The mountains are impure. The semantics of lexical plurality*

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Abstract This paper is concerned with the semantics of so-called *plurals of extension*, a class of lexical plurals such as *mountains, cliffs, skies, Hebrides*, and *Pyrenees*. While similar on the surface to regular plural nouns, they behave differently in certain regards, including their compatibility with determiners, interpretation in *half of the N* partitives and possibility to occur as weak definites. We will argue that plurals of extension denote predicates over *impure atoms*, predicting that they behave as singulars from a semantic point of view and as plurals from a morphological point of view. The analysis will be extended to temporal plurals of extension and plural mass nouns.

Keywords: impure atoms, lexical plurals, plurals of extension, eigenspace semantics, mereotopology, determiners, numerals, partitives, weak definites, plural mass nouns

1 Introduction

In formal semantics, plural nouns are traditionally analysed with the use of the Linkian star operator *, which formalises the common-sense intuition that plurality expresses the existence of more than one of whatever the singular means. However, many languages including English use plural morphology in ways that (at least on the face of it) cannot be captured by applying * to the denotation of a singular noun; these plurals are usually known as lexical plurals (see, among many others, Acquaviva 2008; Alexiadou 2021). In this paper, we analyse the behaviour of a particular class of lexical plurals illustrated by the example in (1):

(1)   We bought a cabin in the mountains.

In this sentence, the plural *the mountains* is used to refer to a mountainous area or a mountain range rather than to a plurality of mountain-individuals. This explains why

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a cabin can be said to be located *in the mountains* even if it is not actually 'in' any mountain or mountains. We will call these plurals "plurals of extension" following Waltke & O'Connor (1990); the category includes nouns such as *mountains*, *cliffs*, and *skies* as well as certain pluralia tantum such as *Pyrenees*.

In this paper, we will propose that plurals of extension denote *sets of impure atoms*. This means that the DP *the mountains* denotes an atomic individual despite its plural form. Like many authors before us (e.g. Link 1984; Landman 1989; Winter 2001; de Vries 2015) we conceive of such individuals as having a conceptually salient part-whole structure (hence their atomicity is not 'pure'); however, these parts are inaccessible to the compositional semantics, meaning impure atoms are incompatible with determiners and quantifiers that require actual semantic plurality. In (2)-(4), this pattern is illustrated for the paradigmatic case of collective nouns. As (2) shows, DPs denoting some collection of entities can often be used interchangeably with a plural DP expressing the sum of that collection's members, indicating that they can pick out the same referent. On the other hand, (3)-(4) show that collective DPs (unlike plurals) do not allow quantification over collection members, indicating that these DPs treat these referents in different ways: while a plural DP picks out a sum of entities, the corresponding collective treats its referent as a compositionally indivisible whole.

(2)   a.   The group is smiling.
          b.   The group members are smiling.

(3)   a.   One of the team members is smiling.
          b.   *One of the team is smiling.[1]

(4)   a.   The committee members hate each other.
          b.   *The committee hates each other.

In section 2, we will offer several types of empirical evidence for our claim that plurals of extension are semantically singular despite their morphosyntactically plural form. After that, section 3 will provide a detailed proposal on the way this denotation is derived, which involves a lexicalised 'atomisation operation' that we will define in mereotopological terms following Grimm 2012. Section 4 will extend the proposal to temporal nouns of extension (*festivities*, *holidays*) and plural mass nouns (*waters*, *sands*) and section 5 will conclude the paper.

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[1] Sentences like these tend to be better in certain varieties of English, most notably British English. It is often argued (e.g. Barker 1992; de Vries 2013) that DPs like *the team* in these varieties denote (or are typeshifted into) genuine plurals, not (impure) atoms.

2 Empirical evidence

In this section we will discuss three types of empirical evidence in favour of our analysis. We will first show that the analysis makes the right predictions concerning the compatibility of plurals of extension and determiners (2.1): only determiners that are compatible with both plural *and* singular nouns may occur with plurals of extension. Next, we show by means of the so-called *half of*-test (Pearson 2011) that plurals of extension differ from ordinary plurals in lacking accessibility of the parts (2.2). The final piece of evidence in favor of our analysis will be the possibility to use plurals of extension as weak definites (2.3).

2.1 Determiners

An important characteristic of plurals of extension is that they are not countable despite being morphologically plural, as illustrated by their incompatibility with numerals and other determiners that typically combine with plural nouns:

(5)   *We took a hike in five/several mountains.

In itself, this observation cannot distinguish between our atomic approach and one that treats these plurals as mass nouns (e.g. Acquaviva 2008). However, they are also incompatible with determiners that are typically found with mass nouns (6a), independently of whether these determiners are also compatible with plurals (*a lot*) or not (*a bit*; cf. (6b-c)). Determiners such as *a lot* and *a bit* are excluded with singular count nouns, which is usually ascribed to the fact that they are only compatible with nouns that have cumulative reference (see for instance Deal 2017, and Doetjes 2021 for discussion).

(6)   a.   *We bought a house in a lot of/a bit of mountains.
        b.   We boiled the vegetables in a lot of/a bit of water.
        c.   We climbed a lot of/*a bit of mountains.
        d.   *We climbed a lot/bit of mountain.
        e.   *We bought a house in a lot/bit of city.

Plurals of extension also differ from singular count nouns, including those that denote sets of impure atoms. As shown in (7a), they are incompatible with determiners such as *a*, *one* and *every*, which are only compatible with singular count nouns (7b-c):

(7)   a.   *We took a hike in one/a mountains.
        b.   one/a/every book/committee
        c.   *one/a/every books/committees/water

The data in (5) to (7) show that plurals of extension differ not only from ordinary plurals, but also from mass nouns and singular count nouns by imposing specific, strong restrictions on the use of determiners. As it turns out, the analysis we propose sheds light on these restrictions. Plurals of extension differ from ordinary plurals in being semantically singular rather than plural, that is, they denote a set of impure atoms and as such they lack cumulative reference. Because of this, we do not expect these nouns to occur with quantity expressions that normally combine with plurals and/or mass nouns and that are incompatible with nouns that are semantically singular. However, they also differ from ordinary count singular nouns by the fact that they bear plural morphology. We propose that this makes them incompatible with the quantity expressions in (7): even though plurals of extension have the right semantics to combine with determiners such as *one*, *a* and *every*, these determiners are also grammatically singular (e.g., they trigger singular agreement) and it is quite plausible that they require the nouns they combine with to be morphologically singular. Given this, we expect only a very limited set of determiners to combine with plurals of extension, namely those that are compatible both with their singular count semantics, and with their plural form.[2] These restrictions are met by the definite article, which is compatible with both mass nouns and plurals. They are also met by *some* and *no*, which are compatible with count plurals and count singulars. As predicted, all of these determiners are compatible with plurals of extension:

(8)   a.   the/no/some mountain(s)/committee(s)
        b.   We spent the weekend hiking in some nearby mountains.
        c.   In the Netherlands, there are no mountains to hike in.

Under our analysis, the incompatibility of plurals of extension and numerals provides an argument in favour of an analysis of numerals in which they select expressions that are semantically plural, as proposed by, among others, Rothstein (2017) and Bale, Gagnon & Khanjian (2010). It goes against the analysis of Ionin & Matushansky (2006, 2018), who argue that numerals select sets of atoms, that is, semantically singular nouns, an assumption that is based on their compositional analysis of complex numerals.[3] Within their analysis, the plural morphology in an expression

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2 One seeming exception to this is the demonstrative *these*. Despite its incompatibility with singular nouns, it still can be used with plurals of extension:

(i)   a.   We bought a house in these magnificent mountains.
        b.   these mountain*(s), committee*(s)

This difference between *these* and plural-only determiners such as *several* is not so surprising under the reasonable assumption that the difference between *this* and *these* is purely one of syntactic agreement and as such does not impose any semantic requirements on the noun it combines with.

3 For reasons of space, we will not discuss the arguments of Ionin and Matushansky in favor of their

such as *five mountains* does not reflect the plural semantics of the noun, but rather expresses agreement with the plural semantics of the noun phrase as a whole. Under this proposal, many plural nouns have singular semantics, and the semantics of *committees* in *five committees* would be exactly the same as the semantics we propose for the plural of extension *mountains*. As such the combination of the two analyses would predict that the expression *the five mountains* could be used to refer to five mountainous areas, contrary to fact.

Another case to consider is *all*. In English, *all of (the)* is compatible with both plural nouns and count singulars:

(9) a. We visited all of the cities mentioned in the tourist guide.
     b. This is our favorite place to eat in all of the city.

However, its meaning is different in both cases. In (9a), *all of the cities* is equivalent to *every city*. With a singular DP, as in (9b), *all* quantifies over subparts of a single entity, and *all of the city* is equivalent to *the entire city*. Plurals of extension, and in particular those that are names of specific regions, such as *the Alps* and *the Pyrenees*, are also found with *all of the*. In these cases, the meaning is always 'entire', never 'every', as expected under the proposed analysis:

(10) This might well be the most beautiful climb in all of the Alps / the entire Alps / *every Alp.

With ordinary plurals of extension, it is also possible to use *all of (the)* and *entire*, even though the former combination occurs mostly in biblical contexts:

(11) a. [I]n all the mountains of Judea people continued talking about all these things. (Luke 1:65, New Century Version)
      b. This is our favorite place to eat in the entire mountains/?all of the mountains.

There is a preference to use *entire*, but this seems also the case for the use of *all of the* with singulars (see (9b)). We leave this here as a question for further research. The interpretation of the examples containing *entire* provides additional evidence for an analysis of plurals of extension as being semantically singular as this adjective is stubbornly distributive in the sense of Schwarzschild (2009), who defines stubbornly distributive predicates as "predicates that only apply to singularities" (page 674). Whenever this adjective is combined with an ordinary plural noun, the exhaustivity operator it introduces applies to every atom the plurality is composed of, that is, the

proposal; see Rothstein 2017 for discussion and an alternative approach to complex numerals, which assumes that nouns that are modified by numerals other than *one* are semantically plural.

meaning is necessarily distributive (cf. *in these entire cities*).[4]

To conclude, the way plurals of extension combine with determiners, as well as the way *entire* is interpreted in combination with these plurals, can be understood by an analysis that treats them semantically as singulars and morphologically as plurals.

2.2 The *half of*-test

Another piece of evidence for the proposed analysis of plurals of extension comes from partitive constructions containing *half of*, illustrated in (12) (Pearson 2011):

(12)   a.   Half of the bricks had been painted yellow.
       b.   Half of the wall had been painted yellow.

(a)   (b)

Figure 1: Half of the (wall of) bricks

The sentence in (12a) is only true if 50 percent of the bricks have been painted completely yellow (figure 1a). In this case, the DP following *of* denotes a sum individual and *half* quantifies over the atomic members of this sum.

The sentence in (12b), however, is also true in a context where each brick has been painted 50 percent yellow (figure 1b). Pearson argues that this reading can only arise if the DP denotes an atom, as is the case for singular definites like *the wall*. In this case, half of the parts of the wall needs to have been painted yellow for (12b) to be true. Since there are many ways to divide a wall into parts there are also many more ways to meet this requirement than there are in the case of (12a).

Our plurals, however, seem to pattern with the atomic singular *wall* rather than the plural *bricks*. As predicted by the impure-atom analysis, a sentence like (13) will be true as long as half of the cliff area is painted yellow. In other words, (13) is true in the situation depicted in both figure 2a and figure 2b.

(13)   Half of the cliffs had been painted yellow.

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4 We would like to thank Peter Sutton for drawing our attention to stubborn distributivity.
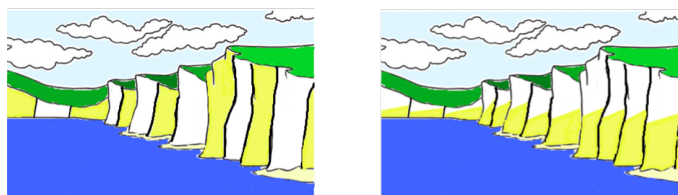
(a)   (b)

Figure 2: Half of the cliffs

This prediction was confirmed by a survey of 37 native speakers of English (Nauta 2021). The results revealed that 23 of those accepted an atomic reading for *the cliffs*, compared to only 13 for *the bricks*.[5]

Similarly, Schwarzschild (1996) argues that the word *part* can only quantify over subparts of singular entities (cf. the discussion of *entire* in 2.1). As such, it can occur with singular count nouns but not plural ones (Schwarzschild 1996: 165). Interestingly, lexical plurals such as *funds* pattern with singulars:

(14)   a.   Part of the car was painted.
        b.   #Part of the boys were in Texas.
        c.   Part of the funds were ill-gotten.

The plurals of extension under consideration in this study behave like *car* and *funds*:

(15)   a.   The Northern part of the Pyrenees lies in France.
        b.   The Southern part of the mountains lies in Nepal.

Thus, the behaviour of plurals of extension in partitive constructions provides further evidence for the idea that they denote sets of (impure) atoms.

2.3 Weak definiteness

Unusually for plurals, at least some of our plurals of extension can be used as weak definites (Aguilar Guevara & Zwarts 2010). Such definites are 'weakly referential': despite referring to individuals, they can be used in contexts in which they have more than one possible referent and do not commit to a specific one.

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5 The fact that 13 out of 37 informants accepted an atomic reading for *the bricks* is somewhat unexpected given Pearson's claims but in line with the findings of de Vries (2015), who found that Dutch speakers tend to interpret inanimate DPs as atomic regardless of their morphosyntactic number. Still, our results show that this tendency is markedly stronger for plurals of extension.

(16)   Ana listened to the radio and so did Joost.   (possibly different radios)

(17)   a.   Ana has a house in the hills and so does Joost. (possibly different hill ranges)

        b.   Ali got lost in the woods and so did Beth. (possibly different woods)

Aguilar-Guevara & Zwarts argue that weak definiteness should be analysed in terms of reference to kinds. Among other things, this explains why weak definites are overwhelmingly singular, and why the weakly referential interpretation disappears when the nouns are pluralised, as in (18) (compare *The lion is/#The lions are related to the domestic cat*).

(18)   Ali had to go to the hospitals and so did Beth.   (the same hospitals)

In light of this, the acceptability of (17) is quite unexpected. In an informal precursor of our present proposal, Aguilar Guevara & Zwarts (2010: 186) suggest dealing with weakly referential plurals by analysing them as semantically singular despite their plural form ("a sort of (...) collective nouns"). In other words, the reason these plurals pattern with singular definites in their ability to receive a kind denotation is that, semantically, they really *are* singular definites.

3   Analysis

We have seen a lot of evidence that plurals of extension are semantically singular despite their plural morphosyntax. We have also suggested that their atomicity is of a particular sort, namely 'impure', and suggested that this puts these plurals in the same semantic category as collective nouns like *team* and *committee*. In this section, we will make our proposal more explicit by proposing a concrete lexical derivation for plurals of extension that clarifies their semantic relationship with an underlying set of pure atoms (e.g. individual mountains). The atomisation operation that we propose - a higher-order and lexicalised version of the atomisation operator from Link (1984); Landman (1989); Winter (2001) - ensures that only referents with certain spatial properties end up in the eventual denotation of the plural, through the use of mereotopological constraints.

3.1   Deriving plurals of extension

The main precedent of our proposed approach is Mador-Haim & Winter 2012, 2015, who study the behaviour of both indefinite and definite DPs in locative constructions.[6] As it turns out, definites and indefinites are located in space in

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6 Mador-Haim & Winter 2012 is an earlier unpublished draft of Mador-Haim & Winter 2015. The present discussion mostly draws on this earlier version as it contains a more elaborate discussion of

different ways. While the location, or 'eigenspace', of an indefinite corresponds to the union of eigenspaces of all individuals in the noun's extension, the eigenspace of a plural definite is often more than the sum of its parts. In particular, whenever the plural's referents are understood to form some kind of 'whole' together, they are taken to occupy a single, uninterrupted eigenspace that includes the spaces in between individuals. Thus, in the situation depicted in figure 3, sentence (19a) is false but (19b) is true.

(19)   a.   The house is 10 metres from **a utility pole**.
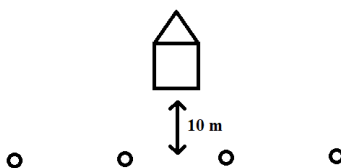   b.   The house is 10 metres from **the utility poles**.
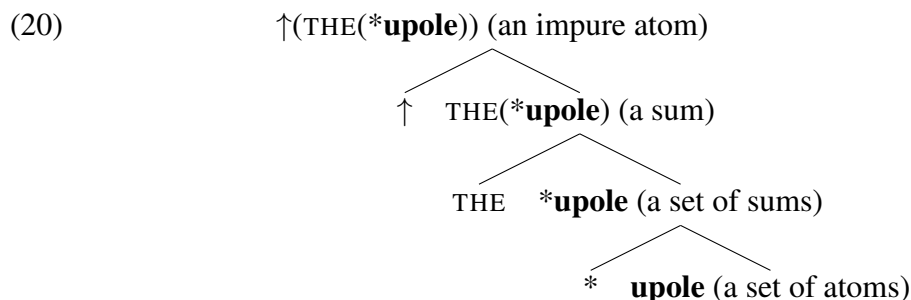

Figure 3: A house and a row of utility poles.

Mador-Haim & Winter (2012) propose that this particular interpretation can arise with plural definites (but not with indefinites) because the plural individuals denoted by these referential DPs may receive an impure atomic interpretation. This effectively creates an ad hoc collective DP, which is located in space as a single whole rather than a set of separate entities. Following a proposal in Winter 2001, we will assume this interpretation is the result of an atomisation typeshift, which we will write ↑ following Landman 1989.

The interpretation of plurals of extensions like *the mountains* or *the Hebrides* is very similar to the interpretation of *the utility poles* in (18). In particular, the space in between the individual mountains or islands is included in the reference (Wierzbicka 1988: 538): a 'cabin in the mountains' could well be located in a valley between two mountains, and it is perfectly possible to go 'sailing in the Hebrides'. Taking our cue from Mador-Haim & Winter's analysis (as well as the suggestion by Aguilar Guevara & Zwarts (2010) mentioned in section 2.3), we propose that plurals of extension similarly involve a shift from sums to impure atoms.

However, we cannot simply copy-and-paste the derivational steps involved in the atomic interpretation of *the utility poles* - shown in (20), where ↑ represents the atomisation typeshift and * is standard Linkian pluralisation - onto plurals of extension like *the mountains*. In Mador-Haim & Winter's analysis, atomisation is a

the impure atomic interpretation of plural definites.

type shift that applies to plural individuals at DP level (provided certain contextual requirements are met). This accounts for the fact that the atomic interpretation arises only with plural definites, as well as the fact that it can arise with *any* plural definite - even ones that contain a numeral, as in (21a). Neither observation is true of plurals of extension, however: we have seen in section 2.1 that the relevant interpretation also arises in certain quantified DPs, but is always incompatible with numerals (as shown in (5) and again in (21b)).

(20)   ↑(THE(***upole**)) (an impure atom)

            ↑   THE(***upole**) (a sum)

               THE   ***upole** (a set of sums)

                          *   **upole** (a set of atoms)

(21)   a.   The house is 10 metres from the 4 utility poles.
         b. #We went sailing in the 70-odd Outer Hebrides.

Moreover, while *the utility poles* is a completely regular plural definite, plurals of extension have many idiosyncratic properties that justify their usual classification as a type of *lexical plural*. This means that their peculiar type of plural reference arises as part of the construction of the noun itself, rather than being a result of compositionally transparent operations at the phrasal level.[7] For instance, the fact that many plurals of extension lack a singular form (**a Hebride*) indicates that their plurality cannot be compositionally derived from a corresponding singular; rather, the word *Hebrides* forms a lexical whole, its plurality baked in from the start.
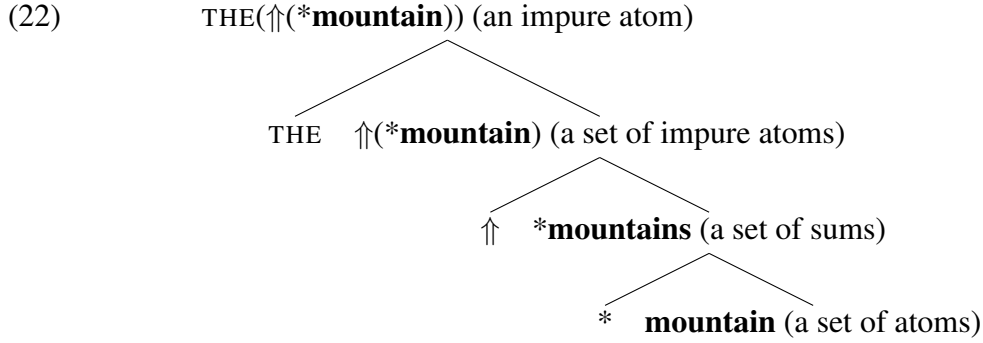
    Finally, while the shift of ⟦*the utility poles*⟧ into an impure atom is licensed by situational factors (we can interpret *the utility poles* as a single individual because the situation in figure 3 clearly groups the individual poles together both spatially and functionally), in the case of *mountains* and other plurals of extension, the requirement is met lexically: the tendency to appear in groups is an inherent part of what it means to be a mountain.

    Given these considerations, we propose that plurals of extension like *mountains*, which refer to clusters of countable entities (or, as we will see in section 4, events)[8],

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7 Our understanding of the word 'lexical' here is informed by constructionist theories according to which 'words' are not linguistic primitives but are constructed in syntax just like phrases. Roughly, we say that a certain derivational process takes place at the 'lexical' level if it is part of the syntactic structure that will eventually be spelled out as a single word.

8 In section 4, we will also discuss plurals of extension that are apparently derived from mass nouns, such as *sands* and *waters*

have the lexical structure shown in (22). (The determiner *the* is not part of the lexical structure, but we show it here to enable a full side-by-side comparison between (22) and the derivation of *the utility poles* in (20).)

(22)   THE($⇑$(*$\textbf{mountain}$)) (an impure atom)

         THE $⇑$(*$\textbf{mountain}$) (a set of impure atoms)

               $⇑$ *$\textbf{mountains}$ (a set of sums)

                        * $\textbf{mountain}$ (a set of atoms)

This structure necessitates the use of a higher-order version of $↑$, written $⇑$ and defined as follows (following de Vries 2015: 17):

(23)   **Higher-order atomisation**
      $⇑(A) =_{def} \{↑(a) \mid a \in A\}$ (non-final)

That is, the result of applying $⇑$ to a set of sums is the set of atomised versions of these sums.

Note that the structure '$⇑$(*$\textbf{mountain}$)' is spelled out as a single lexical item, *mountains*. The underlying atomic predicate $\textbf{mountain}$ does not need to be associated with a lexical item, which explains why the structure in (22) can result in, say, *the Hebrides* even though our lexicon lacks **Hebride*.

3.2   Mereotopological constraints on atomisation

What the structure in (22) and atomisation operation in (23) fail to capture is that not any collection of mountains qualifies as a referent for *the mountains*. Similarly to our rows of utility poles, the use of plurals of extension like *the mountains* or *the cliffs* is limited to collections that form a kind of whole together. That means that not every sum in *$\textbf{mountain}$ is a viable candidate for atomisation, and we need to adjust our atomisation operation accordingly. The mereotopological system developed in Casati & Varzi 1999 and first applied to the semantics of nominal countability by Grimm (2012) allows us to define the relevant 'wholes' more explicitly, resulting in the extended definition in (24):

(24)   **Lexicalised higher-order atomisation** (final definition, informal version)
      $⇑(A) =_{def} \{↑(a) \mid a \in A$ and a is **maximally proximately self-connected**$\}$

Let's take a closer look at the meaning of this requirement, starting with the notion of connectedness and then adding further specifics. The basic building blocks of the definition in (25) are the mereo(topo)logical relations O (overlap) and C (connectedness): intuitively, two sums overlap if they share parts, and are connected if they either overlap or share a common boundary. Then:

(25)   **Self-connectedness**
       $SC(x) =_{def} \forall y, z (\forall w (O(w,x) \rightarrow (O(w,y) \vee O(w,z))) \rightarrow C(y,z))$
       (A sum x is self-connected if any two parts y, z that together make up the whole of x are connected to each other.)

The property of *proximate* self-connectedness involves a slight weakening of the definition in (25) by replacing C with the notion of 'proximate connectedness':

(26)   **Proximate connectedness**
       $ProxC(x,y) =_{def} d(x,y) \leq n$
       (Two sums x and y are proximately connected if the distance between them is less than or equal to some contextually determined nearness standard n.)

Accordingly:

(27)   **Proximate self-connectedness**
       $ProxSC(x) =_{def} \forall y, z (\forall w (O(w,x) \rightarrow (O(w,y) \vee O(w,z))) \rightarrow ProxC(y,z))$

Finally, we want to limit our atomisation operation to *maximal* sums. The purpose of this is both conceptual and technical: first, it is a way to capture our intuition that the individuals that make up *the mountains* or *the cliffs* must form a whole together. Second, it guarantees that THE will be defined for the resulting set of impure atoms.

(28)   **Maximal proximate self-connectedness relative to a property**
       $MProxSC(x,P) =_{def} P(x) \wedge ProxSC(x) \wedge \forall y ((P(y) \wedge ProxSC(y) \wedge ProxC(y,x))$
       $\leftrightarrow y \leq x)$
       A sum x is maximally proximately self-connected (relative to a property P) if it is proximately self-connected, and any sum y such that y is P and proximately connected to x is itself part of x.)

The definition in (28) rules out, for instance, the atomisation of subparts of mountain ranges: a sum of mountains cannot be atomised if there is another mountain-sum proximately connected to it. We can leave out reference to P in our definition of the atomisation operator; it is already covered by the requirement that any candidate for atomisation be a member of the set A.

(29)   **Lexicalised higher-order atomisation**   (final definition, formal version)

$$\Uparrow (A) =_{def} \{\uparrow (a) \mid a \in A \land ProxSC(a) \land \forall a' \in A((ProxSC(a') \land ProxC(a',a)) \leftrightarrow a' \leq a)\}$$

3.3 Summing up

We have claimed that plurals of extension such as *mountains*, whose referents are clusters of individuals that form a whole together (e.g. mountain ranges), should be analysed as sets of impure atoms. The lexical derivation of these sets is based on an underlying set of atomic individuals (which does not need to be associated with a lexical item), to which Linkian pluralisation and lexicalised higher-order atomisation are applied. The atomisation operation is restricted to sums that are maximally proximately self-connected, which formalises the intuitive notion of 'clusters of individuals that form a whole together' in mereotopological terms.

4 Further extensions

So far, our discussion has been limited to geographical nouns which seem to denote some sort of spatial extension, and moreover, to nouns derived from underlying count nouns. In this section, we will discuss two more classes of nouns which do not share these properties but still behave very similarly: plural event nouns (4.1) and plural mass nouns (4.2).

4.1 Plural event nouns

The group of relevant plural event nouns consists of plurals such as *renovations, negotiations, riots, protests* and *holidays*, as in (30). These plurals can be understood as the temporal equivalents of the spatial nouns discussed previously. Thus, where *the mountains* refers to an area characterised by mountains (connected to their 'eigenspace'), *the celebrations* refers to a time period characterised by festivities (connected to the 'eigentime' of the different festive events).

(30)   a.   His father was killed during the riots.
        b.   The celebrations lasted all day.
        c.   The renovations of the house took eight weeks.

For nouns such as *celebrations* and *renovations*, the dominant reading seems to be a collective one (31b), in contrast to other more regular plurals which allow both a collective and distributive reading (31a).

(31)   a.   The games lasted 90 minutes.
             (i)   The games lasted 90 minutes in total.

(ii)   Each game lasted 90 minutes.
b.   The riots lasted 10 hours.
(i)   The riots lasted 10 hours in total.

Thus, as with the spatial plurals of extension discussed previously, the plural noun phrases in (30) seem to refer collectively to a singularity. This interpretation becomes particularly evident when considering the following contrast:

(32)   a.   John fell asleep during the parties.
       b.   John fell asleep during the celebrations.

In (32a) above, the use of a regular plural leads to a semantically odd sentence: the sentence only makes sense if John fell asleep multiple times, namely during each of the parties. Sentence (32b), however, does not require an iterative reading and is perfectly acceptable if John only fell asleep once during the whole period during which the celebrations took place. This interpretation becomes even clearer when the semantics of the verb phrase prevent an iterative reading, as in (33) and (34).

(33)   a.   John's father was killed during the riots.
       b.   #John's father was killed during the battles.

(34)   a.   The company was founded in the early days of the internet.
       b.   #The company was founded in June and July.

Thus, these plurals seem to receive a similar interpretation as the ones discussed in previous sections. As such, we will argue that they also denote sets of impure atoms and can be considered to be a sub-category of plurals of extension. The following paragraphs will discuss their behaviour in more detail.

4.1.1   Determiners

Firstly, the event nouns under consideration can only occur with a limited set of determiners, as in the case of spatial plurals of extension. As shown below, they cannot occur with determiners that normally combine with plurals.

(35)   a.   *His father died during a few/several riots.
       b.   *A few/several celebrations lasted all day.

When the use of these determiners is possible, the intended reading is lost. This can be seen most clearly in the example below, given by Acquaviva (2008: 44). Example (36a), where the plural *plans* is used under the intended reading, means something like 'I am busy tonight'. However, when *a few* is added, this reading disappears, leaving only the more compositional reading 'there are multiple things I intend to

do'.

(36)   a.   I have plans tonight.
          b.   I have a few plans tonight.

Furthermore, our plurals cannot occur with numerals. Thus, they are not countable, despite being plural.

(37)   a.   #The celebrations – all 5 of them – lasted all day.
          b.   #The renovations of the house – all 5 of them – took 8 weeks.

As in the case of the spatial plurals of extension discussed in 2.1, they also cannot combine with determiners such as *one*, *a* or *every*, which typically combine with singular nouns.

(38)   *His father was killed during a/one/every riots.

Again, the only determiners which are able to occur with these plurals are those that are compatible with both their plural form and their singular meaning.

(39)   a.   They are in the middle of doing some major renovations.
          b.   The president is in the middle of some tricky negotiations with North-Korea.
          c.   There were no elections for the student member of the board this year as there was only one candidate.
          d.   There were no Olympic Games in 2020 due to the pandemic.

Finally, we can observe that these nouns behave similarly with respect to *all of* and *entire*. As in the case of the spatial nouns of extension discussed in 2.1:

(40)   a.   The shop remained open during all of the renovations, which lasted several months.
          b.   During the entire festivities, which lasted almost a week, we hardly had time to sleep.
          c.   I would prefer not to spend the entire holidays with my in-laws.

4.1.2 Partitive constructions

Secondly, we have seen that spatial plurals of extension have atomic denotations in partitive constructions. The same holds for the temporal ones.

    In (41b), it is shown that *part* cannot be used to quantify over members of a plurality (that is, we cannot use (41b) to mean that some of the weddings took place on the beach while others did not). However, constructions as in (41c) are acceptable.

(41) a. Part of the wedding took place on the beach.
      b. #Part of the weddings took place on the beach.
      c. Part of the celebrations took place on the beach.

Other examples of the type in (41c) are listed below:

(42) a. The intergovernmental part of the negotiations
      b. The newsworthy part of the protests
      c. The best part of the holidays

These data suggest that these event plurals have atomic reference in the same contexts as the plurals of extension discussed previously.

4.1.3 Weak definites

As with spatial plurals of extension, it is possible for some temporal plurals of extension to occur as weak definites. Consider the context given in (43):

(43) a. Ali has a cabin in the mountains and so does Beth. Ali's is in the Alps while Beth's is in the Pyrenees.
      b. They both like to go there during the holidays. Ali spends their summers at their cabin and Beth, her Christmas break.

As discussed in section 2.3, in (43a), *the mountains* does not refer to a specific mountain range. Similarly, in (43b), *the holidays* does not refer to a specific holiday period; while both Ali and Beth like to spend *the holiday* at their respective cabin, this phrase refers simultaneously to the summer holidays for Ali and the Christmas holidays for Beth. As we have seen in section 2.3, the availability of a weak definite reading is a strong indicator for semantic atomicity since it depends on the DP in question receiving a kind interpretation.

4.1.4 Summing up

Overall, we have seen that plural event nouns behave similarly to the plurals of extension discussed before. As such, we can define two sub-categories of plurals of extension: spatial and temporal plurals of extension. We assume that the analysis presented in section 3 extends straightforwardly to the second class; their only difference is the ontological type of the underlying sets (individual entities in the case of spatial plurals, atomic events in the case of temporal ones). Given the often-noted structural similarities between the spatial and temporal domains (e.g. Obenauer 1983; Bach 1986; Krifka 1989; Champollion 2010; Wellwood, Hespos & Rips 2018; Ji & Papafragou 2022: and many others), the mereotopological constraints defined in

section 3.2 can be straightforwardly applied to the way these events cluster together in time.

4.2   Plural mass nouns

So far, we have focused on plurals of extension that on the surface look like plural count nouns. However, there is a sizeable class of nouns that behave more or less like *the mountains* and *the holidays* that appear to be derived from mass nouns:

(44)   the sands of the Sahara, the snows of the Kilimanjaro, international waters, tar sands, the Troubles, the End Times...

These plural mass nouns have received quite a bit of attention recently in the semantic literature, in which they are often subsumed under 'plurals of abundance' (Mathieu 2012; Acquaviva 2019; Tsoulas 2009; Smith 2016; Rothstein 2021 and to some extent Erbach 2019). We propose that an impure atom-based analysis is feasible for these plurals too, although it is not always straightforward to apply our empirical tests from sections 2 and 4.1 to them, and there are still various little differences between mass and count plurals of extension that deserve closer study.

First, they are incompatible with numerals and either singular-only or plural-only determiners (45), while *the*, *no*, and *some* are fine (46). Similarly, their behaviour with *entire* parallels that of *mountains* and *festivities* (47).[9]

(45)   a.   #three/several/a lot of waters   (only a '*n* types/portions' reading)
          b.   #the many snows of the Kilimanjaro
          c.   *I lived through several of the Troubles.

(46)   a.   No freezing waters around him. Just darkness, and the echo of his footsteps on broken stone floors.
          b.   I've played around with ice showers after saunas in the past in the name of a spa day and have ventured into some freezing waters for modelling jobs...
          c.   I lived through some of the Troubles.

(47)   The views from the front extend to Putsborough and beyond with the entire sands of Woolacombe beach in front of you, simply stunning!!

One noteworthy difference between mass and count plurals of extension is that many of the latter allow a weakly referential use (see section 2.3 and 4.1), while the former

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9 Examples (46a), (46b) and (47) were respectively retrieved from: https://archiveofourown.org/works/34515046/chapters/87396598, https://www.jasminehemsley.com/fashion-blog/2021/6/2/eco-wild-swimming, and https://www.holidayhomehunter.co.uk/accommodation/stepping-stones, all on August 1, 2022.

never do:

(48)   Ali lives near the tar sands and so does Beth. #Ali lives near the Athabasca tar sands and Beth near the Orinoco Belt.

However, this is not in itself sufficient reason to pursue a distinct analysis for both classes of plurals, as not all count plurals of extension can occur as weak definites either (e.g. *cliffs, shores*).

Let's assume, then, that mass plurals of extension also denote sets of impure atoms. Following the common assumption that Linkian pluralisation is blocked from applying to mass predicates since they already are cumulative (Chierchia 1998), we cannot assign these mass plurals precisely the structure in (22). So while we were able to maintain a connection between Linkian pluralisation and the presence of a plural morpheme for count plurals of extension like *the mountains*, we clearly cannot extend this connection to mass plurals like *sands*.

This is not an unwelcome result, however. Not all languages allow pluralisation of mass nouns as freely as English does. Dutch, for instance, has many count plurals of extension that behave just like their English equivalents (*bergen* 'mountains', *bossen* 'woods', *kliffen* 'cliffs', *Hebriden* 'Hebrides', *feestdagen* 'holidays', etc), but hardly any mass ones: *internationale wateren* 'international waters' is fine, but the other examples in (44) all have to be translated as singulars. Perhaps relatedly, note that Dutch has almost no pluralia tantum on a par with English *scissors, ashes, trousers* etc. The contrast between Dutch and English thus suggests that English allows a truly 'lexical' use of the plural morpheme, while in Dutch the plural morpheme always has to reflect the presence of Linkian pluralisation somewhere in the derivation of the noun.

5   Conclusions

We have provided evidence that plurals of extension in both the spatial and temporal domains should be analysed as semantically singular count nouns despite their plural form. We have also claimed that the lexical construction of these nouns involves mereotopological constraints on the spatiotemporal configuration of referents. Importantly, the fact that this same construction can target both entity nouns and event nouns provides evidence for the hypothesis that languages - and by extension, human cognition - assign largely parallel structures to space and time. The behaviour of plurals of extension is thus in line with other phenomena where spatial and temporal structures behave alike (e.g. Champollion 2010; Obenauer 1983) and/or interact (e.g. Krifka 1989, 1992).

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