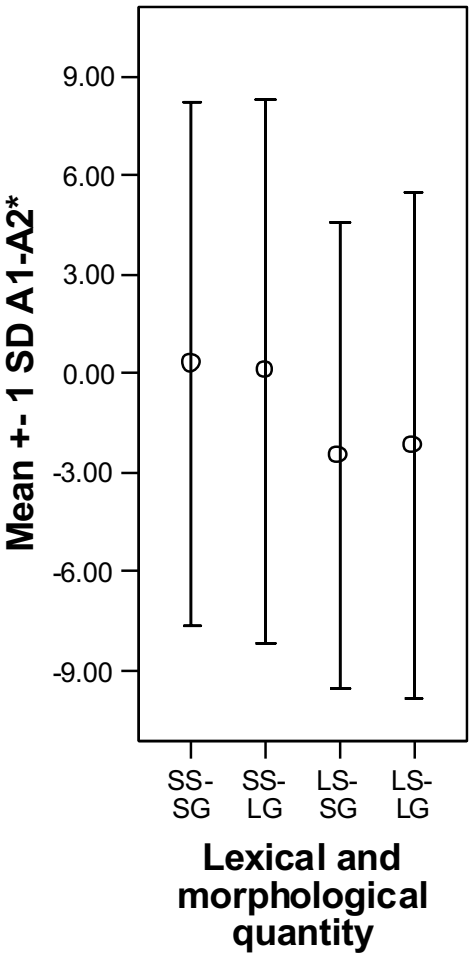
Vowel intensity



Coda intensity



Spectral tilt



Testing the hypotheses

Summary of the results

- In terms of vowel duration, the levels of Lexical/ Morphological separate into three categories:

  SS-SG vs. (SS-LG & LS-SG) vs. LS-LG

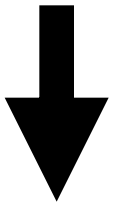
- Vowel quality singles out the short grade of short stems (SS-SG).

- No consistent effects for coda duration or intensity.

Discussion

Discussion

SS-SG vs. (SS-LG & LS-SG) vs. LS-LG



The phonetic evidence from the Luanyjang dialect supports the 3VL hypothesis (Andersen 1987).

Discussion

- **Any hope for the alternative hypothesis – 2VL+2CL?**

Yes –

- in Luanyjang, if the distinction between SS-LG and LS-SG gets neutralised in the contexts we have considered.
- Or in another dialect.

Why are 3-level vowel length systems rare?

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- 2VL:
  V vs. VV = **1:2**
  (Lehiste 1970,
  Broselow et al. 1997).

2VL	Vowel duration
V	76
VV	158

Why are 3-level vowel length systems rare?

- 2VL:
  V vs. VV = **1:2**
  (Lehiste 1970,
  Broselow et al. 1997).

- Dinka:
  V vs. VV
  VV vs. VVV
  } **1:1.5**

2VL	Vowel duration
V	76
VV	158

Dinka	Vowel duration
V	73
VV	103
VVV	147

Why are 3-level vowel length systems rare?

- The range of vowel duration is the same between 2VL and 3VL systems: approx. 70 – 150 ms.
- As a result the levels are closer together in 3VL systems 1:1.5, as compared to 1:2 in 2VL.
- If we would squeeze in a fourth level within the same range, the difference between levels would approach the just-noticeable difference (JND) – approx. 7-20%.

Why are 3-level vowel length systems rare?

- Maintaining the distance between length categories already comes at a cost: short (V) vowels are centralised.

- This means that the V-VV distinction could be reinterpreted diachronically as one of vowel quality (hypocorrection).

Why are 3-level vowel length systems rare?

- Odden (1997: 167): if we drop the binarity constraint on vowel length, there is no principled limit.
- Our study suggests that:
  - The binarity constraint is untenable
  - The phonetics impose a principled limit (3 levels).

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(1) Speech production (range of nucleus duration is roughly constant across vowel length systems).

(2) Speech perception (JND of 7-20%)

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- Odden (1997: 167): if we drop the binarity constraint on vowel length, there is no principled limit.
- Our study suggests that:

  - The binarity constraint is untenable

  - The phonetics impose a principled limit (3 levels).
- Similarly, the difference in no. of levels between length vs. tone distinctions can be related to differences in JND (7-20% vs. 0.5%, respectively).

Many thanks to…

- Caguor Adong Manyang, whose input and support have been crucial to the success of this project.
- Bob Ladd, Peter Ladefoged, and Alice Turk, for thought-provoking discussions on this topic over the years.
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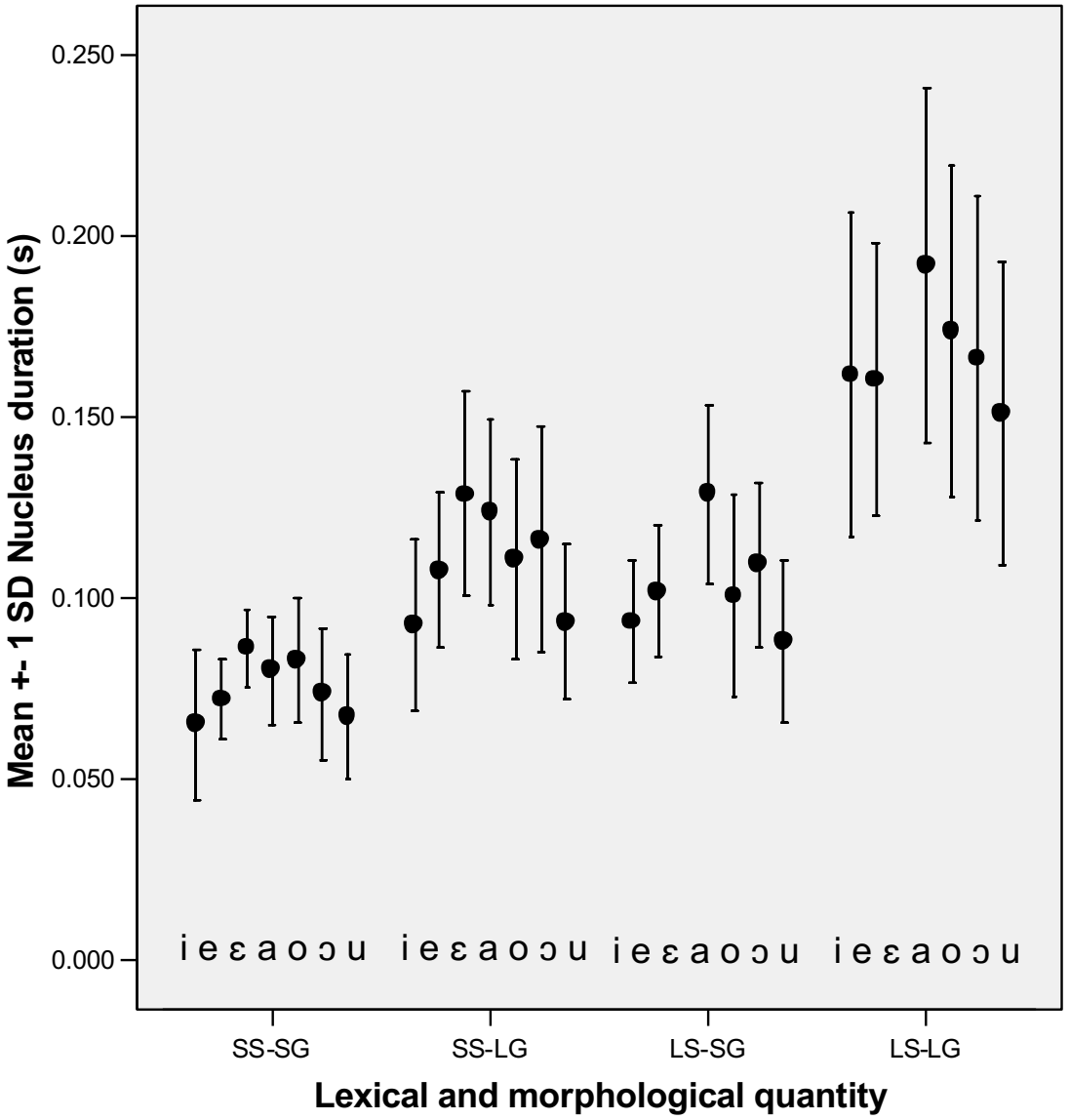
- The Arts & Humanities Research Council and The British Academy, for funding this research.

Quantity x intrinsic duration

Vowel-intrinsic variation in duration is present across quantity conditions:



Quantity x final lengthening

The size of final lengthening increases in a non-linear fashion as a function of phonemic quantity: