Semantics for numerals in Lalo Yi

Xuping LI Weimei BU
Zhejiang University, University of Macau
Email: xupingli@zju.edu.cn

1. Introduction

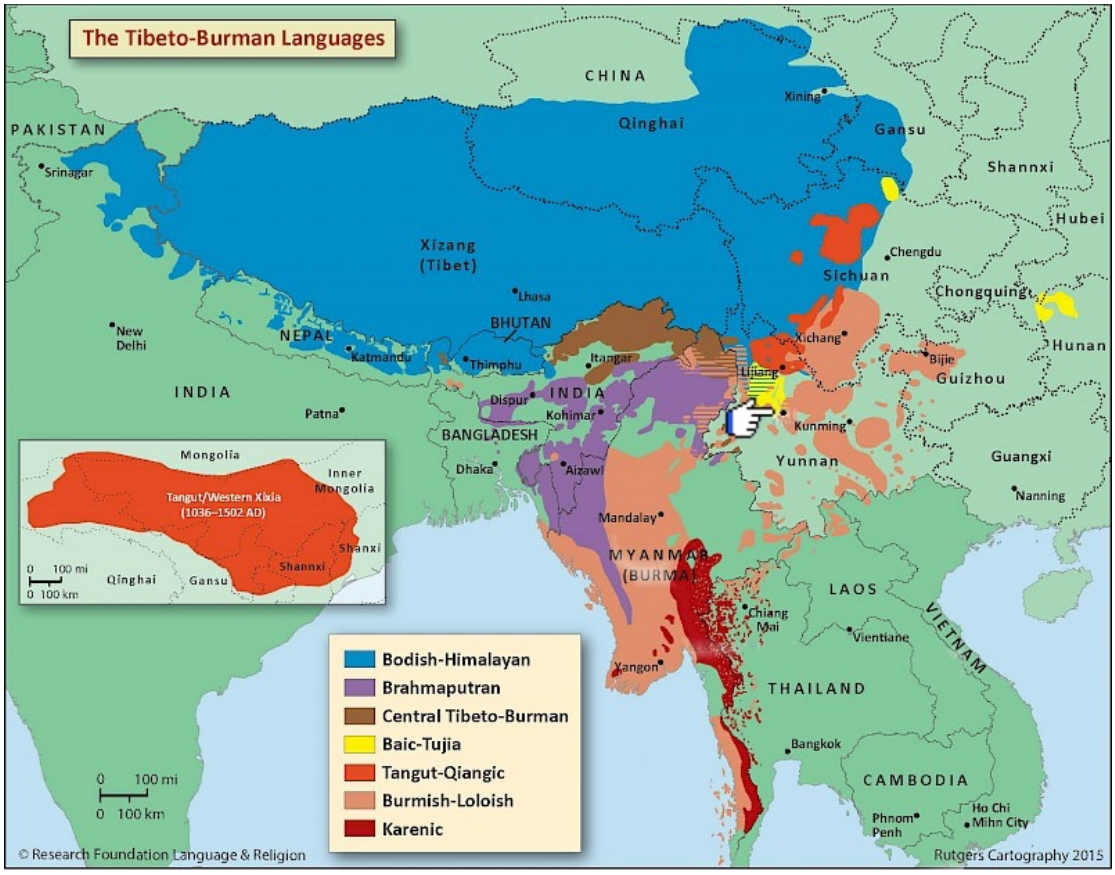
Numerals in English are shiftable between GQs and predicates (Partee 1987; Landman 2004.) And they also have the corresponding nominalized counterparts, i.e. being singular terms (Rothstein 2013).

(1) a. $||\text{three}||_{GQ} = \lambda P \lambda Q.|P \cap Q|=3$
b. $||\text{three}||_{Pred} = \lambda x.\ |x|=3$
c. $||\text{three}||_{Mod} = \lambda P \lambda x.\ P(x) \wedge |x|=3$

(2) $||\text{three}||$: $3= {}^{\cap}\lambda x.\ |x|=3$

Nonetheless, it is not straightforward to what extent the type-shifting principles for English numerals proposed in Partee (1987) and Rothstein (2013) are applicable in languages beyond Europe. At least, they cannot be applied to numerals in classifier languages, whose numerals are either mapped onto singular terms (in Chinese) or predicates (in Korean) and they are not shiftable (Li 2021).

This study looks into the usages of numerals in Lalo Yi, a Loloish language (the Tibeto-Burman family) spoken in Yunan Province, China.



Lalo Yi features two numeral systems, including numerals native to Yi and numerals borrowed from Chinese. They are confined in two sets of syntactic contexts, as exemplified by examples from (3) to (5).

First, Chinese numerals can be used in bare forms in argumental positions, but numerals native to Yi cannot be used unless they are accompanied by a classifier.

(3) 'I can count from one to ten.'

a. **Bare Chinese numerals (borrowed)**

ŋa^{55} ʑi^{13} dʑi^{55}a^{31}ta^{31}hɛ^{33} ʂi^{13} gu^{55} tɛ^{h}i^{55}ʔɛ^{55} a^{31}.
I one LOC-STATE-RES-PRT ten count to can SFP

b. **Num-Cl in Lalo Yi (native)**

ŋa^{55} tʂ^{h}i^{31}*(ma^{55}) dʑi^{55}a^{31}ta^{31}hɛ^{33} tɛ^{h}i^{55}*(ma^{55}) gu^{55} tɛ^{h}i^{55}ʔɛ^{55} a^{31}.
I one-CL LOC-STATE-PAR ten-CL count to can SFP

Second, Lalo Yi is characterized as a classifier language, whose counting predicate must be expressed by the phrase Num-Cl but not by bare numerals.

(4) a. **Numerals native to Yi**

tʂau^{55}p^{h}i^{55}ku^{55} zɛ^{31}mɛ^{31} ʔlɯ^{33}*(ma^{55}) tʂ^{h}u^{5} ni^{33} ʐo^{33}pa^{31} k^{h}o^{31}*(ma^{55}) tʂ^{h}u^{55} mu^{31}.
photo-Loc girl four-CL have and boy six-CL have VIS
'In the photo, girls are four and boys are six.'

b. **Numerals borrowed from Chinese**

tʂau^{55}p^{h}i^{55}ku^{55} zɛ^{31}mɛ^{31} si^{55}*(kə^{55}) tʂ^{h}u^{5} ni^{33} ʐo^{33}pa^{31} lu^{13}*(kə^{55}) tʂ^{h}u^{55} mu^{31}.
photo-Loc girl four-CL have and boy six-CL have VIS
'In the photo, girls are four and boys are six.'

Third, as Bu and Liu (2020) reported, the phrase Num-Cl cannot form a constituent with nouns in Lalo Yi, but its demonstrative phrases can be expressed as N-Dem-Num-Cl.

(5) a. mi^{55}-ku^{55} a^{55}nɯ^{31} ha^{55} nɯ^{31}k^{h}ɯ^{55} dza^{31} ki^{33} a^{31} mu^{31}.
field-Loc cow crops two CL eat PROG SPF VIS
'Two cows are eating the crops in the field.'

b. a^{55}nɯ^{31} na^{55} nɯ^{31}k^{h}ɯ^{55} mi^{55}-ku^{55} ha^{55} dza^{31} ki^{33} a^{31} mu^{31}.
cow that two CL field-Loc crops eat PROG SPF VIS
'Those two cows are eating the crops in the field.'

Questions concerning the semantics of numerals in Lalo Yi:

- How are the two set of numerals in Lalo semantically distinguished?
- How would the presence of classifiers after numerals constrain the semantics of numerals in classifier languages like Lola Yi?
- Why would Num-Cl behave differently between indefinite and definite phrases?

2. Theoretical background: A Fregean semantics for numerals in English

The current wisdom on the semantics for numerals has been built upon the data of Indo-European languages like English, German or Russian, among others (Landman 2004; Hofweber 2005; Moltmann 2013, 2017; Ionin and Matushansky 2006). Two of the controversies on the semantics of numerals in these languages are as follows:

(i) English numerals are characterized with a family of readings, but it is highly controversial as to which reading is taken to be default, from which the other readings are derived.

(ii) There are opposed views concerning the issue of how the first-order properties denoted by numerals can be related to their nominalized counterparts, such as being 'singular terms' in the sense of Frege (1884)?

It has been observed by many (Moltmann 2013, 2017; Rothstein 2013, 2015; Snyder 2017; Bylinina and Nouwen 2020) that numerals in English are used in a wide range of contexts, ranging from being a determiner to a predicate or a predicate modifier, as exemplified by (6).

(6) a. *Eight*$_{GQ}$ planets are discovered.
b. The planets are *eight*$_{Pred}$.
c. There are *eight*$_{Modifier}$ planets.

There is not much morphosyntactic evidence available in English to favor one analysis over the others. It is theoretically possible to shift among these three readings via the "Partee triangle" (1987). There are three semantic analyses available, including the GQ view (Barwise and Cooper 1981; Hofweber 2005), the adjectival view (Moltmann 2013; Landman 2004), and the modifier view (Ionin and Matushansky 2006).

(7) a. eight (planets, {x: x are discovered}) (numerals as GQs)
b. $\exists$x [planets (x) $\wedge$ eight(x)] (numerals as predicates)
c. $\exists$x [eight(planets) (x)] (numerals as modifiers)

Among these three accounts, the analysis of numerals as GQs has been refuted by many:

- **Krifka (1999):** at least some determiners are not determiners.

Unlike other determiner phrases, indefinite phrases expressed by numerical expressions are scopeless. Numerals like *three* and *seven* in (6) have a cumulative reading, which is not predicted by the GQ analysis.

(8) a. Three boys ate seven apples.
b. At least three boys ate at least seven apples.

It is thus suggested that numerical expressions like *three* or *at least three* are analyzed as an adjective that applies to sum individuals which consist of (at least) three atoms.

- **Landman (2004):** numerals are adjectives

Argument 1: numerical expressions can be taken as complement by other determiners.

(9) a. every *three* student
b. the *three* students

Argument 2: the phrase "the *r n* N", such as *the more than 3 students*, has the structure of [the [*r n* N]], where complex numeral phrases are predicates. The relation *r* can be expressed by ≥ (more than), = (exactly) , ≤ (less than) …

(10) || r n||: λx. |x| r n, such that it denotes the set of sums whose cardinality stands in relation r to number n.

- **Frege (1884):** numerals can be used as 'singular terms'.

The number word *eight* in (11) is used in an "identity sentence" (in the form of 'A is B', Higgins 1976), where it has the same status as the referential expression *the number of planets* (see Synder 2018 and Moltmann 2017 for an opposed view). They are supposed to refer to the same object, i.e. being the mathematic object 8.

(11) The number of planets is *eight*.

Rothstein (2013): cardinal numerals start out with a standard modifier interpretation at type <e,t>, with the cardinality function defined in (12a), and it can also denote the individual property correlate of the set, namely, being a singular term, as shown in (12b).

(12) a. $||four||_{<e,t>}$ = λx. |x|=4
b. $||four||_{<n>}$ = $^{\cap}$(λx. |x|=4)

- **Generalization 1:** Numerals in English are interpreted as cardinal predicates.
- **Generalization 2:** Numerals can be shifted from its predicative type into the corresponding arguments, i.e. being singular terms.

3. Numerals in Lalo Yi: an overview

This section examines the usages of numerals in Lalo Yi. We will show that the Fregean semantics for English numerals cannot be extended to numerals in Lalo Yi. We endorse the argumentation that numerals do not have a unified semantics both across and intra linguistically.

Lalo Yi features two sets of numerals, including numerals native to Lalo Yi and numerals borrowed from Chinese (Table 1). We propose that the borrowed numerals from Chinese denote singular terms, and native numerals are mapped onto GQs in Lalo Yi.

	0	1	2	3	4	5	6	7	8	9	10	…
Lalo Yi		tʂhi^{31}	nɯ^{31}	sa^{33}	ʔlɯ^{33}	ŋa^{31}	k^{h}o^{31}	xɯ^{31}	hĩ^{31}	ku^{33}	tɕ^{h}i^{55}	…
Chinese	lin^{31}	ʑi^{13}	ʔɛ^{55}	san^{33}	si^{55}	u^{31}	lu^{13}	tɕ^{h}i^{13}	pa^{13}	tɕiəu^{31}	ʂi^{13}	

Table 1. The two sets of numerals in Lalo Yi

We now show that the two sets of numerals in Lalo Yi can be distinguished in the following contexts.

- **Fact (1): native numerals in Lalo Yi cannot be used as numerical objects, but borrowed numerals from Chinese can.**

As shown in (13), the native Yi numerals *ʈʂhi³¹* 'one' and *nɯ³¹* 'two' cannot be predicated of the properties of being a singular number and of being a dual number, but the Chinese numerals *ʑi¹³* 'one' and *ʔɛ⁵⁵* 'two' can.

(13) One is a singular number and two is a dual number.

a.	**ʈʂʰi³¹*	ka³³	tan³³su⁵⁵,	*nɯ³¹* ka³³	ʂuan³³su⁵⁵.	(Yi)
	one	TOP	singular numeral	two TOP	dual numeral	
b.	ʑi¹³	ka³³	tan³³su⁵⁵,	ʔɛ⁵⁵ ka³³	ʂuan³³su⁵⁵.	(Chinese)
	one	TOP	singular numeral	two TOP	dual numeral	

In the same vein, only Chinese numerals can be used in arithmetic contexts, and the use of Yi numerals is highly restricted. Instead of using bare numerals, they must take the form Num-Cl when making addition and subtraction. Multiplication and division cannot be expressed by Yi numerals at all.

(14) **Chinese numerals in arithmetic contexts**

a. Q: ʑi¹³ tɕa³³ ʔɛ⁵⁵ a³¹da⁵⁵**ma³³**si³¹ ?
one plus two how many-CL
Q: 'One plus two, it is how many?'
A: ʑi¹³ tɕa³³ ʔɛ⁵⁵ ka³³ san³³.
oneplus two TOP three
A: 'One plus two makes three.'

b. Q: ʂi¹³ tɕin³¹ tɕiəu³¹ a³¹da⁵⁵**ma³³**si³¹ ?
ten minus nine how many-CL
Q: 'Ten minus nine, it is how many?'
A: ʂi¹³ tɕin³¹ tɕiəu³¹ ka³³ ʑi¹³.
ten minus nine TOP one
A: 'Ten minus nine makes one.'

(15) **Native Yi numerals in arithmetic contexts**

a. tʂʰi³¹ma⁵⁵-ku⁵⁵ tsɛ¹³ tʂʰi³¹ma⁵⁵ ki³³tɕi⁵⁵ ka³³ a³¹da⁵⁵**ma³³**si³¹ ?
one-Cl-Loc again one-Cl put into Gerund how many-CL
'To put one with another one, it is how many?' (Literal: 1+1= ?)

b. nɯ³¹ma⁵⁵-ku⁵⁵ tʂʰi³¹ma⁵⁵ vu⁵⁵-a⁵⁵tɕi⁵⁵ ka³³ tsɛ¹³ **a³¹da⁵⁵ma³³si³¹**?
Two-Cl-Loc one-CL take-PFV Gerund again **how many-CL**
'To take one from the two, it is how many?' (Literal: 2-1= ?)

- **Fact (2): the two sets of numerals in Lalo Yi are involved in two modes of counting.**

We can either directly count natural numbers or count individuals by mapping them to natural numbers. In the former only Chinese numerals can be used, and in the latter, native Yi numerals

are used.

- **Rothstein (2013):** the predicate *counting (up) to…*applies to argumental expressions, which is taken as evidence in support of the status of numerals as singular terms.

(16) a. He can count up to 13.
b. # He can count up to 13 students.

However, in Lalo Yi, the counting context construed by *count up to* ...applies to borrowed numerals from Chinese, but not to native Yi numerals, unless they are accompanied by classifiers, such as the general classifier *ma*.

(17) 'I can count from one to ten: one, two...'
a. Bare numerals in Chinese

ŋa^{55}	*ʑi^{13}*	dʑi^{55}a^{31}ta^{31}hɛ^{33}	*ʂi^{13}*	gu^{55}	tɕ^{h}i^{55}ʔɛ^{55}	a^{31}:	ʑi^{13}, ʔɛ^{55}…
I	one	LOC-STATE-RES-PRT	ten	count	to	can	SFP	one two …

b. Num-Cl in Lalo Yi

ŋa^{55}	*ʈʂhi^{31}ma^{55}*	dʑi^{55}a^{31}ta^{31}hɛ^{33}	*tɕ^{h}i^{55}ma^{55}*	gu^{55}	tɕ^{h}i^{55}	ʔɛ^{55}	a^{31}:	ʈʂ^{h}i^{31}ma^{55}, nɯ^{31}ma^{55}…
I	one-CL	LOC-STATE-PAR	ten-CL	count	to	can	SFP	one-CL two-CL …

We suggest that the two sets of numerals in Lalo Yi used in the context of counting in (15) are enumerations with two distinct domains:

- Counting w.r.t the domain of natural numbers ω_n for Chinese numerals:
  - The example (18a) is a purely mathematic counting with respect to the ordering of natural numbers
- Counting w.r.t. the domain of countable individuals ω_e for native numerals in Lalo Yi:
  - In the example (18b), there is a mapping from N to S, i.e. from the set of natural numbers to the set of discrete entities.

- **Fact (3): neither native Yi numerals nor Chinese numerals cannot be used as predicates. Both sets of numerals can be used in predicates only when they are accompanied by classifiers.**

The sentences in (18) and (19) provide a predicative position for numerical expressions, where neither the native Yi numerals nor the borrowed Chinese numerals become possible in their bare forms. Only the expression Num-Cl is licensed in this context.

(18) a.

ʔi^{33}nɯ^{33}	ɕo^{13}sen^{33}	tɕ^{h}in^{31}tɕa^{55}	a^{55}	sa^{33}ma^{55}.		(Num-Cl in Lalo Yi)
today	students	ask for leave	NMLZ	three-CL		

'The students who asked for leave today is three.'

b.

ʔi^{33}nɯ^{33}	ɕo^{13}sen^{33}	tɕ^{h}in^{31}tɕa^{55}	a^{55}	san^{33}kə^{33}.	(Num-Cl in Chinese)
today	students	ask for leave	NMLZ	three-CL	

'The students who asked for leave today is three.'

(19) a. tʂau^{55}p^{h}i^{55}ku^{55} zɛ^{31}mɛ^{31} ʔlɯ^{33}*(ma^{55}) tʂ^{h}u^{55} ni^{33} ʐo^{33}pa^{31} k^{h}o^{31}*(ma^{55}) tʂ^{h}u^{55} mu^{31}.
photo-Loc girl four-Cl have andboy six-Cl have VIS
'In the photo, girls are four and boys are six.'

b. tʂau^{55}p^{h}i^{55}ku^{55} zɛ^{31}mɛ^{31} si^{55}*(kə^{55}) tʂ^{h}u^{55} ni^{33} ʐo^{33}pa^{31} lu^{13}*(kə^{55}) tʂ^{h}u^{55} mu^{31}.
photo-Loc girl four-Cl have andboy six-Cl have VIS
'In the photo, girls are four and boys are six.'

	n is a natural number	1+1=2	count to *n*	the reasons be *n*	n+N
English nums	YES	YES	YES	YES	YES
Borrowed Chinese nums	YES	YES	YES	NO	NO
Native Yi nums	NO	NO	NO	NO	NO

Table 2. Usages of numerals in English and Lalo Yi

Generalization: English numerals can be seen as numerical adjectives at type <e,t>, Chinese numerals are mapped onto singular terms at type n, but native numerals in Lola Yi are neither predicate nor singular terms. What is their semantic type then?

4. Semantics for numerals in Lalo Yi

4.1 GQ analysis for native numerals in Lalo Yi

In classifier languages we are familiar with such as Mandarin and Japanese, numeral classifiers are often found in the context of Num-Cl-N or N-Num-Cl, depending on whether nominal phrases are parameterized with a head-initial order or a head-final order.

- **Bale and Coon (2014):** it is still under debate whether numeral classifiers are required by numerals or by nouns.
- **Classifiers are needed by numerals in Lalo Yi:** native numerals in Lalo Yi must be used with the accompaniment of classifiers in all the possible syntactic contexts and Num-Cl can be used independent of nouns.

Bu and Liu (2020): the constituent of Num-Cl in Lalo Yi does not form a constituent with nouns, regardless of whether the noun is intended to be interpreted as subject or object.

◆ Evidence 1: the constituent Num-Cl behaves like a floating quantifier, which can be separated from NPs by adverbials or some other NPs.

(20) a. a^{55}ni^{55}za^{31} ɣa^{31}hen^{55} ʔlɯ^{33}ma^{55}ŋu^{55} ki^{33} a^{31} mu^{31}.
child hard four CL cry PROG SFP VIS
'Four kids are crying sadly.'

b. mi^{55}-ku^{55} a^{55}nɯ^{31} ha^{55} nɯ^{31}-k^{h}ɯ^{55} dza^{31} ki^{33} a^{31} mu^{31}.
field-Loc cow crops two-CL eat PROG SPF VIS
'Two cows are eating the crops in the field.'

◆ Evidence 2: it is also impossible to conjoin to NumPs. Expressions like [[N-Num-Cl and N-Num-Cl] VP] are not possible.

(21) a.* a^{55}mu^{13} pi^{13} nɯ ^{31} ʂɿ lɛ ^{33} thi ^{31} u ^{31} sa ^{55} pen ^{13} vɛ ^{55} ka ^{33} la ^{55} mu ^{31}.

Amu pen two-CL and book three CL buy back VIS

b. a^{55}mu^{13} pi^{13} nɯ ^{31} ʂɿvɛ ^{55} ka ^{33} la ^{55} lɛ ^{33} thi ^{31} u ^{31} sa ^{55} pen ^{13} vɛ ^{55} ka ^{33} la ^{55} mu ^{31}.

Amu pen two-CL buy back and book three CL buy back VIS

'Amu bought two pens and three books'

Unfortunately, this puzzle was not solved why the phrase Num-Cl cannot merge with nouns in their account.

Our proposal: native numerals in Lalo Yi are neither predicates nor singular terms but they are generalized quantifiers.

- It is the classifier but not the noun that comes to saturate the restrictor associated with GQs in Lalo Yi.
- When numerals in Lalo Yi are suggested to be of type <<e,t>, <<e,t>, t>>, the first argument is saturated by the subsequent classifier, and the constituent Num-Cl then takes the verb as its second argument.

(22) $||ʔlɯ^{33}||_{<<e,t>,\ <<e,t>,t>>}=\lambda P\lambda Q.\exists x.P(x) \wedge Q(x) \wedge |x|=4$

We showed earlier that one of the most robust evidence to refute the GQ analysis for English numerals is that its NumPs are subject to a cumulative reading. However, **in Lalo Yi, its NumPs, i.e. the constituent Num-Cl, have the anti-cumulativity effect.**

Lalo Yi disallows the occurrence of double NumPs in a single sentence in a general fashion. And the single occurrence of Num-Cl, which sits next to the predicate, is always scope-taking.

(23) a.*zɿ^{31} pa^{31} ʔlɯ^{33}ma^{55} la^{31}pa^{31} sa^{33}ma^{55} kho^{31}ɕi^{31} a^{55}tɕi^{55} a^{55} mu^{55}.

leopard four-CL tiger three-CL bite die PFV SFP VIS

Intended: 'Four leopard(s) killed three tigers.'

b. la^{31}pa^{31} sa^{33}ma^{55} k^{h}o^{31}ɕi^{55} a^{55}tɕi^{55} a^{55} zɿ^{31}pa^{31} ʔlɯ^{33}ma^{55}.

tiger three-Cl bite die PFV NMLZ leopard four-Cl

'The leopards that killed three tigers are four.'

Given that only one occurence of Num-Cl is allowed for a certain two-place predicate, one of its arguments is expressed by Num-Cl and the other is reserved for a bare noun. Although the phrase Num-Cl and bare nouns do not form a constituent, they can be coreferential with each other. Consider the example in (24).

(24) tʂ^{h}u^{55} la^{31}pa^{31} ŋa^{31}-ma^{55} tʂa^{33} ʑi^{55} k^{h}u^{55} a^{31} mu^{31}.

people tiger five-Cl seek go want SFP VIS

a. 'As for tigers, the people are going to feed five.'

Lit: 'The people are going to seek five tigers.' (seek > five tigers or five tigers > seek)

b. 'As for people, five are going to seek tigers.'

Lit: 'Five people are going to seek tigers.' (five people <seek< tigers)

The GQ status of Yi numerals is corroborated by the following facts independently.

- **Fact 1:** there is no lexicalized quantifier like *every*, *all* or *the* in Lalo Yi. Hence, the phrase Num-Cl cannot be taken as complement of other determiners. Unlike what we saw in English, word orders like *Num-Cl-THE or *Num-Cl-EVERY in Lalo Yi are not available in Lalo Yi.

The distributive meaning of noun phrases is achieved by reduplicating the plural phrase Num-Cl. As a result, the form Num-Cl-Num-Cl is comparable to a distributive quantifier.

(25) a. a^{55}ni^{55}za^{31} sa^{33}ma^{55} sa^{33} ma^{55} p^{h}in^{31}ko^{31} tʂ^{h}i^{31}ma^{55} dza^{31}.
kid three CL three CL apple one CL eat
'Every three kids eat one apple.'

The singular phrase ONE-Cl cannot be reduplicated to express the distributive meaning. Instead, we can employ the strategy of relative clauses, when we intend to express the meaning of *every NP*.

(26) a^{55}ni^{55}za^{31} ha^{55} tʂ^{h}i^{31}ma^{55} ŋa^{55} a^{55} p^{h}in^{31}ko^{31} dza^{31}pɛ^{55} a^{55} mu^{55}.
kid all one CL be NMLZ apple eat PFV SFP VIS
'As for kids, all who is a kid, ate apples.'
Lit: 'Every kid ate apples.'

- **Fact 2:** degree modifiers like *more than*, *less than*, *exactly, around* are not available in Lalo Yi, which implies the constituent Num-Cl is not susceptible to the modification of predicative modifiers.

Instead, the Yi language may use the verb *ma^{31}ts$^{h}i^{55}$* 'exceed' and *ma^{31}tɕ$^{h}i^{55}$* 'fall behind, be inferior' to express the 'comparative' meaning 'more than' and 'less than' respectively.

(27) ɕo^{13}sen^{33} k^{h}au^{31}ʂi^{55} la^{55} a^{55} tʂ^{h}i^{31}hã^{55}-ma^{55} ma^{31}ts^{h}i^{55}/ma^{31}tɕ^{h}i^{55} mu^{55}.
student exam come NMLZ one-hundred-Cl exceed / not reach VIS
'The students who came to sit for exam exceeded/ fell behind 100.'
Lit: 'More than/less than one hundred students took the exam.'

- **Fact 3:** the constituent of Num-Cl under the guise of various syntactic/phonological forms are used to express various quantificational meanings, including the distributive reading and the definite reading.

⇨ We suggest that the apparent definite article *tʂ$^{h}i^{55}$* is grammaticalized from the numeral *tʂ$^{h}i^{31}$* 'one', which is manifested by the tone sandhi from its base tone 31 to a high-level tone 55.

The morpheme *tʂ$^{h}i^{55}$* appears to be the definite article in Lalo Yi, but it applies to singular phrases only, i.e. [*tʂ$^{h}i^{55}$*-Cl-N]. It is impossible for *tʂ$^{h}i^{55}$* to take Num-Cl-N as complement to express the definite reading.

(28) a. pha^{55} tʂ^{h}i^{55} k^{h}ɛ^{33} t^{h}u^{55} mu^{31}. [*tʂ$^{h}i^{55}$*-Cl-N]
clothes the Cl thick VIS
'This item of clothes is thick.'

b. *pha^{55} tʂ^{h}i^{55} sa^{33} k^{h}ɛ^{33} t^{h}u^{55} mu^{31}. [*tʂ^{h}i^{55}-Num-Cl-N]
clothes the three Cl thick VIS
Intended: 'These three items of clothes are thick.'

4.2 Semantics for native numerals in Lalo Yi

While acknowledging the analysis of the phrase Num-Cl as a generalized quantifier, it is expected that the GQ reading can be coerced into a predicative reading via standard type-shifting principles proposed in Partee (1987).

As shown earlier, Num-Cl can also be used in predicative positions. We suggest that GQs can only be shifted to predicates by the type-lowering BE, but the lowering from GQs to e is blocked and it is compensated by the Chinese numeral system instead.

(29) a. la^{31}pa^{31} sa^{33}ma^{55} k^{h}o^{31}ɕi^{55} a^{55}tɕi^{55} a^{55} zɳ^{31}pa^{31} ʔlɯ^{33}ma^{55}.
tiger three-Cl bite die PFV NMLZ leopard four-Cl
'The leopards that killed three tigers are four.'
b. || ʔlɯ^{33} ma^{55}||=λQ.∃x.Q(x)∧ATOM(x)∧|x|=4
c. BE (||ʔlɯ^{33} ma^{55}||) =∃x.ATOM(x)∧|x|=4

This shifted predicative reading is also available for the Num-Cl phrase in demonstrative phrases. Although there is no definite article in Lalo Yi, demonstratives are the most suitable candidate to express definiteness. DemPs are expressed in the order of N-Dem-Num-Cl in Lalo Yi.

- **Bu and Liu (2020):** demonstrative phrases in Lola Yi do not observe the same syntactic constraint as indefinite phrases that Num-Cl that demonstratives can in fact merge with nouns to be a quantificational phrase.

(30) a. ŋa^{55} a^{55}k^{h}ɯ^{31} na^{55} sa^{33}ma^{55} ʔvu̱^{33}hu^{55} a^{55}tɕi^{55} a^{55}.
I dog that three-Cl sell out PFV SFP
'I sold out those three dogs.'
b. a^{55}k^{h}ɯ^{31} na^{55} sa^{33}-ma^{55} ŋa^{55} ʔvu̱^{33}hu^{55} a^{55}tɕi^{55} a^{55}.
dog that three-Cl I sell out PFV SFP
'Those three dogs, I sold out.'
c. *a^{55}k^{h}ɯ^{31} sa^{33}ma^{55} ŋa^{55} ʔvu̱^{33}hu^{55} a^{55}tɕi^{55} a^{55}.
dog three Cl I sell out PFV SFP
Intended: 'Three dogs, I sold out.'

We suggest that demonstratives, which provides a predicative position for its complements, are able to trigger Num-Cl to be shifted from <<e,t>t> to <e,t>. The coerced Num-Cl can merge with NPs via the mechanism of predicate modification (Heim and Kratzer 1997).

(31) ||N-Dem-Num-Cl||= ||Dem|| (|| N-Num-Cl||)= ||Dem|| (||Num-Cl|| ∩ ||N||)

4.3 Semantics for borrowed Chinese numerals

The second issue to be tackled in this section is concerned with the availability of numerals as singular terms.

According to Rothstein (2013), cardinal numerals start out with a standard modifier interpretation at type <e,t>, with the cardinality function defined in (31a), and it can also denote

the individual property correlate of the set, namely, being a singular term (31b).

(32) a. $||four||_{<e,t>} = \lambda x.\ |x|=4$
b. $||four||_{<n>} = {}^{\cap}(\lambda x.\ |x|=4)$ (Rothstein 2013)

Till now, we've seen that native numerals in Lalo Yi do not have corresponding nominalized counterparts. Namely, they fail to be used as singular terms. Instead, they resort to the Chinese numerals to represent numeral as mathematic objects, which are abstracted at a higher level.

We argue that borrowed Chinese numerals are born as singular terms, which are analogous to the kind denotation of bare nouns in Chinese as proposed in Chierchia (1998). They can be coerced with a predicative meaning by lexical device, e.g. the use of classifiers, which results in the counting predicate Num-Cl.

(33) la^{31}pa^{31} san^{33} kə^{55} k^{h}o^{31}ɕi^{55} a^{55}tɕi^{55} a^{55} zɿ^{31}pa^{31} si^{55} kə^{55}.
tiger three-Cl bite die PFV NMLZ leopard four-Cl
'The leopards that killed three tigers are four.'

In Lalo Yi, borrowed Chinese numerals go with borrowed Chinese classifiers. We suggest that classifiers in Chinese denote the cardinality function from natural numbers to a set of atomic individuals (Li 2021).

(34) a. $||si^{55}|_{n}=4$ b. $||$ kə$^{55}||= \lambda n\lambda x.\ \mu(x)=<n, Unit>$
c. $||$ si^{55} kə$^{55}||= ||$ kə$^{55}||_{<n,\ <e,t>>}$ $(||si^{55}||_{n})$
$= \lambda n\lambda x[\mu(x)=<n, Unit>]$ (4) $= \lambda x.[\mu(x)=<4, Unit >]$

In a word, both cross-linguistically and intra-linguistically, numerals are not endowed with a unified semantics. In Lalo Yi, the two sets of numerals diverge from each other in either serving as a functor that takes classifiers as its argument, or as an argument (e.g. being a numeric object) to saturate the variable for numeral associated with the semantics of classifiers. In these two cases, classifiers are not analyzed with a unified semantics either.

5. Some more puzzles unsolved

- **Puzzle 1:** the phrase Cl-N cannot compose with adjectival predicates as its argument. The phrase Num-Cl can only function as a predicate, which is predicated of a relativized NP.

(35) a. ɕo^{13}sen^{33} sa^{33}-ma^{55} tɕhin^{31}tɕa^{55} a^{55}tɕi^{55} a^{55} mu^{55}.
student three-Cl ask for leave PFV SFP VIS
'Three students asked for leave.'
b. *ɕo^{13}sen^{33} sa^{33}-ma^{55} (mɛ^{13}) sa^{31} mu^{55}.
student three-Cl very clever VIS
Intended: 'Three students are intelligent.'
c. ɕo^{13}sen^{33} (mɛ^{13}) sa^{31} a^{55} sa^{33}ma^{55}.
Student very clever nmlz three-Cl
'Students who are intelligent are three. '

It seems not highly motivated to associate the phrase Num-Cl with an event interpretation. The most I can think of is that, following Chung and Ladusaw (2001:13), the phrase Num-Cl composes with the VP via restriction, and there is also an event variable, which must be existentially closed before the closure of the restricted argument is forced at the end. But would this move makes us give up the GQ analysis for Num-Cl?

Puzzle 2: different aspectual markers may affect the interpretation of Num-Cl to be co-referential with a subject NP or an object NP.

According to Bu and Liu (2020), when the verb is marked by progressive or immediate future markers, the phrase Num-Cl can be coreferential with the subject or object NP; when the verb is marked by durative, experiential or perfective aspects, it can only be coreferential with the object NP.

Subject NP	Object NP	Num-Cl	Verb	Aspect	Lexical source
Antecedent_x	Antecedent_y	$_{x/y}$		Progressive	hide (put intentionally)
Antecedent_x	Antecedent_y	$_{x/y}$		Immediate future	want
	Antecedent_y	$_y$		Durative	Mandarin loanword 着
	Antecedent_y	$_y$		Experiential	?
	Antecedent_y	$_y$		Perfective	?

We speculate that whether the aspectual markers are intensional or not might play a role here. Not only the immediate future marker but also the progressive marker is intensional, the latter of which means ‘to hide’, i.e. ‘to put intensionally’. However, other aspectual markers are not intensional in any case. We, following Filip (1996), assume that these aspectual markers are lexical V-operators that quantifies over episodic predicates and their argument. They bind the incremental theme argument. This makes Num-Cl a part of the predicate, which, as a consequence, leads to a narrow-scope reading.

Selected references:

Hofweber, T. (2005). Number determiners, numbers, and arithmetic. *The Philosophical Review*, *114*, 179–225.

Ionin, T. and O. Matushansky (2006). The composition of complex cardinals. *Journal of Semantics 23*, 315–360.

Bu, W. and H. Liu. (2020). Split numeral quantifier in Lalo Yi dialect. *Studies of the Chinese Language*. 2020(5), 609-624.

Moltmann, F. (2013a). Reference to numbers in natural language. *Philosophical Studies*, *162*, 499–536.

Rothstein, S. (2013). A fregean semantics for number words. In *Proceedings of the 19th Amsterdam Colloquium*, pp. 179–186. Universiteit van Amsterdam, Amsterdam.