

## Zero, null individuals, and nominal semantics in Cantonese\*

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**Abstract** It has been convincingly argued that English *zero* provides evidence for introducing null individuals into the ontology of natural language (Bylina & Nouwen 2018). We examine ‘zero’ in Cantonese, where it provides evidence that such null individuals are a matter of crosslinguistic variation. Cantonese zero has a more restricted distribution. It occurs widely in a number of contexts, but it is systematically ruled out with (normal) classifiers. These facts, coupled with assumptions about the nature of measurement and nominal semantics, demonstrate despite its extensive use in the language, zero is impossible in precisely the uses that require null individuals. Cantonese seems to be telling us that such null individuals are simply absent from its ontology, implying an interesting difference in natural language metaphysics between the languages—and perhaps a different perspective on what theoretical shape crosslinguistic variation can take.

**Keywords:** numerals, zero, plurality, Cantonese, natural language metaphysics, semantic variation

### 1 Introduction

There appears to be a close connection between *zero* and other numerals in English. They certainly seem to appear in similar syntactic contexts (modulo some interesting exceptions; Chen 2018):

- (1) a. Three dogs barked.
- b. Zero dogs barked.

Whatever the syntactic connections, however, it would seem that their semantics cannot be similarly parallel. A standard denotation for (1a) would require that there be a plural individual made up of dogs that barked whose cardinality is 3, as in (2a):

- (2) a.  $\exists x[\mathbf{dogs}(x) \wedge \mathbf{barked}(x) \wedge |x| = 3]$
- b.  $\exists x[\mathbf{dogs}(x) \wedge \mathbf{barked}(x) \wedge |x| = 0]$  *(for illustration only)*

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But taking the same path for *zero*, as in (2b), yields an odd result: a denotation that would require that there be such a plural individual that has no members. But this is odd in two ways. First, it requires that there be plural individuals composed of no members, contrary to standard conceptions of plural individuals like that of Link (1983). This certainly something one might imagine in principle, and some have (Champollion & Krifka 2015, Nouwen 2015), but it is metaphysically spooky, an ‘ontological oddity’ in Bylinina & Nouwen’s own words. Second, even if we were to assume that such individuals exist, the result would be completely uninformative. If exactly four dogs barked, it will necessarily also be possible to find a three-membered plurality of dogs that barked (and a two-membered one and so on). And for similar reasons, if we allow zero-membered pluralities, it will also be possible to find a zero-membered plurality of dogs that barked. Put another way, this approach yields an ‘at least’ reading for numerals, and it will always be the case that at least zero dogs barked, irrespective of how many dogs barked. This would seem to point toward an approach that treats *zero* as a negative quantifier instead.

Nevertheless, the grammatical parallel is so close it leads Bylinina & Nouwen to pursue a numeral analysis like (2b) even in the face of these facts, and they argue convincingly that such an analysis—suitably elaborated—is actually the more enlightening one. It rests on an important assumption that will be our starting point. We will call it the Null Individual Hypothesis:

(3) THE NULL INDIVIDUAL HYPOTHESIS

The ontology of natural language includes plural individuals with no members.

If this hypothesis is true, it is a fact about the structure of the model underlying the semantics, a fact about natural language metaphysics. It’s not typical to suppose that the model underlying the semantics varies from one language to another in this way. This is partly convention. It’s also partly because of the tradition inherited from philosophy that the model *is* the actual world and not merely a cognitive representation of it. And it’s partly because—whatever our assumptions—the world in which all speakers live is approximately the same. So if the Null Individual Hypothesis is true for English, it should be true across languages, and we should be able to find evidence for it everywhere.

Our aim here will be to hunt for evidence of null individuals in Cantonese. What we find is that there is indeed extensive use of ‘zero’, largely in ways consistent with the numeral-based approach Bylinina & Nouwen establish for English. But crucially, despite this, there is no evidence for null individuals in Cantonese. This result is striking because it suggests a parametric difference between the languages that really is at the level of the model: the Null Individual Hypothesis is true for

English but false for Cantonese, making it a Null Individual Parameter.

To make the case, we lay out the distribution of ‘zero’ in Cantonese in section 2, demonstrating that it is a robustly productive part of the language and very much conceptually available, as much as any ordinary numeral, though it is not indistinguishable from ordinary numerals in its distribution. In section 3, we lay the groundwork by sketching the Bylinina & Nouwen approach in more detail. In section 4, we present the principal part of our analysis, a treatment of classifiers and of what we’ll call UNIT NOUNS. We offer some notes on the analysis of what we’ll call CHANCE NOUNS in section 5. Section 6 concludes by returning to the Null Individual Hypothesis, reflecting what it might reveal about how languages vary.

## 2 Cantonese zero: the data

The temptation to regard ‘zero’ as a negative quantifier is great, so we’ll first offer one piece of evidence for this. Of course, ultimately, the choice has to be made by articulating both approaches and selecting the more explanatory and economical, which can only be done by considering the full range of data as a whole.

First, an English fact. One of Bylinina & Nouwen’s most consequential empirical observations is that English *zero* is not a negative quantifier. That’s apparent in part because it doesn’t license negative polarity items such as *any* or *at all* (but see [Chen 2018](#) for important possible counterevidence):

- (4)  $\left\{ \begin{array}{l} \text{No} \\ \text{*Zero} \end{array} \right\}$  students bought any car at all.

The ‘zero’ of Cantonese, *ling4*, likewise fails to license them:

- (5) #ling4 gei1 wui2 gaa1 jam6 ho4 sik1  
 zero chance add any interest rate  
 ‘zero chance lift any interest rate’

So as in English, there is reason in Cantonese to explore another analytical direction.

To discern the relationship between ‘zero’ and ordinary numerals, it will be necessary to register how ordinary numerals work. As is widely known, numerals in Cantonese generally require a classifier (a vast literature attests to this, but some landmarks include [Chierchia 1998](#) and [Cheng & Sybesma 1999](#)):

- (6) a. leong5 go3 pang4 jau5  
 two CL.unit friend  
 ‘two friends’

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- b. jat1 zek3          gau2  
one CL.livestock dog  
'one dog'

Here we encounter the first wrinkle. Cantonese 'zero' is odd with classifiers:

- (7) a. #ling4 go3      pang4 jau5  
zero CL.unit friend  
'zero friends'  
b. #ling4 zek3          gau2  
zero CL.livestock dog  
'zero dogs'

So does that suggest that 'zero' is not numeral-like in Cantonese after all?

To provide an answer, it will be necessary to introduce an important distinction in the grammar of Cantonese nominals. For CONCRETE NOUNS like 'friends' and 'dogs' in (7), a classifier is indeed necessary to introduce a numeral. But there is another class of expressions, which we'll call UNIT NOUNS, which include words for 'calories', 'age', 'grade points', and the like. These are the rough counterparts in Cantonese of English unit or measure terms like *inch* or *pound*. Our proposed term 'unit noun' is not ideal, because the analysis we'll pursue assimilates them to classifiers rather than to (ordinary) nouns—and of course, not coincidentally, the counterparts in Cantonese of measure terms are also classifiers.

With unit nouns, the facts are reversed. For concrete nouns, a numeral can only be introduced in the presence of a classifier. For unit nouns, a numeral can only be introduced in the *absence* of one:

- (8) a. sap6 ng5 fan1  
ten five grade  
'fifteen grade points'  
b. ji6 sap6 kaa1 lou6 leoi5  
two ten calories  
'twenty calories'  
c. saam1 seoi3  
three age  
'three years old'

Introducing a classifier into (8a), for example, results in ungrammaticality:

- (9) #sap6 ng5 go3 fan1  
 ten five CL.unit grade  
 ‘fifteen grade points’

So ordinary numerals and unit nouns seem to be in complementary distribution.

But surprisingly, with unit nouns ‘zero’ is possible:

- (10) a. ling4 fan1  
 zero grade  
 ‘zero grade points’  
 b. ling4 kaa1 lou6 leoi5  
 zero calories  
 ‘zero calories’  
 c. ling4 seoi3  
 zero age  
 ‘zero years old’

The interpretation here is numeral-like rather than like a negative quantifier. To say that a student received a grade of 0 is not to say that a student received no grade. We’ll return to this point in section 4.

There is a third class of nouns that we will need to distinguish. We’ll call these CHANCE NOUNS, because ‘chance’ is a clear exemplar of this class. Others include ‘probability’, ‘trust’, and ‘confidence’. Like concrete nouns, these nouns require a classifier to combine with ordinary numerals:

- (11) a. leong5 ci3                    gei1 wui2  
 two CL.instance chance  
 ‘two chances’  
 b. #leong5 gei1 wui2  
 two chance  
 ‘two chances’

It’s worth highlighting, though, that the readings that arise with a non-zero numeral are often not quite the same as the ones that occur with zero, and some nouns—such as *seon3 jam6* ‘trust’—are simply impossible with numerals greater than or equal to 1. With ‘zero’, the picture is again reversed. Chance nouns allow ‘zero’ in the absence of a classifier:

- (12) a. ling4 gei1 wui2  
 zero chance  
 ‘zero chance’

- b. ling4 seon3 jam6  
 zero trust  
 ‘zero trust’

Indeed, chance nouns *prohibit* classifiers with ‘zero’:

- (13) a. #ling4 ci3            gei1 wui2  
          zero CL.instance chance  
          ‘zero chance’  
       b. #ling4 go3        seon3 jam6  
          zero CL.unit trust  
          ‘zero trust’

As an aside, it’s not just ‘zero’ that has this distribution. Proportional numerals like percentages and fraction terms like ‘one-third’ are also possible with chance nouns—again, only in the absence of a classifier. That’s one reason to suspect that that this distinction is not about negative quantifiers versus numerals, but rather between *varieties* of numerals (for much more on distinctions of this sort, see [Gobeski & Morzycki to appear](#)). Another reason is that again, to say that something has a likelihood of zero is not to say that it doesn’t have any likelihood at all.

English is like Cantonese in the behavior of its chance nouns. As [Chen \(2018\)](#) observed, *confidence* can occur with *zero* in English and not other numerals:

- (14) Floyd has  $\left\{ \begin{array}{l} \text{zero} \\ \#one \\ \#two \end{array} \right\} \left\{ \begin{array}{l} \text{confidence in himself} \\ \text{tolerance of rain} \\ \text{interest in physics} \\ \text{sense of fashion} \end{array} \right\}.$

Chen also notes that in contexts like these, *zero* often has an emphatic flavor. That’s also true in Cantonese, though we will not attempt a distinct analysis of this fact. It seems likely that it’s a Gricean effect, arising from having chosen the mathematically-flavored *zero* over the more typical *no*. Where appropriate conceptual measures are in principle available, English is also like Cantonese in permitting proportional numerals with chance nouns:

- (15) Floyd has a  $\left\{ \begin{array}{l} \text{zero} \\ 50\% \\ \#two \end{array} \right\} \left\{ \begin{array}{l} \text{chance} \\ \text{probability} \end{array} \right\}$  of winning the game.

For this reason, our suggestions in section 5 about how chance nouns work in Cantonese could reasonably be extended to English as well.

In a nutshell, then, the facts are these:

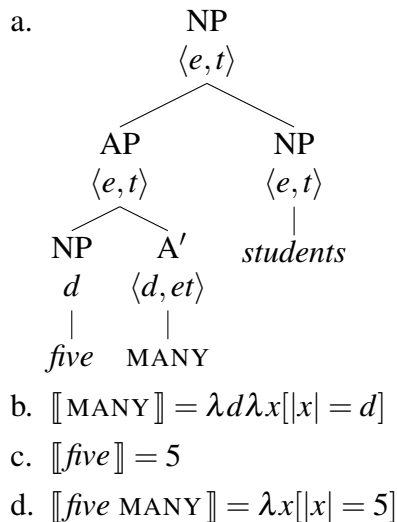
- (16) a. **With concrete nouns**, ordinary numerals require a classifier and zero is impossible.
- b. **With unit nouns**, ordinary numerals and zero both prohibit a classifier.
- c. **With chance nouns**, ordinary numerals require a classifier and zero prohibits one.

### 3 Laying the groundwork: Bylinina & Nouwen on ‘zero’

The foundation on which we’ll be building is Bylinina & Nouwen, so it will be necessary to briefly summarize their approach to English *zero*.

First, they adopt one standard conception of numerals that treats them as measure phrases occupying the specifier position of an unpronounced adjective MANY (Bresnan 1973, Hackl 2000, Solt 2009). Assuming that this adjective denotes a relation between a degree and an individual (type  $\langle d, et \rangle$ ), the numeral itself can directly denote a degree:

- (17) Five students passed.



This yields a property denotation for *five MANY*, which can combine intersectively with the NP denotation, which is a property of pluralities of students.

This requires a nontrivial move in the NP as well. On its own, *student* denotes a property of atomic (i.e., single) students, not pluralities of them. So the plural morpheme has to be interpreted as moving from one to the other. Link (1983) represents this pluralizing operation with an operator  $*$ , which applies to a property of atomic individuals and yields a property that holds of a plural individual iff every individual part of that plural individual is one that satisfies the original property.

Bylinina & Nouwen represent Link's pluralization operator as in (18), where  $\sqcup X$  represents the result of joining every member of the set  $X$  together to assemble a plural individual (in (18) this is also formulated as a set rather than a function):

$$(18) \quad *Z \stackrel{\text{def}}{=} \{\sqcup X : X \subseteq Z \wedge X \neq \emptyset\}$$

Thus  $*Z$  is a set consisting of all individuals that can be formed by joining together (with the generalized join operator  $\sqcup$ ) the members of  $Z$ 's non-empty subsets. So **student** holds of any individual that's a student, and **\*student** holds of any non-empty plural individual made up only of students.

Returning to the computation, then, (17) will involve pluralizing *student* in this way, as in (19b), intersecting the result with  $\llbracket \text{five MANY} \rrbracket$  to yield (19c), and ultimately interpreting the result as the first argument of an implicit existential quantificational determiner to yield the sentence denotation in (19d):

- (19) a.  $\llbracket \text{student} \rrbracket = \mathbf{student}$   
 b.  $\llbracket \text{students} \rrbracket = \mathbf{*student}$   
 c.  $\llbracket \text{five MANY students} \rrbracket = \lambda x[|x| = 5 \wedge \mathbf{*students}(x)]$   
 d.  $\llbracket \exists \text{five MANY students passed} \rrbracket$   
 $= 1 \text{ iff } \exists x[|x| = 5 \wedge \mathbf{*students}(x) \wedge \mathbf{*passed}(x)]$

The next challenge is to extend this to *zero*.

For the most part, the story of *zero* can be perfectly identical, differing only in requiring a cardinality of 0 rather than of 5, except for one additional difference: as defined above, the Link-style denotation for  $*$  rules out zero-membered pluralities, and so pluralizing *student* in this way would not include zero-membered student pluralities and the sentence would be necessarily false, irrespective of the facts. Here, Bylinina & Nouwen introduce a crucial distinction. Instead of using Link's original  $*$ , whose definition they present as (20a) (this repeats (18)), they propose using instead a new pluralization operator  $\times$ , which they define as in (20b):

- (20) a.  $*Z \stackrel{\text{def}}{=} \{\sqcup X : X \subseteq Z \wedge X \neq \emptyset\}$   
 b.  $\times Z \stackrel{\text{def}}{=} \{\sqcup X : X \subseteq Z\}$

These differ only in whether the definition stipulates that the extension of the pluralized predicate excludes plural individuals assembled from the null set. This means that **\*student** will exclude zero-membered pluralities from its extension, but  **$\times$ students** will not.

Compositionally, everything apart from the pluralization operator is as before:



- (21) Zero students passed.
- a.  $\exists$  [ zero MANY ] students passed
  - b.  $\llbracket zero \rrbracket = 0$
  - c.  $\llbracket \exists$  [ zero MANY ] students passed  $\rrbracket$   
 $= 1$  iff  $\exists x[|x| = 0 \wedge \times\text{student}(x) \wedge \times\text{passed}(x)]$

Their ingenious move is just to introduce a slight change in what the pluralization operator means—indeed, apparently to simplify it, eliminating the superficially odd extrinsic stipulation that the null set has no corresponding plural individual. (We return to the question of relative naturalness in the following section.)

There is an element of the story that’s missing, and it is an important one—though it is also one for which we will have no need in this paper. This additional element is a theory of how we avoid the problem of a semantics that is so truth-conditionally weak as to be trivial. Again, the issue is that denotations like those pursued in this section give numerals an ‘at least’ interpretation rather than an ‘exactly’ one, even when an = is used, because any context in which there is a five-student plurality that passed is also necessarily one in which there is a four-student plurality that did so, even if only a four-student subplurality of the five-student one. But assigning *zero* an ‘at least’ reading renders a sentence trivially true. If no students passed, it’s true that there is a zero-student plurality that passed, and likewise too if five students passed.

The approach Bylinina & Nouwen take is to suppose that, in order to avoid a semantics that is unusably weak, an unpronounced exhaustivity operator (Chierchia 2004) negates all truth-conditionally stronger alternatives. If we think of any *zero* sentence as having in its alternative set meanings that involve every number other than zero as well, the exhaustivity operator would contribute the additional inference that any alternative truth-conditionally stronger than the meaning of the original sentence is false. Because the meaning ‘five students passed’ is stronger than ‘zero students passed’, the exhaustivity operator will negate it. Indeed, because it will negate every alternative in which the cardinality of the student plurality that passed is greater than zero, the result of using this exhaustivity can be represented as in (22):

- (22)  $\llbracket \text{EXH Zero student passed} \rrbracket$   
 $= 1$  iff  $\exists x[|x| = 0 \wedge \times\text{student}(x) \wedge \times\text{passed-the-test}(x)] \wedge$   
 $\neg \exists y[|y| > 0 \wedge \times\text{student}(y) \wedge \times\text{passed-the-test}(y)]$

This correctly leads to an ‘exactly zero’ reading. Exhaustivity operators are used in many different semantic contexts, so it isn’t especially shocking that they should have a crucial role here. It’s interesting, therefore, that Haida & Trinh (2020) found experimental evidence that seem to suggest a reappraisal of this part of the analysis. Again, however, the exhaustification component will not need to play any role in our

narrative here.

## 4 Null individuals and the analysis of classifiers and unit nouns

### 4.1 Unit nouns are like measure terms

We will begin the analysis with classifiers and unit nouns, because it is there that the analytical picture is clearest and the consequences most readily discerned.

Unit nouns like *fan1* ‘grade’ and *kaa1 lou6 leoi5* ‘calories’ are inherently about measurement along a scale specified by the noun, and so they can be conceptualized as corresponding to measure functions, as in (23):

- (23) a. ‘zero calories’:  $\mu_{\text{calories}}(x) = 0$   
 b. ‘zero grade’:  $\mu_{\text{grade}}(x) = 0$   
 c. ‘zero age’:  $\mu_{\text{years}}(x) = 0$

Thus to say that an individual has zero calories is to say that a measure function  $\mu_{\text{calories}}$  that maps individuals to the number of calories they contain yields 0 when applied to that individual. These means that they are rather like measure terms such as English *liters* or *inches*.

The next question, then, is what then are measure terms like? Answers are available. [Scontras \(2014\)](#), building on [Krifka \(1989\)](#) and others, proposes that measure terms combine first with a complement that denotes a kind and second with a numeral to yield a property of individuals whose measure along the appropriate dimension is the numeral’s denotation. Thus *pounds* will work as in (24) (where  $n$  is a variable over numbers, construed as a variety of degree, and  $\cup$  type shifts a kind to the property of being a realization of it in the style of [Chierchia 1984, 1998](#)):

- (24) a.  $\llbracket \text{pounds} \rrbracket = \lambda k \lambda n \lambda x [\cup k(x) \wedge \mu_{\text{pounds}}(x) = n]$   
 b.  $\llbracket 30 \text{ pounds of cheese} \rrbracket = \llbracket \text{pounds} \rrbracket (\llbracket \text{cheese} \rrbracket) (\llbracket 30 \rrbracket)$   
 $= \lambda x [\cup \text{CHEESE}(x) \wedge \mu_{\text{pounds}}(x) = 30]$

Concretely,  $\llbracket \text{pounds} \rrbracket$  combines with a kind (CHEESE), a number (30, conceptualized as a degree), and an ordinary individual, and requires that the individual be a realization of the kind and that the number express its measure using the  $\mu_{\text{pounds}}$  measure function.

This semantics for measure terms straightforwardly extends to Cantonese unit nouns. The only major difference is that unit nouns don’t occur with complements:

- (25) a.  $\llbracket \text{kaa1 lou6 leoi5 ‘calories’} \rrbracket = \lambda n \lambda x [\mu_{\text{calories}}(x) = n]$   
 b.  $\llbracket \text{fan1 ‘grade’} \rrbracket = \lambda n \lambda x [\mu_{\text{grade}}(x) = n]$

This correctly predicts that unit nouns should freely occur with arbitrary numerals, including zero:

- (26) a.  $\llbracket \text{ling4 'zero' kaa1 lou6 leoi5 'calories'} \rrbracket = \lambda x[\mu_{\text{calories}}(x) = 0]$   
 b.  $\llbracket \text{loeng5 'two' kaa1 lou6 leoi5 'calories'} \rrbracket = \lambda x[\mu_{\text{calories}}(x) = 2]$

There is, after all, no relevant deep difference between 0 and 1 as the result of an arbitrary measure function.

#### 4.2 Classifiers are transitive unit nouns

With these assumptions made, classifiers naturally find their place. They are simply transitive unit nouns. It is no doubt among the oldest observations about classifiers that their counterparts in non-classifier languages are measure terms. A classifier denotation, then, would have essentially the same shape as a measure term denotation, including the kind-denoting complement. After all, there are good independent reasons to think Chinese bare nouns denote kinds (Chierchia 1998 a.o.). Scontras (2014) goes down this analytical road, arriving at denotations like (27):

- (27)  $\llbracket \text{go3 'CL.unit'} \rrbracket = \lambda k \lambda n \lambda x[\pi(k)(x) \wedge \mu_{\text{card}}(x) = n]$

The general classifier *go3* thus does two things. Starting with the second conjunct, its first task is to measure an individual in its cardinality. That's represented here with a measure function  $\mu_{\text{card}}$  to highlight the parallel to unit nouns and measure terms, but of course its precisely what was indicated elsewhere above with  $|\cdot|$ . As for the first conjunct, it makes use of a partition function  $\pi$ . This function applies to a kind, but does something slightly more subtle than the plain kind-to-property type-shift  $\cup$ . It individuates a kind into non-overlapping portions of its realizations. Applying to the kind CHEESE, for example, it would yield properties of portions of cheese. This largely converges with the classifier semantics of Jenks (2011).

This yields a very natural semantics for how classifiers combine with non-zero numerals. To express 'two friends', this classifier denotation would combine with the kind FRIEND to yield a property of individuated non-overlapping friend-portions whose measure on the cardinality scale is two:

- (28)  $\llbracket \text{loeng5 'two' go3 'CL.unit' pang4 jau5 'friend'} \rrbracket$   
 $= \llbracket \text{go3 'CL.unit'} \rrbracket (\llbracket \text{loeng5 'two'} \rrbracket) (\llbracket \text{pang4 jau5 'friend'} \rrbracket)$   
 $= \lambda x[\pi(\text{FRIEND})(x) \wedge \mu_{\text{card}}(x) = 2]$

But what we'd like to explain is not just how classifiers combine with numerals, but also why they systematically fail to combine with 'zero'. There is no progress on that

front yet. Given these assumptions, ‘zero’ would work just as well compositionally as any other numeral:

$$(29) \quad \llbracket \text{ling4 'zero' go3 'CL.unit' pang4 jau5 'friend'} \rrbracket \\ = \lambda x[\pi(\text{FRIEND})(x) \wedge \mu_{\text{card}}(x) = 0]$$

So there’s a piece of the picture that’s not yet in place.

### 4.3 Why is ‘zero’ special?

One strategy for adding this component would be to treat it as a presupposition: classifiers, one might suppose, simply presuppose that their number argument is not zero:

$$(30) \quad \llbracket \text{go3 'CL.unit'} \rrbracket = \lambda k . \lambda n : n \neq 0 . \lambda x[\pi(k)(x) \wedge \mu_{\text{card}}(x) = n]$$

This would work perfectly well, but it doesn’t capture the generalization about classifiers and zero. It’s not just *go3* that has this presupposition, after all. It seems to be *all* classifiers. If this were just a matter of presupposition, we should expect there to be some—even if only vanishingly few—exceptional classifiers that happen not to have such a presupposition. If it’s a fact that has to be stipulated for each classifier, it’s precisely the sort of thing that we might expect to also vary lexically. Moreover, if there were such presuppositions, one might also expect arbitrary other similar numerical presuppositions, such as a requirement that the numeral be greater than 2, say. Conversely, on this approach it should also be the case that some unit nouns by chance happen to also have a numeric presupposition of this form, with the result—contrary to fact—that some unit nouns should disallow ‘zero’. And of course if this were a purely lexical fact, it should be possible to coin classifiers that allow zero or unit nouns that don’t.

But none of these expectations are met. No classifier is compatible with ‘zero’. No unit nouns is incompatible with it.

Faced with this, one might feel tempted into a weaselly game of hide-the-presupposition. Perhaps it’s not each classifier that has a presupposition, as a lexical stipulation. Perhaps instead it’s all about the cardinality measure function  $\mu_{\text{card}}$  itself? Perhaps it is simply not defined for any individual with zero cardinality. Effectively, the presupposition would be not for each classifier, but rather for how cardinality measurement works.

That’s reasonable, but odd. After all, cardinality is conceptually basic. There is no reason to expect *different* cardinality measure functions across languages. More disconcerting, where in the theory could one put such a fact? How could the grammar encode that this restricted cardinality measure function is present in Cantonese, and, more puzzling, that *no other* cardinality measure function is?

If one is inclined to be sufficiently radical, these questions have answers. One could, for example, suppose that denotations are composed exclusively of atomic building blocks in the language of thought à la Jackendoff or semantic primes in a Natural Semantic Metalanguage à la Wierzbicka. Cardinality measurement might have a claim to being such a building block. But then how to reflect that two languages might have different dialects of thought itself? The point of such things is that they are to be universal. It seems a bridge too far to suppose that English speakers and Cantonese speakers make use of different thought dialects. And if it were true, what would this mean? That speakers with one form of cardinality measurement couldn't conceive of the other? That's deeply implausible, and the moment one accepts that implausibility it becomes inescapable that the notion of cardinality measurement itself should *not*, in fact, vary in such a way.

The more straightforward move—and ultimately the more conservative one—is nevertheless bold and interesting, but better motivated and less conceptually problematic. It is to simply assume that zero-membered pluralities don't exist in the ontology of Cantonese, and that they do in the ontology of English. This would have the consequence that zero would exist robustly in Cantonese as a degree, and that measure functions in general could yield that degree as a measure—but one particular measure function, cardinality, would never yield zero because there would be no plural individuals that have that as a measure of their cardinality.

Assuming that classifier denotations are always framed in terms of cardinality, this will have the result that any instance of using a classifier with zero would yield a false claim. But that on its own is not enough: classifiers with zero make a sentence ill-formed, not merely false. The crucial additional step is in the kind of falsehood involved. Any sentence that uses zero with a classifier is *necessarily* false. If the model excludes null individuals in principle, it would follow that sentences that require zero cardinalities would be false irrespective of any contingent fact of the world. They would be unusably uninformative by virtue of the design of the language, and it is this that explains the ill-formedness of sentences in which zero occurs with a classifier.

But what design is this, exactly, and what does it mean to have such a design? That's the aim of section 4.4 immediately below. Before addressing that, one big picture point. We started with the Null Individual Hypothesis, the claim that the ontology of natural language includes null individuals. If English has them and Cantonese lacks them, it would seem that the hypothesis is true in a larger sense, but should be reformulated as a Null Individual Parameter, to be set positively for languages that have them and negatively for ones that lack them.

#### 4.4 What does it mean to lack null individuals?

Supposing that English and Cantonese vary in whether null individuals are present in their models, however, is not unproblematic either.

A null plurality is, after all, simply the plural individual formed from the null set. So, one might suppose, claiming that null pluralities don't exist in the ontology of a language would be like claiming that the null set doesn't exist in its ontology. But of course, because the model is a set-theoretic object, it's impossible for it not to include the null set at least in the sense that the null set is a subset of every set. So long as plural individuals are freely assembled from arbitrary sets of individuals, one might conclude that there is no way to exclude them from the model entirely. What we can do is define the pluralization operator in a way that includes or excludes null pluralities from the extensions of pluralized predicates. This is what Bylinina & Nouwen do in defining the two pluralization operators  $*$  and  $\times$  differently.

But this is not the only way to look at it. We'll proceed in two parts. First, we'll reflect on whether including null pluralities—even in the definitions of pluralization operators—is conceptually more natural than excluding them. Then we'll ask the same question at the level of the model and illustrate the connection between characterizing pluralization operators and characterizing the model itself.

The definition of pluralization operators in Bylinina & Nouwen suggests that the zero-including pluralization operator  $\times$  is simpler and conceptually more natural, and that the zero-excluding one requires a clunky extrinsic stipulation. It suggests, essentially, that null pluralities are the null hypothesis. They define Link (1983)'s pluralization operator with a conjunct that rules out pluralities formed by joining the members of the empty set (repeating this definition yet again):

$$(31) \quad *Z \stackrel{\text{def}}{=} \{\sqcup X : X \subseteq Z \wedge X \neq \emptyset\}$$

One is tempted to read too much into this. An alternative that doesn't give rise to this temptation is to build pluralities by joining not subsets of  $Z$  but rather tuples of its members (where  $Z^n$  is the set of  $n$ -tuples of members of  $Z$  and  $\sqcup X$  is the join of the tuple  $X$ ):

$$(32) \quad *Z \stackrel{\text{def}}{=} \{\sqcup X : X \in Z^n\} \text{ for any natural number } n$$

This defines the extension of a pluralized predicate as the set of pluralities built by joining any tuple of members of the corresponding singular predicate's extension. This too excludes null individuals, because no tuple formed from  $Z$  is empty.<sup>1</sup> Its significance is only that it diminishes the rhetorical effect of the earlier definition.

<sup>1</sup> At least it does so if we assume—as is standard and desirable—that singular extensions are composed of singular individuals, and don't include a null element (the zero or bottom element of a lattice,  $\perp$ )

It's possible to go further. It's not just that null individuals aren't inevitable or even necessarily more natural when constructing plural predicates. The same holds when populating the model itself. We'll elaborate on this below, but in brief the point is that the domain of individuals can be a full lattice, with a bottom or zero element  $\perp$ , or it can be a semilattice, without one, and neither option is preferable in principle—but the choice is empirically consequential.

To illustrate, suppose the model includes a set of atomic individuals, **Atoms**. The task will be to assemble from this a domain of individuals,  $\mathbf{D}_e$ , that includes both atomic and plural individuals but not null pluralities. Essentially following Link, we could do this as in (33) (where 'individual sum' is the operation of joining individuals to create pluralities, indicated with  $\sqcup$ ):<sup>2</sup>

- (33) THE DOMAIN OF INDIVIDUALS (WITHOUT NULL PLURALITIES)
- a. All atomic individuals are in  $\mathbf{D}_e$ :  $\mathbf{Atoms} \subseteq \mathbf{D}_e$ .
  - b.  $\mathbf{D}_e$  is closed under individual sum formation; the individual sum of any two individuals in  $\mathbf{D}_e$  is also in  $\mathbf{D}_e$ :  $\forall x \in \mathbf{D}_e \forall y \in \mathbf{D}_e [x \sqcup y \in \mathbf{D}_e]$ .
  - c. Nothing else is in  $\mathbf{D}_e$ .

This defines the domain of individuals in a way that excludes null pluralities, because clause (33b) is framed in terms of joining members of  $\mathbf{D}_e$ , not subsets of it, just like the set-membership-based definition of the pluralization operator in (32).

This means in turn that the two ways of thinking about pluralization—the zero-excluding standard pluralization  $*$  and the zero-including alternative  $\times$ —correspond to two ways of thinking about the domain of individuals itself. One can define it as in (33), with null individuals excluded. Or one could do so instead as in (34), where plural individuals are assembled from subsets and null pluralities are included:

- (34) THE DOMAIN OF INDIVIDUALS WITH NULL PLURALITIES
- a. All atomic individuals are in  $\mathbf{D}_e$ :  $\mathbf{Atoms} \subseteq \mathbf{D}_e$ .
  - b.  $\mathbf{D}_e$  is closed under generalized sum formation; that is, the generalized individual sum of any subset of  $\mathbf{D}_e$  is also in  $\mathbf{D}_e$ :  $\forall X \subseteq \mathbf{D}_e [\sqcup X \in \mathbf{D}_e]$ .
  - c. Nothing else is in  $\mathbf{D}_e$ .

These are not distinctions in the denotation of any linguistic expression, or even in the definition of any predicate of the logic. They are ontological distinctions, different design choices in the organization of the model. Neither is a priori preferable. But the choice does have empirical consequences. A model with null pluralities would

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which, otherwise, could be joined with itself and thereby slip back in, unbidden and unwelcome.  
<sup>2</sup> In (33) and in (34), the assumption is that **Atoms** does not include  $\perp$ .

allow them to occur in the extensions of pluralized predicates. A model without them wouldn't.<sup>3</sup>

So, returning to the key question, what does it mean for a language to lack null individuals? It just means that its model is structured in a way that doesn't include null individuals in the domain of individuals. What is interesting is that it makes the choice between these two ways of characterizing individuals a point of variation between languages. This is ultimately just what Bach (1981, 1989) called natural language metaphysics: drawing ontological conclusions from linguistic facts. The twist here is that when one language suggests a different ontological conclusion than another, we can embrace them both and capture the difference.

For Cantonese, this means that its classifier constructions reveal it has chosen a model without null pluralities. It can and does still use zero robustly as a degree in many different contexts, with one notable exception: when cardinality is measured. In that instance, the language has made ontological choices that eliminate the possibility of zero cardinalities in principle.

## 5 Notes on the analysis of chance nouns

We have yet to return to an intriguing part of the picture: chance nouns. As a reminder: these nouns prohibit a classifier with zero and either require one with ordinary numerals or else prohibit ordinary numerals entirely. They are interestingly similar to their English counterparts. We will confine ourselves to some brief notes.

Part of the puzzle is already explained. When chance nouns occur with classifiers, zero is ruled out. That is of course expected. What is special is the fact that zero, and not ordinary numerals, are possible even without a classifier.

The simplest approach would be to simply suppose that zero can occur as an argument of chance nouns, following Chen (2018), who first described these facts for English. Thus, *gei1 ui2* 'chance' could have a denotation as in (35):

- (35) a.  $\llbracket \textit{gei1 wui2 'chance'} \rrbracket = \lambda n : n < 1. \lambda x [\mathbf{chance}(x) \wedge \mu_{\mathbf{chance}}(x) = n]$   
 b.  $\llbracket \textit{ling4 gei1 wui2 'chance'} \rrbracket = \lambda x [\mathbf{chance}(x) \wedge \mu_{\mathbf{chance}}(x) = 0]$

In (35a), a presupposition is installed ensuring that numbers one and higher are impossible. Importantly, the reading at stake here is the one that means roughly 'probability' and not 'opportunity'. The latter is essentially just a concrete noun homophone of *gei1 ui2* 'chance'.

<sup>3</sup> More precisely, if a predicate of atomic individuals  $P$  is of type  $\langle e, t \rangle$ , pluralizing it in the zero-inclusive way as  ${}^{\times}P$  in a model that excludes null individuals would have the same effect as doing so in the zero-exclusive way as  $*P$ . That's because null pluralities would be excluded from the domain of both of them, because null pluralities would not be members of  $\mathbf{D}_e$ .



This presupposition is a rather brazen stipulation, though. One might imagine that part of it follows from the nature of probability measurement, where the scale of probability measurement is closed on top at 1. That wouldn't explain why 1 itself is also impossible. It's also not entirely clear whether this fact is sufficient to explain the ill-formedness of numbers higher than 1 in the absence of a classifier. Certainly, such sentences would be false, but it's not obvious whether this counts as the kind of grammatically-induced necessary falsehood that results in ill-formedness, in the same spirit as the ill-formedness of classifiers with zero in the section 4 immediately above.

There is, however, much more to say. In English as in Cantonese, chance-nouns are also systematically compatible with fractions and percentages. In both languages, they seem to be associated with closed scales, in the sense of [Kennedy & McNally \(2005\)](#) and many others. In Cantonese and perhaps in English too, they yield an arguably compound-like syntactic structure. (In Cantonese, they license the modificational particle *ge*, the Cantonese counterpart to Mandarin's famous *de* particle). And in both languages, the numerical arguments seem to measure non-monotonically, in the sense of [Schwarzschild \(2006\)](#), and it's precisely in smaller compound(-like) structures where such non-monotonic measurement is expected. All these analytical strands are left for future research.

There are, however, two analytical directions worth highlighting, one a consequence of the other. First, instead of assigning these nouns a degree argument directly, one could treat them instead as denoting a property of a suitable abstract object. One candidate class of abstract objects is tropes ([Moltmann 2009](#)). The other is property concepts ([Francez & Koontz-Garboden 2017](#)).

Pursuing either of these possibilities would be beyond the scope of this paper, but at least on the property concepts approach (and perhaps but less clearly for tropes), an interesting ontological twist is available. The driving idea behind property concepts is that things like 'wisdom' can be said to be an intangible material whose amount can be measured, so that one can say that someone has a great deal of wisdom or very little of it as a way of indicating how wise they are. The most straightforward implementation of this idea to chance nouns would be to suppose that, for example, 'zero trust' involves measuring the amount of an abstract portion, and finding it to be zero. Would that be contrary to the bulk of our analysis, which revolves around the fact that no cardinality measurement can be zero in Cantonese? Not really, because of course measuring the amount of a mass individual is not the same as measuring the cardinality of a plurality. But this would nevertheless mean that although Cantonese has no zero-membered pluralities, it would have zero-amount portions.

That's an intriguing possibility on its own terms, but especially so because it suggests that the Null Individual Hypothesis—and especially its parameter cousin—should actually be divided up into more fine-grained claims about particular varieties of null individual. Indeed, it suggests a typology of flavors of zero, in which

languages could choose some options and not others. For example, a language might have zero degrees, but lack zero-amounts and zero-pluralities; or it might lack them all entirely; or it might actually allow zero more robustly than any language we're aware of, including perhaps null singular individuals too.

## 6 Conclusion

To summarize, we have used the grammar of 'zero' as a probe into nominal semantics in Cantonese—in particular into unit nouns, classifiers, chance nouns, and numerals. Strikingly, Cantonese uses zero extensively, in many different corners of the grammar. These include two different classes of constructions (unit nouns and chance nouns) and a wide variety of scales (essentially, all scales other than cardinality measurement). But curiously, Cantonese prohibits zero in *exactly* the places where having it would require having zero-membered pluralities. The language is going out of its way to tell us that, as a matter of natural language metaphysics, it simply lacks them.

This leads to interesting questions about variation and natural language metaphysics. In the particular case of zero, various conceptual possibilities are available in what kind of zero a language might be said to have. Indeed, the concept of zero is a fairly recent human invention, and in most languages the word and concept (or rather, multiple related concepts) are both borrowed. This means that there must be a narrative to be told about how languages grow a zero: how they develop from lacking one entirely to various degrees of nativizing or 'domesticating' it.

The big-picture conclusions are that the Null Individual Hypothesis is true for English and false for Cantonese. That makes it more of a Null Individual Parameter, an axis for variation. Perhaps this would make it like the Degree Semantics Parameter of Beck, Krasikova, Fleischer, Gergel, Hofstetter, Savelsberg, Vanderelst & Villalta (2009) and subsequent work. There is, however, a crucial distinction. Although one often talks in general terms about whether a language 'has' or 'lacks' degrees, on its most careful interpretation this isn't a claim about the model, and so it's not irreducibly an ontological one. As originally formulated, the Degree Semantics Parameter is about the lexicon: whether the lexicon of a language includes predicates with degree arguments. In principle, one might imagine a similar strategy here too, making the claim about having or lacking zero actually a claim about the lexicon. Yet Cantonese beckons us in another direction, more appealing and perhaps more provocative: to placing the locus of variation squarely in the model itself. If that's not misguided, linguistic variation can take the shape of ontological variation more generally. One might imagine a wide variety of other natural language metaphysics parameters—different constraints on the design of models and different linguistic effects that arise as a consequence of them.

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