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Counting banana trees in Ch'ol

Exploring the syntax and semantics of sortal classifiers

Alan Bale · Jessica Coon · Nicolás Arcos López

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Abstract This paper discusses evidence from the Mayan language Ch'ol that the choice of sortal numeral classifier in counting expressions determines the denotation of the noun. For example, when the classifier *-ts'ijty* is used with the noun *ja'as*, it is understood that *ja'as* denotes a set of bananas, whereas when *-tyejk* is used, *ja'as* is understood as denoting a set of banana trees. Critically, it can be demonstrated that this effect on the meaning of the noun is non-local in the sense that it occurs within a syntactic domain that is completely independent of the classifier. Furthermore, there are strong arguments that the meanings of all sortal classifiers like *-ts'ijty* and *-tyejk* are essentially the same, namely the cardinality measure function $\mu_{\#}$. We hypothesize that there are two possible explanations for the non-local effects of classifiers. One is that the lexical interpretation function is sensitive to non-local syntactic contexts, much like vocabulary insertion rules within Distributed Morphology (Halle and Marantz, 1993). The other is that there are learned, pragmatic conventions that influence how speakers interpret an implicit context-set variable (Westerstahl, 1985). We discuss evidence from noun phrase ellipsis which favours the latter explanation.

Keywords Classifier · Counting · Context Sensitivity · Mayan · Numerals

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A. Bale
Concordia University, Linguistics Program
E-mail: alan.bale@concordia.ca

1 Introduction

There are at least two components to a phrase like *how many bananas* in a sentence such as the one in (1): there is a request to count and a restriction on what to count.

(1) How many bananas are on the table?

This paper explores the grammatical sources that restrict what to count, with a focus on numeral classifier languages like Ch'ol (Mayan). In count-mass languages like English, the grammatical source of this type of restriction is clearly the noun. The understanding of what to count covaries with the chosen noun (*how many bananas*, *how many trees*, etc.). However in classifier languages, there is an additional (often obligatory) morpheme called a classifier that usually appears between the quantifier/numeral and the noun.[1] For example, the morpheme *-ts'ijty* appears between the quantifier *jay* and the noun *ja'as* in the Ch'ol sentence in (2).[2]

(2) Jay-**ts'ijty** ja'as añ tyi mesa?
how.many-CLF banana EXT PREP table
'How many bananas are there on the table?'

Broadly speaking, there are two types of classifiers in Ch'ol (and in classifier languages in general): those that provide a unit of measurement (non-sortal or "measure" classifiers), and those that seem to rely on some sort of natural counting unit inherent to the noun (sortal classifiers). Non-sortal classifiers specify a vague or precise way of measuring and partitioning the nominal denotation. In other words, this type of classifier at least partially determines what is counted, as reflected by the different readings in the examples in (3).

(3) a. ux-**chäjk'** ja'
three-CLF water
'three drops of water'

b. ux-**lojch'** ja'
three-CLF water
'three scoops of water'

In contrast, sortal classifiers like *-kojty* and *-p'ej* in (4) and (5) cannot be so easily glossed. The sortal classifier *-kojty* is used for counting four-legged things, but also chile peppers; *-p'ej* is used for spherical objects, but is also

[1] Sometimes the term *classifier* is reserved for what we call sortal classifiers in this paper. The non-sortal classifiers are often called measure terms or "massifiers".

[2] Abbreviations in glosses are as follows: A – "Set A" person marking (ergative, possessive); B – "Set B" person marking (absolutive); CLF – numeral classifier; DET – determiner; EXT – existential particle; IPFV – imperfective; ITV – intransitive verb suffix; PASS – passive; PFV – perfective; PREP – preposition; REL – relative; SP – Spanish origin; STAT – stative; TV – transitive verb suffix. Ch'ol is written in a Spanish-based practical orthography. Unless otherwise noted, Ch'ol data in this paper comes from the third author, confirmed with other native speakers in the municipality of Salto de Agua.

a generic or default classifier. The partition/measurement that is relevant for counting tomatoes in (5a), for example, is completely different from the one that is relevant for counting beliefs in (5b).

(4) a. cha'-**kojty** mis
two-CLF cat
'two cats'

b. cha'-**kojty** ich
two-CLF pepper
'two peppers'

(5) a. cha'-**p'ej** koya'
two-CLF tomato
'two tomatoes'

b. cha'-**p'ej** ñopbal
two-CLF belief
'two beliefs'

Examples like those in (4) and (5) have led many researchers to treat sortal classifiers differently from non-sortal classifiers. Some researchers have suggested that such classifiers denote a measure function that accesses the inherent divided reference in the noun itself (see Krifka 1995; Bale and Coon 2014, among others). Others have proposed that such morphemes introduce a function, presupposition or overt syntactic marking that the nominal denotation can be partitioned into a set of atomic minimal parts (see Chierchia 2010; Cheng and Sybesma 1999; Doetjes 1996). Still others hypothesize that such morphemes are functions that convert mass nouns into plural count nouns (see Chierchia 1998).

Like all of these theories, this paper proposes that the denotations of sortal classifiers do not directly figure in to the determination of what is counted. We argue that there is a context-set variable that restricts the nominal denotation, but whose value is influenced by the presence or absence of certain types of classifiers. Such consequences follow mainly from noun phrases like (6) in which two different sortal classifiers combine with the same noun yielding different effects on what is counted.

(6) a. cha'-**ts'ijty** ja'as
two-CLF banana
'two bananas'

b. cha'-**tyejk** ja'as
two-CLF banana
'two banana trees'

We argue that such effects cannot be determined by the meaning of the classifier since it can be demonstrated that the noun in these constructions already denotes different things before it combines with the classifier (i.e., *ja'as* in (6a) denotes bananas independent of the interpretation of *cha'-ts'ijty*, and *ja'as* in (6b) denotes banana trees independent of the interpretation of *cha'-tyejk*). We also provide evidence from noun phrase ellipsis that such effects are unlikely due to a co-textually sensitive lexical interpretation function.

The outline of this paper is as follows. In section 2, we review arguments from more well-studied languages that there is a syntactic difference between

numeral constructions that involve partitioning versus those that involve measurement. This sets up the debate for how classifiers and numerals are syntactically represented in Ch'ol. In section 3, we discuss relevant background on numerals and classifiers in Ch'ol. This provides a grammatical context to better understand the arguments for different types of constituency structures. Section 4 argues that classifier constructions in Ch'ol share a single syntactic structure, regardless of whether the classifier is sortal or non-sortal; specifically, we argue that the numeral and classifier together form a constituent which adjoins to a nominal phrase.

The syntactic structure proposed in section 4 is important for the semantic analysis presented in section 5, where we discuss evidence against a strict compositional treatment of nouns in these types of constructions. This section demonstrates that different classifiers trigger different interpretations of a noun, and furthermore, this influence over the interpretation of the noun is syntactically non-local. Section 6 outlines two possible formalizations of the non-local dependencies in Ch'ol: one that hypothesizes a lexical interpretation function that is sensitive to syntactic context and another that hypothesizes the presence of an implicit context-set variable (Westerstahl, 1985) whose interpretation is influenced by learned pragmatic conventions. We discuss some preliminary data from noun phrase ellipsis that favours the presence of implicit context-set variables.

2 Partitioning vs. measuring

Before discussing Ch'ol, it is important to review some of the syntactic hypotheses surrounding measurement constructions in English. Such hypotheses will provide context for our discussion of the syntactic analysis of classifiers in Ch'ol.

In English, there is evidence for a semantic and syntactic difference between measure terms that participate in a measurement versus those that participate in a partition. Intuitively, a measurement involves the potential of dividing a nominal denotation into units like *litres*, *grams*, or *seconds*, without actually partitioning it (at least not in a contextually salient way). In contrast, when a noun is partitioned, the division of the nominal denotation is apparent, usually because there is a physical separation of the denotation into relevant units. This contrast is best understood with an example. Take the English noun *cups*. The sentence in (7) can be understood as indicating that Mary put four separate cups on the table and each cup contains water, or it can be understood as indicating that Mary put one container on the table which contains four cups-worth of water.

(7) Mary put four cups of water on the table.
   i. Mary put four different cups on the table; each cup had water in it.
   ii. Mary measured four cups of water into a bowl, and then put the bowl on the table.

The former interpretation is a partitioned reading whereas the latter is a measured reading. Prototypical measure terms that are predominantly used in measure readings include *litres*, *grams*, *pounds*, *tonnes*, *inches*, *hours*, and *seconds*. Examples of prototypical measure terms that are used in partitioned readings include *items*, *pieces*, *baskets*, *buckets*, and *boxes*. To some degree, all terms can be used to indicate either reading although some terms are more flexible than others, such as *cups*, *teaspoons*, and *barrels*.

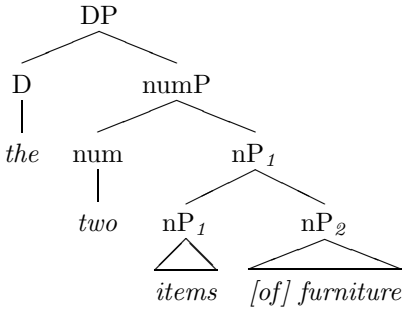
(8) Prototypical Measures
   a. I put 500 grams of sugar in the pot.
   b. We observed ten seconds of silence.

(9) Prototypical Partitions
   a. I put four items of furniture in the hallway.
   b. I put four baskets of books in the hallway.

(10) Ambiguous
   a. I put four cups of water in the fridge.
   b. I put four teaspoons of sugar on the table.

Landman (2004) and Rothstein (2009, 2011) propose that there is a syntactic distinction (and hence a syntactic ambiguity) that tracks these two different readings. According to these authors, partitioned readings have a structure where the measure term is the syntactic head and the non-measure term is either a complement or a modifier, as shown in (11).[3]

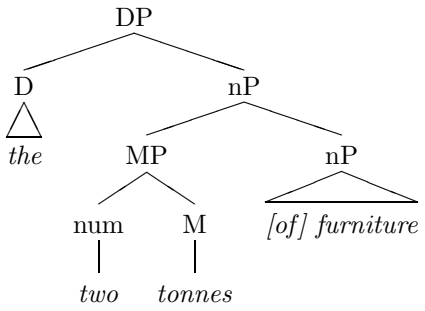
(11) Partition reading



In contrast, measure readings are proposed to have a syntactic structure in which the noun denoting the thing being measured is the head, as shown in (12). The numeral and measure term form a constituent, here MP, that modifies the head noun.

[3]There is variation in the literature as to whether the numeral is represented as a specifier of the phrase headed by the measure term, or as the head of its own projection, as shown here. The choice is not crucial to our discussion below. There is also some variation in the literature whether the *of* term is a head of a Prepositional Phrase with a denotation equal to its complement nP or whether *of* is inserted morphologically for case reasons but is not part of the underlying syntactic structure that feeds semantic interpretation. Once again, the choice of analysis does not affect the discussion here.

(12) Measure reading



As noted by Rothstein (2009, 2011), the structures in (11) and (12) make different syntactic predictions. First, it is expected that the count-mass status of the DP will depend on which noun (the measure term or the non-measure term) is the head. In (11), the head noun is the measure term, which is count. In (12), however, the head noun is the non-measure term, which happens to be mass. Evidence from the distribution of *much* and *many* largely confirms this prediction. Prototypical partition DPs sound awkward when they follow *much of* but sound natural following *many of*, whereas the opposite distribution holds for prototypical measure DPs.

(13) Partition Readings

a. Many of the 300 items of furniture will be exported to India.

b. # Much of the 300 items of furniture will be exported to India.

(14) Measure Readings

a. # Many of the 300 tonnes of furniture will be exported to India.

b. Much of the 300 tonnes of furniture will be exported to India.

The structures in (11) and (12) also make different predictions in terms of number agreement. It is well known that the number status of the subject DP is at least partly determined by number marking on the head noun. Considering this fact, the general structure in (11) predicts that number marking on the measure term should influence the form of the verb/auxiliary. In contrast, the general structure in (12) predicts that it should be the non-measure term that plays a role in agreement. The examples in (15) and (16) suggest that these predictions are on the right track.

(15) Measure Readings

a. The five minutes of silence we observed {was/?were} appropriate.

b. The 500 grams of sugar we added to the sauce {gives/?give} it a sweet aftertaste.

(16) Partition Readings

a. The five boxes of equipment we loaded into the truck {were/#was} going to be shipped to Toronto.

b. The 500 items of furniture that we bought at the flea-market {were/#was} in good condition.

When the non-measure term is singular and the measure term is plural, prototypical measure DPs sound more natural with singular agreement. In contrast, prototypical partition DPs sound more natural with plural agreement. The syntactic structures in (11) and (12) can explain these preferences.[4]

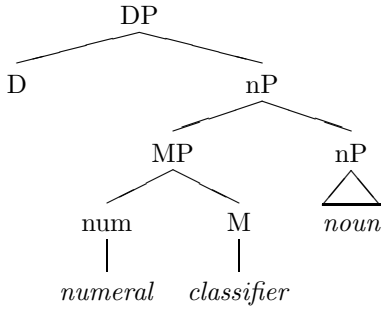
Given the behaviour of measure terms in English, a question arises about how classifiers are syntactically represented in classifier languages like Ch'ol. Do DPs in such languages have a similar syntactic contrast between measured and partitioned readings? Do measure classifiers like the one in (17a) behave differently from sortal classifiers, like the one in (17b)?

(17) a. ux-**chäjk'** ja'
three-CLF water
'three drops of water' =(3a)

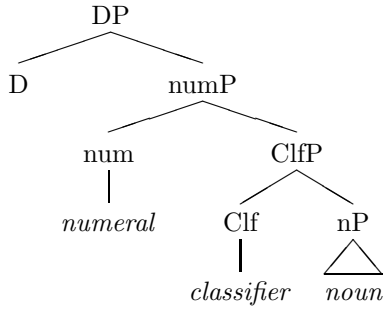
b. cha'-**kojty** mis
two-CLF cat
'two cats' =(4a)

One possibility is that NPs with measure classifiers like (17a) would have the structure in (18), while sortal classifiers like the one in (17b) would have the structure in (40), corresponding to the English structures above. This is the approach taken by Li (2011) for Mandarin. Below we argue instead that all numeral classifier constructions in Ch'ol have the same syntactic structure, namely the measure structure in (18).

(18) Measure reading



(19) Partition reading



We cannot assess classifier constructions in Ch'ol using the same type of syntactic diagnostics used in English. Unlike English measure terms, classifiers in

[4]It remains an open question why plural agreement in (15) is more acceptable than singular agreement in (16). It could be that coercion of *minutes* and *grams* into a partitioned reading is easier than the coercion of *items* and *boxes* into a measured reading. The contrast between (15) and (16) nonetheless lend support to the idea that the measure term is the head of the partitioned reading whereas the non-measure term is the head of the measured reading.

Ch'ol are (with few exceptions, discussed in §4.2 below) not nouns and thus do not have any status in terms of nominal subcategorization (i.e., they cannot be singular/plural nor mass/count). Nonetheless, other tests provide evidence that all classifier phrases in Ch'ol have a structure like the one represented in (37), which is more akin to the syntactic structure that underlies measured readings in English. This has important consequences for the semantic relationship between classifiers and nouns, discussed in section 5.

3 Numerals and classifiers in Ch'ol

This section provides relevant background details about numerals and classifiers in Ch'ol, a Mayan language spoken by around 200,000 people in the state of Chiapas in southern Mexico. Unless otherwise noted, Ch'ol data presented here comes from the third author, as well as speakers consulted in the municipality of Salto de Agua, Chiapas. For overviews of Ch'ol grammar, see Vázquez Álvarez 2011 and Coon to appear-a. We examine numerals in section 3.1 and then the origins of classifiers and productivity of the classifier system in section 3.2.

3.1 Ch'ol numerals

Numerals in counting expressions in Ch'ol—including the interrogative numeral *jay* 'how many' in (2) above—obligatorily occur with a numeral classifier. As in other Mayan languages, the Ch'ol numerical system is vigesimal (base 20). Numerals 1–20 are shown in (20). As numerals never appear alone, numerals 1–19 are presented with the generic classifier *-p'ej*.[5]

(20) Ch'ol numerals (Arcos López, 2009, 24)

1	*jum-p'ej*	11	*juñlujum-p'ej*
2	*cha'-p'ej*	12	*lajchämˆ-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	*bolujum-p'ej*
10	*lujum-p'ej*	20	*juñ-k'al*

The numerals 20 and above involve roots in classifier position which refer to powers of 20 (i.e. measure classifiers), shown in the table in (21). We return to the formation of complex numerals in section 4; see also the appendix in Warkentin and Scott 1980.

[5]Final nasals undergo place assimilation to the following consonant, and in some cases this is represented in the orthography. Relevant for our purposes here, the numeral 'one' alternatives between *juñ* and *jum*, depending on the following classifier.

(21) Classifiers for multiples of 20

20	*-k'al*
400 (20^2)	*-bajk'*
8,000 (20^3)	*-pijk*

The base-20 roots in (21) fill the classifier position in the DP, as shown by the contrast in (22). In (22a), the numeral *ux* appears with the classifier *-kojty* for animals; in (22b), the numeral appears with the classifier *-k'al* for groups of twenty. That these occupy the same slot is shown by their inability to cooccur in (22c); the opposite ordering is ungrammatical as well. We return to this fact below.

(22) a. ux-**kojty** wakax
three-CLF cow
'three cows'

b. ux-**k'al** wakax
three-CLF cow
'sixty cows'

c. * ux-**k'al-kojty** wakax
three-CLF-CLF cow

Today most speakers, even many monolingual speakers, use Ch'ol numerals only up to six, as well as ten, twenty, forty, sixty, eighty, one hundred and four hundred (Vázquez Álvarez, 2011).[6] Numerals borrowed from Spanish are used for higher numbers. While Ch'ol-based numerals obligatorily appear with a classifier in counting constructions, classifiers are impossible with numerals of Spanish origin (Bale and Coon, 2014), as shown in (23). This contrast will also be important to our discussion of the syntax and semantics of classifiers in the following sections.

(23) a. cha'-*(**p'ej**) tyumuty
two-CLF egg
'two eggs'

b. syete(*-**p'ej**) tyumuty
seven(SP)-CLF egg
'seven eggs'

The only other element which appears with a classifier is the "interrogative numeral" *jay* 'how many' (24a). Other quantifiers like *kabäl* 'many' and *ts'itya'* 'few' do not appear with a classifier (24b). Numerals may be reduplicated for a distributive reading and still require a classifier, as in (24c).

(24) a. Jay-*(p'ej) alaxax ya'-añ?
how.many-CLF orange there-EXT
'How many oranges are there?

[6] Vázquez Álvarez (2011, 160) notes that four hundred is still in use because it is used to count corn during harvest times.

b. Ya-añ kabäl(*-p'ej) alaxax.
there-EXT many-CLF orange
'There are many oranges.'

c. Ju-jum-p'ej mi la-k-xip-tyep'-e'.
RED-one-CLF IPFV PL-A1-wrapped-wrap-SUF
'We wrap them up one by one.' (Martínez Cruz, 2007, 88)

3.2 Ch'ol classifiers

Numeral classifiers are found in a number of different Mayan languages, but the most robust systems are found in the Greater Tseltalan branch of the family, which includes Tseltal, Tsotsil, Chontal, Ch'orti', and Ch'ol (see e.g. Keller 1955; Berlin and Romney 1964; Berlin 1968; Fleck 1981). Arcos López (2009) identifies at least 140 sortal classifiers in Ch'ol, and lists another 40 measure classifiers, though this is not an exhaustive list.

In closely-related Tseltal, Berlin and Romney (1964) identify 557 possible numeral classifiers. The table in (25), taken directly from Berlin and Romney 1964, provides an illustration of the richness of the system.

(25) CLASSIFIERS IN DOMAIN OF 'AGGRETATION OF GLOBULAR OBJECTS'

Category	Numeral Classifiers	Criterial Attributes
'aggregations of globular-shaped objects, as corn kernals, coffee beans, peanuts, chili peppers, stones, pieces of corn dough, eggs, etc.'	/b'uhs/	aggregated in a manner such that maximal horizontal extension of items is achieved with minimal spacing between items
	/t'ol/	aggregated in a manner such that maximal vertical piling is achieved

The large number of what are often highly specific classifiers like those in (25) raises questions about how speakers can acquire and use such systems. We discuss the formation of Ch'ol classifiers here, which will be relevant to their syntactic structures below.

A small number of Ch'ol numeral classifiers have an unknown origin (Arcos López, 2009). These include some of the more frequently used numeral classifiers, shown in (26).

(26)

classifier	used to count...
-tyikil	people
-p'ej	spherical things; generic classifier
-k'ej	round and flat things
-ts'ijty	long and skinny things

While classifiers like those in (26) must simply be learned, the vast majority of numeral classifiers are formed from two main classes of roots: transitive

roots and positional roots, discussed in turn below.[7] Richness in the verbal and positional domain thus translates directly to richness in the system of classifiers.

3.2.1 Classifiers from transitive roots

As in other Mayan languages, transitive and positional roots are CVC in form. Coon (to appear-b)—drawing on work in Yucatec Maya (Lois, 2011)—argues that Ch'ol roots show templatic effects, comparable to the more well-studied "root-and-pattern" morphology in Semitic languages (e.g. McCarthy 1981). Both consonants of the CVC roots are fully specified, but suprasegmental vowel qualities are specified during the course of the derivation (see e.g. Arad 2003 on Hebrew). The forms in (27) and (28) illustrate this pattern for transitive roots.

(27) a. Ta' i-**kuch**-u si' jiñi wiñik.
PFV A3-carry-TV firewood DET man
'The man carried firewood (on his back).'

b. Ta' **kujch**-i si'.
PFV carry.PASS-ITV firewood
'Firewood was carried (on back).'

(28) a. Ta' i-**jop**-o kajpe jiñi x'ixik.
PFV A3-gather-TV coffee DET woman
'The woman gathered together coffee (beans).'

b. Ta' **jojp**-i kajpe.
PFV gather.PASS-ITV coffee
'Coffee beans were gathered.'

Transitive roots can be identified by their ability to appear underived in verbal constructions with two arguments (see e.g. Haviland 1994 for a discussion of root classes in Tsotsil). The roots above appear in transitive stem forms in (27a) and (28a) with a plain root vowel: *kuch* and *jop*. The transitive stem requires a harmonic vowel "status suffix" and appears with two arguments. In the passive forms in (27b) and (28b), the root appears with a lengthened and devoiced root vowel, represented in the orthography as CVjC (orthographic *j* = IPA [h]).[8] The stem requires the intransitive status suffix, *-i*, and now takes only a single internal argument.[9]

[7] A smaller number of classifiers are formed from nominal stem forms, not discussed in detail here. These include certain containers, like *p'ejty* 'pot' and *chikib* 'basket' (see §4.2), as well as certain nominal forms of intransitive roots, such as *-ñumel*, used to count repetitions (from the intransitive root *ñum* 'to pass').

[8] Other works on Ch'ol have described the CVjC forms as involving a [j] "infix" (e.g. Vázquez Álvarez 2011). The ultimate analysis is not central to our main point here, but see discussion in Coon to appear-b.

[9] Unlike passive constructions in more familiar languages like English, the expression of an agentive *by*-phrase is restricted in Ch'ol; see Zavala 2007 for discussion.

Numeral classifiers may also be formed from these roots using the same CVjC form found in the intransitive (b) forms above. Examples of classifier forms derived from transitive roots are shown in (29). Note that the internal argument of the transitive and unaccusative forms in (27) and (28) corresponds to the object being counted in the classifier construction.

(29) a. cha'-**kujch** si'
two-CLF firewood
'two loads of firewood' (carried on back)

b. ux-**jojp** kajpe
three-CLF coffee
'three handfuls of coffee (grains)'

Examples of other classifiers formed from transitive roots are shown in (30); see Aulie and Aulie 1978 and Arcos López 2009 for more.

(30) CLASSIFIERS FROM TRANSITIVE ROOTS

classifier	used to count...	root	
-jajts'	beats (of music)	*jats'*	'hit'
-jojp	handfuls (of dry things)	*jop*	'gather (dry things)'
-kejp	hanging bunches (i.e. bananas)	*kep*	'hang'
-kujch	bulks, loads	*kuch*	'carry'
-läjts	piles (i.e. of corn, firewood)	*läts*	'pile up (solid things)'
-lejb	pieces	*leb*	'take apart'
-lejch	spoonfuls (of food)	*lech*	'scoop up food'
-lujch	spoonfuls (of liquid or fine grains)	*luch*	'ladle, scoop liquid'
-mejk'	armfuls (both arms around)	*mek'*	'hug'
-p'ijch	tacos	*p'ich*	'make tacos'
-p'is	cupfuls	*p'is*	'measure'
-sejl	round things (i.e. wheels)	*sel*	'roll'
-sujl	plunges	*sul*	'plunge' (into water)

Importantly, note that just as verb choice may co-vary with the nature of the internal argument, so too do the corresponding numeral classifiers co-vary with the substance of the element counted. This is not unlike English, in which *coffee* is most naturally understood as a brewed beverage in a sentence like *she ladled the coffee*, but as a bean in a sentence like *she spread out the coffee to dry in the sun*. Similarly, in the classifier forms corresponding to transitive roots, a noun with a broad meaning may receive a different interpretation depending on the choice of classifier, as shown by the different readings of the noun *bu'ul* 'bean' in (31).

(31) a. ux-**jojp** bu'ul
three-CLF bean
'three scoops of beans (seeds)' (*jop* – 'to scoop dry things')

b. ux-**tsojl** bu'ul
three-CLF bean
'three rows of beans (plants)' (*tsol* – 'to arrange in a line')

c. ux-**läjts** bu'ul
three-CLF bean
'three piles of beans (pods)' (*läts* – 'to pile up solid things')

d. ux-**lujch** bu'ul
three-CLF bean
'three spoonfuls of beans (cooked)' (*luch* – 'to spoon liquid things')

3.2.2 Classifiers from positional roots

Numeral classifiers in Ch'ol are also derived from *positional* roots (discussed in detail in Arcos López 2009; see also Haviland 1981 on Tsotsil). Positional roots in Mayan languages form a distinct class of roots, distinguishable in part by their semantic content (they usually refer to position, shape, surface quality, or physical state), but also by the special morphology used to form stems (England, 1983, 2001; Haviland, 1994; Henderson, to appear).

In Ch'ol, for example, positional roots form intransitive stative predicates with the suffix *-Vl* (the vowel is harmonic with the root vowel). As with transitive roots, the formation of numeral classifiers from positional roots is quite productive (though we have not systematically tested all roots): something that is CVC-Vl can generally be counted with the classifier -CVjC. Examples with the positional roots *pal* 'clustered' and *koty* 'standing on four legs' are shown in (32) and (33).

(32) a. **Koty**-ol jiñi me'.
standing.on.4.legs-STAT DET deer
'The deer is standing on four legs.'

b. chäñ-**kojty** me'
four-CLF deer
'four deer'

(33) a. **Pal**-al jiñi ja'as tyi tye'.
clustered-STAT DET banana PREP tree
'The bananas are clustered in the tree.'

b. cha'-**pajl** ja'as
two-CLF banana
'two bunches of bananas'

Additional examples are shown in (34).[10]

[10]Roots which end in a fricative consonant—like *box* [boʃ] and *wox* [woʃ]—do not have a CVjC form.

(34) Classifiers from positional roots

classifier	used to count...	root	
-kojty	four-legged things	*koty*	'standing on four legs'
-lijk	pieces of cloth	*lik*	'hanging' (e.g. cloth on a stick)
-box	shoes	*box*	'hollowed out (round)'
-pajl	clusters	*pal*	'clustered, bunched'
-p'ujl	piles	*p'ul*	'piled up'
-tyojk	cracks	*tyok*	'open'
-wejl	sides (e.g. of a board)	*wel*	'flat'
-wojl	bottles	*wol*	'spherical (solid)'
-wox	soft spherical things	*wox*	'spherical (flexible, soft)'
-xejty	convex objects	*xety*	'in a convex form' (e.g. bowl on table)
-xojty	rings	*xoty*	'ring shaped'

Though this process appears to be productive, some CVjC classifiers also have extended uses, not predictable from the meaning of the corresponding CVC root alone. For example, the classifier *-kojty* is derived from the positional root *koty* 'standing on four legs'. It can be predictably used to count four-legged animals such as cows, pigs, deer, and jaguars (35a). Beds, tables, and cars can also be counted with *-kojty* (35b). However, having four limbs is not necessary to be counted with *-kojty*, which is also used to count all animals regardless of the number of limbs: butterflies, snakes, chickens, birds, fish, or a dog with a missing leg (35c). The classifier *-kojty* is also used to count all chili peppers, regardless of shape (35d).

(35) a. cha'-kojty chityam
two-CLF pig
'two pigs'

b. cha'-kojty wäyib
two-CLF bed
'two beds'

c. cha'-kojty p'ejpem
two-CLF butterfly
'two butterflies'

d. cha'-kojty ich
two-CLF pepper
'two peppers'

In a similar vein, the classifier *-tyejk* is derived from the positional root *tyek*, roughly used to describe a configuration of organic things growing out of a sparsely populated surface. Predictably, *-tyejk* may be used to count plants which are growing spaced apart, hairs sprouting out of an otherwise bald head, or several spaced apart teeth (e.g. a baby or an elderly person). For most elements, this configuration is important: *-tyejk* cannot be used to count teeth in a mouth full of teeth. However, *-tyejk* is also used to count all trees, regardless of their spacing.

The relevance of position, shape, and configuration means that—just as in (31) above—a single noun may be counted with more than one classifier.

Snakes are particularly good candidates for this type of productivity, as shown in (36).

(36) a. juñ-**kojty** lukum
one-CLF snake
'one snake (any form)'

b. juñ-**xojty** lukum
one-CLF snake
'one snake (coiled up)'

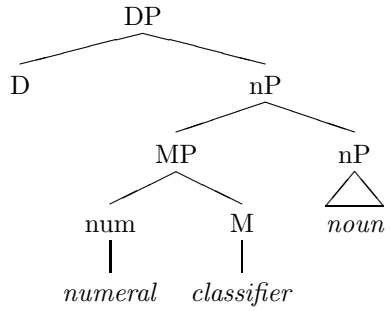
c. juñ-**jäjl** lukum
one-CLF snake
'one snake (stretched out)'

d. juñ-**jijch'** lukum
one-CLF snake
'one snake (hanging face-down)'

4 The structure of numeral classifiers

In this section, we argue that all numeral classifier constructions in Ch'ol have the structure repeated in (37), corresponding to the *measure* structure discussed in section 2 above. Specifically, we argue that the numeral and classifier together form a constituent (MP), which is adjoined to the nP being counted.[11]

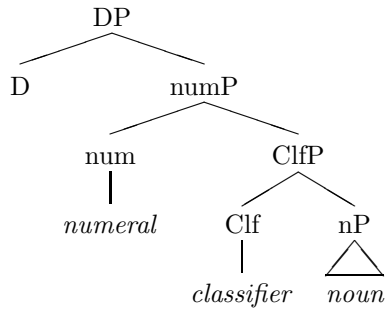
(37) Measure structure



Recall from section 2 above that in previous work, Landman (2004), Rothstein (2009, 2011) and Li (2011) propose that *measure words* and *measure classifiers* in English and Mandarin respectively have the structure in (37). However, these authors argue for a different structure for *partition words* and *sortal classifiers*, shown in (38) below. Cheng and Sybesma (1999) argue for the structure in (38) for classifier constructions in Mandarin more generally.

[11] We represent the classifier as the head of the MP, though the internal structure of MP is not crucial to the analysis below, and different alternative analyses may be possible. What is crucial for our analysis is that the numeral and classifier together constitute a maximal projection.

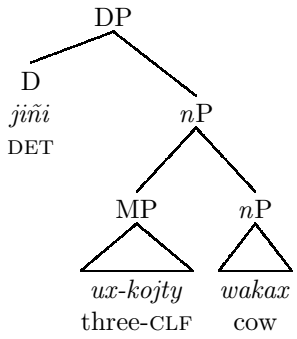
(38) Partition structure



We propose that all numeral classifier constructions have the *measure* structure in Ch'ol, illustrated for the sentence in (39a) in (39b). Specifically, the numeral-plus-classifier string ([NUM+CLF]) forms a constituent, M(easure)P, which adjoins as a modifier to the maximal projection containing the head noun. Since the constituent containing the head noun may include at least possessors, we label it nP.

(39) a. jiñi ux-kojty wakax
DET three-CLF cow
'the three cows'

b.



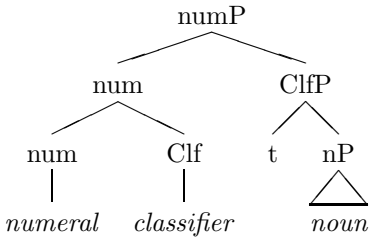
We show below that this structure has welcome consequences for the semantic composition of classifier phrases. In section 4.1 we argue that the [NUM+CLF] behaves as a maximal projection. Next, in section 4.2 we present evidence that this MP constituent modifies the head noun.

4.1 The numeral and classifier form a constituent

The first piece of evidence for the structure in (37) is that the numeral and classifier form a single phonological word in Ch'ol. This fact can be easily accounted for under the *measure* structure in (37), in which the numeral and classifier are both inside the MP constituent. Previous work has accounted for

this fact under the *partition* structure in (40) by proposing that the classifier head undergoes head movement to adjoin to the numeral (see Borer 2005).

(40) Partition Structure after Head Movement



These two possibilities make different predictions: under the *measure* structure, the [NUM+CLF] should behave as a maximal projection (possibly containing complex heads), while under the *partition* structure, the [NUM+CLF] should behave as a complex head.

Some initial evidence in favour of the *measure*-structure approach—in which the [NUM+CLF] is contained in a maximal projection excluding the nominal—comes from the formation of complex numerals. Recall from 3.1 above that Ch'ol's numerical system is base 20. To form numbers which are multiples of twenty, special classifiers denoting powers of twenty fill the classifiers slot of the [NUM+CLF] expression, as in (41).

(41) a. cha'-k'al
two-CLF.20
'forty' (lit. two-20s)

b. cha'-bajk'
two-CLF.400
'eight hundred' (lit. two-400s)

These *veintenas*, or multiples of twenty, are important to the formation of more complex numerals, like those in (42). Numerals of each multiple of twenty belong to the next highest *veintena*, the underlined portion in the expressions below. For example, all numerals between 21 and 40 will contain *cha'-k'al* 'forty', as in (42a); numerals between 81 and 100 will contain *jo'-k'al* 'one hundred' in (42b), and so on.

(42) Complex numerals (Warkentin and Scott, 1980, 108)

a. cha'-p'ej i-cha'-k'al
two-CLF A3-two-CLF.20
'twenty-two' (lit. two of the group of two-20s)

b. lujum-p'ej i-jo'-k'al
ten-CLF A3-five-CLF.20
'ninety' (lit. ten of the group of five-20s)

c. jo'lujuñ-k'al i-cha'-bajk'
fifteen-CLF.20 A3-two-CLF.400
'seven hundred' (lit. fifteen-20s of the group of two-400s)

Relevant for our purposes is that these forms clearly have an internal structure. In these complex expressions, the underlined *veintena* appears with 3rd person agreement ("Set A" in Mayanist terminology), normally found on possessed or relational nouns.[12] Though this system is not in current use by most Ch'ol speakers we have consulted, similar structures are reported in work on other languages in the family as well (e.g. Fleck 1981; Haviland 1981). While we do not elaborate on the structure of complex numeral expressions in Ch'ol, the important point is that the [NUM+CLF] component can contain more material than a single word. We claim that this fact is best accounted for under a structure in which numerals and classifiers form an XP, rather than a single complex head.

Evidence from juxtaposition corroborates the XP status of the [NUM+CLF]. As discussed in Vázquez Álvarez 2011, there are no specific morphemes that indicate conjunction or disjunction in Ch'ol. Coordinate XPs are frequently juxtaposed, a possibility shown for [NUM+CLF] phrases to express indefinite quantities in (43).

(43) a. wajali am-bi li [juñ-tyikil cha'-tyikil] la-k-pi'äl.
back.then EXT-REP DET one-CLF two-CLF PL-A1-friend
'It is said that back then we had some friends.' (Martínez Cruz, 2007, 32)

b. [cha'-tyikil ux-tyikil] kixtyañu
two-CLF three-CLF person
'few people' (Vázquez Álvarez, 2011, 255)

Again, under an analysis where the [NUM+CLF] is a complex head, these constructions would be difficult to account for.

Finally, evidence for the XP status of the [NUM+CLF] unit comes from A'-movement (see Gil 1994 for similar arguments regarding Japanese). Basic word order in Ch'ol is described as VOS/VS(Coon, 2010; Vázquez Álvarez, 2011), but as in other Mayan languages, arguments may front to preverbal position for topic, focus, relativization, and *wh*-questions (see e.g. England 1991; Aissen 1992). An intransitive with a postverbal subject is shown in (44a); in (44b) the subject has fronted and a focus interpretation arises (indicated by italics in the translation).

(44) a. Ta' jul-i-y-ob ux-tyikil x'ixik.
PFV arrive-ITV-EP-PL three-CLF woman
'Three women arrived.'

[12] Ordinal numbers also appear obligatorily with 3rd person Set A possessive morphology, as in (1).

(1) Tsa' chäm-i **i**-cha'-kojty-lel wakax.
PFV die-IV A3-two-CLF-NML cow
'The second cow died.'

Here and above, one might think of these "possessed" numeral stem forms as "belonging" to an abstract set of numbers, though we do not elaborate further on this here. Thanks to John Justeson for pointing out the relevance of ordinal numbers.

b. [Ux-tyikil x'ixik]$_i$ ta' jul-i-y-ob ___$_i$.
three-CLF woman PFV arrive-ITV-EP-PL
'*Three women* arrived.'

As shown in (45), the numeral and classifier can be displaced as a unit independent of the noun (45a), but the numeral cannot be displaced without the classifier (45b).

(45) FOCUS

a. Ux-tyikil$_i$ ta' jul-i-y-ob [___$_i$ x'ixik].
three-CLF PFV arrive-ITV-EP-PL woman
'*Three* women arrived.'

b. * Ux$_i$ ta' jul-i-y-ob [___$_i$ tyikil x'ixik].
three PFV arrive-ITV-EP-PL CLF woman
'*Three* women arrived.'

A similar example involving a *wh*-question is shown in (46) and (47). A transitive sentence with postverbal object is shown in (46a). In (46b) the entire DP has fronted to preverbal position.

(46) WH-QUESTION

a. Ta' a-mäñ-ä cha'-p'ej alaxax.
PFV A2-buy-TV two-CLF orange
'You bought two oranges.'

b. [Jay-p'ej alaxax]$_i$ ta' a-mäñ-ä ___$_i$?
how.many-CLF orange PFV A2-buy-TV
'How many oranges did you buy?

The example in (47a) illustrates that *jay-p'ej* 'how many' can front independently of the noun; fronting *jay* without the classifier is ungrammatical, as in (47b).

(47) a. Jay-p'ej$_i$ ta' a-mäñ-ä [___$_i$ alaxax]?
how.many-CLF PFV A2-buy-TV orange
'How many oranges did you buy?

b. * Jay$_i$ ta' a-mäñ-ä [___$_i$ p'ej alaxax]?
how.many PFV A2-buy-TV CLF orange
'How many oranges did you buy?

The crucial point of these examples it not that it is impossible to separate the numeral and the classifier; given that the two form a phonological word and never appear as stand-alone morphemes, this fact is unsurprising. What is important is that the [NUM+CLF] undergoes A'-fronting *without the nP* to a preverbal position occupied by other fronted XPs. The fact that [NUM+CLF] is eligible for A'-movement provides strong support for its XP status.

Furthermore, this pattern shares properties with clear cases of extraction out of DPs elsewhere in Ch'ol. For example, as discussed in Coon 2009 (see

also Aissen 1996 on Tsotsil) possessor DPs may extract independently of the possessum. A full possessive phrase is shown fronted in (48a); in (48b) the *wh*-possessor has fronted, leaving the possessum in its postverbal base position.

(48) a. [Maxki i-plato] tyi yajl-i ___$_i$?
who A3-plate PFV fall-ITV
'Whose plate fell?

b. **Maxki**$_i$ tyi yajl-i [i-plato ___$_i$]?
who PFV fall-ITV A3-plate
'Whose plate fell?' (Coon, 2009, 166)

Subextraction of both the possessor and of the [NUM+CLF] are subject to the same restriction: subextraction is only possible out of DPs in internal argument position (unaccusative subjects in (45) and (48), and transitive objects as in (47); see the discussion in Aissen 1996 and Coon 2009). Subextracting both possessors and the [NUM+CLF] MP out of a transitive subject, as in (49b) and (50b), is ungrammatical.

(49) a. [Maxki i-chich]$_i$ ta' y-il-ä-y-ety ___$_i$?
who A3-sister PFV A3-see-TV-EP-B2
'Whose sister saw you.'

b. * Maxki$_i$ ta' y-il-ä-y-ety [i-chich ___$_i$]?
who PFV A3-see-TV-EP-B2 A3-sister
intended: 'Whose sister saw you?'

(50) a. [Ux-tyikil xk'aläl-ob]$_i$ ta' y-il-ä-y-ety ___$_i$.
three-CLF girl-PL PFV A3-see-TV-EP-B2
'*Three girls* saw you.'

b. * Ux-tyikil$_i$ ta' y-il-ä-y-ety [___$_i$ xk'aläl-ob].
three-CLF PFV A3-see-TV-EP-B2 girl-PL
intended: '*Three* girls saw you.'

Taken together, the fact that (i) the NUM-CLF may undergo A'-movement, and (ii) this A'-movement is subject to the same restrictions as other clear cases of A'-movement (i.e. subextraction of possessors), suggests that it the [NUM+CLF] forms an XP constituent independent from the noun. Although we illustrated the movement restrictions and juxtaposition facts using sortal classifiers (since these are the more controversial classifiers with respect to the *measure* structure), it is important to note that these patterns hold for non-sortal classifiers as well. For the sake of brevity, we forego the relevant examples (which can be easily obtain by direct substitution).

4.2 The [NUM+CLF] modifies the noun

Having established above that the [NUM+CLF] forms an XP constituent (labeled MP in (37) above), we now turn to evidence that this MP modifies the head noun. Note that in addition to being stranded, the noun may be dropped

altogether (Arcos López, 2009; Vázquez Álvarez, 2011), as in the sortal and non-sortal classifier constructions in (51), where we have represented the NP ellipsis site with the symbol *Δ*:

(51) a. Ta' jul-i-y-ob [ux-tyikil-ob *Δ*].
PFV arrive-ITV-EP-PL three-CLF-PL
'Three (people) arrived.'

b. Ta' k-mäñ-ä [cha'-lujch *Δ*].
PFV A1-buy-TV two-CLF.ladle
'I bought two scoops (of something).'

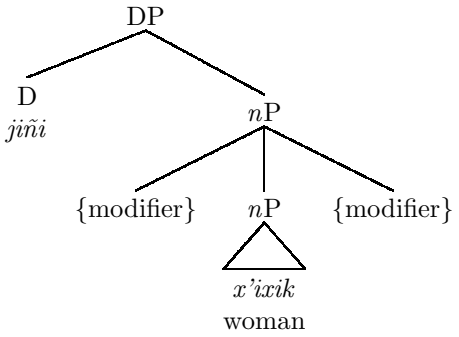
Constructions like these raise the question of whether we could instead analyze the classifier as the head, and the nominal as a modifier. Under this analysis, the sentence in (51b) would be not unlike English *two scoops (of coffee)*.

There are several reasons to think this is not the case. First, the elided noun must be recoverable from context, even when the meaning would be unambiguous. For example, even though the sentence in (51) contains the classifier *-tyikil*, only used to count humans, (51) cannot be felicitously uttered out of the blue. It is only acceptable in a context in which some set of people are already in the conversational common ground.

Further evidence that the noun is the head in these constructions can be found in adjectival modification, discussed in detail in Martínez Cruz 2007. In Ch'ol, modifiers generally appear with the relative clitic *=bä*, and may either precede or follow the head noun. We assume that the DP in (52a) has the structure in (52b), in which the modifier adjoins to the nP.

(52) a. jiñi { buch-ul=bä } x'ixik { buch-ul=bä }
DET seated-STAT=REL woman seated-STAT=REL
'the seated woman'

b.



As Martínez Cruz notes, adjectival modification is a useful way to diagnose the head of the DP. Under our proposal, the [NUM+CLF] in a classifier construction is an MP which modifies the counted nP. While most classifiers are derived from verbal or positional roots (§3), some nouns which denote measures—like *p'ejty* 'pot' and *chikib* 'basket'—may function either as nouns

or as classifiers.[13] While both sentences in (53) below can be translated as 'one pot of eggs', *p'ejty* serves a different function in each.

(53) a. jum-**p'ejty** [$_{nP}$ tyumuty]
one-CLF egg
'one pot of eggs'

b. jum-p'ej [$_{nP}$ i-**p'ejty**-al tyumuty]
one-CLF 3POSS-pot-NML egg
'one pot of eggs'

In (53a), *-p'ejty* is acting as a numeral classifier; under our proposed structure in (37) above, *jump'ejty* is an MP which adjoins to the nP *tyumuty*. In (53b), on the other hand, *p'ejty* is the head noun; the numeral appears with the default classifier *-p'ej*. Internal to the bracketed nP, *tyumuty* behaves like a possessor in following the possessee and triggering Set A possessive agreement ('egg's pot'/'pot of eggs').

Evidence that the bracketed strings in (53) are indeed the heads comes from modification. When a phrase-final modifier is added, it must be interpreted as modifying the head: in (55a) the eggs are broken, while in (55b), the pot itself is broken (and nothing is asserted about the eggs).

(54) a. jum-p'ejty [tyumuty] **tyojp'em=bä**
one-CLF.pot egg broken=REL
'one pot of broken eggs'
not: 'one broken pot of eggs' (Martínez Cruz, 2007, 30)

b. jum-p'ej [i-p'ejty-al tyumuty] **tyojp'em=bä**
one-CLF 3POSS-pot-NML egg broken=REL
'one broken pot of eggs'
not: 'one pot of broken eggs' (Martínez Cruz, 2007, 29)

The modifier can also precede the modified constituents in (55), resulting in the same interpretations as above. As predicted under our analysis, it cannot intervene between *ip'ejtyal* and *tyumuty*, as shown in (55c).

(55) a. jum-p'ejty **tyojp'em=bä** [tyumuty]
one-CLF.pot broken=REL egg
'one pot of broken eggs'
not: 'one broken pot of eggs'

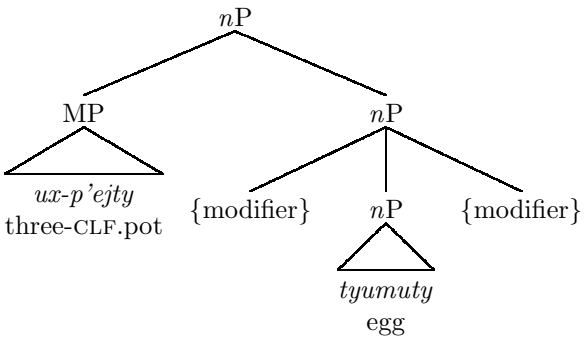
b. jum-p'ej **tyojp'em=bä** [i-p'ejty-al tyumuty]
one-CLF broken=REL 3POSS-pot-NML egg
'one broken pot of eggs'
not: 'one pot of broken eggs'

[13]The possibility of using these nouns as classifiers appears to be subject to dialectal and possibly intra-speaker variation. We report the facts below described in Martínez Cruz 2007, though Arcos López 2009 notes that these are only possible as nouns for speakers he has consulted.

c. * jum-p'ej i-p'ejty-al **tyojp'em=bä** tyumuty
one-CLF 3POSS-pot-NML broken=REL egg

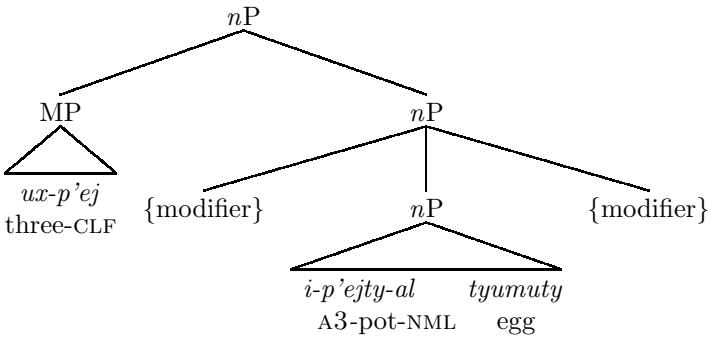
The structures for (53a) and (53b) are given in (56) and (57). The modifier may appear on either side of the nP head (just as in modification without classifiers in (52)), and is interpreted as modifying the head. The [NUM+CLF] adjoins higher up.

(56)



In (57), the measure term is the head of the nP and the modifier may again occur on either side of this nP.

(57)



4.3 Interim summary

To summarize, in this section we defended the proposal that the [NUM+CLF] sequence in Ch'ol classifier constructions forms a syntactic constituent (MP), which may undergo A'-movement and juxtaposition independently of the noun it modifies. The MP may also be complex, with its own internal syntax, as in the complex constructions for numerals above twenty. Furthermore, the classifier is not the head of the DP, as shown by ellipsis and modification facts in the final section.

This in-depth look into Ch'ol numeral classifier constructions provides the backdrop for the semantic discussion to follow. Recall from section 3 that Ch'ol-based numerals must always appear with a classifier in counting constructions. These set of classifiers include sortal and non-sortal, many of which are derived productively from semantically rich positional and transitive roots. Just as these roots place restrictions on the denotations of their internal arguments (i.e. their shape or substance), so too do the corresponding classifiers delimit the nature of the counted noun, as in (58). However, the apparent semantic importance of these classifiers breaks down in at least two environments: Spanish numerals are prohibited from appearing with a classifier (59a), and regular sortal classifiers are replaced with classifiers denoting powers of 20 in higher numerals (59b).

(58) a. ux-**tyejk** ja'as
three-CLF banana
'three banana (trees)'

b. ux-**ts'ijty** ja'as
three-CLF banana
'three bananas'

(59) a. nuebe ja'as
nine(SP) banana
'nine (units of) banana'

b. ux-**k'al** ja'as
three-CLF banana
'sixty (units of) banana'

With these pieces in place, we now turn to the semantics of these classifier constructions.

5 The relationship between sortal classifiers and nouns

The traditional treatment of sortal classifiers hypothesizes that such classifiers depend on the noun to determine the relevant unit for counting (namely, the noun's atomic minimal parts). In contrast, the traditional treatment of non-sortal classifiers hypothesizes that the relevant unit for counting is built into the meaning of the classifier itself. As discussed in this section, Ch'ol poses a problem for this traditional account. At the heart of the problem is evidence that certain sortal classifiers influence the interpretation of nouns—i.e., the interpretation of the noun is dependent on the type of sortal classifier that is used. This influence, however, seems to take place at a distance, in much the same way that a name can determine the reference of a pronoun.

In section 5.1, we review the standard interpretation of sortal and non-sortal classifiers. In section 5.2, we demonstrate that often the same noun in Ch'ol can combine with more than one sortal classifier with different effects on counting. This type of flexibility is unexpected if the relevant units for counting are determined by the noun. We discuss the possibility of treating sortal classifiers like non-sortal classifiers, where the classifier itself determines the relevant unit for counting. However, as outlined in 5.2, this type of interpretation encounters even greater empirical difficulties.

5.1 The traditional treatment of sortal and non-sortal classifiers

Many researchers have hypothesized that sortal classifiers, unlike their non-sortal counterparts, rely on the noun to determine what is counted (see Krifka 1995; Chierchia 1998; Bale and Coon 2014, among others). This type of interpretation can be implemented in a variety of different ways, but for the sake of simplicity, we will use the measure function $\mu_{\#}$ as defined in (60).

(60) a. For all sets S and all individuals/pluralities z that are members of S, $\mu_{\#}(S, z)$ is defined only if $\{x : x \in S \ \& \ \neg\exists y \in S.\ y < x\}$ does not contain any overlapping members.

b. When defined, $\mu_{\#}(S, z) = |\{x\colon x \in S \ \& \ x \leq z \ \& \ \neg\exists y \in S.\ y < x\}|$.

Informally put, $\mu_{\#}$ takes a nominal denotation S and an individual/plurality z and counts the number of minimal parts in a given denotation S that make up z. However, this function is only defined if the minimal parts in S do not overlap. Critically, what is counted is determined by the nature of the minimal parts in the nominal denotation and not by the measure function.

This type of interpretation explains how such classifiers can be used to count things which seem to have different criteria for individuation. For example, the way one identifies corn-grains is completely different from the way one identifies jugs. The meanings of the nouns used to identify these entities encode these differences, such as the meanings of the nouns *ixim* and *bux* in Ch'ol. However, even though the criteria for individuation are different, jugs and corn-grains might share a similar property in that both can serve as non-overlapping minimal parts in a nominal denotation. For example, suppose that a, b, and c are individual corn grains and e, f and g are individual jugs. Suppose further, that *ixim* and *bux*, as they are used in (61), have the interpretations in (62).

(61) a. cha'-p'ej ixim
two-CLF corn
'two grains of corn'

b. cha'-p'ej bux
two-CLF jug
'two jugs'

(62) a. $[\![ixim]\!] = \{a, b, c, ab, ac, bc, abc\}$

b. $[\![bux]\!] = \{e, f, g, ef, eg, fg, efg\}$

If the sortal classifier *p'ej* in Ch'ol were interpreted as $\mu_{\#}$ then it would measure grains of corn when applied to *ixim* and jugs went applied to *bux*.

(63) a. $[\![cha']\!] = \lambda m.\lambda P.\ \{z :\ z \in P \ \& \ m(P, z) = 2\}$

b. $[\![cha'\text{-}p'ej]\!] = [\![cha']\!]([\![p'ej]\!]) = \lambda P.\ \{z :\ z \in P \ \& \ \mu_{\#}(P, z) = 2\}$

c. $[\![cha'\text{-}p'ej]\!]([\![ixim]\!]) = \{ab, ac, bc\}$

d. $[\![cha'\text{-}p'ej]\!]([\![bux]\!]) = \{ef, eg, fg\}$

Thus, the noun determines the minimal parts and the sortal classifier measures individuals based on these minimal parts.

This type of interpretation is critically different from non-sortal classifiers like *-p'ejty* ('pot'). With such classifiers, the nature of the noun does not figure into the relevant partition of the denotation which determines what is counted. For example, consider the measure function in (65), which represents the measured reading for phrases like those in (64).

(64) cha'-p'ejty tyumuty
two-CLF.pot egg
'two pots of eggs'

(65) POT MEASURE

a. Let p_{MEAS} represent the contextually salient pot used to measure potfuls in a given context.

b. Let FULL be a relation between containers, entities and sets such that $\text{FULL}(x, y, S) = \text{T}$ iff ...

i. y is contained within x and $y \in S$

ii. There is no z such that $z \in S$, z is not a part of y, and z is contained within x

iii. It is not possible that there is a z such that $z \in S$, z is not a part of y, and the aggregate yz could be contained within x.[14]

c. Let PART be a relation between a set X and an entity y such that $\text{PART}(X, y) = \text{T}$ iff X is a partition of y (i.e., $\sqcup X = y$ & $\neg\exists z, w.\ z \in X$ & $w \in X$ & $z \sqcap w \neq 0$, where $\sqcup$ is the generalized join operator over a set and $\sqcap$ is the meet operator over entities).

d. For all sets S and all individuals/pluralities z that are members of S, $\mu_{\text{POT}}(S, z) = \iota n$ s.t. $\exists S'.\ \text{PART}(S', z)$ & $S' \subseteq S$ & $\forall y(y \in S' \rightarrow \Diamond(\text{FULL}(p_{\text{MEAS}}, y, S))$ & $|S'| = n$.[15]

The measure function yields a count based on a partition where each member of the partition is a potential potful of objects in the nominal denotation. For example, if the denotation of $[\![tyumuty]\!]$ were the set of all eggs and all pluralities of eggs, then the interpretation of the phrase in (64) could be partially represented in (66).

[14] Technically, the set S should be a kind rather than an extensional set. What is important is that it would be impossible to add anything of the same kind as y to the pot. However, for the sake of simplicity, we do not use kinds here. More generally, it is difficult to specify an empirically adequate notion of *fullness* with respect to an ideal measuring container. In particular, it is not empirically well established how speakers treat measurements that are less than one.

[15] This measure function presupposes that the thing being measured partitions perfectly into pots. It is not clear whether this accurately reflects the way speakers use these terms. Since we concentrate on the semantics of sortal classifiers, we will leave this as an open empirical question.

(66) a. $[\![tyumuty]\!] = \{x :\ x$ is an egg or a plurality of eggs$\}$
$= \{\ldots z, w, x, y \ldots zw, xy \ldots\}$, where z, w, x, and y are pluralities of eggs such that for each member r of $\{z, w, x, y\}$, $\Diamond\textsc{full}(p_{\textsc{meas}}, r, [\![tyumuty]\!]) = T$, and $(x \sqcap y = 0)$ & $(z \sqcap w = 0)$.

b. $[\![p'ejty]\!] = \mu_{\textsc{pot}}$

c. $[\![cha'\text{-}p'ejty]\!] = [\![cha']\!]([\![p'ejty]\!]) = \lambda P.\ \{z :\ z \in P\ \&\ \mu_{\textsc{pot}}(P, z) = 2\}$[16]

d. $[\![cha'\text{-}p'ej]\!]([\![tyumuty]\!]) = \{\ldots xy, zw \ldots\}$

Note that unlike sortal classifiers, the interpretation of *p'ejty* requires a lot of description in order to encode the individuation criterion into the measure function itself.

5.2 Problems for the traditional interpretation of sortal classifiers

The hypothesis that sortal classifiers are interpreted as functions that count non-overlapping minimal parts predicts that all sortal classifiers should be associated with the same basic measure function. Such a hypothesis cannot easily explain how the same noun can be used with two different sortal classifiers to count different types of objects, such as with the Ch'ol noun *ja'as* in (67). The phrase in (67a) is used to count bananas whereas the one in (67b) is used to count banana trees.

(67) a. cha'-ts'ijty ja'as
two-CLF banana
'two bananas'

b. cha'-tyejk ja'as
two-CLF banana
'two banana trees'

At first blush, one might wonder if the classifier *-tyejk* in (67b) behaves more like a non-sortal classifiers in that it might mean something like 'two tree-fuls of bananas'. However, this would not be an accurate translation of the phrase as it can be used to count trees that have just had all of the bananas harvested, or even trees that have not yet grown any bananas (see §3.2).

Similar examples abound. Consider the following phrases with *ixim* and *bu'ul*.

(68) a. cha'-p'ej ixim
two-CLF corn
'two grains of corn'

[16] In set formation of the form $\{z : \phi(z)\}$, we assume that the collection is the set of entities (pluralities or individuals) for which the formula ϕ is true. Individuals for which ϕ is either false or undefined are not members of the set. Critically, presuppositions potentially induced by ϕ do not necessarily hold for the entire domain.

b. cha'-tyejk ixim
two-CLF corn
'two corn stalks'

c. cha'-ts'ijty ixim
two-CLF corn
'two ears of corn'

(69) a. cha'-p'ej bu'ul
two-CLF bean
'two beans (i.e. bean seeds)'

b. cha'-tyejk bu'ul
two-CLF bean
'two bean plants'

c. cha'-ts'ijty bu'ul
two-CLF bean
'two beans-pods'

The classifier *-pe'j* is used to count grains or seeds, the classifier *-tyejk* is used to count plants, whereas the classifier *-ts'ijty* is used to count intermediate instantiations of the noun which are usually rigid, long and thin in shape.

Given examples like those in (67), (68) and (69), it is tempting to treat these types of classifiers in the same way we treated non-sortal classifiers like *p'ejty*—i.e., we could build the individuation criterion necessary for counting into the interpretation of the classifier itself. Consider the following interpretations for *-p'ej*, *-tyejk* and *-ts'ijty* respectively.

(70) Incorrect Interpretations of Sortal Classifiers[17]

a. $[\![p'ej]\!] = \lambda S.\lambda x.\ |\{z :\ z \in S\ \&\ \Phi(z)\ \&\ z \leq x\}|$

b. $[\![tyejk]\!] = \lambda S.\lambda x.\ |\{z :\ z \in S\ \&\ \Psi(z)\ \&\ z \leq x\}|$

c. $[\![ts'ijty]\!] = \lambda S.\lambda x.\ |\{z :\ z \in S\ \&\ \zeta(z)\ \&\ z \leq x\}|$

(71) The predicates Φ, Ψ and ζ have the following definitions:

a. For all x in the domain of discourse, $\Phi(x) = 1$ iff x is a spherical-like object.

b. For all x in the domain of discourse, $\Psi(x) = 1$ iff x is an organic object with a root-like structure.

c. For all x in the domain of discourse, $\zeta(x) = 1$ iff x is a rigid, long, thin object.

For now, we will ignore the vague specification of the truth conditions associated with Φ, Ψ and ζ, but we will return to why they are so vague shortly. The important point here is that the definitions in (70) attempt to specify

[17] The measure functions here are incomplete. There should be lines to ensure that each element in the set only consists of corn grains, trees and ears respectively. However, for the sake of simplicity and because ultimately these types of measure functions will be rejected, we have left out this restriction.

a restriction on what types of things are counted in a given denotation and thus provide a way that different types of so-called sortal classifiers can have different effects on the same nominal denotation.[18] According to these types of interpretations, the function associated with *-p'ej* counts the number of grains or seeds by virtue of the fact that grains/seeds are spherical-like objects. In contrast, the function associated with *-tyejk* counts the number of trees or plants by virtue of the fact that plants/trees are organic objects with root-like structures. Finally, the function associated with *-ts'ijty* counts the number of corn-ears or bean-pods by virtue of the fact that corn-ears/bean-pods are rigid, long, thin objects.

There are three main reasons why these types of interpretations are not plausible. First, the same sortal classifier can be used to count a diversity of objects, both abstract and concrete. We have already discussed how *-p'ej* can be used to count corn-grains, beans and jugs, but this same classifier—the default classifier—can be used to count arms, beliefs, ideas and days, as shown in (72).

(72) a. cha'-p'ej k'äb
two-CLF arm
'two arms'

b. cha'-p'ej ñopbal
two-CLF belief
'two beliefs'

c. cha'-p'ej ña'tyibal
two-CLF idea
'two ideas'

d. cha'-p'ej k'iñ
two-CLF day
'two days'

However, not everything can be counted using *p'ej*. For example, this classifier sounds very awkward if it is used to count cedar trees. To do this, the sortal classifier *-tyejk* is should be used. Speakers report that while examples like these may not be strictly ungrammatical, they sound like they would be spoken by someone who is still learning to speak Ch'ol.

(73) a. # cha'-p'ej caoba
two-CLF cedar

b. cha'-tyejk caoba
two-CLF cedar
two cedar trees

[18] Note, we could have also specified the restrictions on what is counted in terms of a partial function. For example...

$[\![p'ej]\!] = \lambda S.\lambda x : \Phi(x).\ |\{z :\ z \in S\ \&\ z \leq x\}|$

The difference between this type of interpretation and the one given in the text does not matter for the purposes at hand.

Similarly, *-p'ej* sounds very awkward if it is used to count cars or sticks. For these objects, the classifiers *-kojty* and *-ts'ijty*, respectively, should be used.

(74) a. # cha'-p'ej karu
two-CLF car

b. cha'-kojty karu
two-CLF car
two cars

(75) a. # cha'-p'ej tye'
two-CLF wood

b. cha'-ts'ijty tye'
two-CLF wood
two sticks

If *-p'ej* had an interpretation similar to non-sortal classifiers, it would be hard, if not impossible, to think of a measure function that could specify the correct restrictions on the noun that would permit measurements in terms of the number of arms, beliefs, ideas and days but exclude measurements in terms of the number of cedar trees, cars or sticks.

A similar point holds for *-ts'ijty*. Although this classifier can be used to count ears of corn, bananas and bean-pods, it can also be used to count arms, as shown in (76).

(76) cha'-ts'ijty k'äb
two-CLF arms
'two arms'

It is important to emphasize that *-p'ej* and *-ts'ijty* can be used to count the same types of objects in (72a) and (76) although they make critical distinctions when they apply to nouns like *ixim* and *bu'ul*. Once again, it is difficult to think of two measure functions that could suitably distinguish between grains and ears of corn, but yet would both permit the measurement of arms. Furthermore, it is difficult to think of a measure function that would be vague enough to permit a measurement in terms of ears of corn, bean-pods and arms but yet not be able to measure and count long and rigid feathers (instead, the classifier used for counting long thing things like hair is preferred).

(77) # cha'-ts'ijty k'uk'um
two-CLF feathers
'two feathers'

Another reason not to treat these sortal classifiers like non-sortal classifiers is that such classifiers are not always needed to count. As discussed in section 3, Ch'ol nouns can combine directly with borrowed Spanish numerals which prohibit the use of classifiers (Bale and Coon, 2014). However, when these numerals combine with nouns like *ixim* and *ja'as*, the counting units which are associated with the sortal classifiers are still available. For example, consider the phrase in (78).

(78) a. nuebe ixim
nine(SP) corn
'nine ears of corn/corn stalks/corn grains'

b. nuebe ja'as
nine(SP) bananas
'nine bananas/banana trees'

The phrase in (78a) can be used to talk about nine ears of corn, nine grains or nine corn stalks. The phrase in (78b) can be used to talk about nine bananas or nine banana trees. Context helps determine what is being counted, or in some cases more specific nouns may be substituted (for example, while *ixim* may denote a range of corn-related entities, including ears, *wajtyañ* is a noun specifically for ears of corn).

Similar results hold when the classifier *-k'al* is used. This classifier signals that the relevant counting unit is groups of twenty. However, what constitutes the relevant counting unit for the group is underspecified. The phrase in (79a) can be used to talk about forty ears of corn or forty corn stalks. Similarly, the phrase in (79b) can be used to talk about twenty bananas or twenty banana trees.

(79) a. cha'-**k'al** ixim
two-CLF.20 corn
'40 ears of corn/corn stalks'

b. juñ-**k'al** ja'as
one-CLF.20 banana
'20 bananas/banana trees'

Once again, context will help determine the relevant counting unit.

This type of "default" access to a counting unit does not hold for the relevant units typically specified by non-sortal classifiers. For example, although the phrase in (80a) can be used to talk about nine eggs, and the one in (80b) can be used to talk about forty eggs, the same phrases cannot be used to talk about nine or forty pots of eggs respectively.

(80) a. nuebe tyumuty
nine egg
'nine eggs/#pots of eggs'

b. cha'-**k'al** tyumuty
two-CLF.20 egg
'forty eggs/#pots of eggs'

In other words, borrowed Spanish numerals and the group classifier *-k'al* cannot access the same relevant units of counting as the non-sortal classifier *-p'ejty*.

A third and final reason to reject a non-sortal type of interpretation of sortal classifiers is that the relevant unit for counting is determined before the point where the [NUM+CLF] constituent merges with the rest of the noun

phrase. Consider the Ch'ol adjective *kolem* 'big'. Like in English, the threshold of what counts as big is determined by the noun that the adjective modifies (see Kennedy 1999; Bale 2011; Klein 1980, 1982; Ludlow 1989; Cresswell 1976, among others). For example, the size something has to be to qualify as a *kolem* ('big') rabbit is quite different from the size it would have to be to qualify as a *kolem* ('big') elephant—a small elephant is generally quite a bit bigger than a big rabbit.

In adjective-noun constructions, the comparison class that sets the standard for the adjective is determined by the nature of the denotation of the complement noun. For example, the use of *kolem* in (81a) evaluates the size of ants in terms of the relative size of the average ant whereas *kolem* in (81b) evaluates the size of houses in terms of the relative size of the average house.

(81) a. kolem xiñich'
big ant

b. kolem otyoty
big house

Recall from section 4 that modifiers generally appear with *-bä* and may precede or follow the head noun. The syntactic structures of phrases like those in (82) and (83) are as depicted schematically in (84).

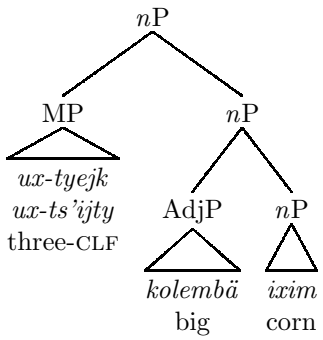
(82) a. ux-tyejk ixim kolem-bä
three-CLF corn big-REL

b. ux-tyejk kolem-bä ixim
three-CLF big-REL corn

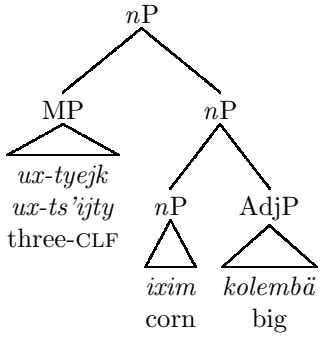
(83) a. ux-ts'ijty ixim kolem-bä
three-CLF corn big-REL

b. ux-ts'ijty kolem-bä ixim
three-CLF big-REL corn

(84) a.



b.



The adjective and noun form a constituent independent of the numeral and classifier. Since the noun determines the comparison class that sets the standard of what counts as big, the interpretation of the adjective should provide information about the interpretation of the noun independent of the measure phrase.

For example, if the noun exclusively referred to corn ears, then the phases in (82) should be interpreted as counting corn stalks that either are currently growing, or potentially could grow, large ears of corn—*kolembä* would mean *big relative to the standard size of ears of corn*. Similarly, if the noun exclusively referred to corn stalks, then the phrases in (83) should be interpreted as counting ears of corn that come from large corn stalks—*kolembä* would mean *big relative to the standard size of corn stalks*. In contrast to both of these potential meanings, if *ixim* referred exclusively to grains of corn, then the phrases in (82) should be interpreted as counting corn stalks that come from or produce large corn-grains, whereas the phrases in (83) should be interpreted as counting ears of corn that come from or produce large corn-grains.

There is one further prediction that is important to emphasize. Suppose that *ixim* were underspecified in (82) and (83) in terms of its denotation. In other words, suppose that *ixim* denoted all corn-related things—grains, ears and stalks. This too would effect how the standard is set for the adjective. If *ixim* had a broad, underspecified meaning, then *kolembä* would mean *big relative to the standard size of all corn-related things*. Most corn stalks would count as *kolembä* since most stalks are significantly larger than ears and grains of corn. Most grains should not count as *kolembä* since most grains are not significantly larger than stalks and ears of corn.

In terms of judgments, none of these predictions are borne out. The phrases in (82) are interpreted as counting large corn stalks—i.e., stalks that are big relative to the standard size of corn stalks. This suggests that *ixim* in (82) exclusively denotes stalks of corn even before it combines with the measure phrase. Similarly, the phrases in (83) are interpreted as counting large ears of corn—i.e., ears of corn that are big relative to the standard size of ears of corn. This suggests that *ixim* in (83) exclusively denotes ears of corn even before it combines with the measure phrase. Unsurprisingly, the same general pattern holds for (85).

(85) a. ux-p'ej ixim kolem-bä
three-CLF corn big-REL

b. ux-p'ej kolem-bä ixim
three-CLF big-REL corn

The phrases in (85) are interpreted as counting large grains of corn—i.e., corn-grains that are big relative to the standard size of such grains. Once again, this suggests that *ixim* in (85) exclusively denotes grains of corn even before it combines with the measure phrase.

These empirical results highlight two things. Not only do different sortal classifiers count different types of objects, but different sortal classifiers seem to trigger different types of interpretations of the noun. Furthermore, this effect on the interpretation happens within a syntactic domain that is completely independent of the classifier. Assigning a non-sortal type of interpretation to *-p'ej*, *-tyejk* and *-ts'ijty* would not be able to account for this type of pattern.

6 Towards a formal semantics for Ch'ol classifiers and nouns

There are at least two possible analyses of the Ch'ol data that maintains a single syntactic entry for nouns like *ixim* ('corn'), *ja'as* ('banana'), and *bu'ul* ('bean'), but allows for a systematic variation in meaning. One analysis proposes that the interpretation of these words is co-textually sensitive (i.e., the interpretation changes based on its syntactic context). The other maintains that there are implicit contextual variables similar to context sets that restrict the interpretation of nominal predicates (see Westerstahl 1985). This section outlines the theoretical details of each analysis and discusses some relevant empirical data that might help decide between them.

A shared property of both analyses is that sortal classifiers have the same interpretation no matter what their form: they are interpreted as the measure function $\mu_{\#}$. The classifiers have different effects on counting because they influence the interpretation of the nouns they modify. For example, in the environment of *-tyejk*, the interpretation of *ixim* denotes a set of corn stalks and corn-stalk pluralities, whereas in the environment of *-p'ej*, the interpretation of *ixim* denotes a set of corn grains and corn-grain pluralities. The function $\mu_{\#}$ is used to count minimal parts in both types of strurctures. This part of the theory is necessary to capture the non-local effect of the classifiers.

The difference between the two analyses stems from how the classifiers influence the nominal interpretations. In one theory, the interpretation of nouns is directly influenced by syntactic context. In the other, nouns have a constant interpretation that is restricted by a contextual variable. As we will demonstrate in §6.3, evidence from nP ellipsis favours the analysis with contextual variables.

6.1 Co-textually sensitive lexical interpretation rules

One possible analysis of the Ch'ol data builds polysemy into the lexical interpretation function itself. Inspired by Distributed Morphology (hereon DM, see Halle and Marantz 1993), this type of theory maintains that the interpretation function that assigns denotations to lexical items is sensitive to co-textual surroundings, much like how the insertion of underlying phonological forms is sensitive to co-textual environments in DM.

To understand this theory better, let's first consider a prototypical example with respect to underlying phonological forms, namely the various instantiations of the English plural morpheme. This morpheme surfaces /-rən/ when appearing next to the noun *child*, as /-ən/ when appearing next to the noun *ox*, but as /-z/ in most other environments, modulo phonological rules (i.e., devoicing, schwa insertion, etc.). There are other forms of the plural morpheme, including a phonologically null form, but for the sake of simplicity we will concentrate on these three. In DM, this kind of morphological variation is represented by vocabulary insertion rules. Such rules consist of a set of lines with the lexical feature representing the morpheme on the the left of a double arrow, the underlying phonological form to the right of the double arrow, and the morpho-syntactic environment on the far right after the '/' symbol.

(86) Partial List of Vocabulary Insertion Rules for English:
Let PL represent the plural affix and let $\sqrt{\text{child}}$ represent the underlying root for the noun *child* and $\sqrt{\text{ox}}$ represent the underlying root for the noun *ox*.

$$\begin{array}{lcl} \text{PL} & \Leftrightarrow & \text{-rən} \;/\sqrt{\text{child}}\;\underline{\quad} \\ \text{PL} & \Leftrightarrow & \text{-ən} \;/\sqrt{\text{ox}}\;\underline{\quad} \\ \text{PL} & \Leftrightarrow & \text{-z (elsewhere)} \end{array}$$

The correct underlying phonological form for the plural morpheme is inserted only when the morpho-syntactic conditions are met. Critically, more specific contextual environments are favoured over less specific environments. The line with the least specific environment becomes the default form (here listed as having an elsewhere condition).

As with the so-called vocabulary insertion rules, the lexical interpretation function could also be sensitive to its syntactic environment. To represent this possibility, we will let the interpretation of lexical items be an ordered list of possible denotations, each with a specific syntactic environment. The last item on the list will be the default interpretation of the noun. For example, consider the possible lexical interpretation of *ixim* given in (87).

(87) Possible Lexical Interpretation Rule for *ixim*:
Let '$]_{\text{MP}}\;\underline{\quad}$' represent the right edge of the measure phrase immediately to the left of the noun. Let Φ_1 be a predicate that is true of corn stalks and pluralities of corn stalks, let Φ_2 be a predicate that is true of ears of corn and pluralities of ears, let Φ_3 be a predicate that is true of grains of corn and pluralities of grains, and let Φ_4 be a predicate that is true

of corn stalks, corn grains and corn ears or any plurality formed from the stalks, grains or ears:

$$\begin{array}{lcl} [\![ixim]\!] & \Leftrightarrow & \{x : x \in D \ \& \ \Phi_1(x)\} \ / \sqrt{\text{-tyejk}} \ ]_{\text{MP}} \ \_\_ \\ [\![ixim]\!] & \Leftrightarrow & \{x : x \in D \ \& \ \Phi_2(x)\} \ / \sqrt{\text{-ts'ijty}} \ ]_{\text{MP}} \ \_\_ \\ [\![ixim]\!] & \Leftrightarrow & \{x : x \in D \ \& \ \Phi_3(x)\} \ / \sqrt{\text{-p'ej}} \ ]_{\text{MP}} \ \_\_ \\ [\![ixim]\!] & \Leftrightarrow & \{x : x \in D \ \& \ \Phi_4(x)\} \text{ elsewhere} \end{array}$$

There are two important points that are worth emphasizing with respect to this interpretation rule. First, it is critical that the default interpretation be broad enough to handle all of the possible uses of the noun when no classifier is present. As mentioned in section 5, numerals borrowed from Spanish do not permit classifiers and can be used to count a variety of different objects, as long as those objects can also be counted using sortal classifiers in other syntactic contexts. A similar point holds for classifiers that determine counting in terms of groups of twenty. Second, it is critical to note that there is only one syntactic item, i.e., *ixim*, and that this syntactic item only varies in its denotation when different classifiers are syntactically present. This property makes different predictions with respect to nP ellipsis, something we will return to in section 6.3.

In summary, one possible account of the Ch'ol data is that nouns are polysemous and that their different meanings are triggered by their syntactic environments. The polysemous nature of the nouns would then be grammatical through and through: the triggers would be syntactic and polysemy would arise from the nature of the lexical interpretation function.

6.2 Restriction by a contextual variable

Another possible account of the Ch'ol data is based on the idea that the classifier can influence the interpretation of an implicit contextual variable. This type of explanation has its roots in well-known analyses of quantificational restrictions in languages like English, French, and German. Nominal denotations in such languages are contextually restricted and sometimes this contextual restriction can be influenced by other lexical items and phrases in the discourse.

Probably the most thorough discussion of this phenomenon comes from Westerstahl (1985), where he demonstrated that so-called *context sets* can vary within a single sentence and are influence by information supplied by the co-text. For example, the last sentence in (88) has a different implicit restriction on the nouns *students* and *adults* than it does on the nouns *pen-pal* and *academics*.

(88) The people in this area of Montreal have quite an international perspective. The students have all had pen-pals and the adults have all volunteer to host travelling academics.

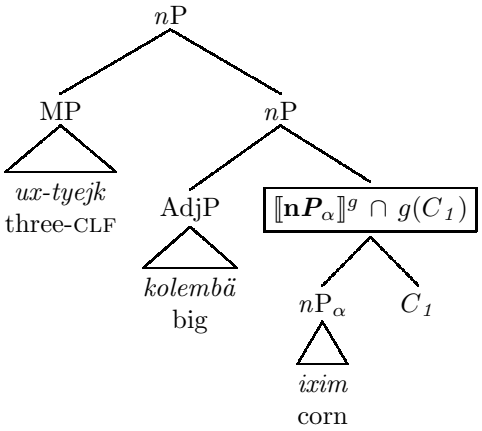
The nouns *students* and *adults* are restricted to the people in *this area of Montreal* whereas the nouns *pen-pal* and *academics* are not. In fact, they are

more naturally understood as being restricted to people outside of Canada. These restrictions are influenced by the overt mention of *people in this area of Montreal* and *international perspective* in the previous sentence. If we change the subject and object in the first sentence then we change how the nouns are restricted.

Westerstahl (1985) proposed that this type of restriction is due to an implicit variable that is assigned a set interpretation by the variable assignment function. Technically speaking, a hearer is free to adopt any variable assignment, even those that would yield uninformative propositions. There are no grammatical restrictions. However, pragmatically speaking the hearer tries to choose the variable assignment function that was intended by the speaker. Contextual and discourse cues help the hearer determine the most likely assignment.

For our purposes, we can assume something similar to Westerstahl's context sets. For example, suppose that every noun in Ch'ol is restricted by a contextual variable, represented as C_1 in (89).

(89)



These variables are interpreted by the variable assignment function, represented by the superscript g. As suggested by Westerstahl (1985), each noun phrase can potentially have a different variable and thus each noun can potentially have a different contextual restriction. The interpretation of the nP that immediately dominates the context-set variable, shown in the box, is the intersection of the interpretation of the daughter nP, labelled $n\mathrm{P}_\alpha$, and the set assigned to the context-set variable by the variable assignment function. The variable assignment function, by definition, maps every context-set variable to a subset of the domain closed under group formation (i.e., join).

(90) For every variable assignment function g and every context-set variable C, $g(C) \subseteq D$ and $^*g(C) = g(C)$, where D is the domain of the model and * is Link's (1983) join-closure operator (i.e., For all sets X, $^*X$ is the smallest set that contains every element of X and all groups that can be formed from the elements of X).

The main idea behind this type of theory is that competent Ch'ol speakers assign a broad inclusive meaning to nouns like *ixim*, *bu'ul* and *ja'as* (similar to Pelletier 2012's hypothesis with respect to classifier languages), however they also learn that certain classifiers are associated with certain types of variable assignments.

(91) Let C_S be the set of corn stalks, C_E the set of corn ears, C_G the set of corn grains, B_T the set of banana trees and B_B the set of bananas.
   a. $[\![ixim]\!] = {}^*(C_S \cup C_E \cup C_G)$
   b. $[\![ja'as]\!] = {}^*(B_T \cup B_B)$

(92) Partial list of acquired conventions of language use in Ch'ol:
   a. In a DP with the classifier *-tyejk* and the noun *ixim*, speaker's use a variable assignment function that assigns the context-set variable in the nP to a set that contains plants and plant-pluralities of a certain configuration.
   b. In a DP with the classifier *-ts'ijty* and the noun *ixim*, speaker's use a variable assignment function that assigns the context-set variable in the nP to a set that contains ears of corn and pluralities of ears.
   c. In a DP with the classifier *-p'ej* and the noun *ixim*, speaker's use a variable assignment function that assigns the context-set variable in the nP to a set that contains grains of corn and pluralities of grains.

Under this analysis, the influence of the classifiers is not strictly due to a grammatical rule but rather to a learned convention in interaction with grammatical structures that permit context-set variables.

More broadly speaking, this theory is representative of any theory that employs contextual variables as a means of accounting for the polysemous nature of the nP. A critical aspect of this theory is that semantically speaking, classifiers and nouns have a well-defined, uniform and precise interpretation that is more inclusive than the way that these terms are usually used. It is the context-set variable, sister to the modified noun, that leads to a more restricted, contextually sensitive and idiosyncratic interpretation. This imprecise and idiosyncratic aspect of meaning is *extra-grammatical* in the sense that it is due to learned conventions about speaker intentions.

6.3 Critical discussion between the two theories

There are two main differences between the the co-textual interpretation theory (§6.1) and the context-set theory (§6.2). First, the co-textual interpretation theory is purely grammatical: the semantic interpretation function is sensitive to syntactic environments. No appeal is made to speaker intentions or learned conventions. In contrast, the context-set theory maintains that there is no direct grammatical link between sortal classifiers and nominal denotations.

Rather, the restrictions mainly come from reasoning about speaker intentions and the conventions of language use established within the community.

Although this is a major theoretical difference, it is hard to establish how it could be evaluated empirically. The context-set theory predicts that mastering the classifier system should come relatively late in the acquisition process, i.e., after children are pragmatically competent at reasoning about speaker intentions relative to a history of language use. In the co-textual interpretation theory, it is possible that children could master the classifier system before achieving this type of pragmatic competence. However, it also remains an open possibility that it would take time for children to memorize the syntactic environments that trigger the polysemy and thus, perhaps in both theories there is a predicted delay in acquisition. Still, it would be encouraging for the context-set theory if there was a correlation between pragmatic competence and the acquisition of the classifier system. As far as we know, no such studies have shown either a correlation or the lack thereof.

The second difference is more syntactic than semantic. The co-textual interpretation theory does not involve any variables whereas the context-set theory critically hypothesizes the existence of a variable that is within the scope of nominal modifiers (since the nominal restriction must occur within the scope of modifiers like *kolembä* 'big'). The presence or absence of this variable leads to at least one possible empirical difference in sentences with nP ellipsis.

Sentences with nP ellipsis in Ch'ol were already briefly discussed in section 4.2, however we present two more examples in (93).[19]

(93) a. Ta' kmäñä nuebe ixim. AjPedro ta' imäñä **syete**.
PFV 1.buy nine(SP) corn. Pedro PFV 3.buy seven(SP)
'I bought nine ears of corn. Pedro bought seven (ears of corn).'

b. Ta' kmäñä cha'-ts'ijty ixim. AjPedro ta' imäñä **ux-ts'ijty**.
PFV 1.buy two-CLF corn. Pedro PFV 3.buy three-CLF
'I bought two ears of corn. Pedro bought three (ears of corn).'

In both of these examples, numeral modifiers appear without an overt nominal head in the second sentence. In (93a), the modifier is a numeral borrowed from Spanish whereas in (93b) the modifier is a Mayan-based numeral with a classifier (both boldfaced). As noted in section 4.2, there are two important facts about nP ellipsis in Ch'ol. First, when Mayan-based numerals are used, a classifier must be affixed to the numeral modifier. In other words, only the modified nP can be elided. Second, like English, usually nP ellipsis requires an overt antecedent in the co-text. A sentence with nP ellipsis cannot appear out of the blue, even when information about which noun was elided is recoverable from the type of classifier that is affixed to the numeral.

An additional observation, critical to the present discussion, is that the semantic meaning of the elided nP is *maximal* in the sense that it is equivalent to the entire antecedent nP, including all of its non-numeral modifiers. For

[19] Morpheme glosses are simplified as these are not directly relevant to the discussion here.

example, in all of the sentences in (94), including the English sentence, the elided nP is understood as denoting the set of *big* ears of corn and pluralities of big ears.

(94) a. John bought two big ears of corn and Mary bought three.

b. Ta' kmäñä nuebe kolembä ixim. AjPedro ta' imäñä syete.
PFV 1.buy nine(SP) big corn. Pedro PFV 3.buy seven(SP)
'I bought nine big ears of corn. Pedro bought seven (big ears of corn).'

c. Ta' kmäñä cha'-ts'ijty kolembä ixim. AjPedro ta' imäñä ux-ts'ijty.
PFV 1.buy two-CLF big corn. Pedro PFV 3.buy three-CLF
'I bought two big ears of corn. Pedro bought three (big ears of corn).'

The modifier *big/kolembä* provides necessary information that helps determine the denotation of the elided nP.

There are two possible analysis of nP ellipsis. One is that the unpronounced nP is an implicit pronoun that obtains its value through a variable assignment function. The overt antecedent determines what value is assigned to the nP pronoun by this variable assignment function. This possibility is represented in (95) with pro_2 standing in for the covert pronoun. The syntactic structure in (95a) is consistent with the co-textual interpretation theory and does not contain any context-set variables in the antecedent nP, whereas the syntactic structure in (95b) contains a context-set variable and hence is compatible with the context-set theory. However, other than this difference in the antecedent clause, the two theories make the same prediction. The value of the covert pronoun is determined by the semantic value of the largest nP constituent in the antecedent clause.

(95) a. Ta' kmäñä nuebe $[_{nP}$ kolembä $[_{nP}$ ixim]]. AjPedro ta' imäñä syete pro_2.

b. Ta' kmäñä nuebe $[_{nP}$ kolembä $[_{nP}$ ixim C_1]]. AjPedro ta' imäñä syete pro_2.

The weakness of this type of explanation is that it cannot readily explain the need for an overt antecedent. Since this type of analysis has some weaknesses, and since it does not help us distinguish between the co-textual interpretation theory and the context-set theory, we will leave this analysis aside for now.

Another possibility—one that makes different predictions with respect to the two theories under consideration—is that nP ellipsis involves copying or deleting syntactic material in the elided nP position. In this type of analysis, the antecedent nP serves either as a target for copying or as a trigger for deletion, much like antecedents in VP ellipsis. Building on what is known about VP ellipsis, this type of theory makes important predictions with respect to how the elided nP is interpreted. In both the co-textual interpretation theory and the context-set theory, the deleted or copied nP is identical to the largest

antecedent nP, including any variable contained within the nP. The co-textual interpretation theory, in contrast to the context-set theory, does not have any variables in the antecedent, as shown by the contrast between (96a) and (96b).

(96) a. Ta' kmäñä nuebe [$_{nP}$ kolembä [$_{nP}$ ixim]]. AjPedro ta' imäñä syete ~~[$_{nP}$ kolembä [$_{nP}$ ixim]]~~.

b. Ta' kmäñä nuebe [$_{nP}$ kolembä [$_{nP}$ ixim C_1]]. AjPedro ta' imäñä syete ~~[$_{nP}$ kolembä [$_{nP}$ ixim C_1]]~~.

Critically, in (96b) the same variable appears in both the antecedent clause and the elided clause. When similar constructions appear in VP ellipsis, the two variables necessarily receive identical interpretations (see the discussion of unbound pronouns in Sag 1976; Williams 1977; Reinhart 1983, among others). For example, in the sentence *Sue likes him$_1$ and Mary does ~~like him$_1$~~ too*, the overt and covert instance of *him$_1$* must refer to one and the same person.

This constraint on the interpretation of variables does not cause any problems with the sentences in (96) above, however consider the unacceptable variant of (96) in (97a).

(97) a. * Ta' kmäñä cha'-ts'ijty kolembä ixim. AjPedro ta' imäñä
PFV 1.buy two-CLF big corn. Pedro PFV 3.buy
ux-tyejk.
three-CLF
INTENDED: 'I bought two big ears of corn. Pedro bought three (big corn stalks/ears of corn).'

b. Ta' kmäñä cha'-ts'ijty kolembä ixim. AjPedro ta' imäñä
PFV 1.buy two-CLF big corn. Pedro PFV 3.buy
ux-tyejk kolembä ixim.
three-CLF big corn
'I bought two big ears of corn. Pedro bought three big corn stalks.'

Unlike the acceptable sentences with nP ellipsis, the sentence in (97a) has different classifiers in the two sentences: the first sentence has the classifier *-ts'ijty* whereas the second, with the elided nP, has the classifier *-tyejk*. Interestingly, the context-set theory in combination with a theory of nP ellipsis that includes copying or deleting syntactic structure, can naturally explain the contrast between (97a) and the sentences in (96). In the context-set theory, the context-set variable necessarily appears as part of the elided clause. This would yield the basic structure in (98) for the sentence in (97a).

(98) * Ta' kmäñä cha'-ts'ijty [$_{nP}$ kolembä [$_{nP}$ ixim C_1]]. AjPedro ta' imäñä ux-tyejk ~~[$_{nP}$ kolembä [$_{nP}$ ixim C_1]]~~.

However, a hearer would receive contradictory information about how to interpret the variable C_1. In the first clause, the presence of the classifier *-ts'ijty* signals to the hearer that the variable assignment function assigns C_1 to a

set of ears of corn and pluralities of such ears. In the second clause, the presence of the classifier *-tyejk* signals to the hearer that C_1 is assigned to a set of plants and pluralities of such plants. However, the hearer also knows that both instances of C_1 must have the same interpretation. As a consequence, the hearer is unable to assign an interpretation to (98), at least not one that would be consistent with the conversational context.

Unlike the context-set theory, the co-textual interpretation theory does not obviously yield an incoherent interpretation. This theory would assign a structure such as the one in (99) to the sentence in (97a).

(99) * Ta' kmäñä cha'-ts'ijty [$_{nP}$ kolembä [$_{nP}$ ixim]]. AjPedro ta' imäñä ux-tyejk ~~[$_{nP}$ kolembä [$_{nP}$ ixim]]~~.

The noun *ixim* in the first sentence would be interpreted as denoting the set of ears of corn and all pluralities formed from those ears whereas the noun *ixim* in the second sentence would be interpreted as denoting the set of corn stalks and pluralities formed from those corn stalks.

It is interesting to note that the pronominal theory of ellipsis cannot straightforwardly account for the unacceptability of (97a) either, no matter which theory of classifiers is adopted. In both theories, all sortal classifiers are interpreted at $\mu_{\#}$ and the covert pronoun (pro_1) has a value assigned to it that is depended on the value of the largest overt nP antecedent. In both theories, the antecedent nP is a set of big ears of corn. Thus accordingly, the unacceptable sentence in (97a), repeated with a covert pronominal representation in (100a) should have an acceptable interpretation that is identical to (94c), repeated in (100b). In (100b), the classifiers have the same form.

(100) Where $[\![pro_2]\!]^g = [\![\lceil_{nP}$ *kolembä* $\lceil_{nP}$ *ixim* $(C_1)\rceil\rceil]\!]\ldots$

a. * Ta' kmäñä cha't-ts'ijty [$_{nP}$ kolembä [$_{nP}$ ixim (C_1)]]. AjPedro ta' imäñä ux-tyejk pro_2.

b. Ta' kmäñä cha't-ts'ijty [$_{nP}$ kolembä [$_{nP}$ ixim (C_1)]]. AjPedro ta' imäñä ux-ts'jty pro_2.

In summary, we have shown that nP ellipsis is permitted when both the antecedent DP and the DP with the elided nP match, either in terms of not having a classifier or in terms of having the same classifier. However, as we have seen, nP ellipsis is not acceptable if the classifier in the DP antecedent is different from the one in the DP with the elided nP. The context-set theory, in conjunction with a theory that ellipsis involves either syntactic deletion or copying, could easily account for the unacceptability of these types of sentences. It is a well known empirical fact that unbounded variables, like the context-set variable, must receive the same interpretation in the antecedent phrase as they do in the elided phrase. However, the use of different classifiers signals to the hearer that such variables should receive different interpretations. This conflicting information makes the sentences uninterpretable. The co-textual interpretation theory, or either theory in conjunction with a

pronominal analysis of ellipsis, does not have a straightforward explanation of these facts.[20]

7 Conclusion

In this paper we explored the syntactic and semantic representation of classifiers in Ch'ol. We demonstrated that classifiers and numerals form a constituent that modifies the noun phrase. However, we also discussed the effect that different types of sortal classifiers have on the interpretation of nouns. We argued that all sortal classifiers have the same basic interpretation, namely the function $\mu_{\#}$ which counts minimal parts. However, we discussed some preliminary evidence from nP ellipsis that supports the hypothesis that different sortal classifiers influence the interpretation of noun phrases through implicit context-set variables. Specifically, by hypothesizing an implicit context-set variable we were able to explain some limitations on nP ellipsis: namely such ellipsis is unacceptable when the classifier in clause with the elided nP is different from the classifier in the antecedent clause. As a result, although sortal classifiers might not differ in terms of their formal semantics, they do yield different effects on the truth conditions of sentences via learned linguistic conventions.

Although our entire discussion has been limited to Ch'ol, the framework of the arguments we have developed here can be readily applied to other classifier languages. In particular, this paper provided a variety of syntactic diagnostics to help diagnose (i) whether classifiers and numerals form a constituent independent of the nouns they modify and (ii) whether the modified noun serves as the head of the nominal constituent. Similarly, we have established a way of diagnosing whether sortal classifiers have a non-local effect on the denotation of nouns using gradable predicates that require comparison classes. Finally, we have demonstrated how ellipsis facts can be used to provide evidence either in support or against an implicit context-set variable.

An important contribution of this paper is that it maintains a rigid and uniform semantics for sortal classifiers, while still being able to explain their

[20] There are some possible avenues that one might want to explore to rescue the co-textual interpretation theory. For example, it is well-known that there are certain semantic constraints on ellipsis (see Merchant 2001) and perhaps the polysemous nature of the Ch'ol nouns leads to violations of such constraints. However, it should be noted that a straightforward application of these constraints would not be able to rescue the co-textual interpretation theory. One would have to argue that such constraint behave differently with respect to polysemous nouns. Most semantic constraints on ellipsis are based on mutual entailment or a semantic equivalence between two phrases relative to quantifying over a variable that replaces a focused constituent in the antecedent clause and in the elided clause. The interesting thing about these constructions is that the focused constituents, namely the measure phrases, contain the relevant material that triggers the polysemous nature of the noun, namely the classifier. On the surface, one would expect that once the focused material was replace by the variable in terms of evaluating the phrase for nP ellipsis, the nouns would have a broad inclusive interpretation similar to the interpretation they have when no classifier is present, and hence mutual entailment/semantic equivalence would hold.

somewhat idiosyncratic influence on how expressions are used to count. Critically, the less systematic aspects of meaning (and not coincidentally, the less compositional aspects as well) are accounted for by appealing to learned conventions of language use rather than some core aspect of meaning.

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