

# Decomposing distributive numerals in ʔayʔajuθəm (Comox-Sliammon Salish)<sup>1</sup>

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**Abstract.** In this paper we examine distributive numerals in ʔayʔajuθəm (a.k.a. Comox-Sliammon; Central Salish). We first show that unlike in neighbouring St’át’imcets (Northern Interior Salish), ʔayʔajuθəm distributive numerals require specifically temporal distribution over sub-events, as opposed to over locations or event participants. We then provide a compositional analysis of the three morphological components of distributive numerals: the numeral itself; diminutive reduplication, which excludes alternatives in the denotation of the numeral; and a pluractional infix, which when applied to a numeral and a predicate of events yields temporally distributed sub-events, where the number of participants in each sub-event is given by the numeral. Finally, we point out that though our account handles core cases of distributed numerals, their syntactic distribution is extremely broad, mirroring precisely that of bare numerals: this causes non-trivial problems for compositionality.

**Keywords:** distributivity, pluractionality, numerals, Salish.

## 1. Introduction

In this paper we examine distributive numerals in ʔayʔajuθəm (a.k.a. Comox-Sliammon; Central Salish, ISO 363-3 coo). ʔayʔajuθəm is traditionally spoken in south coastal British Columbia by the Tla’amin, K’ómoks, Homalco, and Klahoose First Nations; it is highly endangered, with an estimated 47 remaining first language speakers as of 2018 (FPCC, 2018). The ʔayʔajuθəm data presented in this paper come from original fieldwork with 10 speakers.

Building on previous work by Matthewson (2000) on the neighbouring Northern Interior Salish language St’át’imcets (a.k.a. Lillooet, ISO 363-3 lil), we first show that distributive numerals in ʔayʔajuθəm specifically require *temporal* distribution over sub-events, as opposed to distribution over locations or individuals. We then show that unlike other distributive numerals discussed in the literature, the ones in ʔayʔajuθəm are transparently composed of three morphemes: a numeral root, diminutive reduplication, and a pluractional infix. We provide a compositional analysis based on these three morphemes, observing however that the extreme ‘syntactic promiscuity’ of the ʔayʔajuθəm distributive numerals – their ability to appear in at least six different surface syntactic environments – raises significant challenges for the syntax-

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semantics interface.<sup>2</sup>

### 1.1 Distributive numerals

Distributive numerals enforce a distributive plural interpretation of the predicates with which they are associated. They are often ambiguous between participant-related and event-related interpretations, allowing for distributivity over either individuals or events. A representative example from Tlingit (Na-Dene) is given in (1), from Cable (2014). The plain numeral in (1a) favours collective or cumulative readings, but the distributive numeral in (1b) enforces a distributive reading, either over individuals or over events.<sup>3</sup>

(1) *Tlingit*:

- a. **Nás'k**    xáat    has aawasháat.  
**three**    fish    PL.3O.PFV.3S.catch  
 'They caught three fish.'
- b. **Nás'gigáa**    xáat    has aawasháat.  
**three.DIST**    fish    PL.3O.PFV.3O.catch  
 'They caught three fish each.'  
 'They caught three fish each time.'

(Cable, 2014:564)

There is cross-linguistic variation in the interpretation of distributive numerals. For example, the distributive numeral *pəlpálaʔ~pipálaʔ* 'one by one' in St'át'imcets allows temporal or spatial distribution over events, but not distribution over individuals.<sup>4</sup> The example in (2) shows ambiguity between temporal and spatial readings.

(2) *St'át'imcets*:

- pipápplaʔ*                      l=as                      x<sup>w</sup>ík-əm                      ʔi=ʔux<sup>w</sup>almíx<sup>w</sup>=a  
 one.HUM.DIST              COMP=IPFV+3CJV      cut.fish-MID      PL.DET=person=EXIS  
 l=ta=sísxəc=a<sup>5</sup>  
 on=DET=shore=EXIS

<sup>2</sup> Such challenges are a hallmark of distributive numerals cross-linguistically; see Gil (1982), Choe (1987), Farkas (1997), Zimmermann (2002), Henderson (2011), Cable (2014), among others. ʔayʔajuθəm is a particularly challenging case, as we show in Section 4.

<sup>3</sup> The transcription (and glossing) from Cable (2014) are unchanged, while examples from St'át'imcets and ʔayʔajuθəm are given in North American Phonetic Alphabet (NAPA) notation. Primary stress in St'át'imcets is marked with an accent, but in ʔayʔajuθəm it falls predictably on the first syllable, and is therefore not marked. Labels outside of the standard Leipzig glossing conventions include: 3O = third-person object, 3S = third-person subject, CJV = 'conjunctive' (the Salishanist term for subjunctive), CTR = control transitive, DIM = diminutive, DIR = directive (control) transitivizer, DIST = distributive, EXIS = existential, HUM = human, MID = middle, NTR = non-control transitive, NTS = non-topic subject, and STAT = stative. Note that DIST is used here, as in Cable (2014) and Matthewson (2000), to mean 'distributive' rather than 'distal'.

<sup>4</sup> *pəlpálaʔ* and *pipálaʔ* are dialectal variants, with no meaning difference.

<sup>5</sup> *pipápplaʔ* is a form of *pipálaʔ* optionally used when counting humans. Note that though distributive numerals in St'át'imcets are derived from bare numerals by reduplication, they are largely opaque in terms of morphological composition, unlike in ʔayʔajuθəm.

- (i) ‘People are cutting fish one by one.’ (e.g., if taking turns at the same fish rack)
- (ii) ‘People are cutting fish here and there.’ (e.g., if fish racks are scattered along the shore)

The absence of a participant-distributive reading for *pəlpála?~pipála?* is illustrated in (3)-(4). (3) shows that the distributive numeral does not require each individual to participate in an event of table-lifting, while (4) shows that it does require each sub-event of table-lifting to contain only one individual.

(3) *St’át’imcets*:

Context: There were four women trying to lift a table. Victoria lifted it by herself, Anne lifted it by herself, and Mary and Elizabeth didn’t manage.

[*pəlpála?*    ʔi=sməlmúlac=a]                      xat-añ-táli                      ta=típəl=a  
 [one.DIST    PL.DET=women=EXIS]                      lift-DIR-NTS                      DET=table=EXIS  
 ‘The women lifted the table one at a time.’                      (Matthewson, 2000:101)

(4) *St’át’imcets*:

Context: There were four women. Victoria lifted the table by herself, Anne lifted it by herself, and Mary and Elizabeth lifted it together.

# [*pəlpála?*    ʔi=sməlmúlac=a]                      xat-añ-táli                      ta=típəl=a  
 [one.DIST    PL.DET=women=EXIS]                      lift-DIR-NTS                      DET=table=EXIS  
 ‘The women lifted the table one at a time.’                      (Matthewson, 2000:105)

As we will now show, the cognate form (*paʔapyá?*) in ʔayʔaʃuθəm is even more restricted, allowing neither distribution over participants nor over locations, but only over times.

## 2. The interpretation of distributive numerals in ʔayʔaʃuθəm

Distributive numerals in ʔayʔaʃuθəm do not universally quantify over individuals, as shown in (5)-(6). Although not every egg is broken or pair of cookies is eaten, the sentences are felicitous.

(5) Context: A recipe calls for four eggs, but I have 12.

p<a?>a<p>ya?    [                      təq̣ʷ-t-an                      x̣ʷax̣ʷit]  
 one<PL><DIM>    [[DET] crack-CTR-1SG.ERG    [DET] egg]  
 ‘I broke the eggs one at a time.’<sup>6</sup>

<sup>6</sup> Proclitics, including determiners and the clausal nominalizer *s*, are more often than not phonologically elided in ʔayʔaʃuθəm, though they can be restored in careful speech. The presence of the nominalizer can also sometimes (but not always) be inferred from possessive subject marking on a nominalized clause. We mark the presence of elided elements by [...] in the gloss line: e.g., [DET] [NMLZ]. Note also that nominalized complement clauses are introduced by elements that are formally indistinguishable from determiners (though not all determiners introduce

- (6) Context: Bruno ate cookies stacked two on top of each other, but some are left on the plate.

**s<a?>a<s>yaʔ** [ mə~mk<sup>w</sup>-t-as]  
**two<PL><DIM>** [[DET] IPFV~eat-CTR-3ERG]  
 ‘He is eating them two at a time.’

The felicitous use of a distributive numeral requires exhaustive distribution over sub-events, such that in each sub-event, the number of participants is given by the numeral. In (7), the requirement imposed by the numeral ‘one’ is that each cracking sub-event contain only one egg. Since two eggs are cracked together, the sentence is infelicitous. And as we just saw in (6), the distributive numeral ‘two’ requires two individuals (in this case, cookies) to be involved in each sub-event.

- (7) Context: A recipe calls for four eggs and I crack one egg, then another, before cracking the last two together.

# **p<a?>a<p>yaʔ** [ təq<sup>w</sup>-t-an x<sup>w</sup>a x<sup>w</sup>it]  
**one<PL><DIM>** [[DET] crack-CTR-1SG.ERG [DET] egg]  
 ‘I broke the eggs one at a time.’

The sentence in (8) shows that *ʔayʔajuθəm* distributive numerals further entail that there is no temporal overlap between sub-events. The locking events must occur one after the other, not all at once, in order for the sentence to be felicitous.

- (8) **p<a?>a<p>yaʔ** [ ləkli-t-as ʔəm~ʔimin]  
**one<PL><DIM>** [[DET] lock-CTR-3ERG [DET] PL~door]  
 ‘She locked the doors one by one.’

Ok in context: I went around and manually locked doors on the car.

Ok in context: I work at a dealership and I press buttons sequentially to lock each car.

# in context: I pressed a button and all the doors locked simultaneously on my car.

In summary so far, *ʔayʔajuθəm* distributive numerals enforce distribution over sub-events, such that no sub-events overlap temporally, and each sub-event involves (possibly plural) participants whose cardinality is given by the numeral.

### 3. The decomposition of distributive numerals

In this section, we provide a step-by-step account of how the three morphological components of distributive numerals (a numeral root, diminutive reduplication, and reduplicative pluractional infix) combine in that order, and the semantics we need at each stage. The

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clauses); we gloss these ‘determiner-complementizer’ elements as DET here, without committing to an analysis whereby they are semantically identical to determiners.

morphological decomposition of the distributive numerals ‘one by one’ and ‘two by two’ is illustrated in (9) and (10), respectively.<sup>7</sup>

- |      |    |                       |    |   |    |  |
|------|----|-----------------------|----|---|----|--|
| (9)  | a. | √paʔa<br>one<br>‘one’ | b. | pa<p>yaʔ<br>one<DIM><br>‘just/only one’ | c. | p<aʔ>a<p>yaʔ<br>one<PL><DIM><br>‘one by one’ |
| (10) | a. | √saʔa<br>two<br>‘two’ | b. | sa<s>yaʔ<br>two<DIM><br>‘just/only two’ | c. | s<aʔ>a<s>yaʔ<br>two<PL><DIM><br>‘two by two’ |

We begin with the numeral root, which can surface in unmodified form as a bare (simplex) numeral.

### 3.1. Bare numerals

Bare numerals in ʔayʔaʃuθəm, as in other Salish languages, have the status of cardinality predicates rather than determiners (see Jelinek, 1995; Matthewson, 1998). They may count either individuals or events, as shown in (11) and (12) respectively. Note that the numeral in these examples is in the clause-initial main predicate position, with the individual or event argument represented by the following DP (with an elided determiner).<sup>8</sup>

- (11) **saʔa** [        mimaw]  
**two**    [[DET] cat    ]  
 ‘There are two cats.’  
 Literally: ‘The cats are two.’
- (12) **čaləs** [                                kʷitʰ-əm=s        Gloria]  
**three**    [[DET] [NMLZ]    jump-MID=3POSS    Gloria]  
 ‘Gloria jumped three times.’  
 Literally: ‘Gloria’s jumpings were three.’

As in English, ʔayʔaʃuθəm bare numerals are compatible with ‘at least’ interpretations, in addition to an ‘exactly’ interpretation. This is illustrated in (13)-(14).

- (13) Context: If Gloria wakes up more than twice, she will go for a walk before going back to bed. Last night, she woke up three times. Someone asks why she went for a walk at 4a.m.

**saʔa** [                                p<iʔ>i<p>č-əm]  
**two**    [[DET] [NMLZ]    wake<PL><DIM>-MID]

<sup>7</sup> There are additional (regular) morpho-phonological changes involved here; see Mellesmoen (in press).

<sup>8</sup> Event-counting as opposed to entity-counting with numerals and other cardinality predicates requires a nominalized subordinate clause, as shown in the contrast between (11) and (12). We assume here that nominalization is necessary to trigger lambda abstraction over an event argument, whereas no such operation is required for entities.

‘She woke up twice.’

Literally: ‘Her waking ups were two.’

AT LEAST

- (14) **saʔa** čayiš [ t<sup>θ</sup> χəʔ<sup>θ</sup>-t-ul]  
**two** hand [[DET] 1SG.POSS [NMLZ] measure-CTR-PST]  
 ‘I measured it as two hands (long).’ EXACTLY

Following Krifka (1999), we model the ‘at least’ interpretation of bare numerals by including alternatives to the ordinary semantic value (which has an ‘exactly’ interpretation) in the denotations. For example, the ordinary semantic value of the bare numeral *saʔa* ‘two’ gives the interpretation ‘exactly two’ (15a), and the alternative semantic value in addition allows an ‘at least two’ reading (15b).<sup>9</sup> The default for an assertion is that the alternatives are understood not to be asserted; this gives rise to the usual scalar implicature effects (see Krifka, 1999 for details).

- (15) a.  $\llbracket \text{saʔa} \rrbracket = \lambda x . 2(x)$  ‘the number of atoms in the sum individual *x* is 2’  
 b.  $\llbracket \text{saʔa} \rrbracket_A = \{\lambda x . n(x) \mid n \in \mathbb{N} \ \& \ n \geq 2\}$  (adapted from Krifka, 1999)

The denotations in (15) account for the use of numerals when they take individual arguments, as in (11). For numerals which take clausal arguments, we need to also allow the numerals to be predicates of events (of type  $\langle l, t \rangle$ ), as in (16).

- (16) a.  $\llbracket \text{saʔa} \rrbracket = \lambda e . 2(e)$   
 b.  $\llbracket \text{saʔa} \rrbracket_A = \{\lambda e . n(e) \mid n \in \mathbb{N} \ \& \ n \geq 2\}$

Using these lexical entries, we provide denotations in (17) and (18) for the ordinary semantic value of the sentences in (11) and (13), respectively. For current purposes, we assume a choice function analysis of *ʔayʔajuθəm* determiners, whereby they pick a contextually salient (possibly plural) individual from a set (cf. Matthewson, 1999, 2001; Davis, 2010 for St’át’imcets).<sup>10</sup>

- (17)  $\llbracket \text{saʔa}_{\text{DET}_i} \text{ mimaw} \rrbracket^g = [\lambda x . 2(x)] (g(i)(\{y \mid y \text{ is a cat}\}))$   
 $= 1 \text{ iff } 2(g(i)(\{y . y \text{ is a cat}\}))$   
 ‘The number of atoms in the individual chosen from the set of cats by the choice function  $g(i)$  is 2’  $\approx$  ‘There are two salient cats.’
- (18)  $\llbracket \text{saʔa}_{\text{DET}_i} \text{ piʔipčəm} \rrbracket^g = [\lambda e . 2(e)] (g(i)(\{e' \mid e' \text{ is an event of her waking up}\}))$   
 $= 1 \text{ iff } 2(g(i)(\{e' \mid e' \text{ is an event of her waking up}\}))$   
 ‘The number of atoms in the individual chosen from the set of events of her waking up by the choice function  $g(i)$  is 2’  $\approx$  ‘There are two salient events of her waking up.’

<sup>9</sup> Krifka (1999) allows ‘at most’ readings for numerals as well. This seems to be the case also in *ʔayʔajuθəm*, although they are less common (as they are in English) and we set them aside here.

<sup>10</sup> We are taking the liberty of speaking sloppily about the difference between sets and plural individuals throughout this paper.

## 3.2. Diminutive reduplication

Diminutive (-C<sub>1</sub>-) reduplication infixes a copy of the first consonant of the root after the initial vowel. It applies to roots of any lexical category, and, as its name implies, usually yields a meaning of ‘small size, amount, or reduced force’, depending on the root class to which it attaches (Watanabe, 2003:385).

- (19) tʰə<tʰ>q-əm  
drip<DIM>-MID  
‘dripping a little bit/from one place/slowly’

- (20) ti<t>q-it  
close<DIM>-STAT  
‘a little bit closed’

- (21) ta<t>l-awus-tən  
money<DIM>-eye-instrument  
‘child-size eyeglasses’

With numerals, however, diminutive reduplication yields a special meaning of ‘exactly n’ (Watanabe, 2003:502), as shown in (22)-(23). The bare numeral in (23a) (originally given as (13)) is fine with the ‘at least’ reading required by this context, but the diminutive numeral in (23b) is rejected. (Note that (23b) is felicitous in a context in which Gloria did wake up exactly twice.)

- (22) **sa<s>yaʔ** [            mimaw]  
**two<DIM>** [[DET] cat]  
‘There are just two cats.’

- (23) Context: If Gloria wakes up more than twice, she will go for a walk before going back to bed. Last night, she woke up three times. Someone asks why she went for a walk at 4a.m.

- a. **saʔa** [                            p<iʔ>i<p>č-əm]  
**two** [[DET] [NMLZ]    wake<PL><DIM>-MID]  
‘She woke up twice.’
- b. # **sa<s>yaʔ** [                            p<iʔ>i<p>č-əm]  
**two<DIM>** [[DET] [NMLZ]    wake<PL><DIM>-MID]  
‘She woke up (just) twice.’

We model the semantic effect of the diminutive, when it applies to a numeral, as the elimination of the alternatives present in the denotation of the bare numeral (see (15)): when a numeral undergoes diminutive reduplication, only the ordinary (‘exact’) value is possible. The lexical entry for diminutive reduplication as applied to numerals is given in (24): it returns the ordinary

semantic value of the numeral, minus its alternatives, as shown in (25) for application to *saʔa* ‘two’.<sup>11</sup>

(24)  $\llbracket -C_1\text{-[NUM]}(P) \rrbracket$  is defined iff  $P$  is a numeral predicate.

If defined,  $\llbracket -C_1\text{-[NUM]}(P) \rrbracket = \lambda x . P(x) \ \& \ \neg \exists Q [Q \neq P \ \& \ Q \in P_A \ \& \ Q(x)]$

(25)  $\llbracket sa\langle s \rangle yaʔ \rrbracket = \lambda x . 2(x) \ \& \ \neg \exists Q [Q \neq [\lambda x . 2(x)] \ \& \ Q \in \{\lambda y . n(y) \mid n \in \mathbb{N} \ \& \ n \geq 2\} \ \& \ Q(x)]$

Using this lexical entry for the diminutive, the denotation of the sentence in (22) is given in (26).

(26)  $\llbracket sa\langle s \rangle yaʔ \text{ DET}_i \text{ mimaw} \rrbracket^g = 1$  iff  $2(g(i)(\{y . y \text{ is a cat}\})) \ \& \ \neg \exists Q [Q \neq [\lambda x . 2(x)] \ \& \ Q \in \{\lambda y . n(y) \mid n \in \mathbb{N} \ \& \ n \geq 2\} \ \& \ Q(g(i)(\{y . y \text{ is a cat}\}))]$

‘The number of atoms in the sum individual chosen from the set of cats by the choice function  $g(i)$  is 2 and there are no alternative numerals greater than 2 which are the number of atoms in that sum individual’  $\approx$  ‘There are exactly two salient cats.’

### 3.3. The pluractional infix (-V<sub>1</sub>-)

The -V<sub>1</sub>- pluractional infix attaches to verbs to yield temporally distributed event repetition, as shown in (27). It usually co-occurs with diminutive reduplication, leading Watanabe (2003:403) to treat the two processes as components of a single complex CVʔV- reduplication process. Since diminutive (-C<sub>1</sub>-) reduplication can occur on its own, however, we isolate the pluractional component as the contribution of the -V<sub>1</sub>- infix (see Mellesmoen, in press for argumentation, and Blake, 2000 for a similar description of a plural infix distinct from diminutive reduplication).

(27)  $\dot{\lambda}\langle a \rangle a \langle \dot{\lambda} \rangle k^w$  [ nik<sup>w</sup>ayu]  
 turn.off<PL><DIM> [[DET] light]  
 ‘The lights are flickering on and off.’

The denotation for the pluractional infix when it applies to verbs is given in (28). It applies to a predicate  $P$ , and outputs a relation between individuals  $x$  and events  $e$ , such that  $e$  is made up of a set of sub-events, and for each of these sub-events  $e_n$ , there is an individual  $z$  which is part of  $x$  and  $e_n$  is an event of  $P$  applying to  $z$ , and no two sub-events of  $e$  overlap temporally.

(28)  $\llbracket -V_1- \rrbracket = \lambda P_{\langle e, t \rangle} \lambda x \lambda e . [\exists e_1 \dots \exists e_n [e = e_1 + \dots + e_n \ \& \ \forall e_n [[e_n < e] \rightarrow \exists z [z \leq x \ \& \ P(z)(e_n)] \ \& \ \forall e_n, e_m [[e_n, e_m < e] \rightarrow \neg [\tau(e_n) \circ \tau(e_m)]]]]]$

This denotation is applied to the sentence in (27) in (29). The sentence is true if and only if there is an event  $e$  with sub-events  $e_1 \dots e_n$ , and for each of these sub-events  $e_n$ , there is an

<sup>11</sup> It would be desirable to provide a unified lexical entry for diminutive reduplication that yields appropriate meanings for each lexical class which it applies to. That task is beyond the scope of this paper, however.



individual  $z$  which is part of the set of salient lights, and  $e_n$  is an event of  $z$  turning off, and no two sub-events of  $e$  overlap temporally.

- (29)  $\llbracket \lambda \langle a \rangle \langle a \rangle \lambda \langle k \rangle^w \text{DET}_i \text{nik}^w \text{ayu} \rrbracket^g = \exists e [\exists e_1 \dots \exists e_n [e = e_1 + \dots + e_n \ \& \ \forall e_n [[e_n < e] \rightarrow \exists z [z \leq (g(i)(\{v \mid v \text{ is a light}\}) \ \& \ e_n \text{ is an event of } z \text{ turning off} \ \& \ \forall e_n, e_m [[e_n, e_m < e] \rightarrow \neg[\tau(e_n) \circ \tau(e_m)]]]]]]]$

This pluractional infix can also appear inside numerals, as we have seen. When it does so (along with diminutive reduplication), it yields temporally distributed sub-events, where the number of participants in each sub-event is given by the numeral.<sup>12</sup> An example is given in (30).

- (30) **s<a?>a<s>ya?**      [                      pəč-əm      tə      məm~mimaw]  
**two<PL><DIM>**      [[DET] [NMLZ]      wake-MID      DET      PL~cat]  
 ‘The cats woke up two by two.’  
 Literally: ‘The waking ups by cats were two by two.’

Compare these cases to those of simplex numerals in predicate position (e.g. (12) and (13)), which take plural events as arguments and count the number of their sub-events (see the denotation in (18)). Notice in particular that it is only *pluractionalized* numerals which constrain the *number of participants* in each sub-event.

In order to model the special behavior of the pluractional infix on (diminutive) numerals, we give it a second lexical entry, shown in (31). (This parallels the fact that the diminutive marker also has a specific effect when adding to numerals; see (24) above.) A distributed numeral, created by infixation of the pluractional marker into a numeral predicate  $P$ , takes a predicate of events  $R$  and yields a set of events, each of whose sub-events is mapped onto an event-participant  $z$ , and the number of atoms in each participant  $z$  is given by the numeral.<sup>13</sup>

- (31)  $\llbracket -V_1\text{-NUM}(P) \rrbracket$  is defined iff  $P$  is a numeral predicate.  
 If defined,  $\llbracket -V_1\text{-NUM}(P) \rrbracket = \lambda R_{\langle t \rangle} \lambda e . \exists e_1 \dots \exists e_n [e = e_1 + \dots + e_n \ \& \ \forall e_n [[e_n < e] \rightarrow \exists z [\text{PARTICIPANT}(z)(e_n) \ \& \ R(e_n) \ \& \ P(z)] \ \& \ \forall e_n, e_m [[e_n, e_m < e] \rightarrow \neg[\tau(e_n) \circ \tau(e_m)]]]]]$

The denotation for (30) we derive by employing (31) is given in (32). This says that there is an event  $e$  which is made up of sub-events  $e_1 \dots e_n$  and for each of these sub-events  $e_n$  there is a participant  $z$  in  $e_n$  which has two atoms, and  $e_n$  is an event of salient cats waking up and no sub-events overlap temporally.

- (32)  $\llbracket (30) \rrbracket = \exists e \exists e_1 \dots \exists e_n [e = e_1 + \dots + e_n \ \& \ \forall e_n [[e_n < e] \rightarrow \exists z [\text{PARTICIPANT}(z)(e_n) \ \& \ \text{wake.up}((g(i)(\{y \mid y \text{ is a cat}\}))(e_n) \ \& \ 2(z) \ \& \ \forall e_n, e_m [[e_n, e_m < e] \rightarrow \neg[\tau(e_n) \circ \tau(e_m)]]]]]]]$

<sup>12</sup> The pluractional infix is not attested with numbers independently of diminutive reduplication.

<sup>13</sup> In order to simplify the calculation, we treat the (elided) determiner which introduces the predicate of events as semantically vacuous here. As for why we introduce a PARTICIPANT operator, cf. Cable (2014) and see Section 4.2 below.

#### 4. Challenges for compositionality

The analysis given immediately above successfully handles cases in which a distributive numeral applies to a predicate of events, including most of the examples we have seen so far.

However, this does not exhaust the range of syntactic contexts in which distributed numerals occur: in fact, far from it, since in *ʔayʔaʃuθəm* distributive numerals display pervasive syntactic flexibility. Furthermore, this flexibility is shared by *all* numeral predicates, including simplex ones; and importantly, the semantic effect of each type of numeral (including both distributive and simplex cases) is identical regardless of where they occur.<sup>14</sup>

These facts pose some serious challenges for a compositional analysis. In this section, we will first outline the range of environments in which both simplex and distributed numerals occur (4.1), and then address the two most salient sets of problems, which we will refer to as the ‘missing argument problem’ (4.2) and the ‘argument ordering problem’ (4.3). Though we cannot claim to have solved either of them, we do have some ideas as to why they might have arisen, which we discuss in 4.4.

##### 4.1 The syntactic distribution of (distributive) numerals

Both bare and distributive numerals occur as main predicates, as we have seen. However, the range of syntactic arguments which they take is considerably broader than the cases we have analyzed so far, which involve a nominalized complement clause acting semantically as a predicate of events, as further illustrated in (33). The other cases involve DP arguments, including headed relative clauses, as in (34), headless (or *pro*-headed) relative clauses, as in (35), and simple (non-clausal) DPs, as in (36).

- (33) a. **paʔa** [k<sup>w</sup> puh-ut=s candle]  
**one** [DET [NMLZ] blow-CTR=3POSS candle]  
 ‘She blew out one candle.’  
 Literally: ‘It was one (time) that she blew out the candle.’
- b. **p<aʔ>a<p>yaʔ** [tə nap-at=s nəgapti]  
**one<PL><DIM>** [DET [NMLZ] lecture-CTR=3POSS women]  
 ‘He lectures the women, one at a time.’  
 Literally: ‘It is one at a time that he lectures the women.’ (Mellesmoen, in press)
- (34) a. **paʔa** [tə walθ q<sup>w</sup>um-qi(n)-t-as-ut Ophelia]<sup>15</sup>  
**one** [DET frog put.in.mouth-inside.of.mouth-CTR-3ERG-PST Ophelia]  
 ‘Ophelia kissed one frog.’  
 Literally: ‘The frog Ophelia kissed was one.’

<sup>14</sup> Diminutive numerals which lack the pluractional infix (such as *papyaʔ*) also share the same positional variability and invariant interpretation.

<sup>15</sup> The /n/ in the suffix *-qin* ‘inside of mouth’ is systematically deleted before /t/.

- b. **p<a?>a<p>ya?** [tə cars k<sup>w</sup>ə~k<sup>w</sup>t-igən]  
**one<PL><DIM>** [DET cars IPFV~pass.by-side.of.body]  
 ‘One by one, they (the cars) passed by.’  
 Literally: ‘The cars that passed by were one by one.’ (Mellesmoen, in press)
- (35) a. **paʔa** [tə q<sup>w</sup>um-qi(n)-t-as-ul] Ophelia]  
 one [DET put.in.mouth-inside.of.mouth-CTR-3ERG-PST] Ophelia]  
 ‘Ophelia kissed one.’  
 Literally: ‘The one Ophelia kissed was one.’
- b. **p<a?>a<p>ya?** [tə k<sup>w</sup>a~k<sup>w</sup><a>t-igən]  
**one<PL><DIM>** [DET IPFV~pass.by<PL>-side.of.body]  
 ‘One by one, they (the cars) passed by.’  
 Literally: ‘The ones that passed by were one by one.’ (Mellesmoen, in press)
- (36) a. **paʔa** [tə k<sup>w</sup>asta]  
**one** [DET cup]  
 ‘There is one cup.’  
 Literally: ‘The cup is one.’
- b. **p<a?>a<p>ya?** [tə k<sup>w</sup>asta]  
**one<PL><DIM>** [DET cup]  
 ‘(Hand me) the cups, one by one.’ (Mellesmoen, in press)  
 Literally: ‘One by one the cups.’

Both bare and distributive numerals may also occur as both predicate and argument modifiers. As predicate modifiers, they form a constituent with a nominal in predicate position, as in (37) (see Davis et al., 1997).

- (37) a. [**paʔa** bagel] [tə čəw-ul]  
 [**one** bagel] [DET steal-PST]  
 ‘She stole one bagel.’  
 Literally: ‘The one she stole was one bagel.’
- b. [**p<a?>a<p>ya?** bagels] [tə čəw-ul]  
 [**one<PL><DIM>** bagels] [DET steal-PST]  
 ‘She stole the bagels, one at a time.’  
 Literally: ‘The ones she stole were one by one bagels.’ (Mellesmoen, in press)

As argument modifiers, numerals occur in DP in both pre-determiner (38) and post-determiner (39) positions.

- (38) a. x<sup>w</sup>ətm-əx<sup>w</sup>-an [**paʔa** [tə laplaš]]  
 drop-NTR-1SG.ERG [**one** [DET board]]  
 ‘I dropped one board.’

- b. nam-at-as-ul [p<aʔ>a<p>yaʔ [tə pipa]]  
 write-CTR-3ERG-PST [one<PL><DIM> [DET paper]]  
 ‘She wrote the papers, one at a time.’ (Mellesmoen, in press)  
 Literally: ‘She wrote the one by one papers.’
- (39) a. xʷətm-əxʷ-an [tə [paʔa laplaʃ]]  
 drop-NTR-1SG.ERG [DET [one board]]  
 ‘I dropped one board.’
- b. nam-at-as-ul [tə [p<aʔ>a<p>yaʔ pipa]]  
 write-CTR-3ERG-PST [DET [one<PL><DIM> paper]]  
 ‘She wrote the papers, one at a time.’ (Mellesmoen, in press)  
 Literally: ‘She wrote the one by one papers.’

Table 1 summarizes the range of syntactic environments where bare (*paʔa*) and distributive (*paʔapyaʔ*) numerals are found. Their distribution is identical, showing that there is nothing special about the syntax of distributive numerals relative to bare numerals. However, the compositionality issues are more problematic for distributive numerals, because of the semantic requirement that they distribute over sub-events, irrespective of their syntactic environment.

Role of numeral	Syntactic environment	Bare numeral e.g., <i>paʔa</i>	Distributive numeral e.g., <i>paʔapyaʔ</i>
Main predicate	with a nominalized complement clause argument (33)	✓	✓
	with a relative clause argument (34), (35)	✓	✓
	with a simple DP argument (36)	✓	✓
Predicate modifier	in a complex nominal predicate (37)	✓	✓
Argument modifier	adjoined to NP (38)	✓	✓
	adjoined to DP (39)	✓	✓

Table 1: Syntactic environments for ʔayʔaʃuθəm numerals

As indicated above, the compositionality problems raised by the flexible syntax of numerals – more specifically, of distributive numerals – can be divided into two types. The first is where the predicate of events that acts as the argument of the distributed numeral is not overtly present at all: this is most obvious with non-clausal DP arguments, as in (36). The second is where the predicate of events is in the wrong syntactic position to compose with the distributed numeral, either because it is embedded inside a DP complement (as in the relative clause cases in (34) and (35) as well as the complex nominal predicate case in (37)), or because the distributed numeral is embedded inside a DP complement to the predicate, as in the argument modifier cases in (38) and (39). We discuss the ‘missing argument’ problem in 4.2, before turning to the

more difficult ‘argument ordering’ cases in 4.3.

#### 4.2 The missing (semantic) argument problem

ʔayʔajuθəm distributive numerals may appear with only a nominal argument, yet give rise to pluractional readings in which sub-events are distributed over. This is illustrated in (40) and (41), which are a minimal pair differing only in discourse context, and in (42)-(43). (36b) was also an example of this phenomenon.

- (40) Context: There are a bunch of bagels left over after a party and Kaining asks what she should do with them. I say:

**p<a?>a<p>yaʔ** [ *bagels*]  
**one<PL><DIM>** [[DET] *bagels*]  
 ‘(Eat) the bagels, one by one.’ (Mellesmoen, in press)

- (41) Context: We left some bagels sitting out for too long after a lab party and now they are stale and no longer good to eat. I am throwing bagels at other members of the lab group and Kaining asks what she should do with them. I say:

**p<a?>a<p>yaʔ** [ *bagels*]  
**one<PL><DIM>** [[DET] *bagels*]  
 ‘(Throw) the bagels, one by one.’ (Mellesmoen, in press)

- (42) Context: Elicited with a set of pictures.

**p<a?>a<p>yaʔ** [ *qʷasəm*]  
**one<PL><DIM>** [[DET] *flower*]  
 ‘(He is throwing) the flowers, one at a time.’  
 ‘(She is catching) the flowers, one by one.’  
 ‘(She is painting) flowers one at a time.’  
 ‘(She is drying) flowers, one at a time.’

- (43) **s<a?>a<s>yaʔ** [ *məm~mimaw*]  
**two<PL><DIM>** [[DET] *PL~cat*]  
 ‘He is doing (squeezing) the cats, two by two.’

Apart from the missing verb, these cases are important because they bring to light a point about the individual argument which is targeted by the distributive numeral. All the cases in (40)-(43) involve the relevant participants being introduced by the direct object of a transitive predicate. They thus differ from earlier examples like (44) (repeated from (30)), where the relevant participants are represented by the subject of an intransitive predicate:

- (44) **s<a?>a<s>yaʔ** [ *pəč-əm tə məm~mimaw*]  
**two<PL><DIM>** [DET] [NMLZ] *wake-MID DET PL~cat*]

‘The cats woke up two by two.’

The fact that the relevant argument can be the object, not the subject, is not actually specific to cases without overt verbs; (6) above, repeated here as (45), is an example of this. Here the object is phonologically null rather than the verb, but the interpretive schema parallels the data set immediately above.

- (45) Context: Bruno ate cookies stacked two on top of each other, but some are left on the plate.

**s<a?>a<s>yaʔ** [ mə~mk<sup>w</sup>-t-as]  
**two<PL><DIM>** [[DET] IPFV~eat-CTR-3ERG]  
 ‘He is eating them two at a time.’

(44) requires the cats to wake up in groups of two, while (43) requires the agent (‘he’) to squeeze cats in groups of two and (45) requires the agent (Bruno) to eat cookies in groups of two. We conclude that the distributive numeral has to be able to ‘see’ *any* salient participant role in an event; that is why we introduced the PARTICIPANT operator in (31) above.<sup>16</sup>

Returning to the ‘missing’ verbal predicate in cases like (40)-(43), for now we model these as simply involving a phonologically null light verb, or a syntactic process of verb ellipsis. Once this is assumed, they can be dealt with in the same way as we outlined for cases like (30) earlier.<sup>17</sup>

### 4.3 The argument ordering problem

A more tricky compositionality problem is posed by those syntactic configurations where the distributive numeral does not receive an argument of the right type – in particular, it does not receive a predicate over events. Take, for example, the case of a predicative distributive numeral with a headed relative clause, illustrated in (46) (repeated from (34b)):

- (46) **p<a?>a<p>yaʔ** [tə cars k<sup>w</sup>ə~k<sup>w</sup>t-igən]  
**one<PL><DIM>** [DET cars IPFV~pass.by-side.of.body]  
 ‘One by one, the cars passed by.’  
 Literally: ‘The cars that passed by were one by one.’

The analysis presented in Section 3 involves a pluractional morpheme which takes two arguments: first, a numeral predicate (to which it infixes) and second, a predicate of events (the syntactic sister of the numeral). This allows the distributive numeral to (a) temporally distribute over sub-events and (b) count the atomic individuals involved in each sub-event. In the case of (46), then, the infix would need to apply to a set of events of cars passing by – but this is not provided by the syntax. The event of cars passing by is existentially closed within the relative

<sup>16</sup> Cable (2014:582) proposes a similar mechanism to deal with distributive numerals in Tlingit.

<sup>17</sup> Of course, ideally we would have evidence for either a null light verb or a verb ellipsis process, neither of which at this point are independently syntactically motivated; this is a topic for future research.

clause (which denotes the contextually salient cars which passed by).

The two most obvious potential solutions to this problem both suffer from severe problems. The first is to maneuver constituents syntactically into positions where they can be composed in a well-behaved fashion. The problem with this is that the movements necessary for many of the cases listed in Table 1 violate well-established constraints on syntactic movement. In (46), for example, this would mean either that the predicate of events *kʷəkʷtigən* ‘pass by’ must raise out of a relative clause to a position where it combines with the matrix predicate *paʔapyaʔ*, or equally hopelessly, the distributive numeral must lower to a position inside the relative clause where it can combine with the predicate of events. Neither option is viable on any reasonably constrained theory of syntactic movement.

A purely semantic alternative, instead, would consist of massive amounts of type-shifting. For (46), for example, we might type-shift the predicate *kʷəkʷtigən*, so that rather than being a simple relation between individuals and events, it is an operator which takes a predicate of individuals (in this case, *cars*), and outputs a predicate of events (which are passings-by by cars). That could then compose with the distributive numeral to give the right meaning (setting aside the extra complication of the contribution of the choice function determiner, which we have ignored in this scenario). Similar type-shifts could account for the other syntactic environments summarized in Table 1 which remain unaccounted for, including the complex nominal predicates (as in (37b), ‘The ones she stole were one by one bagels’) and the cases where the distributive numeral is adjoined to a nominal argument (as in (38b)-(39b), ‘She wrote the one by one papers’). However, it is easy to see that this approach is a convenient way to ignore the syntax – a mechanism which would effectively nullify the predictions of compositionality.

In other words, there is no easy way to deal with these cases in a compositional fashion. Rather than attempting to propose a solution, we leave the problem for future work; however, before concluding, we offer some remarks on *why* distributive numerals should end up posing such a thorny problem for compositionality.

#### 4.4 A syntax-semantics mismatch in the analysis of distributed numerals

The first key observation we want to stress here is that syntactically, distributive numerals show identical behavior to simplex numerals, which also occur as predicates, predicate modifiers, and argument modifiers (also mirroring the syntactic behavior of weak quantifiers such as ‘few’ or ‘many’ in Salish languages: see Matthewson, 1998).

The next thing to note is that the variety of positions occupied by simplex numerals do not cause the same types of problems for compositionality as distributive numerals. This is because simplex nominals are semantically as well as syntactically flexible; they can count events or individuals, and either act as intersective or non-intersective modifiers.

Distributive numerals in *ʔayʔajuθəm*, on the other hand, are semantically *inflexible*: they require both sub-events and individuals in their denotations. What this means is that the

distributional freedom which the syntax allows for all numerals runs into trouble when the semantics requires a very specific type of semantic composition, as with distributive numerals.

The question now arises as to why the syntax of distributive numerals does not immediately adjust to only allow the restricted type of composition demanded by the semantics of the distributive numeral (essentially, the derivation given in (32)). The tentative answer we would like to suggest is that the syntax is partially ‘semantics-blind’: it provides the structures which allow composition, but is insensitive to the specific compositional demands of individual lexical items, whether primitive or derived.<sup>18</sup>

How is the problem of mismatch then resolved? Possibly, by massive type-shifting of the kind contemplated unenthusiastically in the previous section. On this view, though, there are reasons why composition in this case looks so ugly: its job is to stitch up the syntax and the semantics in the best way it can, seamlessly in cases where the syntax and semantics correspond closely, but much more raggedly where they do not. In this respect, mismatched cases like the *ʔayʔajuθəm* distributive numerals provide important evidence for the (partial) independence of syntax from semantics, just as cases of prosody-syntax mismatch prove crucial in establishing the independence of prosodic and syntactic constituents.

It is also worth pointing out that although the *ʔayʔajuθəm* case is quite extreme, the compositionality issue has been raised many times before with distributive numerals, as pointed out for example by Cable (2014: 565) with respect to Tlingit:

This [distributed numeral] morphology somehow signals the distribution of a property larger than the constituent it marks, so there is an apparent mismatch between the surface location of this morphology (the numeral) and the locus of its semantic effect (the larger, distributed property).

## 5. Conclusion

This paper has provided the first detailed semantic examination of distributive numerals in *ʔayʔajuθəm*. We have established the following generalizations.

First, distributive numerals in *ʔayʔajuθəm* are restricted to temporal distribution over non-overlapping sub-events; in contrast, the related Salish language *St’át’imcets* permits its distributive numerals to distribute either over time or space, while unrelated Tlingit (Cable, 2014) allows distribution over time or event participants.

Second, distributive numerals in *ʔayʔajuθəm* are composed of three semantic components: the numeral itself; diminutive reduplication, which eliminates alternatives to the numeral and thus

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<sup>18</sup> We would like to propose this as a general statement about compositionality, but obviously, we are in no position to support it properly here. Systematic documentation across semantic domains and languages is necessary to establish how widespread syntax-semantics mismatches of this kind actually are; our impression is that they are quite pervasive with distributive numerals, but it remains to be seen whether this represents a special case or an instance of a wider phenomenon.



enforces an ‘exactly’ reading; and a pluractional infix, which adds to reduplicated numerals with cardinality  $n$  to yield a meaning of ‘ $n$  at a time’ by selecting an event argument, pluralizing and temporally distributing its sub-events, and counting the participants in each sub-event.

Finally, although we have provided a denotation for the ‘core’ case of distributed nominals, in which they act as predicates taking event descriptions as arguments, we have also pointed out that this is just one of a range of syntactic environments in which they may occur. The generalization governing these cases is a syntactic one: distributive numerals have an identical distribution to simplex numerals. Compositionality issues arise when the distributed numeral is syntactically separated from the predicate of events to which it applies, as for example, when the event is contained in a relative clause which is a syntactic sister to the numeral.

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