Deriving the nonconcatenative preference in Dinka*

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Reading group, November 2

▷ Western Nilotic languages have been cited as a challenge for concatenative approaches to morphology, because of an **preference for non-concatenative processes** (e.g. Aronoff and Fudeman 2011:54; Inkelas 2014:72; Arkadiev and Klamer 2018:450). In Dinka, many inflected forms are marked only by changes to the root, as illustrated for the verb *mîit* 'pull' in (1):

(1) **Table 1. Forms of *mîit* 'pull' marked only by non-concatenative morphology.**

	Simple	CF	CP	APPL	AP.APPL	AP
UNM	mìit	mîiit	mi̱iit	mî̱it	mî̱iit	mi̱it
NF	mîiit	mjêɛɛt	mjɛ̀eet	mjɛ̂̀et	mjɛ̂̀eet	mí̱iit
NTS	míiit	míiit	mí̱iit	mí̱it	mí̱iit	mí̱iit
1SG	mjèɛɛt	mjêɛɛt	mjɛ̀eet	mjɛ̂̀et	mjɛ̂̀eet	mjɛ̀eet
2SG	mîit		mí̱iit			mí̱it
3SG	mìiit	mîiit	mi̱iit	mî̱it	mî̱iit	mi̱iit
PASS	mîit					

▷ The most frequent expression of non-concatenative inflection in Dinka is through vowel lowering and fronting, Andersen's (1993) "vowel grades":

(2) **Vowel fronting (Grade 2):**

Underlying form[1]	Centrifugal	Meaning
nàj	nɛ̂ɛj	'plait'
cɔ̂ɔl	cɛ̂ɛɛl[2]	'call'
bwɔ̂ɔt̪	bjɛ̂ɛɛt̪	'follow'

(Agar Dinka; Andersen 2017:13, 21–22)

(3) **Vowel lowering and breaking (Grade 3):**

Underlying form	1SG	Meaning
pî̱k	pjɛ̀ek	'push'
bù̱t̪	bwɔ̰̀ot̪	'build'
bô̰k	bɔ̰̀ɔk	'throw at'

(Agar Dinka; Andersen 1993:11–12)

*Our thanks to Matthew Baerman, Mirella Blum, Irina Monich, Zhouyi Sun and audiences for talks at Leipzig and UCL for discussion.

[1]The underlying form reflects the root types proposed by Andersen. See Trommer (2011:sec. 5.2) for a proposal that posits different tones.

[2]Note that fronting in underlying forms with ɔ is optional (Andersen 2017:sec. 3.3).

This talk: We develop a concatenative view of these vowel grades, in which they are taken to reflect -V affixes that integrate into the root (cf. Trommer 2011, 2015).

- ▷ We demonstrate that licit -V suffixes in Dinka show vowel reduction and propose that -V suffixes incorporate into the root **to escape a ban on vowel contrast in final position**.
- ▷ This proposal explains the **strong correlation between grade changes and lengthening across paradigms** in verbal and nominal morphology and provides an explanation of an apparent exception in -CV affixes.

⇒ The apparent preference for non-concatenative morphology reflects surface conditions on the wellformedness of suffixes. As a result, Dinka morphology in fact provides evidence for an approach in which non-concatenative expression may be determined by the phonology.

1 Non-concatenative morphology in Dinka

▷ Dinka roots are usually restricted to a monosyllabic template. Within the root, distinctions in **length, tone, and voice quality** are used to mark morphological categories.

▷ Non-concatenative inflection is typically expressed through **vowel lowering and vowel fronting**, described by Andersen (1993) by means of **three "vowel grades"**.

1.1 Constraints on Dinka roots

▷ In this talk, we discuss the Agar variety of Dinka (Nilotic; South Sudan), described by Andersen (1993, 2014, 2017), as well as the Luanyjang dialect (Remijsen and Ladd 2008; Ladd et al. 2009; Remijsen and Manyang 2009).

▷ Dinka roots are generally **monosyllabic with an obligatory onset and coda**, as illustrated with some nouns and verbs in Luanyjang Dinka (4a–h):

(4)

	Noun	Meaning		Verb	Meaning
a.	jòom	'wind'	e.	máaan	'hate.NF'
b.	kít	'color'	f.	kóoot	'care.for.NF'
c.	pjɛ̀en	'viper'	g.	kwà̰at̪	'wrap.NF'
d.	gwɛ̀ɛl	'collar bone'	h.	tɛ̆et	'pick.NF'

(Remijsen and Ladd 2008:180,186, Remijsen and Manyang 2009:115,119)

⇒ Andersen (1993:2) and Remijsen and Manyang (2009:114) provide the following template for the surface form of Dinka nouns and verbs in Agar and Luanyjang, respectively:

(5) **Surface template for Dinka nouns and verbs:**
C (w) (j) V (V) (V) C

Note: The *underlying* form of roots is more restricted and maximally permits a long vowel and one glide (Andersen 1993, 2014; Ladd and Blum 2021).

Length, voice, and tone in Dinka roots

▷ Dinka vowels display a **ternary contrast in length** (Remijsen and Gilley 2008), between short, long, and overlong vowels. Some near-minimal triplets from Luanyjang are in (6):[3]

(6)

Short		**Medium**		**Long**	
láŋ	‘k.o. berries	làaŋ	‘k.o. berry’	lăaaŋ	‘slave’
kít	‘color’	kḭ̀it	‘colors’	kḭ̀iiṭ	‘cloth bag’
cól	‘mouse’	cŏol	‘charcoal’	còool	‘charcoal.PL’

▷ Most Dinka dialects distinguish **three or four tones**, high /ó/, low /ò/, falling /ô/, and sometimes also rising /ǒ/. Agar Dinka has three tones, while Luanyjang Dinka has all four.

▷ Finally, vowels show a binary contrast between **modal/creaky voice (unmarked) and breathy voice /◌̤/**, in all vowels except *u*. Examples from Luanyjang in (7) illustrate:

(7)

Creaky		**Breathy**	
ɟ̰áak	‘pelican’	ɟă̤al	‘visitor, guest’
gwḛ́ṭ	‘Nile perch’	gwĕ̤t	‘bead’
ŋɛ́ɛɛr	‘k.o. gazelle’	nwɛ̤̀ɛɛr	‘Nuer’
kḭ̀iir	‘big river’	kḭ̀iir	‘thorny k.o. tree’
tóoc	‘swamp’	tọ̀oŋ	‘pot’
rwɔ̀ɔŋ	‘stone of fruit’	rwɔ̤̂ɔn	‘year’
		wṳ́uk	‘wing’

Note: We mark voice and tone only on the first vowel, following Andersen.

1.2 Andersen’s vowel grades

The most common expression of non-concatenative morphology in Dinka involves two processes of **vowel lowering and vowel fronting**. Andersen (1993) describes these effects in terms of **three distinct vowel “grades”**. Each morphological category falls into Grade 1, Grade 2, or Grade 3, outlined in Table 2:

(8) **Table 2. Dinka vowel grades, without glides.**[4]

	Creaky					**Breathy**					
Grade 1	i	e	a	ɔ	o	i̤	e̤	a̤	ɔ̤	o̤	ṳ
Grade 2	i	e	ɛ	ɔ	o	i̤	e̤	ɛ̤	ɔ̤	o̤	ṳ
Grade 3	jɛ	ɛ	a	a	wɔ	je̤	ɛ̤	a̤	a̤	ɔ̤	wo̤

[3] Luanyjang examples are taken from the Remijsen (2013) corpus of noun pairs, where a source is not specifically indicated.

[4] See Ladd and Blum (2021:sec. 2.1.2) for a discussion of some minor differences in how these vowel grades function in Luanyjang Dinka.

Each row lists all vowels found in a grade, and each column indicates how vowels correspond across grades.

▷ **Grade 1:** This vowel grade is considered basic, and assumed to reflect the underlying vowel in the root, since it is most frequent and surfaces in unmarked forms (see Andersen 1993, 2017 for more arguments).

▷ **Grade 2:** A number of different inflectional and derivational categories shift the underlying vowel to Grade 2, fronting *a* to *ɛ*, but leaving all other vowels unaffected.[5]

(9)

Underlying form	**3SG**	**Non-topical subject**	**Meaning**
lêer	lèeer	léeer	‘roll’
ŋáaŋ	ŋɛ̀ɛɛŋ	ŋɛ́ɛɛŋ	‘open’
cɔ̂ɔl	cɔ̀ɔɔl	cɔ́ɔɔl	‘call’

(Agar Dinka; Andersen 1993:20)

▷ **Grade 3:** Other morphological categories systematically involve **vowel lowering and breaking** (of peripheral vowels), except when the root vowel is already low *a*.

(10)

Underlying form	**1SG**	**2PL**	**Meaning**
pḭ̂k	pjɛ̀ɛk	pjɛ́k-kạ̀	‘push’
bṵ̀ṭ	bwɔ̤̀ot	bwɔ́ṭ-kạ̀	‘build’
bô̤k	bɔ̤̀ɔk	bɔ́k-kạ̀	‘throw at’
lât	làat	lát-kạ̀	‘insult’

(Agar Dinka; Andersen 1993:11–12)

Historically, these assimilatory processes reflect vowel suffixes that have since been lost. Andersen (2014:239) points out that these vowel suffixes are preserved in other Nilotic languages, as in Surkum (Sudan):

(11)

Unmarked	**1SG (Grade 3)**	**3SG (Grade 2)**	**Meaning**	
lɔ̀ɔk	làaak	lɔ̀ɔɔk	‘wash’	*Agar Dinka*
càm	càam	cɛ̀ɛm	‘eat’	
lɔ̀ɔk	lɔ̀ɔg-**á**	lɔ̀ɔg-**ɛ̀**	‘wash’	*Surkum*
ʔàm	ʔàm-**à**	ʔàm-**ɛ̀**	‘eat’	

⇒ **Key point:** A vowel grade does not represent a single morpheme, but describes recurring processes that are used by a variety of morphological categories to signal inflection.

[5] With centrifugal verbs and some antipassives, Grade 2 also optionally fronts *ɔ* to *ɛ* (Andersen 2017:sec. 3.3).

2 Constraints on Dinka suffixes

Why would a language prefer non-concatenative morphology?

- ▷ The effect of Dinka vowel grades can be modeled by means of underspecified affixes. But, if concatenation is primary, the question remains **why a language would have a preference for non-concatenative inflection**.
- ▷ This section argues that the form of affixes is significantly restricted in Dinka. Suffixes are limited to a -(C)V template (see also Reid 2020:52 on Nuer). Moreover, vocalic suffixes always take the shape of **the reduced vowel *ɐ̟***.

⇒ We propose that Dinka places a **constraint on vowel contrast word-finally**, so that a -V affix is preferentially integrated into the root. Non-concatenative morphology then is a result of **surface phonological constraints**.

2.1 Restrictions on affixes in Dinka

What do affixes look like in Dinka?

I focus on **suffixes in Agar Dinka**, since non-concatenative morphology is oriented to the final syllable (as evident in polysyllabic nouns). Dinka has two paradigms of suffixes:

1. **Verbal suffixes.**
   Verbs take a number of suffixes, which either have the form -V or -CV. All vocalic suffixes are *-ɐ̟*, whereas the CV suffixes are *-kɑ̟*/*kʊ̟*/*kɐ̟*.

Table 3. Agar Dinka verbal paradigms by suffix.

	Simple	CF	CP	APPL	AP.APPL	AP
UNM						
NF						
NTS						
1SG						
2SG		-ɛ̟́		-ɛ̟́	-ɛ̟́	-ɛ̟́
3SG						
1PL	-kʊ̟/kʊ̟́	-kʊ̟	-kʊ̟	-kʊ̟	-kʊ̟	-kʊ̟
2PL	-kɑ̟/kɑ̟́	-kɑ̟	-kɑ̟	-kɑ̟	-kɑ̟	-kɑ̟
3PL	-kɐ̟/kɐ̟́	-kɐ̟	-kɐ̟	-kɐ̟	-kɐ̟	-kɐ̟
PASS		-ɐ̟	-ɐ̟	-ɐ̟	-ɐ̟	–
PASS:CT	-ɐ̟	-ɐ̟	-ɐ̟	-ɐ̟	-ɐ̟	-ɐ̟

(CF = centrifugal, CP = centripetal, APPL = applicative, AP.APPL = antipassive applicative)

2. **Nominal construct state suffixes.**
   There are two -C suffixes that mark **construct state forms**, modified nouns. In the singular, for example, a suffix *-n* often triggers nasal replacement of the coda consonant of the root.

(12) a. ɖɔ̟̀ɔk
‘boy’
b. ɖɔ̟́ɔ**ŋ** dɑ̟̀
boy.CS1 another
‘another boy’ (Agar Dinka; Andersen 2020:275,277)

This suffix has a more restricted plural counterpart *-k* (Andersen 2020:291).

Enclitic demonstratives and possessors

Demonstratives and pronominal possessors are also candidates for nominal suffixes. But, as Andersen (2020) argues, demonstratives and possessors are **phrasal enclitics**, which do not have to attach directly to the noun:

(13) a. ɲíɲ ɐ̟̀ kɑ̟̀ŋ=**dʊ̟**
know.NMLZ.CS1 of thing.PL.GEN=SG.2SG
‘your knowledge of things’
b. ɲà-n bɛ́ɛɛr=**ɐ̟̀**
girl-CS1 tall.CS1=DEM1.SG
‘this tall girl’
(Andersen 2020:293,298)

⇒ Dinka places **significant restrictions on suffixes:**

- ▷ **Optional onset:** Unlike roots, suffixes may surface without an onset.
- ▷ **No length:** Unlike roots, suffixes do not display long or overlong vowels.
- ▷ **No coda:** Unlike roots, suffixes do not surface with a coda.
- ▷ **Little stacking:** Suffixes display little stacking (though the plural clitics can be decomposed into a -C and -V suffix).

A -CV template:
Suffixes are restricted to **the form -CV maximally**.

2.2 Vowel grades as -V suffixes

Key observation: Dinka permits few -V suffixes. Those that do surface **have the form -ẹ̱**.

- ▷ The suffix -ẹ̱ marks the passive, passive circumstantial topic, and 2nd person singular. No other vowel suffixes occur (though CV suffixes may have different vowels, a point to which we return).
- ▷ There is evidence that ẹ̱ is the underspecified vowel in Dinka:
  - Remijsen and Gilley (2008:p. 335) note that short *e* (breathy or creaky) is "appropriately transcribed [ə] in many of its realizations".
  - Andersen (2007:fn. 20) points out that much of the reduced functional vocabulary ends in ẹ̱, suggesting that at least some of these forms have undergone **vowel reduction**. Examples include the preposition *ɛ̀*/*nɛ̀*, the negative auxiliary *cɛ̀*, and some complementizers (e.g. *kɛ̀* 'then', *ɛ́* 'while').
  - In the paradigms of the perfect auxiliary *cɛ́* and future auxiliary *bɛ́*, short forms surface with ẹ̱, alternating with full vowels in long forms.

⇒ **Suggestion:** The prevalence of -ẹ̱ reflects a pressure to **reduce vowel contrast** in word-final position. As a result, vocalic affixes either integrate into the root or undergo reduction.

Proposal: Dinka vowel grades reflect -V affixes that undergo metathesis **to escape vowel reduction**.

- ▷ **Grade 2:** We posit a front vowel suffix -*i* for Grade 2 (or possibly -*ɛ*), since this grade triggers fronting. In addition, this grade likely has its origins in a front vowel. See the cognates of 3rd person singular:

(14)

Form	**Gloss**	**Language**
ʔàm-**ɛ̀**	eat-3SG	Surkum (Andersen 2014:239)
ríiŋ-**ɛ́**	run-3SG	Nuer (Reid 2020:102)
ā-gɛ́ɛr-**ɛ̄**	PST-build-3SG	Anywa (Reh 1996:194)

- ▷ **Grade 3:** We identify Grade 3 with the low vowel -*a*, since this grade triggers vowel lowering across the board. The cognate of Grade 3 inflection is also often a low vowel, such as in the 1st person singular:

(15)

Form	**Gloss**	**Language**
ʔàm-**à**	eat-1SG	Surkum (Andersen 2014:239)
lɛ̄ap-**á̱**	open-1SG	Nuer (Reid 2020:103)
ā-gɛ́ɛr-**ā**	PST-build-1SG	Anywa (Reh 1996:194)

Note: One piece of evidence for this proposal is that auxiliaries with a reduced vowel (the perfect *cɛ́* and future *bɛ́*) surface with these vowels in Grade 2 and Grade 3 contexts, respectively:

Table 4. Paradigm of perfect auxiliary.[6]

	Grade	Perfect
UNM		cɛ́
NTS	2	**cɛ́i**
1SG	3	**cà**
2SG	(3)	**cá**
3SG	2	cɛ̀
1PL		cʊ̀uk
2PL	3	**câak**
3PL		cɪ̀ik
PASS	(2)	**cɛ́i**
PASS:CT	2	**cɛ́in-ɛ̀**

(NF = non-finite, NTS = non-topical subject, CT = circumstantial topic)

2.3 Prominence reduction drives metathesis

What constraints drive vowel reduction?

- ▷ Crosswhite (2001, 2004), based on a crosslinguistically survey on vowel reduction, proposes that vowel reduction is driven in some languages by what she calls "prominence reduction", a pressure to neutralize contrast in less prominent positions.
- ▷ We suggest that the word-final position is a less prominent position in Dinka. We adopt a constraint that **bans a mora word-finally**:

(16) *μ#: Assign a violation mark for a word-final mora.

- ▷ We propose that reduction to the default vowel ẹ̱ occurs because **ẹ̱ can be a non-moraic vowel in Dinka** (see also Crosswhite 2001 on schwa). As a result, ẹ̱ will not violate (16).

What happens when a root takes a suffix with a moraic vowel (e.g. -*i* or -*a*)?

- ▷ The proposal is that, for vocalic affixes with moraic vowels, (16) drives incorporation into the root if faithfulness constraints preventing vowel reduction or deletion outrank constraints blocking metathesis (MAXμ >> LINEARITY).
- ▷ We illustrate with a tableau in (17) for Grade 2, the 3rd person singular of *mîit* 'pull'. As motivated above, the Grade 2 suffix is -*i*.

[6] Grades in parentheses indicate the grade found in derived paradigms.

(17) **Tableau for Grade 2 3SG suffix.**

	Input: [mîit+ì$_{3SG}$]	MAXμ	*μ#	LINEARITY
☞	a. mìiit			∗
	b. mìit	∗!		
	c. mîit-ì		∗!	
	d. mîit-ẹ̀	∗!		

▷ (We model the fronting and lowering effects as the outcome of feature spreading, see also Zaleska 2020. The appendix presents a detailed proposal.)

⇒ In accordance with this view, Grade 2 and Grade 3 morphological categories reliably lengthen roots by **one degree of length** across verbal and nominal paradigms (Andersen 1993, 2017; Ladd and Blum 2021; van Urk and Sun 2021). Underlyingly short roots become long and underlyingly long roots become overlong.

2.4 Implementing a -(C)V template for affixes

How do we model the -CV restriction on suffixes?

▷ **On the -(C)V shape.**

- The onset requirement of roots is evidence for high-ranking ONSET. In suffixes, the **onset C is already provided by the obligatory coda consonant of the root**.[7]
- We attribute the absence of codas to NOCODA. Roots must be exempted from this effect by whatever constraint drives the obligatory coda consonant, perhaps McCarthy and Prince's (1990) FINALC (see also Gafos 1998).
- The absence of long or overlong vowels is attributable to a constraint on long vowels at the end of the word, *μμ#. A similar restriction is active in Nuer (Reid 2020).

▷ **Little stacking.**
A number of authors have related **word maximality effects to metrical structure** (de Lacy 2003; Ketner 2006; Uchihara and Mendoza Ruiz 2021).

[7] In support of this, notice that some auxiliaries lacking a coda, such as the perfect auxiliary *cɛ́* or the sequentive *góo* insert a consonant before a -V suffix (e.g. *cɛ̂ì**n**-ẹ̀* 'PRF-PASS.CT' and *gôo**r**-ẹ̀* 'SEQ-PASS.CT', Andersen 2007). But there are other functional items without onsets, such as the nominal prefix *a-* or the general purpose preposition *ẹ̀*. So it is also possible that ONSET applies to roots only.

The combination of maximal root and affix template are reminiscent of a **disyllabic foot**:

(18) [$_{Ft}$ bwó̰t̰-kà̰]
build-2PL

To enforce this maximum, we propose **two constraints on foot shape**: i) a (categorical) constraint forcing right-aligned feet (Uchihara and Mendoza Ruiz 2021), and ii) a constraint anchoring the root to a foot boundary.

(19) ALIGN-R(FT,WD): A foot should be right-aligned with the word edge.
ALIGN-L(ROOT,FT): The root should be left-aligned with a foot.

Taken together, these constraints ensure that a prosodic word ideally consists of one foot, anchored by the root.[8]

⇒ **Suffixes come in all shapes that fit the CV maximum** determined by independent constraints (-C, -V, and -CV). Non-concatenative morphology results from **surface phonological conditions on the wellformedness of those suffixes** and how Dinka prefers to resolve violations of them.

2.5 The lack of vowel reduction in -CV suffixes

Consider the verbal paradigm for the simple transitive:

Table 5. Verbal paradigms of simple transitive.

	Grade	CVC/F	CVC/L	CVVC/F	CVVC/H
UNM		CV̀C	CV̀C	CV̀VC	CV̀VC
NF		CV̂VC	CV̀VC	CV̂VVC	CV́VVC
NTS	2	CV́VC	CV́VC	CV́VVC	CV́VVC
1SG	3	CV̀VC	CV̀VC	CV̀VVC	CV̀VVC
2SG		CV̀C	CV̀C	CV̂VC	CV́VC
3SG	2	CV̀VC	CV̀VC	CV̀VVC	CV̀VVC
1PL		CV́C-kṳ̀	CV́C-kṳ̀	CV̀VC-kṳ́	CV̀VC-kṳ́
2PL	3	CV́C-kà̱	CV́C-kà̱	CV̀VC-ká̱	CV̀VC-ká̱
3PL		CV́C-kɛ̀	CV́C-kɛ̀	CV̀VC-kɛ́	CV̀VC-kɛ́
PASS		CV́C	CV́C	CV̂VC	CV́VC
PASS:CT	2	CV̂VC-ɛ̀	CV̂VC-ɛ̀	CV̂VVC-ɛ̀	CV̂VVC-ɛ̀

(NF = non-finite, NTS = non-topical subject, CT = circumstantial topic)

(**Note:** There are four root types (see fn. 1), which we follow Andersen (1993) in labeling according to the length and tone displayed in the non-finite form.)

[8] Of course, we also need constraints that enforce the root template.

Observation:
There is no obvious restriction on vowels in the plural -CV suffixes (e.g. 2PL *-kạ* and 1PL *-kụ*).

- ▷ The account we provided for vowel incorporation in section 2 posited the ranking MAX-μ >> *μ#. This ranking will block simple vowel reduction in the usual case. The effect of the constraint favoring reduction only emerges because of the low ranking of LINEARITY.
- ▷ This set-up predicts that, if **metathesis is impossible**, then we should not see any reduction. We suggest that, in -CV suffixes, the initial consonant **protects** the vowel from integration.
- ▷ In particular, we posit a ban on **non-local metathesis**, enforced by Carpenter's (2002) I-ADJACENCY, in addition to high-ranking constraints blocking complex codas and consonant deletion.[9] Since reduction is blocked by MAXμ >> *μ#, the vowel surfaces faithfully:

	Input: [cɔ̀ɔl+kṵ$_{1PL}$]	MAXC	*COMPLEX CODA	I-ADJ	MAXμ	*μ#	LINEARITY
☞	a. cɔ̀ɔl-kṵ					*	
	b. cɔ̀ɔɔl	*!					*
	c. cɔ̀ɔɔlk		*!	**			**
	d. cɔ̀ɔl-kẹ́				*!		
	d. cɔ̀ɔɔl-kẹ́			*!*			**

⇒ In accordance with this account, there is **no lengthening before -CV suffixes**. As evident in Table 5, short roots remain short and long roots remain long.

3 A concatenative view of multiple affixation

In this section, we apply this proposal to the **complex verbal morphology** of Agar Dinka and generalize this account to -CV suffixes as well as instances of multiple affixation.

- ▷ First, we show that, across verbal paradigms, **grade changes strongly correlate with lengthening**, by one degree.
- ▷ As noted by Andersen (1992) and Trommer (2015), multiple affixation in Dinka does not give rise to cumulative lengthening. Building on Zimmermann's (2021) work on multiple reduplication, we propose a ban on overlengthening of short roots forces mora coalescence.

[9] We may also want to block metathesis within the -CV suffix, to rule out the candidate *càal-ạ́k*. But note that codas are generally banned in affixes in any case, so the impossibility of this repair may simply reflect a NOCODA constraint.

- ▷ This account also explains why no overt vocalic suffixes surface in the applicative, which enforces a bimoraic template (Andersen 1992; Flack 2007; Trommer 2015).

3.1 Grade changes imply lengthening in verbal paradigms

Changes in vowel grade **strongly correlate with lengthening** across verbal paradigms. The distribution of vowel grade and length in Agar Dinka is presented below, for five verbal paradigms (Andersen 1992, 1993, 2017).[10]

Table 6. Agar Dinka paradigms by grade.

	Simple	CF	CP	APPL	AP.APPL
UNM		2	2	2	2
NF		3	3	3	3
NTS	2	2	2	2	2
1SG	3	3	3	3	3
2SG		3	2	3	3
3SG	2	2	2	2	2
1PL		2	2	2	2
2PL	**3**	3	3	3	3
3PL		2	2	2	2
PASS		2	2	2	2
PASS:CT	2	2	2	2	2

Table 7. Agar Dinka paradigms by length.

	Simple	CF	CP	APPL	AP.APPL
UNM		-μ	-μ	-μ$_{II}$	-μ
NF	**-μ**	-μ	-μ	-μ$_{II}$	-μ
NTS	-μ	-μ	-μ	-μ$_{II}$	-μ
1SG	-μ	-μ	-μ	-μ$_{II}$	-μ
2SG		-μ	-μ	-μ$_{II}$	-μ
3SG	-μ	-μ	-μ	-μ$_{II}$	-μ
1PL		-μ	-μ	-μ$_{II}$	-μ
2PL		-μ	-μ	-μ$_{II}$	-μ
3PL		-μ	-μ	-μ$_{II}$	-μ
PASS		-μ	-μ	-μ$_{II}$	-μ
PASS:CT	-μ	-μ	-μ	-μ$_{II}$	-μ

(CF = centrifugal, CP = centripetal, APPL = applicative, AP.APPL = antipassive applicative, -μ = lengthening of the root by one mora, -μ$_{II}$ = lengthening of the root up to a bimoraic limit)

[10] I omit the antipassive paradigms here, where there is significant variation depending on root type. This variation appears to be in line with the prediction that grade changes imply lengthening, although long roots show some unexpected shortening effects in the antipassive (shortening in the antipassive is common in Nilotic). This shortening effect is systematic in the long high-toned roots, but seems to be more variable in long falling-toned roots. See Andersen (2017) for a detailed overview.

Key observations:

- ▷ **Vowel grades lengthen.** The cells marked by a grade change are almost identical to those that show lengthening. There are two exceptions (bolded): i) 2PL is marked by Grade 3 but not length (see the appendix), and ii) the NF form shows lengthening, but no grade change.
- ▷ **No cumulative lengthening.** As discussed by Andersen (1992) and Trommer (2015), these verbal paradigms do not show lengthening by two degrees, even when both morphological categories should generate lengthening and are marked by the same grade (e.g. the PASS.CT forms of the derived paradigms).
- ▷ **Grade 3 wins.** When a form would be marked by Grade 3 and Grade 2, Grade 3 wins out. We see this effect, for example, in the 1SG, 2PL, and non-finite forms (all Grade 3) of the centrifugal, centripetal, applicative, and antipassive applicative (all Grade 2).

3.2 Multiple affixation and mora coalescence

Why do verbs appear to be restricted to at most one Grade 2 or Grade 3 affix?

- ▷ We can see in Table 6 that most of what Andersen (1993) and Trommer (2011) call the "derivational" morphology (centrifugal, centripetal, applicative, and applicative antipassive) is usually marked by Grade 2.[11]
- ▷ When we combine a Grade 2 derivational category with one of the "inflectional" categories marked by a vowel grade (e.g. NTS, 1SG, 3SG), we only get one degree of lengthening.

Proposal: We adopt a constraint that penalizes lengthening a short root to overlong, building on the intuition that this type of overlengthening is too great a change.

(20) MATCH-LENGTH: Assign a violation mark if the length of a syllable input differs by more than one degree in the output.

This constraint will allow lengthening of a short root to long and a long root to overlong, but prevents multiple lengthening.

> **Problem:** If this constraint is highly-ranked, we should see a preference for overt affixation return (because MAXμ >> *μ# blocks reduction).

Why are overt Grade 2/3 affixes avoided in multiple affixation?

- ▷ We want to draw an analogy with work on multiple reduplication avoidance (Stonham 2007; Zimmermann 2021).

[11] There are two systematic cases where Grade 2 is not observed when there is no Grade 2/3 in the simple paradigm, which is that the NF and 2SG forms are often marked by Grade 3.

- ▷ In some reduplicating languages, such as Nuu-chah-nulth, **only one reduplicating morpheme surfaces** in contexts with multiple triggers of reduplication (the underlined suffixes):

(21) **m'aa**-m'aaɬ-ʔas-ap
RED-cold-at.wrist-really
'S/he has really cold wrists.' (Nuu-chah-nulth; Rose 1981:341)

- ▷ Zimmermann argues that the abstract prosodic material associated with reduplicating morpheme can undergo **prosodic coalescence**, in violation of the constraint UNIFORMITY, which regulates the one-to-one correspondence of input and output elements.

(22) UNIFORMITYμ: Assign a violation mark for every input mora that does not map to a unique output mora.

⇒ We suggest that a similar repair is at work in multiple affixation. Multiple grade affixes will generate multiple moras that incorporate into the root, but these undergo **mora coalescence**. The ranking *μ# >> UNIFORMITYμ ensures a preference for coalescence over overt affixation:

The bimoraic template in the applicative

- ▷ As discussed by Andersen (1992), Flack (2007), and Trommer (2015), the applicative **imposes a bimoraic template** and blocks lengthening of long roots to overlong:

(23) **Bimoraic template in applicative:**

Unmarked form	Unmarked applicative	Meaning
wèc	wɛ̰ec	'kick'
nàj	nɛ̰ɛj	'plait'
cɔ̀ɔl	cɔ̰ɔl	'call'
ŋàaŋ	ŋɛ̰ɛŋ	'open'

(Agar Dinka; Andersen 2017:14)

- ▷ We follow Flack (2007) in assuming that the applicative is associated with an **indexed markedness constraint** penalizing overlong vowels.
- ▷ This markedness constraint will play the same role as MATCH-LENGTH in limiting mora incorporation, leading to mora coalescence instead of overt affixation.

3.3 The passive and 2SG

▷ One effect that is not predicted by our approach is that lengthening can co-occur with an overt suffix. But the passive *-e̱* and 2nd person singular *-e̱* also trigger Grade 2 and Grade 3 lengthening on the root in the centrifugal, applicative, and applicative antipassive:

(24) **Grade change and suffix in passive and 2SG:**

Unmarked form	Passive applicative (2)	2SG applicative (3)	Meaning
wèc	wɛ̰̀ec-è̱	wɛ̰̀ɛc-é̱	'kick'
nàj	nɛ̰̀ɛj-è̱	nɛ̰̀aj-é̱	'plait'
cɔ̀ɔl	cɔ̰̀ol-è̱	cɔ̰̀ɔl-é̱	'call'
ŋàaŋ	ŋɛ̰̀ɛŋ-è̱	ŋɛ̰̀aŋ-é̱	'open'

(Agar Dinka; Andersen 2017:14)

▷ We note that these categories also **behave uniquely with regard to tone**. Trommer (2011) identifies three morphological categories that he calls "outer inflection", since the tones they contribute overwrite derivational tones:

– The passive is always associated with **a falling tone on the root**, and a low tone on the suffix.

– The 2nd person singular is always associated with **a low tone on the root**, and a high tone on the suffix.

– The non-topical subject inflection triggers a high tone on the root (with no affix).

Our proposal

▷ We suggest that the *-e̱* suffix surfaces in these morphological categories in order to **host the affix tone**.

▷ In particular, we interpret Trommer's "outer inflection" as a group of affixes that **impose a tonal template on the preceding morpheme** (McPherson 2014; Rolle 2018), regardless of whether they carry a tone themselves as well.

▷ In this view, the passive and the 2SG are Grade 3 and Grade 2 affixes that introduce their own tone as well as a tonal template:

(25) **Representation of "outer inflection":**

PASS → [HL …]-ɛ̀
2SG → [L …]-ɛ́
NTS → [H …]-ɛ̄

⇒ If (25) is correct, we can understand the presence of the *-e̱* suffix as a result of a pressure to realize **both the tonal template and the underlying tone of the affix**.

Concluding remarks

▷ We have argued that the prevalence of non-concatenative inflection in Dinka ultimately derives from **surface phonological constraints on permissible suffixes**.

▷ We're currently working on extending this view across Western Nilotic systems, focusing on Shilluk and Nuer. A number of observations that we think are promising:

– In Shilluk, all affixes are limited to [-ATR] vowels. Instead of process of lowering and fronting, several morphological categories in Shilluk shift the root vowel to [+ATR].

– In Dinka/Nuer, no contrast in creaky/breathy voice is found in suffix vowels. In Dinka, all suffix vowels are breathy. In Nuer, voice quality is strictly determined by [ATR] value in suffixes. Both languages shift the root vowel to breathy in a number of paradigms.

– In Shilluk, almost all suffixes contain short vowels. All lengthening lengthens the root to overlong (i.e. by two degrees of length if possible).

⇒ Dinka morphology in fact **provides evidence that affixation is underlyingly concatenative**, since such a view posits a direct relationship between the wellformedness of suffixation and non-concatenative processes.

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Appendix 1: Fronting and lowering as harmony

In this appendix, we present a concise version of our account of lowering and fronting in Dinka's vowel grades. The vowel grades are repeated below:

(26) **Table 8. Dinka vowel grades, without glides.**

	Creaky					Breathy					
Grade 1	i	e	a	ɔ	o	i̤	e̤	a̤	ɔ̤	o̤	ṳ
Grade 2	i	e	ɛ	ɔ	o	i̤	e̤	ɛ̤	ɔ̤	o̤	ṳ
Grade 3	jɛ	ɛ	a	a	wɔ	je̤	ɛ̤	a̤	a̤	ɔ̤	wo̤

- ▷ Grade 2 involves an operation of **fronting**, but only of the low central vowel *a*.
- ▷ Grade 3 involves **partial lowering**, except for the low central vowel *a*, and includes at least one chain shift *o̤* -> *ɔ̤* -> *a̤*. In addition, high vowels trigger breaking.

What constraints drive fronting and lowering?

⇒ We propose that fronting and lowering should be understood as **assimilatory coalescence**, in Zaleska's (2020) terms, the prioritization of certain features under vowel coalescence regulated by the same constraint that govern assimilation.

Assimilation in 2PL and Grade 3 as regressive [-ATR] harmony

- ▷ In the discussion of the lengthening effect of the vowel grades, we noted one apparent exception to the generalization that Grade 2 and Grade 3 lengthen the root, the 2PL *-ka̤*, which triggers Grade 3 but no lengthening:

(27) **Grade 3 without lengthening in 2PL:**

Unmarked form	2PL	Meaning
gù̱t	gwó̱t-kà̱	'stab'
t̪à̱r	t̪á̱r-kà̱	'spear'
mìit	mjɛ̀ɛt-ká̱	'pull'

(Agar Dinka; Andersen 2017:11–13)

- ▷ We suggest that this grade change is an instance of **vowel harmony**. In this view, it is no accident that the 2PL contains the low vowel *a̤*, which we identify with Grade 3 affixes.
- ▷ In particular, Grade 3, including the chain shift in breathy back vowels, can be viewed as the combination of two harmony effects:

1. **Regressive [-ATR] harmony.**
   Most Grade 1 vowels are [+ATR] and become [-ATR] in Grade 3 (e.g. *e/e̤* → *ɛ/ɛ̤*, *o* → *ɔ*). Note that breathy [-ATR] vowels independently raise after glides in Agar, with *je̤* and *wɔ̤* raising to *je̤* and *wo̤*.[12]

[12] In Luanyjang Dinka, we do see the predicted *wɔ̤* (Ladd and Blum 2021).

2. **Parasitic centralization of *ɔ/ɔ̤*.**
   The low back vowel *ɔ/ɔ̤* is the only [-ATR] vowel in Grade 1 and it shows an additional effect of centralizing to *a*.[13] We treat this effect as parasitic harmony among low vowels.

- ▷ To model regressive harmony, we propose an ALIGN constraint that spreads [-ATR] leftward (Kirchner 1993). We identify the domain of harmony as the foot:

(28) ALIGN-L([-ATR],Foot): An [-ATR] feature should be aligned to the leftmost mora in the foot.

- ▷ This constraint will drive leftward [-ATR] harmony from the 2PL suffix *-ka̤*. The same effect is achieved in cases in which vowel incorporates, as an instance of assimilatory coalescence.[14]

Grade 2 and fronting of *a*

- ▷ We model grade 2 as **fronting harmony**, driven by a similar constraint:

(29) ALIGN-L([front],Foot): A [front] feature should be aligned to the leftmost mora in the foot.

- ▷ This constraint is ranked below a faithfulness constraint for [back], explaining why Grade 2 fails to affect back vowels (prioritized by MAX[back]) or front vowels (which vacuously satisfy (29)). The vowel *a* is the only central vowel and so fronts to the low front vowel *ɛ*.

Why does Grade 3 win out?

- ▷ Since our harmony constraints operate on different features, their effects can be combined. Grade 2 does not affect front or back vowels, so the combination of Grade 2 and Grade 3 harmony will **usually be identical to Grade 3**.
- ▷ But with the low central vowel *a*, we see that Grade 3 is prioritized. This effect could reflect the high-ranking of constraints driving parasitic centralization.
- ▷ Alternatively, we note that Grade 3 affixes are arguably always outside of Grade 2 affixes (since all the derivational affixes are Grade 2). The fact that Grade 3 wins out could then reflect successive assimilation.

[13] The acoustic measurements given for Luanyjang Dinka by Remijsen and Gilley (2008) show that *a* is central in its realization and that *ɛ* and *ɔ* are much lower than their [+ATR] counterparts. Remijsen and Manyang (2009:117) note that "the phonetic quality of /ɛ/ is typically between [ɛ] and [æ], and that of /ɔ/ between [ɔ] and [ɒ]". We treat all three as low vowels, distinguished primarily along the front-central-back dimension.

[14] We will not go into breaking in detail here. Breaking occurs with high vowels and is derivable from the fact that Dinka only permits high glides. The one complication here is the fact that creaky *o* undergoes breaking, which presumably relates to the absence of creaky *u*.

Appendix 2: Moraic coalescence

Our proposal for moraic coalescence is demonstrated with a full range of candidates in the tableau below:

(30) **Tableau for Grade 2 CF and Grade 2 3SG suffix on *gû̱t* 'stab'.**

Input: [gû̱t+íCF+ì3SG]	MATCH-LENGTH	MAXμ	*μ#	UNIFμ	LIN	DEPV
☞ a. gú̱ut				*	**	
b. gú̱t				**!	**	
c. gú̱uut	*!				**	
d. gú̱ut-ì			*!		*	
Input: [gû̱t+íCF+ì3SG]	MATCH-LENGTH	MAXμ	*μ#	UNIFμ	LIN	DEPV
e. gú̱ut		*!			*	
f. gú̱ut-ẹ̀				*	**	*!
f. gú̱ut-ẹ̀				*	**	*!