Equal addenda numerals in Kordofanian Lumun number words and gestures

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1 Introduction

A number of African languages have numerals that are built according to a system of equal addenda. After introducing the principle of equal addenda as first identified by Schmidl (1915), we discuss the numerals 1-10 in languages belonging to the Heiban and Talodi groups of Kordofanian (Nuba Mountains, Sudan). In particular, we compare spoken numerals of the Talodi language Lumun with their gestured counterparts and discuss their (non)-alignment. We also describe some examples of number gestures in spontaneous discourse.

1.1 Number words and gestures

Numbers are communicated through various conventional forms, notably in number words, written numerals, number gestures, but also in other representations (Butterworth 1999). The way numbers are communicated is not universal. Despite being based on body parts that are universally available, number gestures are culture-specific too, both in their form and in their existence. Bender & Beller (2012) find that the extent to which number words, written numerals and number gestures align in form differs from one culture to another. On the other hand, the 10 fingers being readily available is often mentioned as an explanation for the widespread use of decimal systems in the world's languages (Comrie 2011). Equally widespread seems to be the use of a 5-base in number gesture systems, e.g. in Fulfulde (Lex 1991). For an overview of counting words and gestures in Africa, see also Zaslavsky (1999).

1.2 Approximately equal addenda systems

A system that deviates from the 5-base principle in a categorical way is the equal addenda system first identified in a survey of numeral words and gestures in Africa by Schmidl (1915). In an equal addenda system, numerals are composed by splitting up the number value in two equal halves, whereby

6 is built up as 3+3, and 8 as 4+4. Uneven numbers are split up into two maximally equal halves, whereby 7 = 4+3, and 9 = 5+4. Maes (1911) documented the use of equal addenda numeral gestures with speakers of Mongwandi, see Figure (1). In the gesture for 4, the index and the middle finger are extended and joined, and so are the little and the ring finger, thus presenting two groups of 2. The gesture for 5 has the form of a fist, with the thumb inserted between the same two groups of fingers, as such presenting 2+1+2.

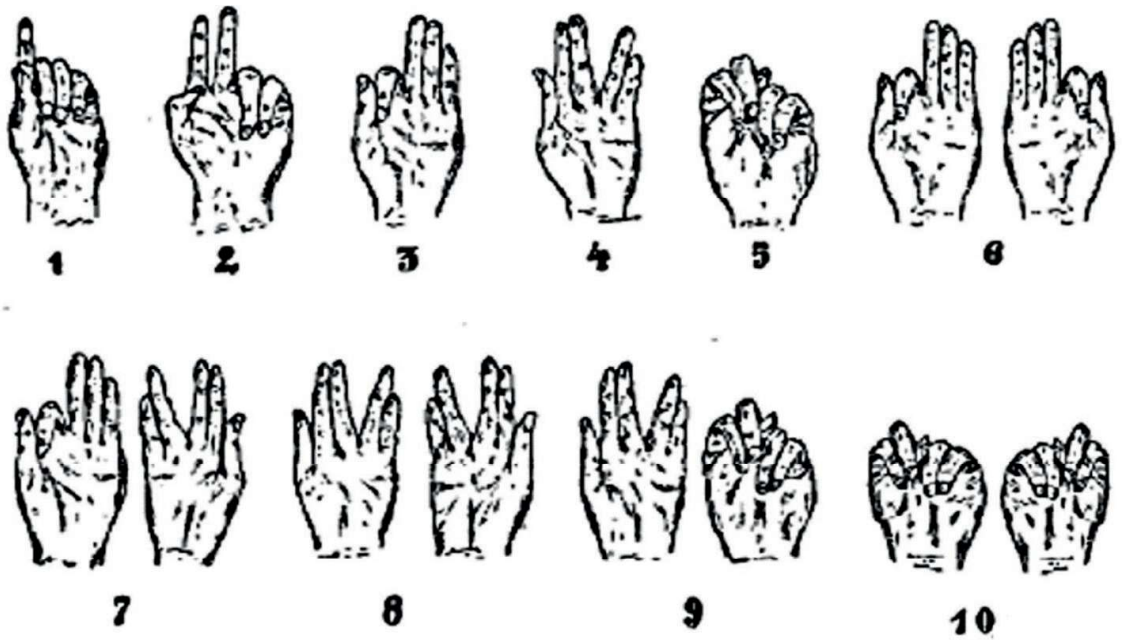

Figure 1
Numeral gestures in Mongwandi (Maes 1911).

Among the languages with spoken numerals that Schmidl (1915) recognized as following a system of equal addenda were Otoro (Kawama) and Tira (Kanderma), two languages of a larger set of – then "newly discovered" – languages of the Nuba Mountains, reported on in Bork (1912).[1]

1.3 On the use of number words and number gestures

In addition to structural analyses of numeral systems, Schmidl also presented a number of observations in the literature on the use of number gestures and their interaction with number words in African languages. She mentions that in Kirundi, numbers are not referred to without a number gesture (Schmidl 1915: 175). Dorsch (1910) is quoted in stating that in Akoose (Nkosi) spoken in Cameroon, a speaker does not utter a number word but only uses a number gesture to express a number value, while the listener pronounces the number

1 The data in Bork were collected and published by Seligmann (1910-1911).

word. If for some reason the speaker is unable to show the number gesture, he warns the listener to "pay attention" and then utters the number word (Schmidl 1915: 167). A more recent source mentioning specific restrictions with respect to the distribution of number words and gestures is Gulliver (1958). Gulliver describes how in Arusha Maasai (Tanzania) number communication requires both a number gesture and a number word. The speaker typically expresses a number gesturally (optionally adding the number word), upon which the listener is supposed to confirm the number gesture by uttering the corresponding number word. A similar integration of number gestures and words is reported by Mous (p.c. 24-6-2019) for Iraqw. Iraqw speakers typically use a number gesture to express a number. Optionally, the speaker or the interlocutor may or may not verbalize the number word in addition to the gestured expression.

2 Kordofanian: numeral systems in the Heiban and Talodi groups

Since Schmidl's study more data on spoken numerals in languages of the Nuba Mountains have become available. Apart from in Otoro and Tira, equal addenda numerals occur in some additional languages belonging to the Heiban group of Kordofanian, as well as in a few languages belonging to the Talodi group. Before focusing on Lumun, we briefly describe the types of systems found in Heiban and Talodi languages.

2.1 Numeral systems in Heiban languages

In the Heiban languages three types of numeral systems can be distinguished. The first type involves numerals applying the system of equal addenda. Not only in Tira (see Table 1) and Otoro, but also in Laro (Laru), Heiban (Ebang, Abul) and Shwai-Shirumba, 6 alludes to 3, 7 involves 4 and 3, and 9 is made up of 5 and 4 (Schadeberg 1981a). The same goes for Logol, though in the composing parts of 9, only 4 is recognized. In Shwai-Shirumba, 9 is not composed as 5 and 4 but as 4 and 5 (Schadeberg 1981a). Within these paradigms, 9 can be regarded as a case of equal addenda, though, of course, 5 and 4 would equally fit into a 5-based system. Numerals are thus formed according to a principle of symmetry, striving for equality in the composing numbers. For 8, however, all these languages use a base form[2].

2 According to Schmidl (1915), 8 is often a special number in the row from 6-9, in the sense that it patterns differently from the other numbers or that the other numbers refer to it. In many of the languages surveyed by Schmidl, 8 is the only number built following the equal addenda principle. In the Heiban languages that have equal addenda numerals, 8 is the only number in the row from 6-9 not following the principle.

Table 1
Tira numerals 1-10 (Schadeberg 1981a: 56-57).

1	*kɛnnɛ*	6	*lʈ̀cíʈcin*	cf. 3
2	*kʈ̀can*	7	*maaldʊ kʈ̀cin*	4-3
3	*kʈ̀cin*	8	*ɔ́bbɔ*	
4	*maaldʊ*	9	*ðéénɛ́ maaldu*	5-4
5	*ðé(n)énɛ*	10	*órrí*	

A second group is formed by Koalib, in the northern part of the Heiban speech area. Numerals in Koalib varieties deviate from Tira, Otoro, Laro, Heiban, Shwai-Shirumba and Logol in that they apply subtraction to express 9 and 7. 9 and 7 are composed as (something like) 'something missing to 10' and 'something missing to 8', respectively (p.c. Nicolas Quint 2019). Quint informed us that in all Koalib varieties 8 is expressed as 'big 8', with the part referring to 8 being a base form. He also pointed out that in one variety, *ŋèréɛʈɛ̀* or Central Koalib, 7 does not involve subtraction from 8, but is expressed as 'small 8'. Table 2 presents the numerals 7-10 in Central Koalib.

Table 2
Central Koalib numerals 7-10 (p.c. Quint 2019).

7	*dɔ̀pɔ̀kkwóʈɔ̀ny*	'small 8'	8	*dɔ̀pɔ̀kkwóppà*	'big 8'
9	*kwúnɔ̀ttùrrí*	'something missing to 10'	10	*rúi*	

A third group within Heiban consists of Moro and Ko, situated, respectively, at the western and south-eastern edge of the Heiban speech area. Moro and Ko have straightforward 5-based systems. The forms for 6, 7, 8 and 9 are made up as 5-1, 5-2, 5-3 and 5-4 (Schadeberg 1981a and, more recently, Jenks 2013 for Moro).

Quint reported in 2011 that in Warnang, located south-west of Ko at the south-eastern edge of the Heiban speech area, indigenous numerals were replaced by Arabic ones, except for 1, 2 and 3 (Chan's database *Numeral systems of the world's languages*). In the mid-1970s, Schadeberg (1981a) had obtained items from his very young consultants (then aged 7 and 10) only for 1 and 2. A speaker interviewed by Quint nevertheless remembered additional numbers showing a 5-based system, with 8, however, relating to 4 (Chan's database *Numeral systems of the world's languages*).

In a few Heiban languages the numerals 2 and 3 show a striking resemblance, among them Tira (see Table 1) and Moro. There is, however, no evidence that

2 forms a part of 3 (any more than vice versa), nor that 3 involves a form for 1. Moreover, 3 is not a longer word than 2. Though there is clearly a relationship between 2 and 3 in these languages, the forms for 3 do not seem to be cases of equal addenda.

2.2 Numerals in Lumun and other Talodi languages

Most Talodi languages have a 5-based system. Acheron, Dagik, Tuwal, and Nding build 6, 7, 8 and 9 as 5-1, 5-2, 5-3, and 5-4 (Schadeberg 1981b; Norton and Alaki 2015). Daloka (Ngile) too, has a 5-based system, but 5 itself is not expressed in 6 up to 9 (Schadeberg 1981b). 5-based forms for 6 up to 9 that leave out 5 are also described for Dagik (Vanderelst 2016). Lafofa (Tegem) has a 5-based system[3], while in Talodi (Jomang) numerals above 3 have been replaced by Arabic ones (Schadeberg 1981b).

Lumun and Tocho, by contrast, have an equal addenda system. In Tocho, 6 is composed as 3-3, 7 as 4-3, 8 as 4-4 and 9 as 5-4 (Schadeberg 1981b; Norton and Alaki 2015). In Lumun, 6 alludes to 3, 7 can be expressed as 4-3, but is more commonly stated as (probably) 2-2-3, and 9 is composed as 5-4 (Smits 2017).[4] 8 contains a reduplicated form *mɔr*, which possibly relates to *cɔɽ* in 4, 9 (5-4) and 7 (4-3). *cɔɽ* and *mɔr* are possibly remnants of a today unattested singular-plural pair of nouns from the c-/m- class pair (Smits 2017).

In most Talodi languages, 2 and 3 have a certain similarity, but 1 cannot be identified as part of 3. Interestingly, this is different in Lumun and Torona, a language now probably extinct (Norton and Alaki 2016). In these languages 3 is clearly 2-1, i.e. formed according to the equal addenda principle. For Torona, information about numbers higher than 4 is lacking.

Table 3 presents the numerals 1-10 in Lumun (see also Smits 2017).[5]

3 We consider Lafofa as part of the Talodi group, as in Schadeberg (1981b).

4 The form for 7 *maɽamaɽakkʊrʊk* given in Norton and Alaki (2015: 151) was rejected by our consultant. 6 in Lumun (indeed) alludes to 3, but does not seem analysable as 2-5, as Norton and Alaki propose. We do not follow the view that 6 and 7 contain a component 2 that functions as a 'succession operator on the previous numeral' (Norton and Alaki 2015: 152).

5 Hyphens in the table represent (consonantal) concords agreeing with the head noun.

Table 3
Lumun numerals 1-10.

1	*-ulukkû*		6	*-əɽâkkʊrʊk, -əɽârəpʊrʊk*	cf. 3
2	*-ɛɽá*		7	*-êɽɛ(-ə)ɽapúrʊk* *-ɔcɔɽa(-ə)ɽapúrʊk*	2-2-3 4-3
3	*-əɽapúrʊk*	2-1	8	*mɔrəmɔr, -amɔ́rəmɔr*	cf. 4 (?)
4	*-ɔcɔɽɪn*		9	*ʊkʊllácɔɽɪn, -ʊkʊllácɔɽɪn*	5-4
5	*ukulúk, -ukulúk*	'one hand' (< *ʊkʊn wulukkû*)	10	*attʊl, -áttʊl*	

2.3 Discussion of equal addenda in Heiban and Talodi

Contemporary Heiban and Talodi languages thus present extensive equal addenda numeral systems, in particular Lumun.

Looking at the geographical distribution of the Kordofanian languages (see the map in Figure 2), we see that the languages with non-equal addenda systems (whether applying subtraction or having 5-based numerals, as well as those that have largely replaced their numerals by Arabic ones) are situated in the periphery of the Heiban-Talodi area: Koalib in the north, Moro in the west, Daloka, Tuwal, Dagik, Talodi, Nding and Lafofa in the west, south-west and south, Warnang and Ko in the south-east. Acheron, a Talodi language closely related to Lumun, Tocho and Torona, but using a 5-based system, is spoken in an area west of the Lumun, across a valley, and bordering immediately on Moro land. Conversely, the Heiban and Talodi languages discussed in this article as having equal addenda numerals are all found adjacent to each other, in the centre of the area covered by the Heiban and Talodi languages. Notably, Lumun, Tocho, a variety of Tira, as well as formerly Torona share a mountain area.

A likely hypothesis is that both Heiban and Talodi languages originally had equal addenda numerals, but that the languages on the edges of the area lost them due to extensive exposure to other systems. An alternative hypothesis, namely that Talodi languages did not originally have equal addenda numerals, but adopted them due to contact with Heiban languages, perhaps especially Tira, seems far less likely. The Lumun system in particular is extreme in its use of the equal addenda system and seems unlikely to have evolved from contact. Moreover, parts of the Lumun area have, up to this day, remained particularly isolated.

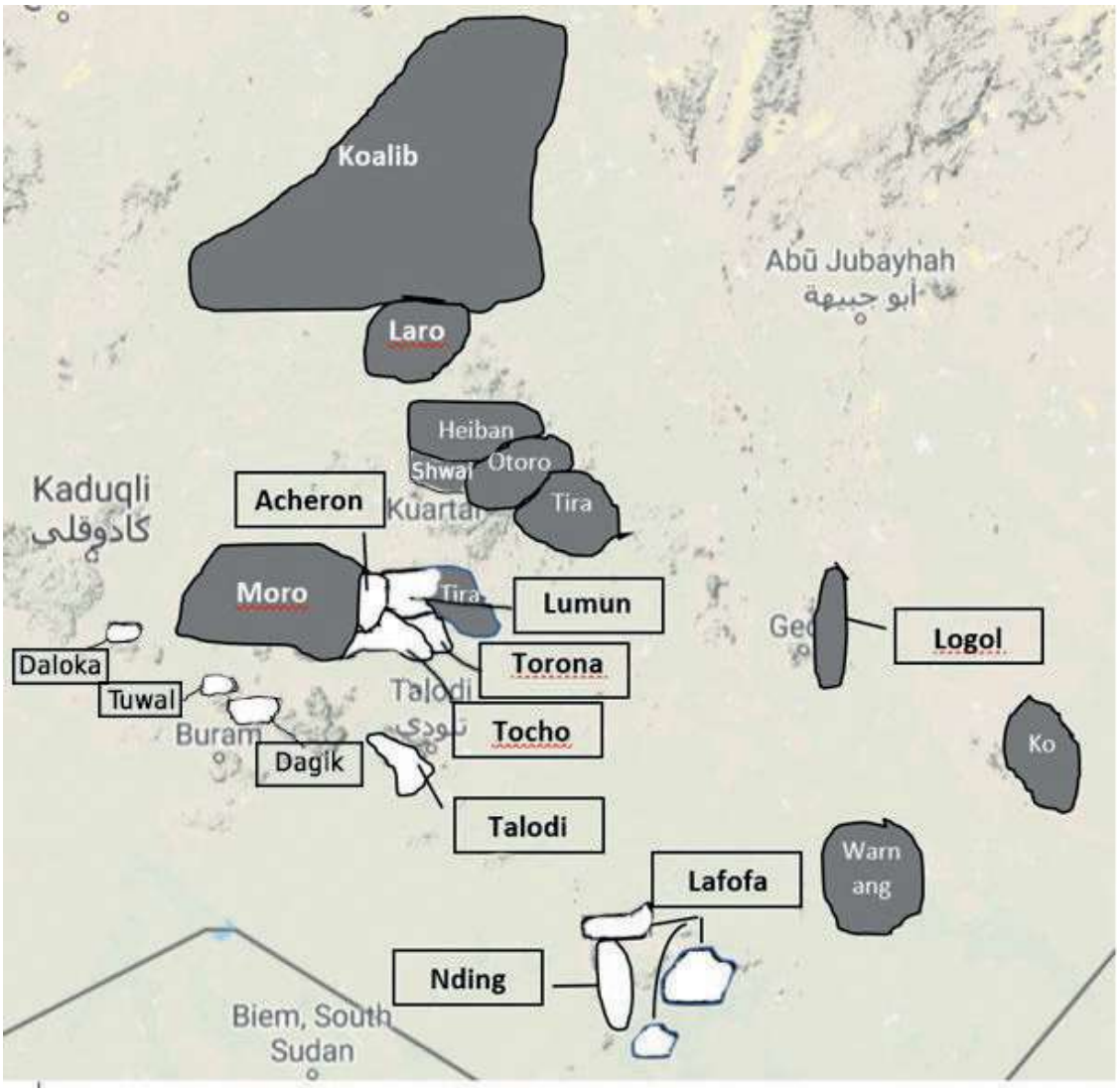

Figure 2
Map of Heiban languages (in grey) and Talodi languages (in white).

3 Lumun number gestures

Schmidl does not report on number gestures for any of the Kordofanian languages. To our knowledge, more recent accounts of Kordofanian number gestures are not available either. In this article we will describe number gestures for Lumun, to see to what extent they reflect the equal addenda principle found in the spoken number words.

The data on Lumun number gestures presented in this article are based on discussion and elicitation with John Shakir, mother tongue speaker of Lumun and born in the Lumun area in the Nuba Mountains in 1973. Number gestures were elicited and recorded with him on video and in still images in 2011. In addition, an analysis of number gestures in use is presented based on an oral history narrative by Osman Alope, a Lumun elder and former chief.[6] The

6 Osman Alope sadly passed away on 1 October 2018.

recordings with Osman Alope were made in Omdurman, in 2012. We will first present the number gestures as recorded with John Shakir, and then give an analysis of the number expressions found in the narrative of Osman Alope.

3.1 Number gesture repertoire

A distinction can be made between counting on the fingers, and gestures showing a particular number value. The Lumun gestures used for counting consist of closing the fingers one by one, starting with the pinky finger of the left hand and moving up to the thumb. The Lumun gestures for showing numbers are as follows.

The number 'one' is formed by extending the index. As such it differs from all higher numbers, which are formed by folding, rather than extending, an additional digit. Thus, TWO is made by forming a circle with the index and the thumb. To form the one-handed gestures THREE, FOUR, and FIVE the middle finger, ring finger and pinky finger are added to this circle respectively.

From 'four' upwards, two-handed, compositional gestures are found, consisting of combinations of the one-handed gestures for the numbers below 'five'. From 'four' to 'ten', a complete paradigm is found of compositional gestures according to the equal addenda principle, i.e. the number is divided into two maximally equal numbers. Thus, the two-handed gesture for 'four' (i.e. FOUR_2+2) is composed of two TWO handshapes. Similarly, one of the two gestures for 'six' (i.e. SIX_3+3) consists of two THREE handshapes, and of two FOUR handshapes in the case of EIGHT_4+4. In the case of uneven numbers, the two composing number approach an equal division as much as possible. Thus, FIVE_3+2 consists of a TWO and a THREE handshape, SEVEN_4+3 of a FOUR and a THREE handshape, and NINE of a FIVE and a FOUR handshape. In the case of uneven numbers, the highest number is shown on the right hand, and the lowest on the left. Note that the number gestures NINE and TEN comply both with an equal addenda system as well as with a 5-based system.

Indeed, in addition to equal addenda gestures, there are also two variants that uniquely align with a 5-base principle. The gestures for NINE and TEN both consist of a FIVE handshape on the right hand as well, with a FOUR and a FIVE handshape on the left hand respectively. Thus, SEVEN_5+2 and EIGHT_5+3 consist of a FIVE handshape on the right hand, and a TWO and THREE handshape on the left respectively. Thus, the Lumun number gestures come in two types, with both equal addenda and 5-based number gestures.

A remaining number gesture that does not comply with either of the two systems is SIX_4+2. There is an equal addenda variant of this number: SIX_3+3. Surprisingly, a 5-based variant is missing. Where the variants of other equal addenda gestures are 5-based gestures, 6 only has an equal addenda gesture and a variant that is four-based. A potential explanation lies

in the observation that adjacent numbers 7 and 8 both have a FOUR handshape on the right hand as well. An alternative explanation concerns the deviant shape of the ONE gesture, which consists of an extended digit, rather than a folded one. One might argue that the simultaneous combination of the extension and folding of salient fingers in one composite form is avoided (especially in a mixed system that strives for uniformity of both hands in an important part of its gestures).

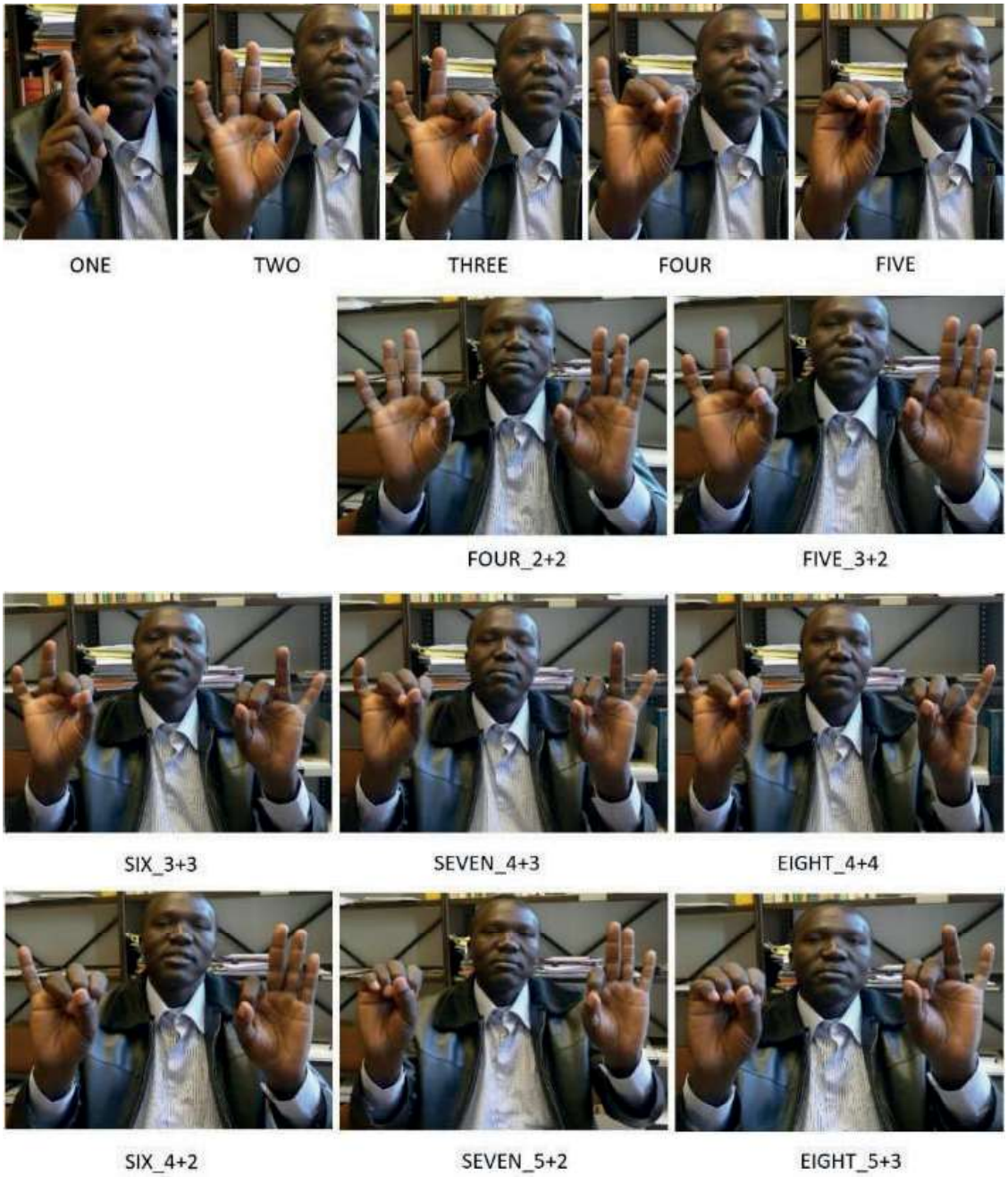

Figure 3
John Shakir shows the Lumun gestures for the numbers 1-10, including variants.

3.2 Number gestures in use in Lumun

Lumun speakers, particularly elderly, typically use a number gesture to express a number, while in many cases using the deictic word *mâ* 'like this' in speech. Like in Iraqw, the speaker or the interlocutor may or may not verbalize the number word in addition to the gestured expression. In a recording of oral history telling by Osman Alope about settlement and customs of the Lumun in the Nuba Mountains, there are instances of gestured 1, 2, 3, 4, 5 and 8. In the instances of 1, Osman Alope himself combines the gesture with Arabic *wahid* 'one'. Talking about how the Lumun bury their dead, he explains that they dig one single hole, as a family grave. While making the gesture for 1, he twice adds the Arabic word for 1, *wahid,* see (1).[7]

(1) ONE[8]

wahid	*tʊpʊ*	*wahid*
one	hole	one

'One hole, one'

7 By 2012 Osman Alope had been living in Omdurman for many years. There are several instances of mixed-in Arabic expressions in his narrative.

8 The word in capitals is the number gesture produced by the speaker. The underlining shows the temporal alignment of the gesture with the spoken utterance.

Figure 4
Osman Alope produces the gesture ONE as part of the utterance in (1).

In the same narrative, he explains how once you have recovered from a particular illness, you bring the healer who cured you five calabashes of beer, five bundles of tobacco, and a goat, see (2). Both for the beer and the tobacco, the speaker does not verbalize the numeral himself, but makes the gesture for 5 and clearly invites one of the interlocutors to verbalize the number word by locking eyes with him and rotating the fist a few times. Both times, the interlocutor addressed pronounces the word *ukulúk* 'five' in response.

(2)

			FIVE
a-kín	*ɔ́nɛ́kat*	*ɲəpák*	*ínâ*
and-they	bring	amounts_of_beer	like_this

		FIVE
ana	*ą́ṯṯɔ́pá*	*ínâ*
and	amounts_of_tobacco	like_this

ana *imít*
and goat

'And they bring amounts of beer like this (5), and amounts of tobacco like this (5), and a goat.'

Figure 5
The gesture FIVE articulated with a rotating wrist and produced as part of the utterance in (2).

A fascinating example of using the number gestures without any verbalized number words is found in (3). Here, Osman Alope is talking about a group of four persons who were later joined by an old man, so that they ended up as a group of five persons. Gestures are crucial information bearing units in this account. In the first statement, about the group of four persons, the number 4 is only conveyed by a gesture, without an accompanying spoken number. Then he adds a sentence about an old man joining them. After that, he adds a gestural comment – without any accompanying speech – in the form of the gesture for 5, to say that they ended up being five in total.

(3)

		FOUR
lɔcuáí	*lɔkát*	*ínâ*
Shwai	were	like_this

	FIVE
ana	*ʈɔ́mɔccɔ*
and	old_man …….

‘And the Shwai were four and an old man (was added and) [they were five]’

Figure 6
The gesture FOUR as produced as part of the utterance in (3).

Figure 7
The gesture FIVE as produced as part of the utterance in (3).

This little group had eight cows. Osman Alope first gestures the number to Lotti Tager, the interlocutor in the pictures above, then turns to an interlocutor to his front-left side, while rotating both wrists, to invite him to say the number aloud, see (4) and Figure 8. This is followed by a response (though not clearly identifiable in the recording).

(4) EIGHT_4+4

ɔkín	*ʈɔ́nú*	*kie*	*ɱâ*
they	have	cows	like_this

'They had eight cows.'

Figure 8
Osman Alope turns to another interlocutor, making the gesture for EIGHT with rotating wrists to invite a verbalization of the number, as in (4).

3.3 Discussion of Lumun number gestures

The number gestures found for Lumun are interesting in comparison to other number gesture systems, as well as in comparison to the number words in the associated spoken language.

3.4 Equal addenda structuring in Lumun number gestures

The data for Lumun provide a contemporary account of an equal addenda system in number gestures. It is different from most equal addenda number gestures reported in the literature in having two-handed gestures for 4 and 5. Also, Lumun has a relatively large set of number gestures built on the equal addenda principle. In other equal addenda systems, the smallest value having a two-handed gesture is 6 or 8. Thus, in Bété, only the gestures for 6 and 8 are reported as having an equal addenda structure (Coninckx 1978: 296).

Also, the Lumun number gestures show features that have not been reported in the literature before. One of these features is the position of the salient

fingers for the numbers 2, 3, and 4, i.e. forming a circle with the thumb and hence bending the finger joints. Bending of the finger joints is commonly observed in 5, which in many places consists of a fist or of a hand in which all digits are joined at the tips. Folding of the fingers is commonly found when counting or listing items on the fingers, but less so in number gestures with the purpose of showing a number value. We are not aware of studies describing folding the fingers for number gestures below 5. Also, in those cases where the fingers are folded, this usually starts with the pinky finger moving up to the index finger. In the Lumun number gestures, the finger folding starts with the index moving to the pinky finger. The gestures were performed without hesitation and seem to be the conventional way of forming number gestures for speakers of Lumun.

The number gestures described for Lumun have also been observed in spontaneous conversations. The analysis of number gestures in an oral history account narrated by Osman Alope documents the tight integration of number words and gestures, also reported (without documentary examples) for other East African languages, including Kirundi (Schmidl 1915), Maasai (Gulliver 1958), Akoose (Nkosi) (Dorsch 1910), and Iraqw (Mous, p.c. 2019). The same analysis illustrates how number gestures are used in the absence of number words, even to the extent of conveying the equivalent of an entire utterance.

4 The structure of number words and gestures compared

As noted above, Lumun has both words and gestures that use the equal addenda principle. Indeed, Lumun seems to have an exceptional set of equal addenda number words and gestures. However, the lowest equal addenda *word* is 3, and the lowest equal addenda *gesture* is 4. In addition to the equal addenda gestures in Lumun, a variant set of gestures is found that seems to be 5-based. The variant gesture for 6 forms an interesting exception, as it does not consist of 5 + 1, but rather of 4 + 2. As such, it is motivated neither by an equal addenda principle, nor by a 5-based one. One tentative explanation may lie in the fact that the gesture for 1 is the only gesture with an extended instead of a bent digit. A 5-based version of 6 would thus require a combination of folded digits on one hand, and an extended digit on the other. In 4 + 2, all digits are folded. A related observation may be that the spoken number word for 3 is already an equal addenda term consisting of 2 + 1, but the number gesture is a one-handed gesture consisting of 3 folded digits. One could argue here too that the combination of folded digits on one hand, and an extended digit on the other, may have blocked the use of an equal addenda gesture, like in the case of 6. The discrepancy in words and gestures for 3 and 6 may thus suggests that the consistency within the word or gesture paradigm prevails over consistency between the word and gesture paradigms. Finally, an important difference between the Lumun spoken and gestural system is that all compositional number words are built according to one principle (i.e. the equal addenda principle), but that there are two paradigms for number gestures (i.e. one using the equal addenda principle and the other using a 5

as a base). The discrepancies listed here shed new light on the question to what extent number words are based on number gestures or the other way around.

Table 4
An overview of the number words and gestures in Lumun.

Number	Lumun gestures	Lumun gesture variant	Lumun words	Lumun word variant	Similarity with regard to equal addenda (e.a.)
1	1		1		-
2	2		2		no e.a.
3	3		2+1		e.a. only in speech
4	2+2	4	4		e.a. only in gesture
5	3+2	5	5		e.a. only in gesture
6	3+3	4+2	involves 3		e.a. in gesture and speech
7	4+3	5+2	3+2+2	4+3	e.a. in gesture and speech
8	4+4		4+4 (?)		e.a. in gesture and possibly speech
9	5+4		5+4		e.a. in gesture and
10	5+5		10		e.a. only in gesture

5 Conclusion

The Lumun data provide contemporary evidence of the principle in use in words and gestures, showing an extreme equal addenda system, in the sense that even the number 3 is composed according to this principle. The Lumun numeral gestures are also found to have formal features not reported in the literature before, including two-handed gestures for 4 and 5, and the salient fingers forming a circle with the thumb. Unexpected discrepancies are found between number words and gestures in Lumun, shedding new light on the relation between the two, in particular the role of paradigm formation.

The equal addenda principle is found in number words and gestures in a wide variety of African languages, including spoken and signed languages. The cross-linguistic distribution of the principle seems to be areally defined, with languages reported as having more than 1 equal addenda number word, and languages reported to use equal addenda number gestures being found in an area running from West to East Africa.

Similarly, equal addenda numerals in Kordofanian languages show a regional distribution, with the Heiban and Talodi languages in the center of the area occupied by these families all using the equal addenda system, and other members of the same families -more peripheral in terms of location- not using it. We have not come across reports of this system outside of the African continent.

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