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Do all languages make countability distinctions? Evidence from Nez Perce[1]

Amy Rose Deal — University of California, Berkeley

Abstract. At first glance, Nez Perce looks like a language lacking any correlate of the traditional mass-count distinction. All Nez Perce nouns behave like canonical count nouns in three ways: all nouns combine with numerals without an overt measure phrase, all NPs may host plural features, and all NPs may host adjectives like *big* and *small*. I show that Nez Perce nevertheless makes two countability distinctions in noun semantics. A sums-based (cumulativity) distinction is revealed in the interaction of quantifiers with plural; a parts-based (divisiveness) distinction is revealed in certain quantity judgments. Both types of evidence involve complex structures to which language learners likely have little to no actual exposure. I suggest that Nez Perce furnishes a poverty of the stimulus argument in favor of semantic countability distinctions as a language universal.

Keywords: mass-count distinction, countability, variation, quantity judgment, cumulativity.

1. Introduction: two semantic countability distinctions

Early work on the semantic basis of the mass-count distinction emphasized two distinctive properties of mass nouns, one concerned with sums and one concerned with parts. The property concerned with sums was introduced by Quine (1960) as *cumulativity*; the property concerned with parts, as introduced by Cheng (1973), was dubbed *divisiveness* by Krifka (1989). In general terms:

(1) A noun is cumulative iff it denotes a cumulative predicate.
A predicate p is cumulative iff any sum of parts that are p is also p.

(2) A noun is divisive iff it denotes a divisive predicate.
A predicate p is divisive iff any part of something that is p is also p.

These properties describe patterns of inference: *water* (for instance) is cumulative because if a is water, and b is water, then $a + b$ is water. The major explanatory goal for a semantic account of countability distinctions has typically been to connect this type of inference to the morphosyntactic differences between the traditional classes of mass and count nouns. These include pluralization, combination with numerals, choice of quantifiers (*each, many, fewer* vs. *much, less*), and combination with 'count adjectives' (e.g. *small*). Both cumulativity and divisiveness have come in for their share of critique and controversy in this role. The result has been two kinds of advances.

First, one productive line of work has sought to refine the parts-based property in such a way

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as to avoid the so-called minimal parts problem. For Chierchia (2010), Landman (2011), and Grimm (2012), for instance, mass denotations may have minimal parts (and so are not properly divisive), but there nevertheless remains a parts-based property distinctive to mass nouns. Second, a complementary line of work has investigated the connections between cumulativity, divisiveness (or alternative parts-based notions), and particular morphosyntactic patterns. Here, a key role has been played by 'aggregate' nouns like *footwear, furniture* and *jewelry*. Such nouns occupy an intermediate place between canonical count nouns and canonical mass nouns in terms of inference: they are cumulative, but not divisive (or replacement notion). Notably, such nouns also occupy an intermediate place on distributional tests. Like canonical mass nouns, they lack plural forms, fail to combine with numerals directly, and combine with *much* and *less* instead of *many* and *fewer*. Yet like canonical count nouns, they combine with count adjectives (Schwarzschild's (2011) "stubs"):

(3) a. the small cat / the small furniture
b. *the small water

In addition, as Barner and Snedeker (2005) discuss, aggregate nouns behave like canonical count nouns in the interpretation of comparative constructions like (4). The most natural interpretation of (4a) is numerosity-based: Mary has a greater number of cats, or greater number of pieces of footwear, than Sue does; the mass or volume of Mary and Sue's respective possessions does not matter. By contrast, the dominant interpretation of (4b) is mass- or volume-based: Mary has a greater mass or volume of water than Sue does, without regard to how many portions it comes in.

(4) a. Mary has more cats / footwear than Sue.
b. Mary has more water than Sue.

These two advances together suggest that both sums- and parts-based distinctions have a role to play in explaining countability. We can retain the idea that mass nouns are distinguished by a parts-based property without requiring mass denotations to lack minimal parts *sensu stricto*. But we could not adopt *only* a parts-based distinction without losing sight of the special behavior of aggregate nouns. Aggregate nouns show us that noun denotations manifest not a two-way split, mass vs. count, but rather a three-way split, with nouns like *footwear* in the middle:

(5)

	CORE COUNT e.g. *cat*	AGGREGATE e.g. *footwear*	CORE MASS e.g. *water*
(a) pluralization	✓	*	*
(b) direct combination with numerals	✓	*	*
(c) quantifiers	*many, fewer*	*much, less*	*much, less*
(d) combination with count adjectives	✓	✓	*
(e) comparison based on …	number	number	volume

The facts summarized in (5) suggest that plural, numerals, and quantifiers are regulated by a sums-based property (as in Chierchia 1998), whereas count adjectives and comparatives are regulated by a parts-based property (as in Bale and Barner 2009 and Schwarzschild 2011). Accordingly, if we take the relevant thesis about parts to be divisiveness, the three varieties of noun denotation can be sets of atoms for nouns like *cat*; atomic join semilattices for nouns like *footwear*; and nonatomic join semilattices for nouns like *water*. A picture along these lines is proposed by Doetjes (1997).[2]

2. The question, and a preview of the argument

One consequence of adopting a two-distinction theory of countability is a refinement of the questions to be asked about crosslinguistic variation. The proper question is not whether a given language (or indeed all languages) have *the* mass-count distinction, but rather what type(s) of countability distinctions a given language (or indeed all languages) make. We might probe the limits of crosslinguistic variability by asking a series of existence questions. For instance: Are there languages where no nouns are cumulative? Are there languages where all nouns are equally atomic?

Such questions are of course easier to answer in the affirmative than the negative. To give a negative answer, we must either exhaustively canvass the world's languages, or give a general argument that languages without countability distinctions cannot be acquired by humans. In the latter case, the argument turns on the poverty of the stimulus: even when faced with a data set that provides no major evidence for countability distinctions, learners nevertheless acquire a lexicon that encodes these distinctions in the semantics of nouns. This type of example would suggest that systems without semantic countability distinctions do not feature in the hypothesis space considered by children. And if this is so, there cannot be a language without semantic countability distinctions.

It is this type of argument to which I aspire in this paper. My discussion will center on Nez Perce, a language with no morphosyntactic evidence for a countability distinction in the obvious places – numerals, number marking, and count adjectives.[3] [4] I will show that Nez Perce nevertheless does encode a *semantic* distinction between nouns describing objects (i.e. core count nouns) and nouns describing substances (i.e. core mass nouns). The evidence for this distinction can only be found in grammatical configurations of a type which is essentially absent in corpora and daily conversation. The subtlety of the crucial evidence suggests that the acquisition of semantic countability distinctions in Nez Perce may not be attributable purely to linguistic experience on the part of the language learner. Instead, a linguistic universal is involved – one grounded in independently attested strategies used by learners to acquire the meanings of new words.

My argument proceeds as follows. In section 3, I present three *prima facie* arguments that all Nez

[2] Schwarzschild's (2011) proposal is somewhat similar, though couched in an event semantics.

[3] Nez Perce is a highly endangered Sahaptian language spoken in Idaho, Washington, and Oregon, USA. The data in this paper were collected over five field trips, 2011-2015, from two native speaker consultants in Lapwai, ID, USA.

[4] The argument is extended to Yudja, described by Lima (2014) as lacking countability distinctions, in Deal (To appear). Also discussed there is Mandarin, which makes a parts-based distinction only (Doetjes, 1997).

Perce nouns have the same type of semantic analysis. For the distribution of numerals, number marking, and count adjectives, we will see that all Nez Perce nouns behave like core English count nouns. In section 4, I propose an analysis of these facts that nevertheless lexically encodes both parts- and sums-based distinctions between object nouns and substance nouns. I then present the evidence that these distinctions are indeed required, in sections 5 (sums) and 6 (parts). In section 7 I discuss the availability of this evidence to the learner, and conclude.

3. Nez Perce: a language with no countability distinctions?

Contemporary Nez Perce is not a classifier language (Deal, 2016); nouns may combine with numerals without any overt classifying or measuring expression. The direct combination of an object NP with a numeral is seen in Nez Perce examples (6).[5]

(6) a. mitaat nicka'niicka'
three strawberry
3 strawberries

b. naaqc himeeq'is walc
one big knife
1 big knife

This behavior is familiar for object nouns in non-classifier languages. By contrast, in familiar non-classifier languages, substance nouns may combine with numerals directly iff the noun is coerced into countability – that is, iff it is interpreted as a property of subkinds of the stuff present in the substance denotation (sorting), or as a property of conventionally packaged units of the stuff present in the substance denotation (packaging). There is an extensive literature on coercion of both types (e.g. Pelletier and Schubert (2003), Grimm (2012: §3.6.3), and references there).

In Nez Perce, the combination of substance nouns with numerals is by outward appearances just as direct as for object nouns; however, this combination does not depend on any familiar type of coercion. In (7a), *'itx* 'clay' combines with a numeral, and the interpretation involves counting two portions of clay. Both are of the same type of clay, and neither is a conventional package. Compare, in this context, English (7b).

(7) a. (Speaker is toying with two nearly identical pieces of white modeling clay.)
'Ee wee-s **lepit 'itx̂**, kii kaa yox̂.
2SG.CLITIC have-PRES two clay, DEM and DEM.
You have two pieces of clay, this one and that one.

b. # You have two clay(s).

[5]The following abbreviations are used in glosses: CISLOC cislocative, COMP comparative, DEM demonstrative, GEN genitive, HUM human, IMPER imperative, P perfect/perfective aspect (see Deal 2010: §2.3), PL plural, PRES present tense, REM.PAST remote past tense, SG singular, 2/1 2nd person subject and 1st person object portmanteau agreement, 3SUBJ 3rd person subject agreement.

Likewise, in (8a) and (9a), *tuutnin'* 'flour' and *kike't* 'blood' combine with numerals, and the interpretation involves counting by piles or drops of the substance. Compare (8b) and (9b).

(8) a. (Describing a photograph of a pile of flour on a table)
Naaqc himeeq'is x̂ayx̂ayx̂ tuutnin' hii-we-s.
one big white flour 3SUBJ-be-PRES
There's one big pile of white flour.

b. # There's one big white flour.

(9) a. (Discussing a nosebleed)
Lepit kike't hi-sew-n-e.
two blood 3SUBJ-fall-P-REM.PAST
Two drops of blood fell.

b. # Two blood(s) fell.

These data show that it is possible to count substances in Nez Perce by the portions the substance occurs in, even when these portions do not represent distinct subkinds and do not correspond to conventional packages. The pattern holds for substances of various types, including flexible solids (clay), powders (flour), and liquids (blood).

We turn now to number marking. Like many languages, Nez Perce marks plural not just on nouns but also on nominal modifiers and verbs. That is, it is a language with number agreement and number concord. Compare singular (10a) to plural (10b), where plural is marked on four different lexical items (bolded).

(10) a. Yox̂ kuhet 'aayat hii-we-s 'eemti.
DEM tall woman 3SUBJ-be-PRES outside
That tall woman is outside.

b. Yox̂-**me** **ki**-kuhet **ha**-'aayat hi-w-s-**iix** 'eemti.
DEM-PL PL-tall PL-woman 3SUBJ-be-PRES-PL outside
Those tall women are outside.

Following Sauerland (2003), I will assume that at most one [PL] feature is semantically interpreted per plural nominal, even though plural may be exponed multiple times.[6] Following Ritter (1991) and many others, I assume that this single [PL] feature originates on a functional head in the nominal projection. The syntax and LF structures I adopt for the subjects of (10a,b), respectively, are shown in (11a,b). (The absence of a [PL] feature on Num is indicated with a dash.)

[6]The precise conditions on this multiple exponence are explored in Deal 2016.

(11) a. [*yox̂* ‘that’ [Num: – [*kuhet* ‘tall’ *’aayat* ‘woman’]]]
b. [*yox̂* ‘that’ [Num: [PL] [*kuhet* ‘tall’ *’aayat* ‘woman’]]]

From this perspective, information about the plural *form* of the noun *per se* is not available to the semantics. Morphological form is a PF matter, determined in a PF component of grammar. This means we must recast the traditional idea that a noun’s meaning determines whether it has a plural form. What a noun’s meaning determines is whether or not it may co-occur with a plural Num head in its nominal projection. When a noun co-occurs with a plural Num head, a [PL] feature is present for interpretation at LF and potentially at PF as well.

On the assumption that plurality is a feature of nominal projections, rather than nouns themselves, there is no particular reason to limit our attention to *noun* morphology when we seek PF evidence for the presence of [PL] in a particular language. A plural affix on a noun furnishes one type of evidence that the nominal contains a [PL] feature, but so does a plural affix on a nominal modifier.

In Nez Perce, the morphology of nouns themselves proves a limited diagnostic for [PL] features in view of an interaction between number marking and animacy (gender). I have shown elsewhere that plural marking on nouns in this language is tightly constrained by animacy (Deal, 2016). The nouns that show plural marking all belong to the human class, a pattern that is crosslinguistically common.[7] A representative selection of nouns with morphological plural forms is given in Deal 2016: (33); these include *’aayat* ‘woman’, *haama* ‘man’, *teeq’is* ‘elder’. In nominals headed by these nouns, noun morphology provides evidence regarding the presence of [PL] on Num. Nouns outside the human class, however, do not possess plural forms. In nominals headed by nouns like *picpic* ‘cat’, *’imes* ‘deer’, *piswe* ‘rock’, *timaanit* ‘apple’, or *kuus* ‘water’, noun morphology provides no evidence regarding [PL] on Num. We must look for evidence of a different type.

This evidence comes from adjective inflection. Many (though not all) Nez Perce adjectives have plural forms. Like in many languages, plural marking on adjectives uses the same set of affixes used for plural on nouns (*-me*, *he-* and reduplicative *Ci-*; see Deal 2016). Also like in many languages, both singular and plural forms exist for a range of adjectives expected to be inherently distributive, such as *kuhet* ‘tall’, *cilpcílp* ‘round’, and *limeq’is* ‘deep’. Finally, plural adjectives cannot be used in nominals that are otherwise unambiguously singular. Example (12) features a human-class noun, *’aayat* ‘woman’, which possesses a plural form; when the plural form of this word is not used, the nominal must be singular. In this context, a plural adjective cannot be used. Contrast (10b), where the noun form is plural and the plural adjective is acceptable. These facts together make it clear that adjectives mark a contrast of number, rather than (say) distributivity.

[7] In Nez Perce, the implication does not work in reverse; some human-class nouns lack plurals. Note as well that Nez Perce plural markers do *not* encode definiteness along with plurality. See Deal 2016 for discussion.

(12) Yox̂ kuhet / *ki-kuhet ’aayat hii-we-s ’eemti.
DEM tall / *PL-tall woman.SG 3SUBJ-be-PRES outside
That tall woman is outside.

Plural marking on attributive adjectives is unrestricted by the animacy class of the head noun. Plural adjectives modifying inanimate-class nouns are particularly interesting, as in this case, plural is expressed morphologically *only* on the adjective. In (13), the subject is headed by inanimate-class noun *taam’am* ‘egg’, which has no plural form. The form of N itself therefore provides no evidence about the presence of a [PL] feature. The plurality of the argument is visible morphologically only on the plural adjective, bolded. (Compare English *These deer ran*, where plurality is visible morphologically only on the demonstrative.)

(13) Himeeq’is ’itet’es-pe hii-we-s [**ki-kuckuc** taam’am].
big bag-in 3SUBJ-be-PRES PL-small egg
In the big bag there are little eggs.

This type of data reveals that any Nez Perce argument, regardless of animacy, may contain [PL]. I propose that the LF structure of an inanimate plural nominal and an animate plural nominal are parallel; the difference is at PF only. Compare the LF structure of the subject of (10b), introduced above, to the LF structure of the subject of (13):

(14) a. [*yox̂* ‘that’ [Num: [PL] [*kuhet* ‘tall’ *’aayat* ‘woman’]]] (10b)
b. [Num: [PL] [*kuckuc* ‘small’ *taam’am* ‘egg’]] (13)

With this background, let us turn our focus to plural adjectives as a distributional diagnostic for countability distinctions. Plural adjectives allow us to ask whether Nez Perce shows a distinction within the inanimate class akin to English *table/tables*, *blood/*bloods*. What we find is that NPs consistently permit [PL] in Nez Perce, regardless of whether the head noun is a substance noun or an object noun. Plural substance NPs describe pluralities of portions of the substance. In (15a), plural occurs in an NP headed by *sitx̂* ‘mud’; the example introduces a plurality of portions of red mud. Again, familiar packaging and sorting coercions are not involved; these portions are of the same subkind and do not correspond to conventional packages.

(15) a. (Discussing road construction)
He-’ilp-e-’ilp sitx̂ hii-we-s x̂uysx̂uys ’iskit-pe.
PL-red mud 3SUBJ-be-PRES slippery road-on
There are red muddy spots that are slippery on the road.
b. # Red muds are slippery on the road.

(See Deal (To appear) for further examples.) Overall, once we know where to look for a distributional distinction in number marking in Nez Perce – namely, on attributive adjectives – we see that substance nouns and object nouns behave entirely the same.

So far, in considering numerals and plural, we have considered evidence bearing on a sums-based countability distinction. A parts-based distinction can be assessed distributionally by looking at count adjectives. In Nez Perce, count adjectives may combine both with substance nouns and with object nouns. *Himeeq'is* 'big', for instance, may combine with substance noun *kuus* 'water' to describe a big puddle or portion of water. Compare Nez Perce (16a) to English (17).

(16) a. himeeq'is kuus
big water
(the) big portion of water

cf. b. himeeq'is picpic
big cat
(the) big cat

(17) # big water

4. A modest proposal

In terms of combination with numerals, the distribution of [PL], and count adjectives, all Nez Perce nouns behave like English core count nouns. The denotations of English core count nouns are quantized; they are neither cumulative nor divisive. One possible conclusion, given the facts of the previous section, is that all nouns in Nez Perce are lexically quantized. Another possibility is that Nez Perce substance nouns are not inherently quantized, but are subject to a very general mapping into quantized denotations. In this section I flesh out this latter idea.

I start with the proposal that object nouns in Nez Perce have a special status: they alone denote sets of atoms in their root form. By 'root form' I mean the core open-class lexical representation of the noun, which may or may not be semantically equivalent to the noun root once it has combined with various (perhaps silent) pieces of functional morphology. Following the practice of Distributed Morphology, I will indicate noun roots using the symbol $\sqrt{}$. In this notation, my proposal is that roots like $\sqrt{}$*picpic* 'cat' and $\sqrt{}$*tiim'en'es* 'pencil' have quantized denotations.

In contrast to object nouns, the roots of substance nouns do not denote sets of atoms; their denotations are homogeneous (both cumulative and divisive). On this hypothesis, the meanings of core English count roots and mass roots are (in mereological terms) identical with those of their Nez Perce counterparts: $\sqrt{}$*cat* and its Nez Perce counterpart $\sqrt{}$*picpic* both have quantized denotations, whereas $\sqrt{}$*blood* and its Nez Perce counterpart $\sqrt{}$*kike't* both have homogeneous denotations.

(18) $[\![\sqrt{}\textit{cat}]\!] = [\![\sqrt{}\textit{picpic}]\!] =$ (the characteristic function of) the set of all cat-atoms

(19) $[\![\sqrt{}\textit{blood}]\!] = [\![\sqrt{}\textit{kike't}]\!] =$ (the characteristic function of) the set of all portions of blood

Pluralization and counting with substance nouns is more flexible in Nez Perce than in English because Nez Perce allows a more general type of homogeneous→quantized meaning shift than English does. The shift that Nez Perce makes available is fully productive (unlike English packaging and sorting coercions), so there is little cause to record it in the lexical entries of nouns. In principle, it could be accomplished purely in the semantic component, by the analogue of a type-shifting rule; it could alternatively be accomplished in the ordinary compositional semantics with the help of a silent syntactic piece. I will provide an implementation of the latter type.

My proposal, then, is that pluralization and counting with substance nouns involves a silent piece α_n, which attaches between the core NP and numerals, [PL], or count adjectives. The role of α_n is to map homogeneous denotations to quantized ones. This mapping must make room for context sensitivity: *'ipeex̂* 'bread', for instance, can take on a quantized denotation consisting of bread loaves, or one consisting of bread slices.

(20) a. Out of the blue: 'Iin-im wee-s piilept 'ipeex̂.
1SG-GEN have-PRES four bread
(lit. I have four bread.)
ARD: Would you think I have four slices or four loaves?
Speaker: Four loaves.

b. We are making sandwiches and I say: Pii-'ni-m lepit 'ipeex̂!
2/1-give-CISLOC.IMPER two bread
(lit. Give me two bread!)
ARD: What would you give me?
Speaker: If I heard that, I'd probably figure you wanted slices.

Let us then treat α_n as introducing a variable over atomization functions AT. At minimum, an atomization function must meet two conditions: atoms must instantiate the property of which they are an atomization, and no element of an atomization may have a proper part which is also an element of that atomization. (22b) ensures that the atomization of any property is quantized.

(21) $[\![\alpha_n]\!]^g = \lambda P \lambda x . AT_n(P)(x)$ *where AT_n = g(n) = the n^{th} atomization function*

(22) Conditions on atomization functions:
a. $AT_n(P)(x) \rightarrow P(x)$
b. $AT_n(P)(x) \rightarrow \neg\exists y[y \neq x \wedge y \leq x \wedge AT_n(P)(y)]$

We will now see how this proposal accounts for combinations of substance nouns with numerals, [PL], and count adjectives. Substance root $\sqrt{}$*kike't* 'blood' combines with a numeral in (9a), repeated below along with the LF structure of the substance nominal. (I assume, following Krifka (1989), that no [PL] feature is present at LF in nominals with numerals. Morphological plural as

in *two cats* results from PF agreement processes.) Sentence (23a) is true in a context iff there are at least two elements of the contextually-provided atomization of *blood* that fell.[8]

(23) a. Lepit kike't hi-sew-n-e.
two blood 3SUBJ-fall-P-REM.PAST
Two drops of blood fell.

b. [*lepit* 'two' [Num:− [α_n $\sqrt{}$*kike't* 'blood']]

(24) $|\{x : AT_n(blood)(x) \wedge fell(x)\}| \geqslant 2$

Substance root $\sqrt{}$*sitx̂* 'mud' combines with plural in (15a), repeated below along with the LF structure of the substance nominal. (I depict the adjective $\sqrt{}$*'ilp'ilp* 'red' as attaching below α_n, but this choice is not crucial.) Supposing plural contributes Link's (1983) * operator (simple closure under sum), the sentence is true iff there is an element of $^*AT_n(\lambda x.red(x) \wedge mud(x))$ that is slippery on the road, (26).

(25) a. He-'ilp-e-'ilp **sitx̂** hii-we-s x̂uysx̂uys 'iskit-pe.
PL-red mud 3SUBJ-be-PRES slippery road-on
There are red muddy spots that are slippery on the road.

b. [Num: [PL] [α_n $\sqrt{}$*'ilp'ilp* 'red' $\sqrt{}$*sitx̂* 'mud']]

(26) $\exists y[^*AT_n(\lambda x.red(x) \wedge mud(x))(y) \wedge$ ***slippery-on-the-road***$(y)]$

Finally, substance root $\sqrt{}$*kuus* 'water' combines with a count adjective in (16a), again repeated below with its LF structure. (I ignore the possible definite reading here, which presumably results either from a null D or from an ι type-shift.)

(27) a. himeeq'is kuus
big water
(the) big portion of water

b. [$\sqrt{}$*himeeq'is* 'big' [α_n $\sqrt{}$*kuus* 'water']]

We learn from examples like *small furniture* that count adjectives do not require their complements to be quantized *per se*; their distinctive property relates strictly to parts, rather than to sums. For concreteness, let us suppose that adjectives like *himeeq'is* 'big' lexically presuppose that their complements' denotations contain minimal parts, (28). Unlike $\sqrt{}$*'ilp'ilp* 'red' in (25), which in principle could attach either above or below α_n, $\sqrt{}$*himeeq'is* 'big' can only attach above α_n, where its complement denotes $\lambda x.AT_n(water)(x)$. Thus (27b) denotes the property of being big and an element of the contextually-provided atomization of *water*, (29).

[8] Note that $\geqslant$ in (24) represents the inequality relation, by contrast to the mereological parthood relation $\leq$.

(28) $[\![\sqrt{\textit{big}}]\!] = [\![\sqrt{\textit{himeeq'is}}]\!] =$
$\lambda P \lambda z : \exists X[X \neq \emptyset \wedge \forall x \in X[P(x) \wedge \neg \exists y[y \neq x \wedge y \leq x \wedge P(y)]]].\ P(z) \wedge big(z)$

(29) $\lambda z.AT_n(water)(z) \wedge big(z)$

We have now seen how the results of the previous section can be made compatible with the hypothesis that Nez Perce indeed makes semantic countability distinctions in its nominal lexicon. On this hypothesis, Nez Perce nouns come to denote sets of atoms in two distinct ways. Object nouns are born that way – their roots come from the lexicon already quantized – but substance roots must use α_n. Nouns also come to have cumulative denotations in two distinct ways. Substance nouns are born that way – their roots come from the lexicon already homogeneous – but object roots must combine with a semantically interpreted [PL]. The situation is summarized in table (30).

(30)

Denotation is a set of atoms	*Denotation is a join semilattice*
Substance root + α_n	Substance root by itself
Object root by itself	Object root + [PL]

On this approach, the reason that Nez Perce appears to lack any countability distinctions is simply that α_n is always inaudible. The complements of numerals, [PL] Num, and count adjectives are all environments in which a nominal denotation must come from the left-hand column in (30). It happens that Nez Perce morphology does not visibly distinguish the simplex forms in this column (object roots) from the complex ones (substance roots + α_n).

It is time now to consider the right-hand column in (30) – the column which crucially features [PL]. Unlike α_n, [PL] is an element that Nez Perce sometimes makes overt. To see a first difference emerge between object and substance roots, we need to find an area of the grammar that calls for cumulative predicates. Object roots should require plural in such cases, but substance roots should not. Quantificational structures provide the environment that bears out this prediction.

5. Cumulativity and the quantifier system

Nez Perce has six D-quantifiers. Two of these are universal quantifiers (the difference between which is not presently clear); others are translation equivalents of 'a lot / many / much', 'a few / a little', 'how many / how much', and a partitive 'some'.[9]

(31)

'oykala	la'am	'ilex̂ni	miil'ac	mac	tato's
all_1	all_2	a lot	a few/little	how many/much	some (of)

[9] All quantifiers show a special form for gender concord with [+HUMAN] nouns, featuring an agreement suffix which is underlyingly *-me* or *-we*. Gender concord with [+HUMAN] nouns is generally optional (see Deal 2016).

All quantifiers combine with all nouns, and (crucially) all quantifiers require cumulative complements. We will now see that object- and substance-roots give rise to cumulative NPs in different ways. Object roots require [PL] to be cumulative, but substance roots are simply born cumulative.

All quantifiers require their object NP complements to contain [PL]. Accordingly, nouns that have plural forms must take those forms when preceded by a quantifier, (32). Recall that all such nouns are [+HUMAN]. Plural is also morphologically visible if the NP contains an adjective, as in (33); the plural form of the adjective is systematically preferred in [Q A N_{object}] constituents. The schematic LF structure of these examples is shown in (34). Overall, we see a consistent pattern across the set of object nouns: [PL] must be present in the complement of a quantifier.

(32) a. ’oykal-o ha-’aayat/*’aayat
all$_1$-HUM PL-woman/*woman.SG
all the women

b. ’ilex̂ni ha-ham/*haama
a.lot PL-man/*man.SG
a lot of men

(33) a. ’oykala ??k’uupnin’ / k’i-k’uupnin’ tiim’en’es
all$_1$ broken / PL-broken pencil
all broken pencils

b. ’ilex̂ni ??tiyaaw’ic / ti-tiyaw’ic wix̂si’likeecet’es
a.lot ??sturdy / PL-sturdy chair
a lot of sturdy chairs

(34) [Q [Num: [PL] [($\sqrt{}$ADJECTIVE) $\sqrt{}$OBJECT-ROOT]]]

The behavior of substance NPs with quantifiers is sharply contrasting. *All quantifiers combine with substance NPs that do not contain* [PL]. Here, there is no preference for plural adjectives:

(35) a. ’oykala ta’c hipt
all$_1$ good food
all good food

b. ’ilexni yoosyoos tiipip
a.lot blue frosting
a lot of blue frosting

The LF structure of these examples contrasts with (34) in lacking a [PL] feature on Num. Num contains no contentful features in this case:

(36) [Q [Num: – [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]

These facts show that what Nez Perce quantifiers require of their complements is not plurality but cumulativity. They require object roots to combine with plural, but they impose no such requirement on substance roots. The pattern is one familiar from quantifiers in various languages,

including English. It is precisely the contrast between *all blood* and *all cat*(s)*. Nez Perce presents a highly generalized version of this pattern, extending it to all D-quantifiers.

The data thus far concern whether [PL] is *mandatory* in the complement of a quantifier, not whether it is merely possible. Should we expect [PL] to be available in the complement of a quantifier when the root is a substance noun? Indeed we should, given that substance roots may freely combine with α_n. A substance root in combination with α_n has a non-cumulative denotation, like an object root on its own. Accordingly, it must combine with [PL] in a quantifier complement.

As expected, we find that substance roots may coexist with [PL] in quantifier complements, and whenever they do, an atomized reading surfaces for the substance noun. Compare (37), with a non-plural adjective and a substance noun, to the minimally different (38), where the adjective is marked plural. In (37), the quantifier is able to combine directly with the NP because the NP denotation is cumulative. Num contributes no content. In (38), by contrast, the substance NP combines with α_n, inducing an atomization of $\lambda x.black(x) \wedge fabric(x)$. The atomized property is not cumulative and therefore must combine with plural before it combines with the quantifier.

(37) a. ’ileχ̂ni cimuuxcimux samq’ayn
a.lot black fabric
a lot of black fabric

b. [Q [Num: – [$\sqrt{}$*cimuuxcimux* ‘black’ $\sqrt{}$*samq’ayn* ‘fabric’]]]

c. $Q(\lambda x.black(x) \wedge fabric(x))$

(38) a. ’ileχ̂ni cicmuxcicmux samq’ayn
a.lot PL.black fabric
a lot of pieces of black fabric

b. [Q [Num: [PL] [α_n [$\sqrt{}$*cimuuxcimux* ‘black’ $\sqrt{}$*samq’ayn* ‘fabric’]]]]

c. $Q(^*AT_n[\lambda x.black(x) \wedge fabric(x)])$

The overall empirical picture on combinations of quantifiers, adjectives and nouns is summarized in table (39). LF structures for the three well-formed options are given in (34) (cell B), (36) (cell C) and (38b) (cell D). The missing cell, cell A, corresponds to LF structure (40).

(39) Quantifier, adjective, noun: grammaticality judgments

	Q A(non-pl) N	Q A.pl N
Complement headed by object $\sqrt{}$	* CELL A	✓ CELL B
Complement headed by substance $\sqrt{}$	✓ CELL C	✓ (α-based structure) CELL D

(40) [Q [Num: – [$\sqrt{}$ADJECTIVE $\sqrt{}$OBJECT-ROOT]]] ✗

Structure (40) is ill-formed because the complement of the quantifier is not cumulative. The crucial contrast is between this structure and the minimally different (36) with a substance root. The contrast is explained by treating object roots as basically quantized and substance roots as basically cumulative. In sum: Nez Perce has a countability distinction in terms of cumulativity.

6. Divisiveness and quantity comparatives

Recall that comparatives furnish a diagnostic for minimal parts based on the particular scale involved in the comparison. In English, quantity comparisons with nouns like *cat* and *footwear* are assessed on a scale of numerosity, whereas those with nouns like *water* are assessed on a scale of volume. According to Bale and Barner (2009), comparatives like (4) involve a measure function variable μ, relating the set of cats/instances of footwear/portions of water that Mary has and the set of cats/instances of footwear/portions of water that Sue has. Iff the two sets contain atoms, μ is fixed as the numerosity comparison function m_1. Otherwise, μ is contextually determined, and may be fixed in various contexts as volume comparison, etc.

(41) $m_1(X)(Y)$ =1 iff X and Y are join semi-lattices and $|\{x : x \text{ is an atom in } X\}| > |\{y : y \text{ is an atom in } Y\}|$

In Nez Perce, quantity comparatives are formed using the quantifier *'ileχ̂ni* 'a lot' together with comparative word *qetu* '-er'.[10] A simple example featuring a substance noun is provided in (42). (For reasons to become clear, I temporarily withhold a free translation.)

(42) A-nm 'uu-s qetu 'ileχ̂ni kuus B-x.
A-GEN have-PRES COMP a.lot water B-from

Suppose the measure of comparison for this example is numerosity: A must have more portions of water than B does. This suggests that the two sets under comparison contain atoms. But how does the grammar provide these two sets? One possibility is that $[\![\sqrt{}\textit{kuus}]\!]$ 'water' contains atoms; the noun combines directly with *qetu 'ileχ̂ni* 'more'. On this hypothesis, the atoms used for numerosity comparison come directly from the root denotation. Another possibility is that $[\![\sqrt{}\textit{kuus}]\!]$ 'water' is homogeneous and the combination of the noun and quantifier is mediated by α_n; the atoms used for numerosity comparison come from α_n in combination with the root.

Our investigation of quantifiers and cumulativity has revealed a method for empirically distinguishing these two hypotheses. We have seen that all Nez Perce quantifiers require their complements

[10] This corresponds straightforwardly to Bresnan's (1973) decomposition of English *more* as *many/much + -er*. Similarly, Nez Perce 'less' comparatives feature *qetu* '-er' plus *miil'ac* 'few/little'.

to be cumulative. This holds of *'ilex̂ni* 'a lot'; presumably it holds no less of complex quantifier *qetu 'ilex̂ni* 'more'. If the complement of *qetu 'ilex̂ni* 'more' must be cumulative, it cannot simply consist of a substance root plus α_n. [PL] must be present in the complement of the quantifier whenever α_n is. The two candidate LFs for the relevant portion of (42) are thus as shown in (43). When adjectives are introduced, the result is (44), matching what we saw in (37b) and (38b).

(43) a. **Hypothesis 1:** [*qetu 'ilex̂ni* 'more' [Num: - [$\sqrt{}$*kuus* 'water']]]
b. **Hypothesis 2:** [*qetu 'ilex̂ni* 'more' [Num: [PL] [α_n $\sqrt{}$*kuus* 'water']]]

(44) a. [Q [Num: – [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]
b. [Q [Num: [PL] [α_n [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]]

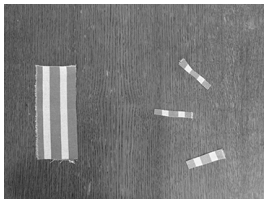
Structures (44) are empirically distinguishable: the presence of an adjective makes it possible to morphologically assess whether or not [PL] is present. In turn, if we know that [PL] is present with a substance root in a quantifier complement, we know that α_n is present. We can therefore assess the hypothesis that numerosity comparison with substance nouns requires α_n by assessing whether numerosity comparison with substance nouns requires an adjective to mark plural.

Here are the predictions, in sum: if $[\![\sqrt{}$*kuus*$]\!]$ 'water' is atomic (cf. $[\![\sqrt{}$*furniture*$]\!]$), then numerosity comparison should be possible in structure (44a). In this structure an adjective cannot be marked plural. (There is no [PL] feature to be transferred to the adjective by concord.) If, on the other hand, $[\![\sqrt{}$*kuus*$]\!]$ 'water' is non-atomic (cf. $[\![\sqrt{}$*water*$]\!]$), numerosity comparison should be possible only in structure (44b). In this structure an adjective must be marked plural.

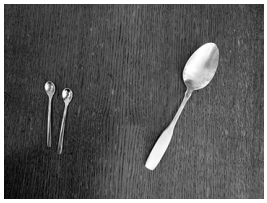
These predictions were tested using the quantity judgment paradigm introduced by Barner and Snedeker (2005). Seven test stimuli were constructed, featuring seven substances named by common Nez Perce words: dirt (*'itx̂*), flour (*tuutnin'*), milk (*qahas*), cloth (*samq'ayn*), paper (*tii'men'es*), water (*kuus*) and sugar (*cicyuuk'is*). Each stimulus showed one side with a larger number of portions and one side with a greater overall volume of substance. The stimuli consisted of photographs on a wooden surface. Two example stimuli are shown in (45a,b). In addition to these test items, 10 additional stimuli were constructed, featuring objects rather than substances. An example is shown in (45c). The 17 photographs were arranged in pseudo-randomized order, varying objects versus substances as well as the side of the larger object/portion.

(45) Sample photos used in quantity judgment task

(a) *qahas* 'milk'



(b) *samq'ayn* 'fabric'



(c) *soox̂* 'spoon'

While looking at each picture, Nez Perce speakers provided answers to quantity judgment questions featuring adjectives and nouns. In line with previous findings, quantity judgments with object nouns were reliably assessed in terms of number. Recall that a [Q A N_{object}] constituent always requires the adjective to be plural (table (39)). A question with an object root is shown in (46) with the corresponding schematic LF. Comparison in terms of numerosity is correctly predicted here because $[\![\sqrt{}$*'ileeptik'ey*$]\!]$ 'sock' contains atoms.

(46) Object root condition

a. 'Isii-nm 'uu-s qetu 'ileχ̂ni ti-ta'c 'ileeptik'ey?
who-GEN have-PRES COMP a.lot PL-good sock?
Who has more good socks?

b. [*qetu 'ileχ̂ni* 'more' [Num: [PL] [$\sqrt{}$ADJECTIVE $\sqrt{}$OBJECT-ROOT]]]

When a quantifier's complement is headed by a substance noun, an adjective contained in that complement need not be plural (see table (39)). To assess the atomicity of substance root denotations, the baseline condition, shown in (47), was a plural adjective condition. (The pluralized adjective is bolded.) Plural morphology on the adjective indicates the presence of [PL]; in a quantifier complement headed by a substance noun, this requires α_n.

(47) Plural adjective / substance root condition

a. 'Isii-nm 'uu-s qetu 'ileχ̂ni **ti-ta'c** qahas?
who-GEN have-PRES COMP a.lot PL-good milk?
Who has more portions of good milk?

b. [*qetu 'ileχ̂ni* 'more' [Num: [PL] [α_n [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]]

Given that α_n is present, the complement of the quantifier has atoms in its denotation, and numerosity-based answers are predicted. This prediction is borne out: answers in the plural adjective / substance noun condition were strictly based on numerosity, not volume (100% of responses).

To compare Hypotheses 1 and 2 in (43)/(44), the crucial test case is the non-plural adjective / substance root condition, (48). Here, the absence of plural morphology on the adjective indicates the absence of [PL]. Without [PL], α_n cannot be present in a quantifier complement. Therefore, the interpretation of the quantity comparison must be based on the denotation of the root alone.

(48) Non-plural adjective / substance root condition

a. 'Isii-nm 'uu-s qetu 'ileχ̂ni **ta'c** qahas?
who-GEN have-PRES COMP a.lot good milk?
Who has more good milk?

b. [*qetu 'ileχ̂ni* 'more' [Num: – [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]

The finding in this condition contrasts markedly with the plural adjective / substance root condition (47). Answers in the non-plural adjective / substance root condition were based strictly on volume, rather than numerosity (100%). This provides evidence that substance roots by themselves do not have denotations that include atoms. That contrasts with object roots, as shown in (46). The results are summarized in table (49).

(49) Quantifier, adjective, noun: interpretation of comparison

	Q A(non-pl) N	Q A.pl N
Complement headed by object √	n/a (ill-formed)	**number** (46)
Complement headed by substance √	**volume** (48)	**number** (47)

The findings should be contrasted with the predictions that would be made if all nouns had atomic denotations in Nez Perce: we would expect numerosity-based comparison across the board. In actual fact, numerosity comparison somehow becomes unavailable when the quantity judgment question contains a substance root with a non-plural adjective. The overall conclusion is that Nez Perce noun roots show a countability distinction in terms of minimal parts.

7. Implications

The subtlety of the evidence for countability distinctions in Nez Perce raises serious questions for language acquisition. How exactly do learners arrive at quantized denotations for object roots but homogeneous denotations for substance roots? Must they consider (and somehow rule out) the hypothesis that the language they are learning has no countability distinctions at all? The decision could be made on the basis of linguistic input only if learners have sufficient exposure to [Q A N] constituents. A corpus study of the largest collection of Nez Perce texts suggests that learners may have little to no exposure of this type. Of the 403 quantifiers identified in the corpus, none occurred in a [Q A N] constituent (Deal To appear).

The alternative hypothesis is that learners do not acquire semantic countability distinctions from primary linguistic input. The distinctions arise instead from basic mechanisms of language acquisition. Soja et al. (1991) and Chierchia (1994) discuss a mechanism of precisely the relevant type. To acquire root meaning early in acquisition, children build on the cognitive distinction between substances and objects. When a new noun describes an object, they conclude that the extension of the root consists of atoms of the same type as that object. When a new noun describes a sample of substance, they conclude that the extension of the root consists of a homogeneous join semilattice of stuff of the same kind as that substance. If these strategies are *independent of* exposure to any particular language and *carried out prior* to the point at which children master the morphosyntax of countability (as Soja et al.'s experimental findings suggest), then we expect the resulting semantic encoding of countability distinctions to be a language universal.

This final conclusion does *not* mean, in Chierchia's (2010) terms, that "every language encodes [countability distinctions] in a number of conspicuous morphosyntactic ways." Nez Perce in fact shows us that that type of obvious encoding cannot be taken for granted. The real universal is more subtle and more interesting. It is in what nouns mean, not directly in their surface distribution. Only where we can actually tell apart root semantics from the semantics of roots plus hidden functional morphology should we expect to see a countability distinction universally emerge.

References

Bale, A. and D. Barner (2009). The interpretation of functional heads: using comparatives to explore the mass/count distinction. *Journal of Semantics 26*, 217–252.

Barner, D. and J. Snedeker (2005). Quantity judgments and individuation: evidence that mass nouns count. *Cognition 97*, 41–66.

Bresnan, J. (1973). Syntax of the comparative clause construction in English. *LI 4*, 275–343.

Cheng, C. (1973). Response to Moravscik. In *Approaches to natural language*, pp. 286–288.

Chierchia, G. (1994). Syntactic bootstrapping and the acquisition of noun meanings: the mass-count issue. In *Syntactic Theory and First Language Acquisition*, pp. 301–318. Erlbaum.

Chierchia, G. (1998). Reference to kinds across languages. *NLS 6*, 339–405.

Chierchia, G. (2010). Mass nouns, vagueness and semantic variation. *Synthese 174*, 99–149.

Deal, A. R. (2010). *Topics in the Nez Perce verb*. Ph. D. thesis, UMass Amherst.

Deal, A. R. (2016). Plural exponence in the Nez Perce DP: a DM analysis. *Morphology*, in press.

Deal, A. R. (To appear). Countability distinctions and semantic variation. *Natural Language Semantics*.

Doetjes, J. (1997). *Quantifiers and Selection*. The Hague: Holland Academic Graphics.

Grimm, S. (2012). *Number and individuation*. Ph. D. thesis, Stanford.

Krifka, M. (1989). Nominal reference, temporal constitution and quantification in event semantics. In *Semantics and Contextual Expression*, pp. 75–115. Foris.

Landman, F. (2011). Count nouns, mass nouns, neat nouns, mess nouns. In *Formal semantics and pragmatics*, Manhattan, KS. New Prarie Press.

Lima, S. (2014). *The grammar of individuation and counting*. Ph. D. thesis, UMass Amherst.

Link, G. (1983). The logical analysis of plurals and mass terms: A lattice-theoretical approach. In R. Bäuerle (Ed.), *Meaning, Use and Interpretation of Language*, pp. 302–323. DeGruyter.

Pelletier, F. J. and L. Schubert (1989/2003). Mass expressions. In F. Guenthner and D. Gabbay (Eds.), *Handbook of Philosophical Logic* (2nd ed.), Volume 10, pp. 249–336. Kluwer.

Quine, W. (1960). *Word and object*. Cambridge, MA: MIT Press.

Ritter, E. (1991). Two functional categories in the noun phrase: evidence from Modern Hebrew. In S. Anderson and S. D. Rothstein (Eds.), *Syntax and semantics 25*, pp. 37–62.

Sauerland, U. (2003). A new semantics for number. In *Proceedings of SALT 13*, pp. 258–275.

Schwarzschild, R. (2011). Stubborn distributivity, multiparticipant nouns and the count/mass distinction. In *NELS 39 proceedings*, Amherst, pp. 661–678. GLSA.

Soja, N. N., S. Carey, and E. Spelke (1991). Ontological categories guide young children's inductions of word meaning: object terms and substance terms. *Cognition 38*, 179–211.