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Classifiers can be for numerals *or* nouns: Two strategies for numeral modification

Carol Rose Little, University of Oklahoma, US, little@ou.edu

Mary Moroney, University of Rochester, US, mary.moroney@rochester.edu

Justin Royer, University of California, Berkeley, US, justinroyer@berkeley.edu

This paper compares two families of theories for numeral classifiers drawing on fieldwork data from two languages, Ch'ol (Mayan, Mexico) and Shan (Kra-Dai, Myanmar). We discuss *classifier-for-numeral* theories and *classifier-for-noun* theories, which we argue make different predictions based on the syntactic position and semantic contribution of the classifier in each set of theories. We argue that Ch'ol is a classifier-for-numeral language and Shan is a classifier-for-noun language. This analysis attributes the distinction between classifier-for-numeral and classifier-for-noun languages to cross-linguistic variation in the strategies for numeral modification. The proposed diagnostics are based on the semantic role of the classifier in numeral modification and can be used to distinguish between the two types of numeral classifiers across other languages.

1 Introduction

This paper investigates the function of numeral classifiers, expressions that occur with numerals in a language (as defined by Aikhenvald 2000). We categorize theories of numeral classifiers into two main families. One set of theories argues that classifiers are needed for numerals (e.g., Krifka 1995; Bale & Coon 2014; Bale et al. 2019): the numeral is semantically dependent on the classifier. We will refer to such theories as *classifier-for-numeral* theories. The other set of theories argues that classifiers are needed for nouns (e.g., Chierchia 1998; Jenks 2011): the classifier changes the semantics of the noun so that it can be modified by a numeral. We refer to these theories as *classifier-for-noun* theories. Throughout the paper, we use 'classifier' as a shorthand for 'numeral classifier', unless otherwise specified.

In both Ch'ol (Mayan) and Shan (Kra-Dai), classifiers obligatorily appear with numerals, as in (1) and (2). In the Ch'ol example in (1), the numeral classifier *-kojty* must accompany the numeral. The same is true of the Shan classifier *tǒ* in (2).

(1) Wä'-añ [ux*(-**kojty**) ts'i']
here-EXT three-CLF dog
'There are three dogs here.' Ch'ol

(2) Mí [mǎa sǎam *(**tǒ**)] tinaj
have dog three *CLF here
'There are three dogs here.' Shan

Given data such as in (1) and (2), it is not immediately clear how to make a principled choice between the two families of proposals. Here, we investigate predictions of both families of theories and provide evidence that both are correct, but for different languages. We propose that the distinct methods employed for numeral modification in languages like Ch'ol and Shan can account for differences exhibited among languages with numeral classifiers. In these two modification strategies, classifiers fill *different* functions semantically and have different syntactic positions.

We begin by providing an overview of the different kinds of numeral classifier theories in Section 2, focusing on sortal numeral classifiers. We then provide background on the relevant empirical patterns concerning classifiers in Ch'ol and Shan in Section 3. We provide support for two syntactic structures for the two languages from ellipsis diagnostics, A′-movement and the availability of plural marking. Turning to the semantics, in Section 4 we propose that the main point of variation between the two sets of theories should lie in the strategy for numeral modification. We argue that Ch'ol classifiers are classifiers-for-numerals and Shan classifiers are classifiers-for-nouns, based on diagnostics with respect to whether numerals or nouns govern the appearance of classifiers, and if the classifier appears in contexts other than with numerals. We also propose a new counting diagnostic that can help distinguish between types of classifiers.

This paper thus supports that classifiers in these two languages are semantically distinct, which is a property that can be reflected syntactically. Section 5 is the conclusion.

2 Proposal preliminaries: Variation in numeral modification

In this section, we review the previous literature on semantic analyses of numeral classifiers and take as a starting point variation in the way that the noun combines with the numeral and classifier. In Section 2.1, we identify two broad strategies for numeral modification that have been proposed in the literature on classifier languages. In Section 2.2, we lay out our theoretical assumptions for the denotation and semantic type of nouns, including that nouns denote predicates, following Deal (2017). Based on these two types of theories and the assumption that nouns across languages are type $\langle e,t \rangle$, Section 2.3 briefly discusses our proposal that variation in the denotation of numerals plays a key role in understanding cross-linguistic differences regarding numeral classifiers. In Section 2.4, we outline the predictions made by this proposal.

2.1 A short history of numeral classifier analyses

For both Krifka (1995) and Chierchia (1998), who, to our knowledge, are the first to propose the classifier-for-numeral and classifier-for-noun theories (respectively), nouns in a language with numeral classifiers denote kinds rather than sets of entities. For them, part of the function of the classifier is to semantically access the atoms and plural entities that are members of the kind.

One feature that is shared among all semantic analyses of classifiers is the necessity to identify atomic entities in the set denoted by the noun. The definitions of *atom* and *atomic* are given in (3). An atom cannot have any subparts, and an atomic set is made up of entities that are themselves composed of atoms. For example, the set {*a,b*} contains only atoms and is an atomic set; whereas, the set {*a,b,ab*} contains both atoms (*a,b*) and a sum (*ab*) and is also an atomic set.

(3) Atom vs Atomic (Landman 1989: 561)

a. Atom: a is an atom in A iff for every $b \in A$: if $b \leq a$ then $b = a$.

b. Atomic: A is atomic iff for all $b \in A$: there is an $a \in At$ such that $a \leq b$, where At is the set of atoms in A.

Previous analyses of numeral classifiers vary on a number of important semantic points that are connected to the extended structure of noun phrases. These points of variation include (i) the semantic type of the noun, (ii) the semantic function of the classifier, and (iii) the denotation of the numeral. We discuss these points of variation in turn below.

Among the semantic analyses for classifiers, there are three semantic types that have been proposed for nouns: (i) kinds (e^k), (ii) sets of atoms and pluralities, or (iii) sets of atoms. Having kinds as the starting denotation is proposed by Krifka (1995), Chierchia (1998), Jenks (2011), and Dayal (2012), among others. Bale & Coon (2014) give the starting denotation of the noun as a set of atoms. For Wilhelm (2008), Nomoto (2013), and Bale et al. (2019), the noun denotes an atomic join-semilattice, containing both atoms and pluralities.

There are roughly four ways that the function of the classifier has been characterized: (i) as a proper semantic mediator between the numeral and classifier (Krifka 1995; Wilhelm 2008; Jiang 2012), (ii) as changing the denotation of the noun (Chierchia 1998; Jenks 2011; Dayal 2012; Nomoto 2013), (iii) as a measure function argument required by the numeral (Bale & Coon 2014; Bale et al. 2019), and (iv) as semantically vacuous (Cheng & Sybesma 1999).[1] Numeral classifier semantics is intricately connected to the semantics of numerals, since together they make up the strategy for numeral modification in a language.

For the semantics of numerals, there have been three main proposals: (i) numerals of type *n*; (ii) entity-measuring numerals (e.g., the numeral TWO combines with a nominal predicate that denotes a join-semilattice and yields only the entities that consist of two atoms); (iii) plurality-forming numerals (e.g., the numeral TWO combines with a nominal predicate that denotes only a set of atoms, retrieves sums of two members of the set).

Krifka (1995) and Wilhelm (2008) propose that the numeral is type *n* and that it does not have any measure semantics of its own. In such theories, the classifier mediates between the numeral and the noun and provides a measure function. Chierchia (1998) does not specify what sort of numeral to use, but since the noun denotes a set of atoms and pluralities before it combines with a numeral, it would follow that the numeral measures entities. Bale et al. (2019) also use a plurality measuring numeral for their analysis. For analyses where the noun denotes a set of atoms when it combines with the numeral, it is necessary to have a plurality forming numeral. Jenks (2011),[2] Jiang (2012), Dayal (2012), Nomoto (2013), and Bale & Coon (2014) use a plurality forming numeral, meaning that the numeral forms pluralities where each plurality has a set number of sub-entities.

Summarized in **Table 1** are the analyses of classifiers discussed in this section. The second column shows the starting type of the noun assumed by the analysis of the reference given in the first column. The third column shows the semantic type of the classifier. The final column shows the function of the numeral in each theory—"*n*" represents numerals that form a basic semantic type of their own, "|ENTITY|" stands for numerals that are entity measuring, and "*" stands for numerals that are plurality forming.

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[1] Many theories, such as Krifka (1995) and Chierchia (1998), have connected the presence of classifiers in a language to the absence of the mass/count distinction in that language. This view has, however, been challenged in work such as in Cheng & Sybesma (1998; 1999; 2005), (see also Nomoto 2013; Deal 2017, and references therein).

[2] Specifically, Jenks (2011) proposes that 'multiplicative bases' (which include powers of 10) have the numeral semantics proposed by Ionin & Matushansky (2006), while simple cardinal numerals 1–9 are type *e*, but a compositional account of this is not provided.

	Noun type	Classifier type	Num
Krifka 1995	e^k	$\langle n, \langle k, \langle e, t\rangle\rangle\rangle$	n
Wilhelm 2008	$\langle e, t\rangle$	$\langle n, \langle\langle e, t\rangle, \langle e, t\rangle\rangle\rangle$	n
Jiang 2012	e^k	$\langle k, \langle n, \langle e, t\rangle\rangle\rangle$	*
Bale & Coon 2014	$\langle e_{AT}, t\rangle$	$\langle e, n\rangle$	*
Bale et al. 2019	$\langle e, t\rangle$	$\langle e, n\rangle$	$\lvert\textsc{Entity}\rvert$
Chierchia 1998	e^k	$\langle k, \langle e, t\rangle\rangle$	$\lvert\textsc{Entity}\rvert$
Jenks 2011	e^k	$\langle k, \langle e, t\rangle\rangle$	*
Dayal 2012	e^k	$\langle k, \langle e, t\rangle\rangle$	*
Nomoto 2013	$\langle e, t\rangle$	$\langle\langle e, t\rangle, \langle e, t\rangle\rangle$	*

Table 1: Summary of previous semantic analyses of classifiers.

The four proposed classifier functions reflect the degree to which the classifier function is tied to numeral modification versus other semantic functions in the nominal domain. If the classifier is functioning as a semantic mediator between the noun and numeral or as a measure function, we would expect it to appear only in contexts that include numerals. If the classifier functions to affect the noun denotation, we might see it in the absence of a numeral. Therefore, we claim that two broad categorizations into classifier-for-noun and classifier-for-numeral theories can cover the primary distinction between accounts in terms of their predictions. We categorize Krifka (1995), Wilhelm (2008), Jiang (2012), Bale & Coon (2014), and Bale et al. (2019), located in the upper part of **Table 1**, as classifier-for-numeral theories. Chierchia (1998), Jenks (2011), Dayal (2012), and Nomoto (2013), located in the lower part of **Table 1**, make up the classifier-for-noun theories. If the classifier is semantically vacuous, as proposed by Cheng & Sybesma (1999), we would not expect to see it optionally added to influence semantic interpretation.

We will demonstrate that these two types of numeral modification strategies are present cross-linguistically, exemplified by Ch'ol and Shan in subsequent sections. Scontras (2022), similarly, argues for cross-linguistic variation in numeral modification strategies, but this comes about through variation in the selection of the measure function, which is intended to capture the cross-linguistic differences in number marking.

While we believe that the core difference between these theories lies in the the semantic role of the classifier in numeral modification, we will make use of specific analyses in order to demonstrate the predictions that follow from both families of theories. For classifiers-for-numerals, we will assume an account closely related to that of Bale et al. (2019). For classifiers-for-nouns, we will use a theory that builds on Jenks (2011), Dayal (2012), and Nomoto (2013) (as opposed to Chierchia 1998), since, as will be made clear in the next section, the atomizing function of the numeral classifier will turn out to be an important semantic contribution of classifiers-for-nouns.

2.2 Noun type and denotation

One crucial point of variation important in comparing these two families of theories is the starting denotation of the noun. In classifier-for-noun theories, numeral classifiers change the denotation of the noun in some way, whereas in classifier-for-numeral theories, they do not. The previous section included discussion of the noun type proposed in a variety of theories. We assume that all nouns are type ⟨*e, t*⟩, adopting the noun typology proposed by Deal (2017).[3] According to Deal, all languages have a mass/count distinction, and there are two possible countability distinctions made in languages: sums-based and parts-based. A sums-based distinction is a distinction based on whether a noun is cumulative or not. The definition of cumulativity, as defined by Deal (2017), is in (4). The noun 'water' is an example of a cumulative noun: any sum of the parts of water is also water.

(4) A noun is *cumulative* iff it denotes a cumulative predicate.
A predicate *P* is cumulative iff any sum of parts that are *P* is also *P*. (Deal 2017: (6))

A language with a sums-based distinction would have both nouns that are cumulative and the opposite—quantized, as defined in (5). Bare singular count nouns such as 'dog' denote quantized predicates. In terms of the previous distinction between ATOM and ATOMIC, quantized nouns only include ATOMS, so they are by default ATOMIC.

(5) A noun is *quantized* iff it denotes a quantized predicate.
A predicate *P* is quantized iff no proper part of something that is *P* is also *P*.
(Deal 2017: (7))

A parts-based distinction, by contrast, depends on whether a language has a distinction between nouns whose denotations are ATOMIC or not. Thus, a language may have only cumulative nouns, but those cumulative nouns may be atomic or non-atomic.

For Deal, there are three possible noun denotations available cross-linguistically: quantized nouns, atomic join-semilattices, and non-atomic join-semilattices. Quantized nouns are sets of atoms, and thus are atomic but not cumulative; a noun denoting an atomic join-semilattice is both atomic and cumulative; a noun denoting a non-atomic join-semilattice is cumulative but not atomic. As an example, Mandarin Chinese is a language that has been proposed to have a parts-based distinction but not a sums-based distinction (Doetjes 1997). This would mean that noun denotations in Mandarin Chinese are either atomic join-semilattices or non-atomic

[3] This assumption is not central to our discussion, and the following predictions are largely compatible with, e.g., Krifka's (1995) or Chierchia's (1998) kind analysis of nouns, particularly for classifier-for-noun languages.

join-semilattices. Thus, the denotation of Mandarin *gou* ‘dog’ would be atomic and cumulative. The denotation of English *dog* would be quantized (a set of atoms), and the denotation of *dogs* would be atomic and cumulative.

In this paper, we focus primarily on sortal classifiers, in contrast to measure numeral classifiers. A sortal classifier is one used with an atomic noun (often called ‘count nouns’), whereas a measure classifier is one that can be used with a non-atomic noun, which we will call ‘mass nouns’. Atomic nouns are further divided into quantized nouns (consisting of atoms) and cumulative nouns (i.e., atomic join-semilattices—consisting of atoms and sums). We will assume that Shan and Ch’ol nouns are all count (atomic) or mass (non-atomic), and we focus on count nouns which are associated with sortal numeral classifiers. The base denotation of a noun in examples for the two languages will be an atomic join-semilattice. There is more to say about plural marking, but, aside from a brief discussion in Section 3.2, this topic is beyond the scope of this paper. While we do not go into detail whether atomic nouns in the two languages discussed are quantized or cumulative, we will discuss how this distinction factors into our proposal.

2.3 Two strategies for numeral modification

As discussed in the previous subsection, we take as a point of departure that the principle difference between classifier-for-numeral and classifier-for-noun theories comes from the role of the classifier and numeral in numeral modification. We represent this distinction using differences in the denotation of the numeral and the classifier. The particular numeral denotations we use to illustrate this distinction pattern with the *intersective* (for the classifier-for-numeral type) and *subsective* (for the classifier-for-noun type) numeral distinction (Bale et al. 2010; Nomoto 2013). However, for Nomoto (2013), the distinction is less connected to numeral-classifier constituency, which we emphasize here.

Using the noun denotation in (6), we show how each theory derives the meaning of *two dogs* in a numeral-classifier language. (6) denotes a set containing atoms and pluralities of dogs—an atomic join-semilattice.[4] We also assume for purposes of illustration that the denotation of the noun in (6) only contains three atomic entities and their sums.

(6) $[\![\textsc{dogs}]\!] = \lambda x.[\textsc{dogs}(x)] = \{a, b, c, ab, ac, bc, abc\}$

Below, we demonstrate how each theory derives ‘two CLF dogs’, to mean the set of pluralities of two dogs.

[4] (6) could also be written as in (i), with the “star-operator”, which gives the set of individuals in the complete join-semilattice formed from the atomic set of dogs (Link 1983).

(i) $[\![\ \textsc{dogs}\ ]\!] = \lambda x.[{}^{*}\textsc{dog}(x)]$

In classifier-for-numeral theories, classifiers are needed for numerals because the numeral in (7) requires an extra semantic argument in order to compose with the noun (Krifka 1995; Wilhelm 2008; Bale & Coon 2014; Bale et al. 2019). The classifier in (8) saturates the first argument of the numeral in (7), where $\mu_{\#}$ is a variable over measure functions.[5] The measure function is specified for the particular noun it ultimately combines with, e.g., as proposed by Krifka (1995), and it counts the number of atoms/units that make up a sum in the noun denotation.[6]

(7) $[\![\text{TWO}]\!] = \lambda m_{\langle e,\, n\rangle} \lambda P \lambda x.[P(x)\ \&\ m(x) = 2]$

(8) $[\![\text{CLF}]\!] = \mu_{\#}$

The numeral in (7) combines with a measure function *m* and predicate *P* and denotes the set of individuals *x* such that *x* has the property of *P* and the measure of *x* according to *m* is 2. (8) is a measure function which gives the number of atoms in a given plurality (Wilhelm 2008: 55). The numeral in (7) takes the classifier in (8) as its first argument. The noun combines with the numeral classifier constituent to yield the set of pluralities of two dogs, as shown in (9).

(9)

$\lambda x.[\text{DOGS}(x)\ \&\ \mu_{\#}(x) = 2]$
$\{ab, ac, bc\}$

- $\lambda P \lambda x.[P(x)\ \&\ \mu_{\#}(x) = 2]$
  - Num: $\lambda m \lambda P \lambda x.[P(x)\ \&\ m(x) = 2]$
  - Clf: $\mu_{\#}$
- N: $\lambda x.[\text{DOGS}(x)]$, $\{a, b, c, ab, ac, bc, abc\}$

In classifier-for-noun theories, the classifiers are needed to mediate between a noun, as in (4), and a numeral, as in (10) (Chierchia 1998; Jenks 2011). We assume a classifier-for-noun theory following Bale et al. (2019), who use a theory for numerals proposed by Ionin & Matushansky (2006).[7] The numeral needs to combine with an atomic predicate and returns the set containing all sums with the predicate property that have a cardinality of 2:

---

[5] All of the types of classifiers discussed in this paper vary depending on properties of the noun (e.g., whether the noun is human, animal, etc.). For simplicity, we are not representing this in the semantics. Nomoto (2013), following McCready (2009), models part of the meaning of the classifier as a conventional implicature.

[6] We will see that when numerals combine with non-atomic nouns, the classifier specifies the unit of the noun that is counted, e.g., *pots of water*.

[7] For some classifier-for-noun theories, such as Chierchia (1998), the noun denotes a kind and the classifier mediates a type mismatch between the classifier and the noun. This is compatible with our account if we use a minimally different classifier semantics.

(10) $[\![\text{ TWO }]\!] = \lambda P \lambda x.[\exists S[\Pi(S)(x) \ \& \ |S| = 2 \ \& \ \forall s \in S[P(s)]]]$ (Ionin & Matushansky 2006)

(10) is a function that takes a predicate P and yields the set of entities x such that x can be partitioned into two parts and x has the property P. As such, the numeral in (10) generates a set of pluralities from a set of atoms. This is different from (7), where the numeral creates a subset with the right cardinality. The type of numeral in (10) must combine with a set of atoms. (11) defines the partition relation Π between a set S of individuals that forms a cover, defined in (12), of some plurality x.

(11) $\Pi(S)(x) = 1$ iff S is a *cover* of x, and $\forall z, y \in S[z = y \vee \neg\exists a[a \leq z \ \& \ a \leq y]]$
(Forbidding that cells of the partition overlap ensures that no element is counted twice.) (Ionin & Matushansky 2006: (6))

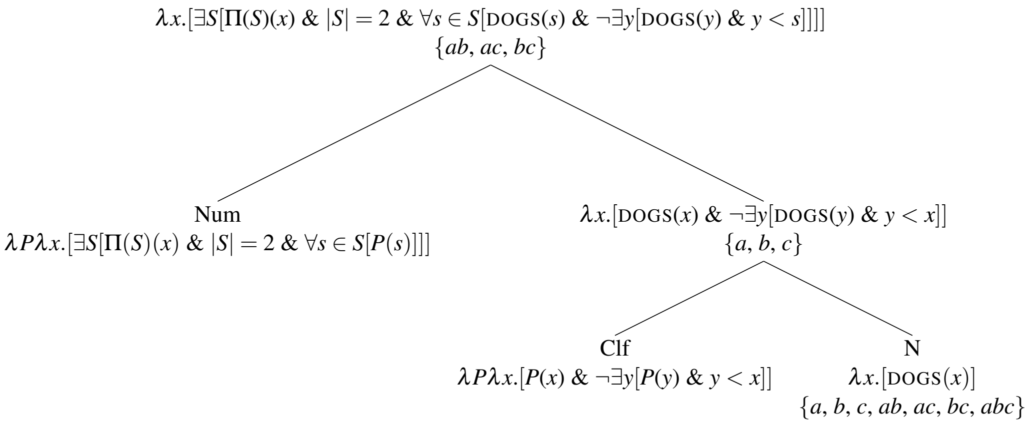
(12) A set of individuals C is a *cover of a plural individual* X iff X is the sum of all members of C: $\sqcup C = X$ (Ionin & Matushansky 2006: (7))

Since the noun in (6) is not composed solely of atoms, classifiers, as in (13), are needed to quantize the set denoted by the NP.

(13) $[\![\text{ CLF }]\!] = \lambda P \lambda x.[P(x) \ \& \ \neg\exists y[P(y) \ \& \ y < x]]$ (Nomoto 2013; Bale et al. 2019)

The function in (13) yields the set of x, such that x has the property P and there is no y with the property P that is a sub-part of x. When it combines with a noun predicate, this classifier generates a set containing atoms with that property. The classifier in (13) first combines with a noun allowing for the numeral in (10) to then combine with the classifier-noun constituent, as shown in (14).

(14)



2.4 Predictions of each theory

Though derivationally distinct, each theory produces the same meaning for *two dogs*: a set containing pluralities made up of two individual dogs. For classifier-for-numeral theories, the numeral takes the classifier as a measure function, and then combines with the noun. For classifier-for-noun theories, the numeral cannot directly combine with the noun, and so a classifier is needed to individuate the members of the nominal predicate to create a set of atoms.

Despite producing similar meanings, the two theories make different predictions regarding the distribution of numeral classifiers. These predictions are summarized in **Table 2**.

If a classifier is semantically connected to the…:		
1	numeral,	we may expect to find idiosyncrasies in whether or not a numeral requires a numeral classifier.
2	noun,	we may expect to find idiosyncrasies in whether or not a noun requires a classifier.
3	noun,	we may expect to find it with the noun in places other than with numerals.
4	numeral,	we may expect to find it with the numeral when it is not combining with a noun.

Table 2: Predictions.

In Section 4, we compare Ch'ol and Shan, which have been described as having numeral classifiers. We show that while Ch'ol shows evidence for predictions 1 and 4, Shan shows evidence for predictions 2 and 3, supporting our proposal in (15).

(15) PROPOSAL
There are two types of numeral classifiers across languages: *classifiers-for-numerals* (CLF-for-NUM) and *classifiers-for-nouns* (CLF-for-N).

Before going through the predictions in **Table 2**, however, Section 3 provides an introduction to classifiers in Ch'ol and Shan and an analysis of their syntactic structures.

3 Classifiers in Ch'ol and Shan

Ch'ol and Shan both have been described as numeral classifier languages, but whose classifiers behave in distinct ways. We emphasize that we concentrate on classifier languages where classifers are *obligatory* with numerals, regardless of whether they appear with other elements.[8]

[8] In Little et al. (2022), we analyzed another Mayan language, Chuj, which has at least two sets of classifiers: *numeral* classifiers and *noun* classifiers. Noun classifiers in Chuj however are not dependent on numerals (see also discussion of the difference between noun and numeral classifiers in Aikhenvald (2000) and Grinevald (2000)). Following Royer (2022a; 2022b), we assume that noun classifiers contribute a uniqueness presupposition.

A reviewer points out that Akatek, a Mayan language closely related to Chuj, has been reported to have four sets of classifiers (Zavala 2000). Examples of the four types of classifiers are given below. As far as we know, Chuj and Q'anjob'al (both Mayan languages of the Q'anjob'alan branch like Akatek) also exhibit a similar pattern to (i), see Hopkins (2012) for Chuj and Toledo (2017) for Q'anjob'al. We have modified some of the glosses in (i) from Zavala (2000) for consistency.

3.1 Ch'ol classifiers

Ch'ol is a Mayan language of the Ch'olan-Tseltalan branch, spoken in southern Mexico by approximately 254,000 speakers (INEGI 2020). There are three main dialects of Ch'ol—Tumbalá, Tila and Sabanilla. The data in this paper come from the Tumbalá and Tila dialects. The patterns were consistent across both dialects with respect to the behavior of classifiers investigated in this paper.

Numerals in Ch'ol obligatorily appear with classifiers; numerals 1–20 are given in **Table 3**. Numerals 1–19 are given with the generic classifier *-p'ej*. The Ch'ol numerical system is vigesimal and has a base-twenty classifier, *-k'al*, which appears in the classifier slot. Other classifiers for multiples of twenty include *-bajk* 'four hundred' and *-pijk* 'eight thousand'.

1	jum-p'ej	11	juñlujum-p'ej
2	cha'-p'ej	12	lajchäm-p'ej
3	ux-p'ej	13	uxlujum-p'ej
4	chäm-p'ej	14	chäñlujum-p'ej
5	jo'-p'ej	15	jo'lujum-p'ej
6	wäk-p'ej	16	wäklujum-p'ej
7	wuk-p'ej	17	wuklujum-p'ej
8	waxäk-p'ej	18	waxäklujum-p'ej
9	bolom-p'ej	19	bolomlujum-p'ej
10	lujum-p'ej	20	juñ-k'al

Table 3: Ch'ol numerals (Arcos López 2009: 24).

(i) a. 'ey kan yuu [kaa-**wan** **eb'** **naj** txanwon].
EXT DIR by two-NUMCLF HUM.PL N.CLF merchant
'There were two merchants.'

b. t'ey [kaa-**(e)b'** **sulan** aw-aan].
here two-NUMCLF SORT.NUMCLF POSS.2-corncob
'Here you have two corncobs.' Akatek, (Zavala 2000: 117), brackets and bolding our own

The only classifiers that are *obligatory* in the presence of numerals are those glossed as NUMCLF in the above examples. Those numeral classifiers seem to pattern like Ch'ol-type classifiers (see also the analysis for Chuj in Little et al. 2022). Zavala (2000), following Craig (1986), argues that noun classifiers such as *naj* indicate that nominals are referential; they do not depend on numerals. Zavala (2000) glosses the plural marker *eb'* as a "classifier," which is also not dependent on numerals (it can occur in contexts where there is no numeral); this raises some interesting questions with respect to plural marking and the presence of classifiers (see also discussion on plurality in Section 3.4). The fourth type of classifier is the sortal numeral classifier *sulan* which adds information about the shape and position of the object being counted and has been analyzed as being in a functional Clf head between NumeralP and NP projections in Svenonius (2008). However, these sortal classifiers are optional in the presence of numerals, as reported by Zavala (2000) for Akatek and Toledo (2017) for Q'anjob'al. Optional classifiers are an area of fruitful future work, however, a dedicated discussion of them falls outside the scope of this paper.

Today, many speakers, including monolinguals, only use Ch’ol numerals up to six and numerals borrowed from Spanish for higher numerals (Vázquez Álvarez 2011: 160). Classifiers are *always* used with Ch’ol-based numerals, as in (16). However, as noted in Bale & Coon (2014), the Spanish-based numerals are ungrammatical with classifiers, as seen in (17).[9]

(16) a. Wä’-añ [ux*(-**p’ej**) we’tye’].
here-EXT three-CLF table
‘There are three tables here.’

b. Tyi yajli [jo’*(**-k’ej**) waj].
PFV fall five-CLF tortilla
‘Five tortillas fell.’ Ch’ol

(17) a. Tyi k-ch’ili [**ocho**(*-p’ej) ja’as].
PFV ERG.1-fry SP:eight-CLF banana
‘I fried eight bananas.’

b. Tyi tyojp’i [**nuebe**(*-p’ej) tyumuty].
PFV break.PSV SP:nine-CLF egg
‘Nine eggs were broken.’ Ch’ol

Arcos López (2009) identifies at least 180 classifiers, though he notes that this is not an exhaustive list. Examples of common classifiers are found in **Table 4**.

Form	Used to count	Examples	Translation
-p’ej	Inanimate/generic	ux-**p’ej** juñ	‘three books’
-kojty	Animals	ux-**kojty** mis	‘three cats’
-tyikil	People	ux-**tyikil** x’ixik	‘three women’
-k’ej	Flat round objects	ux-**k’ej** waj	‘three tortillas’
-ts’ijty	Long things	ux-**ts’ijty** tye’	‘three trees’
-bujch	Seated/propped up things	ux-**bujch** bux	‘three (propped up) bottles’

Table 4: Numeral classifiers in Ch’ol.

While the generic classifier *-p’ej* and the classifier for humans *-tyikil* are of unknown origin (Arcos López 2009), many other classifiers are derived from positional and transitive verb roots (see Arcos López 2009 and Bale et al. 2019 and also Haviland 1981 for Tsotsil). Positional roots

[9] One reviewer asks whether there is a syllabic constraint on whether classifiers appear with numerals in Ch’ol. We note that there are Ch’ol numerals that are multisyllabic, such as ‘eight’, ‘ten’ and ‘sixteen’ in **Table 3**, that appear with classifiers. It is also of note that monosyllabic Spanish borrowed numerals such as *seis* ‘six’ do not occur with a classifier.

are a large and distinct class of roots that convey information about the position or configuration of an object (see e.g., England 1983; Haviland 1994; Henderson 2019). The numeral classifier *-bujch*, used to count objects which are propped up, seated, or leaning against something, is derived from the positional root *buch* 'seated'. The animal classifier *-kojty* is derived from the positional root *koty* 'standing on four legs'.

The position or shape of a noun is relevant for the choice of classifier, meaning that the same noun could be counted with more than one classifier, as in (18). Depending on the shape or position of a tree, a different classifier is used; see also Bale et al. (2019: (39)).

(18) a. juñ**-ts'ijty** tye'
one-CLF tree
'one long tree'

b. juñ**-jäjl** tye'
one-CLF tree
'one stretched out tree'

c. juñ**-bujch** tye'
one-CLF tree
'one fallen tree'

d. juñ**-bujñ** tye'
one-CLF tree
'one fat tree' Ch'ol

Numeral classifiers in Ch'ol *only* occur with numerals and the interrogative quantifier *jay-* 'how many', which we take to be the interrogative version of a numeral. Classifiers in Ch'ol are ungrammatical with quantifiers (19a)–(19b), demonstratives (19c), and modifiers (19d).

(19) a. *kabäl**-k'ej** waj
many-CLF tortilla
Intended: 'many tortillas'

b. *pejtyel**-p'ej** we'tye'
all-CLF table
Intended: 'all the tables'

c. *ixä**-kojty** ts'i'
DEM-CLF dog
Intended: 'that dog'

d. *säsäk**-kojty** wakax
white-CLF cow
Intended: 'a white cow' Ch'ol

To summarize, Ch'ol classifiers are used with Ch'ol-based numerals but not Spanish based ones. They are largely derived from positional roots and vary based on the noun and other semantic information related to the object. Ch'ol classifiers only appear with numerals and the interrogative version of the numeral.

3.2 Shan classifiers

Shan is a Kra-Dai language of the Southwestern Tai branch, spoken in Myanmar and surrounding countries by approximately 4.6 million speakers (Ethnologue 2021). While classifiers in Thai, a related Tai language, have been investigated in detail (e.g., Iwasaki & Ingkaphirom 2005; Piriyawiboon 2010; Jenks 2011), there have been very few descriptions or analyses of Shan numeral classifiers. Cushing (1887) first describes classifiers in Shan, calling them 'numeral auxiliaries', which denote "some rank of being, some form of object or some quality in the noun to which it belongs". The numerals in Shan from one to twenty can be seen in **Table 5**.

1	nɯŋ	11	síp pét
2	sɔ̌ŋ	12	síp sɔ̌ŋ
3	sǎam	13	síp sǎam
4	sì	14	síp sì
5	haa	15	síp haa
6	hók	16	síp hók
7	tsét	17	síp tsét
8	pɛ̀t	18	síp pɛ̀t
9	kaw	19	síp kaw
10	síp	20	sáaw

Table 5: Shan numerals.

Unlike Ch'ol numeral classifiers, which are derived from verbs or positional roots, Shan classifiers appear to be derived from nominal elements. For example, *tǒ*, the classifier for animals, also means 'body'. For some nouns that are typically found as compounds, there is a connection between the form of the classifier and one part of the compound, as in (20). Here the noun compound *ton-mâj* 'tree' and the classifier *ton* both contain *ton*. Classifiers obligatorily appear in the presence of a numeral, as shown in (21). Which classifier appears depends on properties of the noun. **Table 6** gives some examples of properties that determine which classifier is used.

Form	Used to count	Examples	Translation
ʔǎn	Inanimates	tsɔ̂ sǎam **ʔǎn**	‘three spoons’
tǒ	Animals	mɛ́w sǎam **tǒ**	‘three cats’
kɔ̂	People	kón sǎam **kɔ̂**	‘three people’
hòj	Round objects	màak-khɔ̌ sǎam **hòj**	‘three jujube’
ton	Plants, trees	ton-mâj sǎam **ton**	‘three trees’
lǎŋ	Buildings	hɤ́n sǎam **lǎŋ**	‘three houses’

Table 6: Basic numeral classifiers in Shan.

(20) háw lɤk sɯ̂ [**ton**-mâj sǎam **ton**].
1 choose buy plant-tree three plant
‘I bought three trees.’ Shan

(21) háw lɤk sɯ̂ [mǎa sǎam *(**tǒ**)].
1 choose buy dog three CLF
‘I bought three dogs.’ Shan

One interrogative numeral, *lǎaj* ‘how many’ in (22a), obligatorily appears with classifiers, just like the numerals. Some expressions of quantity, like (22b), do not appear with a classifier.

(22) a. háw lɤk sɯ̂ [mǎa lǎaj **tǒ**]?
1 choose buy dog how.many CLF
‘How many dogs did I buy?’

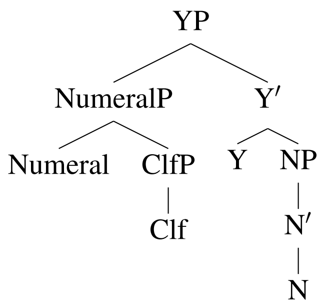
b. mí mɛ́w nǎm (***tǒ**) nàa.
have cat many/much CLF very
‘There are many cats.’ Shan

Shan classifiers are free morphemes derived from nominal elements. We will see in Section 4.3 that classifiers can appear in constructions without numerals.

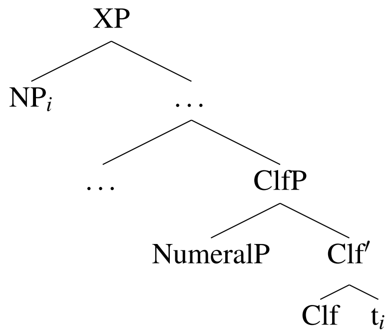
3.3 Syntax of the classifiers in Ch’ol and Shan

We propose the following two syntactic structures for classifiers in each language. The relevant Ch’ol word order is [Numeral Classifier Noun], whereas the Shan order is [Noun Numeral Classifier]. We propose different syntactic structures for each language, based on their distinct syntactic properties (see also work by Danon (2012) who argues that there are two types of numeral-noun syntactic structures). We adopt a proposal from Simpson (2005), also argued for by Jenks (2011) for word order in Thai, that the order in Shan comes as a result of phrasal movement of the nominal constituent from its base position to a position above the numeral and classifier.

(23) a. Ch’ol Structure



b. Shan Structure



The order of elements within the noun phrase for each language is given below.

(24) Order of elements in the NP in Ch’ol
[$_{\text{Dem}}$ ili] [$_{\text{Num}}$ cha’-kojty] [$_{\text{Adj}}$ säsäk] [$_{\text{N}}$ wakax]
this two-CLF white cow
‘these two white cows’ Ch’ol

(25) Order of elements in the NP in Shan
[$_{\text{N}}$ mǎa] [$_{\text{Adj}}$ khǎaw] [$_{\text{Num}}$ sɔ̌ŋ] [$_{\text{Clf}}$ tǒ] [$_{\text{Dem}}$ nâj]
dog white two CLF this
‘these two white dogs’ Shan

We propose that numerals in Ch’ol are in a specifier position of a functional projection (YP) along the nominal spine (see e.g., Cinque 2005).[10] Importantly, the ordering between numerals and adjectives is strict in Ch’ol. A proposal like Bale et al.’s (2019), in which numerals are adjuncts

[10] As suggested by a reviewer, this could be Borer (2005)’s DivP or Ritter (1991)’s NumP. We are agnostic to the exact nature of this functional projection so we leave it as YP.

that adjoin in the same projection as adjectives (*nP* for them), would predict that numerals and adjectives can be ordered freely, which is not borne out in the language.

Furthermore, ellipsis data in Ch'ol confirms that adjectives and numerals behave differently: adjectives cannot license ellipsis, as in (26b), but numerals can (26c). Both (26b) and (26c) are meant to be follow-ups to (26a). The ellipsis data provides evidence that numerals exhibit distinct syntactic properties from adjectives (cf. Bale et al. 2019: §4.2).

(26) a. Tyi a-mäñä cha'-kojty säsäk wakax.
PFV ERG.2-buy two-CLF white cow
'You bought two white cows.'

b. *i tyi k-mäñä ux-kojty i'ik' __.
and PFV ERG.1-buy two-CLF black
Intended: 'I bought three black ones.'

c. i tyi k-mäñä ux-kojty __.
and PFV ERG.1-buy two-CLF
'I bought three (white cows).' Ch'ol

Ellipsis data in Shan also provides evidence for its syntactic structure. In Shan, there is similarly a clear contrast between noun ellipsis when the noun is modified by an adjunct or not. The example in (27a) cannot be followed by (27b) with the noun elided because the noun is modified by an adjective, *súk* 'ripe'. In contrast, it can be followed by (27c), indicating that the numeral and classifier do not form a constituent that is a syntactic adjunct of the noun.

(27) a. jíŋ lǎaw ŋɯ́n laj kǐn màak-moŋ líp sɔ̌ŋ hòj.
Ying Lao Nguen ACH eat mango unripe two CLF
'Ying Lao Nguen ate two unripe mangoes.'

b. *lɛ tsáaj lǎaw khám sâm kǐn __ súk sɔ̌ŋ hòj.
and Jai Lao Kham CONTR eat ripe two CLF
(Intended) 'But Jai Lao Kham ate two ripe (ones).'

c. lɛ tsáaj lǎaw khám sâm kǐn __ sǎam hòj.
and Jai Lao Kham CONTR eat three CLF
'But Jai Lao Kham ate three (unripe mangoes).' Shan

While the ellipsis data support a non-adjunct analysis of numeral-classifier constructions in both languages, it does not necessarily show us that these constructions exhibit different structures. We thus turn to A′-extraction facts to show this. Since numeral-classifier constructions in Ch'ol are phrases contained in a specifier position, it is conceivable that they could undergo A′-extraction. On the other hand, Shan's numeral and classifier do not form a constituent to the exclusion of the NP. It would thus be surprising that they would be able to extract as a constituent without clear motivation for remnant movement. As discussed in Bale et al. (2019) and Little (2020), numerals may extract from their base position to the preverbal focus position, evidence that they form a constituent, shown in (28). Shan numerals and classifiers cannot move to a clause-initial position together, as shown in (29). This is expected if Shan's numeral and classifier are functional heads along the nominal spine—heads cannot undergo A′-movement.

(28) **Cha'-kojty**$_i$ ta' k-tsepe t_i ich.
two-CLF PFV ERG.1-cut chili
'I cut two chilis.' Ch'ol

(29) ***sɔ̌ŋ hòj**$_i$ háw sɔ́j màak-phît t_i.
two CLF 1 cut fruit-chili
'I cut two chilis.' Shan

While this subextraction diagnostic is useful for determining constituency in Ch'ol, it does not follow that all languages with the syntax in (23a) will allow this type of subextraction. As is well known, there is parametric variation regarding which languages allow this type of subextraction from the nominal domain.

We have shown diagnostics for the constituency of the numeral and classifier in Ch'ol (following work in Bale et al. 2019). We refer the reader to Moroney (2021) for further evidence for the structure in (23b) for Shan and to Jenks (2011) and Simpson (2005) for similar arguments for Thai.

3.4 An aside on plural marking

While the focus of this paper is on classifiers and their co-occurrence with nouns/numerals, adopting these different structures yields a welcome result with respect to plural marking. For Borer (2005), plural marking and classifiers are in complementary distribution—which is why they occupy the same functional projection. This accounts for why English does not have classifiers, but has plural marking when appearing with numerals above 1. Mandarin, on the other hand, has classifiers but no plural morphology with numerals. We note that Borer's analysis can be held for the classifier-for-noun languages, such as Shan, but for classifier-for-numeral languages, we predict that classifiers may be able to co-occur with plural morphology given that the classifier in languages like Ch'ol is not in the same projection as plural marking. This indeed seems to be borne out.

Ch'ol has a plural marker that indexes human- and some animal-denoting nouns. If we were to adopt the account in (23b) for Ch'ol, it would incorrectly predict the incompability of plural markers, which is not the case, as shown in (30).

(30)

Tyi	juli-yob	cha'-**tyikil**	wiñik**-ob**.
PFV	arrive-PL	two-CLF	man-PL

'Two men arrived.' Ch'ol

While Ch'ol plural marking in (30) is optional and it is unclear what governs its optionality, Mi'gmaq, a language analyzed as a classifier-for-numeral language in Bale & Coon (2014), has obligatory plural marking. Two examples with grammatically animate and inanimate nouns are given below from the Mi'gmaq Online Dictionary (MOD, Haberlin et al. 1997–2017).

(31) Mi'gmaq

a.

As'gom	**te'si**-j-ig	tmato's**-g**	tms	…
six	CLF.AN-3-PL.AN	tomato-PL.AN	cut.IMP.AN	

'Cut six tomatoes...' MOD: Entry 5512

b.

As'gom	**te's'**-g-l	sigsuti'-**l**	wape'g-l	pgwatele'n.
six	CLF.IN-3-PL.IN	ankle.sock-PL.IN	white-PL.IN	buy.IMP.IN

'Buy six white ankle length socks.' MOD: Entry 4930

The syntax provided in (23a) predicts co-occurrence of plural marking, exhibited in (31), where the functional head Y could host number marking.

3.5 Summary

In sum, while Ch'ol and Shan both have numeral classifiers, the initial data seen in this section suggest that they exhibit a different syntax. As schematized in (23), Ch'ol classifiers form a constituent to the exclusion of the noun (Bale et al. 2019), whereas Shan classifiers do not (Moroney 2021). Both these structures capture the strict linearization between numerals and classifiers—they must be adjacent elements. Even though we propose different structures and semantics for classifiers, there are similarities between these functional projections; namely that they are needed to mediate between a numeral and noun. This importantly rules out the numeral from ever combining with the noun first and then the classifier, as the classifier is needed in both theories to mediate between the noun and the numeral, though, as we emphasize below, in different ways.

It is important to mention that the two syntactic structures we provide in (23) contrast with recent work by Dékány (To appear), who proposes that both Ch'ol-style and Shan-style numeral-classifier constructions have a Shan-style syntax (23b). For her, numerals and classifiers are functional heads along the nominal spine. This analysis would not immediately predict the semantically driven phrasal movement of numerals in (28). Furthermore, it would not predict the compatibility of plural marking with the classifiers in Ch'ol (30) and Mi'gmaq (31). In fact, despite different syntactic structures for what we will argue are languages with classifiers-for-numerals

(Ch'ol) and classifiers-for-nouns (Shan), our semantic account only rules out the alternative constituency when it comes to classifiers-for-numerals. This is because the numeral modification strategy in classifier-for-noun languages is semantically compatible with a syntactic constituency where the classifier first combines with the numeral (for classifier-for-noun analyses that involve this constituency see, e.g., Zhang 2013; Hall 2019). Tiwa, a Tibeto-Burman language, seems like a candidate for having a Ch'ol-style syntax for numeral-classifier constructions, but the semantic contribution of the classifier parallels that of Shan's; see discussion in Dawson (To appear) for further details.

Having provided evidence that Ch'ol and Shan numeral-classifier constructions exhibit a different syntax, we now turn to the semantics: while Ch'ol aligns with the predictions of classifier-for-numeral theories, Shan aligns with those of classifier-for-noun theories.

4 Distinguishing between types of numeral classifiers

In this section, we discuss the predictions laid out in **Table 2**, repeated below in **Table 7**, and how they follow from each theory of numeral classifiers sketched above.

If a classifier is semantically connected to the...:		
1	numeral,	we may expect to find idiosyncrasies in whether or not a numeral requires a numeral classifier.
2	noun,	we may expect to find idiosyncrasies in whether or not a noun requires a classifier.
3	noun,	we may expect to find it with the noun in places other than with numerals.
4	numeral,	we may expect to find it with the numeral when it is not combining with a noun.

Table 7: Predictions (repeated from Table 2).

We provide data from Ch'ol and Shan supporting our proposal in (32) that both types of theories are in fact needed. The overall conclusion will be that Ch'ol classifiers are classifiers-for-numerals, while Shan classifiers are classifiers-for-nouns.

(32) PROPOSAL
There are two types of numeral classifiers across languages: *classifiers-for-numerals* (CLF-for-NUM) and *classifiers-for-nouns* (CLF-for-N).

4.1 Prediction 1 (num): Variation in whether a numeral requires a classifier

In classifier-for-numeral theories, classifiers are needed to saturate an argument required by the numeral, represented as a measure function. Since the appearance of the classifier is contingent on the semantics of the numeral, we might expect to find idiosyncrasies in whether a numeral requires a classifier. That is, as argued in Bale & Coon (2014), some numerals might have the measure function encoded in their lexical semantics, and others not. Such idiosyncrasies are observed in Ch'ol, but not in Shan. As noted above, while higher Mayan-based numerals exist, speakers tend to use Mayan-based numerals when counting up to six and Spanish-based numerals for those higher than six. As shown in Bale & Coon (2014), Mayan-based numerals require a numeral classifier, as in (33a), whereas Spanish-based numerals cannot combine with one (34a). Therefore, the semantics of *ux* 'three' would be (33b), first combining with a measure function (the classifier), and the semantics for *ocho* 'eight' would be (34b), where the measure function is already built in.

(33) a. ux*(**-kojty**) ts'i'
three-**CLF** dog
'three dogs'

b. $[\![\textit{ux}]\!] = \lambda m_{\langle e, n\rangle}\lambda P\lambda x.[P(x) \,\&\, m(x) = 3]$

(34) a. ocho(***-kojty**) ts'i'
SP:eight-**CLF** dog
'eight dogs' Ch'ol

b. $[\![\textit{ocho}]\!] = \lambda P\lambda x.[P(x) \,\&\, \mu_{\#}(x) = 8]$

Further evidence comes from the distinction between Ch'ol and Spanish numerals for measure expressions in (35)–(36).[11] We assume that words like *ja'* 'water' denote non-atomic predicates while words like *ts'i'* 'dog' denote atomic predicates. For Ch'ol-based numerals, there are two ways to do numeral modification with a non-atomic noun: (i) use a container/measure expression in the classifier position as in (35a) or (ii) use the container in a nominal position with the numeral modifying the container expression as in (35b). We assume that in (35a), the container classifier *p'ejty* 'pot' is directly supplying a measure function compatible with non-atomic expressions to the numeral. In (35b), the container nominal expression is already atomic, so it is compatible with the generic classifier.

(35) a. Ta' k-japä [cha'-**p'ejty** ja'].
PFV ERG.1-drink two-CLF.pot water
'I drank two pots of water.' (Bale et al. 2019: (26))

b. Ta' k-japä [cha'-p'ej **p'ejty** ja'].
PFV ERG.1-drink two-CLF pot water
'I drank two pots of water.' Ch'ol

11 There is more to say about how measure expressions pattern with respect to our proposal, but we leave that to future work.

For Spanish based numerals, the measure function is already built into the numeral, so it is not possible to have the container *p'ejty* 'pot' in a classifier position. The only way to measure non-atomic nouns is by forming an atomic nominal expression using the container in a nominal position, as in (36).

(36)	ocho	**p'ejty**	ja'
	SP:eight	pot	water

'eight pots of water' — Ch'ol

The contrast here shows that the measure expression in a classifier position is specifying a measure function that is compatible with a non-atomic predicate. Spanish numerals, which already have a measure function built in, must necessarily combine with an atomic noun. The built-in measure function would essentially be equivalent to the meaning of the generic classifier *p'ej*. We assume that *p'ejty* functions to create an atomic predicate, which ultimately allows Spanish numerals to combine with non-atomic nouns.

No such idiosyncrasies are found in Shan: all numerals appear with a classifier. Further evidence comes from measure expressions in Shan. Measure functions are not part of the numeral semantics, as is expected in classifier-for-noun theories, where the numeral exhibits the denotation in (10), repeated in (37).

(37) $[\![\text{TWO}]\!] = \lambda P \lambda x.[\exists S[\Pi(S)(x) \ \& \ |S| = 2 \ \& \ \forall s \in S[P(s)]]]$ (Ionin & Matushansky 2006)

There are specific classifiers—standard measures or container classifiers—which can appear with mass nouns. In (38), *nâm* 'water' appears with the classifier *kɔ́k* 'cup', which is derived from the noun of the same form.

(38)	mɤnâj	háw	kǐn	[nâm	pɛ̀t	kɔ́k]
	today	1	drink	water	eight	cup

'Today I drank eight cups of water' — Shan

In Shan, classifiers that are compatible with atomic nouns tend to be incompatible with non-atomic nouns. The generic classifier is similarly incompatible with non-atomic nouns, as (39a) shows. While the noun-specific classifier is preferred, the generic classifier sounds better with a noun that has an atomic denotation, as (39b) shows, than it does with one with a non-atomic denotation, as in (39a). Since the classifier quantizes the noun and does not provide a measure function to the numeral, we do not find the same alternative way that Ch'ol has to measure non-atomic nouns, like *lɤt* 'blood'. It is possible to make a compound noun, e.g., *thǒŋ lɤt* 'bag of blood', but this refers to the container more than the contents and still requires the container classifier *thǒŋ* to be felicitous.

(39) a. tinaj mí [lɤt sɔ̌ŋ tɔ̀m / *ʔǎn]
here have blood two drop / CLF:GEN
'Here are two drops / *units of blood'

b. tinaj mí [màakhǒ sɔ̌ŋ hòj / ?ʔǎn]
Here have hat two CLF / CLF:GEN
'Here are two hats' Shan

4.2 Prediction 2 (noun): Variation in whether a noun requires a classifier

For classifier-for-noun theories, we may expect to find the opposite of prediction 1. That is, if a classifier is required to atomize the set denoted by the noun, then there might be variation in whether nouns require atomization (and thus a classifier). For instance, it is possible that a subset of nouns in a language denote only a set of atoms, as argued in Simpson (2005) and Simpson & Ngo (2018) for Vietnamese and other East/Southeast Asian languages. In such cases, the plurality-forming numeral given above in (37) could combine directly with a noun, circumventing the necessity for a classifier.

Ch'ol does not exhibit idiosyncrasies with respect to nouns. While Shan includes some cases that appear to fit this description, as in (40), this is probably best analyzed as a reduced repeater classifier construction, which occurs when the noun is omitted in certain contexts when the form of the noun and classifier are phonologically identical.

(40) pǐ nâj háw laj ʔɛ̀w [sǎam mɤ́ŋ] jâw
year this 1 ACH visit three country PFV
'This year I have visited three countries.' Shan

See Jenks (2011) for discussion of similar data in Thai. These cases require a more complex analysis than simply saying the classifier is absent, but the repeater classifier constructions and reduced repeater constructions are based on the noun used, rather than the numeral. For this diagnostic, we will use the more straightforward data from Simpson & Ngo (2018) on Vietnamese.

In Vietnamese, a language which, as far as we can tell, patterns with classifier-for-noun languages, some nouns never combine with a classifier, as in (41a). Vietnamese has both nouns with optional classifier and nouns with no classifiers (Simpson & Ngo 2018). The optional classifiers have a different form than the noun, making them easily identifiable. We would expect words like *màu* 'color' in (41a) to denote a set of atoms, as in (41b), which is why they do not need a classifier.

(41) a. hai màu
two color
'two colors' Vietnamese (Simpson & Ngo 2018: (4a))

b. $[\![\ \textit{màu}\ ]\!] = \lambda x.[\textsc{color}(x)\ \&\ \textsc{Atom}(x)]$

It would be difficult for a classifier-for-numeral theory to account for this pattern of data. It is clearly the noun that is conditioning this variation, so we would need to propose null classifiers for nouns with this feature. In the classifier-for-numeral theory, the function of the classifier is to specify the measure function for the numeral. In the case of this heterogeneous class of nouns, if they had 'null' classifiers, the measure function would have to be some default measure. However, such nouns in Vietnamese are not compatible with the classifier used for inanimate nouns (Simpson & Ngo 2018), which one might consider to have the same semantics. Similarly, in Shan, the repeater classifier constructions are not compatible with the generic inanimate classifier *ʔăn*.

4.3 Prediction 3 (noun): Classifiers found beyond numerals

For classifier-for-noun theories, if a classifier is used to create an atomic set from the noun predicate, we might expect to find it in environments other than with numerals. That is, it is conceivable that other modifiers or constructions in classifier-for-noun languages require the noun to be atomized, resulting in the presence of the classifier. This has been noted previously for some classifier languages by, for example, Simpson (2005). As shown below, this is the case in Shan, which can have a classifier occur with quantifiers (42a), demonstratives (42b), and relative clauses (42d), even in the absence of a numeral. Furthermore, while nouns are number-neutral in Shan, in (42b) the classifier appears to atomize the noun, giving rise to an obligatorily singular interpretation. The contrast between (42b) and (42c) demonstrates that the number neutrality of nouns in Shan is conditioned by the presence of the classifier, even when there are structurally higher elements, such as a demonstrative.

(42) a. mǎa ku **tǒ**
dog every CLF
'every dog'

b. mǎa **tǒ** nâj
dog CLF DEM
'this dog'

c. mǎa nâj
dog DEM
'this dog/these dogs/dogs (as a kind)'

d. mǎa **tǒ** [$_{RC}$ ʔăn nɔ́n jù nân]
dog CLF COMP sleep IPFV that
'the dog that was sleeping' Shan

This is not the case in Ch'ol. Classifiers in this language only ever appear with numerals or the interrogative numeral *jay-* 'how many'. They are ungrammatical in other contexts, as shown in the example with a demonstrative in (43a) (see also (19) above).

(43) a. *ili-**kojty** ts'i'
DEM-CLF dog
Intended: 'this dog'

b. ili **juñ-kojty** ts'i'
DEM one-CLF dog
'this dog' Ch'ol

Again, in order to maintain a classifier-for-numeral account for this type of data, it would be necessary to propose that a null numeral 'one' appears, for example, in (42a) and (42b). It is not acceptable for an overt 'one' to appear in these contexts. As (44a) and (44b) demonstrate, the numeral 'one' is not acceptable in these contexts. The distributive quantifier *ku* 'every' generally does not appear with a numeral in expressions with nouns, and the demonstrative is not able to appear with the numeral 'one'. In contrast to (44b), the Ch'ol example in (43b) is only possible with an overt 'one'. Rather than positing these null classifiers and numerals to fit these two types of classifier expressions into one schema, we propose to separate them.

(44) a. màakmoŋ ku (*nɯŋ) hòj
mango every one CLF
'every (*one) mango'

b. nôk sǐ-lěŋ (*nɯŋ) tǒ nân
bird color-red one CLF that
'that (*one) red bird' Shan

4.4 Prediction 4 (num): Classifiers can appear with numerals even in the absence of nouns

Finally, we discuss a novel diagnostic regarding theories of numeral classifiers. If a classifier is a measure function which (i) is generally required by a numeral and (ii) forms a constituent with the numeral to the exclusion of the noun, then we may expect it to always appear with that numeral. That is, even when there is no noun, the classifier could occur if it is required by that numeral. This is the case in Ch'ol: classifiers are *always* required, even when counting, as in (45), or when referring directly to the number, as in (46), which describes a context in which a teacher is pointing to a number.

(45) CONTEXT: Students are practicing counting.
jum-*(**p'ej**), cha'-*(**p'ej**), ux-*(**p'ej**) …
one-CLF two-CLF three-CLF
'1, 2, 3, …' Ch'ol

(46) CONTEXT: A teacher is pointing at the number three and says:
Ili jiñ ux-*(**p'ej**).
this DET three-CLF
'This is three.' Ch'ol

In these instances, we propose that the generic classifier is counting abstract points on a number line (indeed the generic classifier appears to count abstract nouns such as 'belief' (Bale et al. 2019)). Even though there is no overt noun, it is inferred that there is still some abstract object being counted (e.g., abstract points on a number line). This is further supported by the fact that in multiplication the classifier *-sujtyel* attaches to the first numeral denoting 'times' then the second numeral appears as a possessor to 'number' ('the number of three'). The example in (47a) refers to generic contexts, e.g., in an educational setting. The classifier changes to *-kojty* if we are multiplying the number of cows in (47b), e.g., in a context where there are two trucks, being able to fit three cows each.[12]

(47) a. Cha'**-sujtyel** i-tsikol ux**-p'ej** wäk**-p'ej** tyi i-pejtyelel.
two-CLF:times POSS.3-number three-CLF six-CLF PREP POSS.3-all
'2 × 3 = 6' (Literally, 'two times the number of three is six in all')

b. Cha'-sujtyel i-tsikol ux**-kojty** wäk**-kojty** tyi i-pejtyelel.
two-CLF:times POSS.3-number three-CLF six-CLF PREP POSS.3-all
'2 × 3 = 6' (Literally, 'two times the number of three is six in all') Ch'ol

This is not a Mayan-only feature: classifiers in sixteenth century Nahuatl (Uto-Aztecan) also must always occur in the presence of numerals even with no overt noun (Herrera 2022).

In contrast, Shan classifiers are not always required with numerals when a noun is not present. For instance, they are degraded when counting, as in (48), and are unacceptable when referring to the number itself, as in (49).

(48) CONTEXT: Students are practicing counting.
nɯŋ (?**tŏ**), sɔ̌ŋ (?**tŏ**), sǎam (?**tŏ**) …
one CLF two CLF three CLF
'1, 2, 3, …' Shan

(49) CONTEXT: A teacher is pointing at the number three and says:
nâj pěn mǎaj sǎam (***tŏ**).
this COP number three CLF
'This is the number three.' Shan

[12] A reviewer notes that the data in (45)–(47) raise a thorny question with respect to whether there is absolutely no noun or if the noun is elided. While a deeper discussion than we can currently provide is necessary, we note that numerals in Ch'ol can appear as predicates, as in (i).

(i) [$_{\text{PRED}}$ Ux-tyikil] -oñ = la.
three-CLF ABS.1 = PL.INCL
'We are three.' Ch'ol

When they are predicates we assume that the numeral + classifier is type ⟨*et*⟩ (i.e., $\lambda x.[\mu_{\#}(x) = 2]$). In this case, we would not expect there to be an elided noun in the predicate position, showing evidence that numerals + classifiers in Ch'ol can appear without nouns in certain constructions.

Before summarizing, we address a caveat of this diagnostic. Reviewers raised the possibility that numerals are affixal in Ch'ol but not in Shan, leading to the requirement that Ch'ol numerals have a classifier even in these contexts. If this were the case, we might expect to see numerals without classifiers in counting contexts in classifier-for-numeral languages that have numerals that are not affixal. We agree that this is possible. In that case, whatever type-shifting takes place to go from modifier numerals to counting would work slightly differently with respect to the semantic contribution of the classifier. While morphophonology plays a role in Ch'ol, we also believe that the analysis we have proposed captures the fact that the classifier does appear even in counting constructions: the classifier in numeral-classifier languages is integral to the interpretation of the numeral. The choice of the classifier still has semantic consequences, as when counting cows, or in mathematical equations. Finally, we refer back to the A′-movement data in (28), where numerals and classifiers can front to preverbal positions. This again supports the fact that the numeral and classifier in Ch'ol form a constituent, regardless of their morphophonological properties—if it were a (fused) head it would not be able to undergo phrasal movement. Our claim is that if a language has obligatory classifiers in counting contexts, it is evidence that the language is a classifier-for-numeral language, but if it does not, it does not provide evidence either way.

4.5 Summary

We began this section with the proposal in (50).

(50) PROPOSAL
There are two types of numeral classifiers across languages: *classifiers-for-numerals* and *classifiers-for-nouns*.

While Ch'ol shows evidence for classifier-for-numeral theories, Shan shows evidence for classifier-for-noun theories. The predictions of each proposal are summarized in **Table 8**.

Supporting theory		**Ch'ol**	**Shan**
CLF-for-NUM	Prediction 1: variation in whether numeral requires CLF	✓	✗
CLF-for-N	Prediction 2: variation in whether noun requires CLF	✗	✓
CLF-for-N	Prediction 3: CLF can appear with other elements	✗	✓
CLF-for-NUM	Prediction 4: CLF appears in counting constructions	✓	✗

Table 8: Summary of predictions supporting CLF-for-NUM and CLF-for-NOUN theories.

Clearly, Shan and Ch'ol numeral classifiers behave differently. Ch'ol numeral classifiers are required by the numeral and therefore always appear with numerals. Shan classifiers are semantically connected to the meaning of the noun, so they can appear in the absence of a numeral. We believe that the different predictions laid out above can be used as diagnostics to identify the type of classifier exhibited in a language.

The literature has largely concentrated on the function of classifiers, and here we have provided evidence that we should distinguish at least two types of numeral classifiers cross-linguistically. We proposed that this follows from variation in the numeral modification strategy, which we took as our point of departure. The semantics of the numeral and classifier will co-vary based on the strategy for how numeral modification proceeds. If the numeral functions to restrict the noun denotation to the pluralities of a certain number of entities, a classifier-for-numeral is more likely to appear. If the numeral functions to form pluralities from a quantized set, a classifier-for-noun is more likely to be used to generate that quantized set. While the constituency in classifier-for-noun languages is not fixed, the constituency in classifier-for-numeral languages is. Classifiers-for-numerals and numerals always form constituents.[13]

The full derivations for the Ch'ol and Shan equivalents of 'two dogs' are given below in (51) and (52). While derivationally distinct, both languages end up with equivalent interpretations after the numeral, classifier, and noun combine. In (51), a Ch'ol-based numeral first combines with a classifier so that the classifier supplies the measure function. The resulting measure phrase then measures entities denoted by the noun, in this case those which consist of two atoms.

(51) Ch'ol

$\lambda x.[\text{DOGS}(x) \ \& \ \mu_{\#}(x) = 2]$
cha'-kojty ts'i'
two-CLF dog
$\{ab, ac, bc\}$

$\lambda P \lambda x.[P(x) \ \& \ \mu_{\#}(x) = 2]$
cha'-kojty
two-CLF

N
$\lambda x.[\text{DOGS}(x)]$
ts'i'
dog
$\{a, b, c, ab, ac, bc, abc\}$

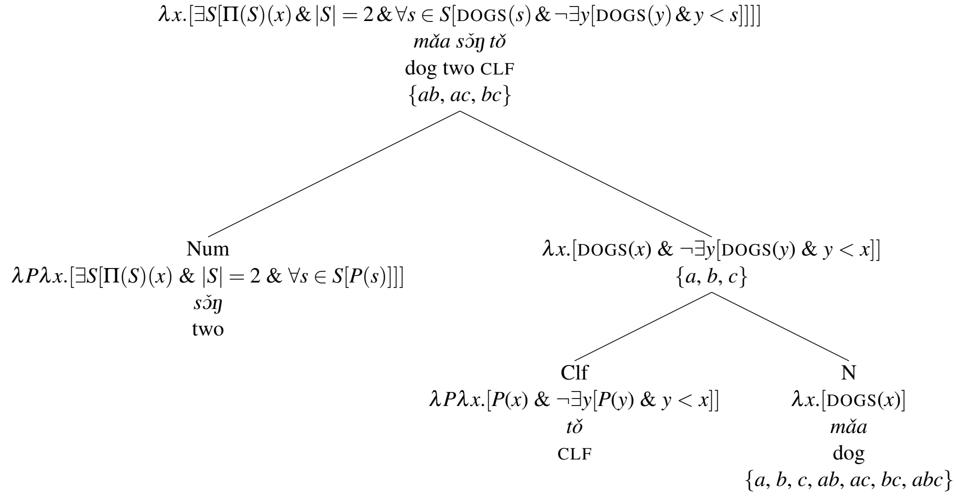
Num
$\lambda m \lambda P \lambda x.[P(x) \ \& \ m(x) = 2]$
cha'-
two

Clf
$\mu_{\#}$
kojty
-CLF

[13] In Mandarin Chinese, the classifier appears to be for nouns, given that the classifier can appear in the absence of a numeral. Zhang (2013) proposes that there are two different constituencies for numeral expressions: in the case of sortal expressions, numerals and nouns combine first, and in the case of measure expressions, numerals and classifiers combine first. With a type shift of the classifier to $\langle e,t \rangle$, instead of $\langle\langle e,t \rangle,\langle e,t \rangle\rangle$, the classifier would be able to specify the measure of the parts that would be formed into pluralities, and then the noun could combine with the numeral-classifier constituent through predicate modification.

In Shan, the proposed semantics is given in (52), abstracting away from word order. A classifier first combines with a noun. This is required given the denotation of the numeral. Numerals in Shan, unlike Ch'ol, do not measure entities. Therefore, the classifier is needed to atomize the noun.

(52) Shan



5 Conclusions

We have explored two families of theories of numeral classifiers and argued that a given language's numeral modification strategy has implications for the type of numeral classifier found in that language. Drawing on two typologically different languages, Ch'ol and Shan, we argued that there are broadly two types of numeral classifiers: classifiers-for-nouns and classifiers-for-numerals, which align with the two families of theories for classifier languages. By putting the variation in the numeral modification strategy, we can also explain why some languages, like English, do not have classifiers: the denotation of the numeral does not require it. Semantic variation in the denotations of numerals and classifiers is therefore a welcome result and can capture cross-linguistic variation.

This paper is compatible with an account of nouns where they are all functions from individuals to truth values, or, type $\langle e,t \rangle$ under an extensional semantic approach. This, indeed, may be a welcome result, as all languages have words that denote entities or sets of entities in the world. The nature and organization of those entities might still vary, such as with count and mass nouns, but languages show consistency in how they separate these categories. However, we have not shown evidence here to support a universal $\langle e,t \rangle$ analysis, and our generalizations are compatible with other accounts of noun denotations.

There is less consistency in numerals cross-linguistically, which we argue is reflected in their semantic composition. We also see evidence of variation in the counting base of numerals across languages; common counting bases are base-10 (such as in English, Shan) and base-20 (such as in Ch'ol and borrowings from Celtic languages into French), but counting bases such as base-4, base-5 and base-6 also exist (Everett 2017). This paper captures the existing linguistic diversity within numeral systems by positing that variation in the strategy for numeral modification determines the distribution of numeral classifiers in that language. While derivationally distinct, every language arrives at the same semantic denotation for 'two dogs' as the set of pluralities of two dogs (e.g., {*ab, ac, bc*} where *a, b* and *c* are dogs).

While we have concentrated on languages where classifiers obligatorily appear with numerals, the study of optional classifiers is an area of fruitful future work. For example, a number of typologically distinct languages have been reported to have optional classifiers: see, for instance, Csirmaz & Dékány (2014) on Hungarian (Uralic), Sağ-Parvardeh (2019) on Turkish (Turkic), and Dalrymple & Mofu (2012) on Indonesian (Austronesian). Considering the semantic contribution and syntactic distribution of these languages will add to our knowledge of the semantic contribution and typology of classifiers.

This paper also has implications for typological studies of *seemingly* connected functional elements. In the literature, numeral classifiers from distinct languages have been identified as typologically connected in that they obligatorily appear in the presence of a numeral (Aikhenvald 2000). However, using a combined syntactic and semantic perspective we have demonstrated that numeral classifiers form a *heterogeneous* class. By questioning this uniform characterization, we can better understand the nature of numeral classifiers as classifiers-for-numerals and classifiers-for-nouns rather than working to reconcile these two types of classifiers as a unified typology.

Abbreviations

1 = first person; 2 = second person; 3 = third person; ACC = accusative; ACH = achievement; AN = animate; CLF = classifier; COMP = complementizer; CONTR = contrast linker; COP = copula; DEM = demonstrative; DET = determiner; DIR = directional; ERG = ergative; EXT = existential; GEN = generic; HUM.PL = plural for humans; IPFV = imperfective aspect; IN = inanimate; N.CLF = noun classifier; NML = nominalizer; NUMCLF = numeral classificatory suffix; POSS = possessive; PFV = perfective aspect; PL = plural; PREP = preposition; PROG = progressive aspect; PSV = passive; SORT.NUMCLF = sortal numeral classifier; SP: = Spanish borrowing; TOP = topic.

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Competing interests

The authors have no competing interests to declare.

Author contributions

All authors participated equally in the original research, data collection, writing and editing of the first version of this paper; the first two authors led the revisions and editing of the manuscript.

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