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All notional mass nouns are count nouns in Yudja*

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Abstract This paper investigates the linguistic expression of individuation and counting in Yudja (Juruna family), a Tupi language spoken in Brazil. Relying on the principles of mereotopology (Casati and Varzi 1999, Varzi 2007), the main claim of this paper is that in Yudja all nouns can be used as count nouns. That is, in Yudja maximal self-connected concrete portions of a kind can be considered atoms and can be counted. This claim is based on two fundamental properties of Yudja. First, all notional mass nouns can be directly combined with numerals. Second, the results of quantity judgements studies with Yudja children and adults suggest that all nouns can be directly combined with count-quantifiers and that count-quantifiers are necessarily interpreted as referring to the number of concrete portions. These properties together suggest that all nouns in Yudja are interpreted as count nouns.

Keywords: numeral, count; mass; Tupi; mereotopology.

1 Introduction

In the Yudja language (Tupi stock; Brazil; 284 people) notional mass nouns can be directly combined with numerals without intervening classifiers or container phrases, as illustrated by the acceptability of sentences (1) and (2):

(1) Txabïu asa he wï he
Three flour in port in
'There are three (bags of) flour in the port.'

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(2) Itxïbï iidja a'i
Many woman here
'There are many women here.'

(3) Itxïbï y'a a'i
Many water here
'There are many (portions of) water here.'

In principle, the examples (1) and (3) do not show that *asa* 'flour' and *y'a* 'water' have a default count interpretation: one could argue that the acceptability of (1) and (3) might be due to mass-to-count coercion. This form of coercion (aka 'universal packager') is illustrated in 'three beers' (for 'three bottles of beers'). Its availability in English is dependent on the existence of standardized or otherwise naturally occurring bounded amounts of the relevant substance (see Gleason 1965, Doetjes 1997, Pelletier 1975, Frisson and Frazier 2005, Wiese and Maling 2005). If coercion played a role in Yudja, speakers would consistently refuse scenarios where a notional mass noun is combined with a numeral and a standardized container is not involved in the individuation of the portions of substance.

In a scenario-based elicitation task (Lima 2012) carried out with two Yudja adults, the consultants had to provide a sentence to describe two different types of scenarios: one that included individualized portions and a standardized container (4a) and another that included individualized portions, but not a standardized container (4b). It was observed that the two speakers combined numerals directly with notional mass nouns in both scenarios, even when containers are not available at all.

(4a) Context: A woman brought three bowls of water to the school and put them on a bench.
Txabïu y'a pïkaha txade anu.
Three water bench above ASP
'There are three (bowls of) water on a bench.'

(4b) Context: A woman was carrying a pan of water. Three drops fell on the ground.
Txabïu y'a anu.
Three water ASP
'There are three (drops of) water.'

This property of the Yudja language is critical to the literature in the count/mass distinction as we must account how atoms are defined for nouns that denote substances. In this paper, we argue that the concrete portions of a kind are atoms and that they can be counted properly, which explains why notional mass nouns can be used in constructions with numerals in Yudja. This analysis is supported by the results of quantity judgements tasks (based on Barner and Snedeker 2005) with Yudja children and adults.

3 Analysis

3.1 Reference to kinds with bare nouns

We will argue that bare nouns in Yudja may refer to kinds. Following Carlson (1977) and Krifka *et al.* (1995), we assume that kinds are individuals. DPs like *the dodo* in sentences like *the dodo is extinct* denote kinds. They are referential expressions, rather than quantifiers. This allows us to account for the restrictiveness of predicates like *become extinct* as a form of semantic selection: these predicates denote functions whose domain only includes kinds and whose value is not defined for any other type of argument.

The use of a bare noun to refer to a kind in Yudja is illustrated in (5). The bare noun *takũ* ('mutum', also known as Red-knobbed Currassow, a bird) is used to denote a kind, since it occurs as the subject of the kind predicate *masehu txa* ('become extinct'). That this predicate selects kind-denoting-subjects is confirmed by the fact that it is ungrammatical with proper names, as illustrated in (6), and with demonstrative phrases that refer to individuals, as in (7).

(5) Takũ masehu txa
mutum extinction go
'The mutum will become extinct'

(6) *Karin masehu txa
Karin extinction go

(7) *Amï takũ masehu txa
this mutum extinction go

Example (8) shows that the bare noun *takũ* may denote individuals that are members of the kind 'mutum' or quantify over such individuals:

(8) Senahï takũ ixu
man mutum eat
'(A/the/some) man ate (a/the/some) mutum'

From these examples, we hypothesize that noun roots refer to kinds in Yudja. Under this analysis, a morphological operation may be used to map the denotation of a root noun to a property: a kind *k* may be mapped to a number neutral property of atomic individuals and their sums who are members of *k.* No additional overt morphology is needed to license the kind or object denotations.

3.2 Deriving object denotations from kind denotations

In this subsection we show how to derive object interpretations of Yudja bare nouns from their kind interpretation. We take it that the basic denotation of the bare noun *takũ* ('mutum') is the kind MUTUM, as in (9), or equivalently (10):

(9) $[[\sqrt{\text{takũ}}]] = \lambda w.\ \text{MUTUM}(w)$

(10) $[[\sqrt{\text{takũ}}]] = \text{MUTUM}$

To turn the root *takũ* into a noun denoting a number neutral property of objects, we must map the kind MUTUM to a property that is true of atomic individuals and their sums. This property is represented in (10). We assume that we have access to a function AT* that maps an individual *x*, a world *w* and a kind *k* to the truth value 1 if and only if x is the sum of atomic parts of k(w). Since any individual x is the sum of x and x, AT* picks out those realizations of k(w) that are either atoms or sums of atoms. Such a function is defined in (11). Let us call it KO, for Kind to Object (see the realization function R in Krifka *et al.* 1995; 66). The result of applying KO to $[[\sqrt{\text{takũ}}]]$ in (9) is the property of being an atomic part of the kind MUTUM, as illustrated in (12):

(11) $\text{KO} = \lambda k{:}\ k \in K.\ \lambda x.\ \lambda w.\ \text{AT*}(w)(x)(k)$

(12) $\text{KO}([[\sqrt{\text{takũ}}]]) = \lambda x.\lambda w.\ \text{AT*}(w)(x)(\text{MUTUM})$

In sum, this operation gives us a number neutral predicative interpretation. The result of applying KO to MUTUM is a property that is true of any individual that is a singular or plural realization of the kind MUTUM. This shows that we can take kinds to be the basic denotations of bare nouns and derive from them number neutral properties of individuals.

3.3 Atomicity

In the introduction of this paper, we have shown that notional mass nouns can be combined with numerals in Yudja. We argued that this phenomenon is not due to coercion, since counting with notional mass nouns like *apeta* ('blood') is possible even when the counting unit is not conventional, and even when the atoms that are being counted differ in shape and size. One way to account for this fact is to assume that the function KO can be applied to any nominal root. As a consequence, notionally mass nouns will have a count denotation, i.e. they will denote characteristic functions of sets of atoms. To illustrate, applying KO to the root *apeta* ('blood') yields the characteristic function of the set of atoms of blood in the world of evaluation.

When the counting units of notional mass nouns in Yudja are not provided by conventions, what are these units? An examination of the counting units in non-conventional contexts in Yudja reveals a common feature: all portions that are treated as a unit are maximal connected portions of the kind denoted by the root. Consider example (13):

CONTEXT: The children brought one bowl full of sand from the beach. While they walked, they dropped a little bit of sand near the school, and a little bit near the hospital (in the drawing the portions were different in size and form).

(13)	Yauda	ali	eta	apa~pa
	two	child	sand	drop~ RED
	'Children dropped two (portions of) sand(s)'			

The two portions of sand that are treated as units in (13) differ in size and shape, and they are not individuated with respect to a container such as a bucket or a bag. Yet, they are both maximal self-connected portions of sand: each portion of sand is a self-connected whole and is not a proper part of any self-connected portion of sand[1].

In this section, we propose that atoms in the extension of Yudja nouns are maximal self-connected portions of the kind described by the root in the world of evaluation. We call such entities 'concrete portions' of (the extension of) a kind.

Let us first define the notion of connectedness. Following Casati and Varzi (1999), we will analyze part-whole relations using a mereotopological theory,

[1] For other examples that corroborate this analysis, see Lima 2014.

which combines mereological and topological axioms[2]. The mereological side of the theory is concerned with notions of parthood, while the topological side of the theory is concerned with notions of connectedness. We define our mereotopological theory by adding a parthood relation $\leq$, an overlap relation O, and a connectedness relation C to the lambda calculus that we have been using so far. These two relations are formalized through a list of axioms that we take from Varzi (2007). All variables that appear to be free in the axioms are tacitly bound by wide scope universal quantifiers. The relation of parthood is required to be reflexive, transitive and antisymmetric:

(14) Axioms of parthood:
1. $x \leq x$ (Reflexivity)
2. $x \leq y \ \& \ y \leq z \rightarrow x \leq z$ (Transitivity)
3. $x \leq y \ \& \ y \leq x \rightarrow x = y$ (Antisymmetry)

The relations of proper parthood and overlap are defined from the relation of parthood as follows:

(15a) Proper parthood: $x < y =_{def} x \leq y \ \& \ \exists z \, [\, z \leq y \ \& \ \neg \ z \leq x \,]$

(15b) Overlap: $O(x)(y) =_{def} \exists z \, [\, z \leq x \ \& \ z \leq y \,]$

The relation of connectedness is required to be reflexive and symmetric:

(16) Connectedness:
1. $C(x)(x)$ (Reflexivity)
2. $C(x)(y) \rightarrow C(y)(x)$ (Symmetry)

The relations of parthood, overlap and connectedness interact in significant ways, which are captured by the following two axioms from Varzi (2007):

(17) Bridging Principles:
1. $x \leq y \rightarrow C(x)(y)$ (Integrity)
2. $O(x)(y) \rightarrow C(x)(y)$ (Unity)
3. $x \leq y \rightarrow \forall z \, [\, C(x)(z) \rightarrow C(z)(y) \,]$ (Monotonicity)

[2] Grimm (2012) must be credited for bringing mereotopology to the attention of semanticists working on countability. In his dissertation, Grimm uses notions of mereotoplogy, notably connectedness, in order to provide an adequate model theoretic defintion of aggregate nouns.

The first axiom states that every part of an entity is connected to that entity. The second axiom states that any two overlapping entities are connected. The last axiom states that if an entity is a part of another entity, every entity that is connected to the first is also connected to the second.

We can now define the property of self-connectedness SC, following Varzi (2007):

(18) Self-connectedness:
$SC(x) =_{def} \forall y \forall z\, [\forall v\, [\, O(v)(x) \leftrightarrow (O(v)(y) \vee O(v)(z))\,] \rightarrow C(y)(z)\,]$

According to definition (18), saying that an entity is self-connected means that whenever we partition this entity into two parts, these two parts are connected to each other.

Finally, we define the notion of a maximal self-connected portion of a kind *k* in a world *w* as follows:

(19) Maximal self-connected portion of a kind in a world of evaluation:
$MSC(x)(k)(w) =_{def} SC(x)\ \&\ x \leq k(w)\ \&\ \neg \exists y\, [\, x < y\ \&\ SC(y)\ \&\ y \leq k(w)\,]$

Saying that an entity is a maximal self-connected portion of a kind *k* in a world *w* means that this entity is a self-connected portion of *k* in *w* that is not a proper part of any self-connected portion of *k* in *w*.

We have defined what it means for an entity to be a concrete portion of a kind in a world of evaluation, i.e. a maximal self-connected portion. Our claim about atomicity in Yudja can now be made more precise as follows:

(20) Condition on atomicity: an entity *x* is an atomic portion of a kind *k* in a world *w* only if *x* is a maximal self-connected part of *k*(*w*).

The definition in (20) states that being a maximal self-connected part of a kind in a world of evaluation is a necessary condition of being an atomic portion of that kind in that world. This condition has two important consequences. First of all, for any kind *k* and world *w*, the mereological fusion of two disconnected parts of *k*(*w*) can never be treated as an atom of *k*(*w*). To illustrate, we predict that speakers will never count the three drops of blood as a single 'blood' or as two 'bloods'.

CONTEXT: João cut his finger and three drops of blood fell on the floor: one near the river, one near the house and another near the school.

(21) Txabïu apeta pe~pe~pe

three blood drip~ RED
'Three (drops of) blood dripped'

Secondly, a mereological part of a kind *k* in a world *w* will never be treated as an atom of *k*(*w*) if it is a proper part of a self-connected part of *k*(*w*). This means that in scenario (21), speakers will never count four 'bloods' by treating one of the drops as two 'bloods'.

In sum, we propose that Yudja is a language where all nouns can be construed as count nouns without coercion. This is possible because the grammar of the language allows its speakers to treat concrete portions of a kind as atoms.

If all nouns in Yudja indeed allow count denotations (expressing number neutral properties of concrete portions of stuff), then when asked 'who has more x?' their answer should always be determined by the number of portions, not volume. This prediction is tested in 3.4.

3.4 Quantity judgements in Yudja

Cross-linguistically, scholars have used quantity judgements in order to describe the properties of count and mass nouns in a language. Quantity judgements consist of visual tasks where speakers have to compare two quantities: one that is voluminous (henceforth 'Volume') and another that is numerous (henceforth 'Number'). In English (Barner and Snedeker 2005) and Chinese (Li, Barner and Huang 2008), participants (16 adults and 16 4-year-olds in English and 56 adults in Chinese) presented different quantity judgements depending on the noun being used in the comparison of these quantities. Participants based their quantity judgements on Volume significantly more when they evaluated mass nouns (such as toothpaste) and they based their quantity judgements significantly more on Number when they evaluated count nouns (such as shoes) or object-mass nouns (such as furniture – in English only).

The analysis of Yudja presented in the previous section predicts that concrete portions of a substance can be considered as atoms for the purposes of counting. We have proposed that this is a consequence of the fact that all nouns have count denotations. Thus, if all nouns have count denotations, we would expect that in quantity judgements all nouns can be evaluated by the number of portions rather than by the volume of the portions (as mass nouns are evaluated in other languages such as English and Chinese). This prediction is tested in the following study.

3.4.1 Study 1

Methods Participants were 18 adults and 22 children (7, 2-to-5-year-olds; 15, 6-to-11-year-olds). Children were divided in two groups according to schooling: 6-to-11-year-olds start to learn Brazilian Portuguese in the school while younger children are monolingual or are in a very early stage as Brazilian Portuguese learners. In this study, on each trial, the participants saw two different drawings one with a big portion of *x* (Volume) and another with many different portions of *x* (Number). The target question was *Ma de bitu x dju au?* 'Who has more *x*?', as illustrated below:

(22a) Notional mass nouns (*asa* 'flour', *y'a* 'water', *kania atxa* 'meat'):

Ma de bitu asa dju a'u?
who more flour have
'Who has more flour?'

(22b) Notional count nouns (*xaa* 'bowl', *txarina* 'chicken', *karaxu* 'spoon'):

Ma de bitu xaa dju a'u?
who more bowl have
'Who has more bowls?'

(23c) Aggregate nouns (*abeata* 'clothes', *wã'e* 'ceramic'):

Ma de bitu abeata dju a'u?
who more clothes have
'Who has more clothes?'

As illustrated in 23a-23c, three notional classes of nouns (mass, count and aggregate nouns) were tested. Similar to the critical items used by Barner and Snedeker 'the three objects had a smaller combined volume and surface area than the large object, allowing responses based on number to be distinguished from those based on mass or volume' (Barner and Snedeker 2005; 50). All items presented the same syntactic and morphological properties, as none of these nouns can be pluralized (only [+human] nouns can be pluralized in Yudja, iidja 'woman'/iidja**i** 'women'; ba'ï 'paca'/*ba'ï**i** 'pacas').

Each participant answered 8 items in the same random order. Three items included notional count nouns (e.g. *xaa* 'bowl'), three items included notional mass nouns (e.g. *asa* 'flour') and two items included aggregate nouns (e.g. *abeata* 'clothes'). For all participants, the study took place in a room in the Yudja's local central school in the Tuba Tuba village. A local teacher known by the children was present in order to facilitate all the tasks that involved children. We introduced the study by explaining that one person owned the big portion of *x* and another person owned the three small portions of *x*. Participants had to point to one of the drawings to answer the target question ('who has more *x*?'):

Results and discussion The results for Study 1 are presented in Table 1. The 2-to-5-year-old children performed at chance, the 6-to-11-year-old children based their quantity judgements on Volume and the adults based their quantity judgements on Number:

Noun ‘category’	Adults	Children (2-5)	Children (6-11)
Notional mass nouns	85%	57%	33%
Notional count nouns	83%	60%	33%
Aggregate nouns	79%	71%	43%

Table 1 Results of Study 1 – presented in percentage of Number responses

The results support the hypothesis presented in this paper in two ways. First, participants did not vary their quantity judgements according to (notional) noun types. That is, the same answer was consistently used across all (notional) noun types for the three groups of participants. Second, adults favored the Number answer for all nouns, which suggests a preference for count interpretation of nouns (including nouns that denote substances) as predicted by our analysis. Mixed effects modeling using Helmert contrasts confirmed that there was no effect of noun type. However, there was a significant effect of Age on proportion of number criterion responses (Wald’s $Z = 2.5$, $p = 0.01$, $\beta = 0.122$). In Study 1, one factor with three levels (‘count’, ‘mass’ and ‘aggregate’) was manipulated in two Helmert contrasts. In the first contrast, notional count nouns were contrasted with aggregate nouns. It was observed that aggregate nouns have a greater probability of Number responses in comparison to notional count nouns, but the difference was not significant (Wald’s $Z = 0.9$, $p = 0.35$, $\beta = 0.208$). In the second contrast, notional mass nouns were contrasted with aggregate and notional count nouns (that is, notional count and aggregate nouns were considered a single category). It was observed that notional count/aggregate nouns are numerically more likely to give Number responses in comparison to notional mass, but again the difference was not statistically significant (Wald’s $Z = - 0.617$, $p = 0.53$, $\beta = - 0.070$):

	Estimate β (Standard error)	z value (Wald's Z)	Pr(>|z|)
Intercept	- 0.76421 (0.96600)	- 0.791	0.4289
Age	0.12246 (0.04801)	2.551	0.0107*
First contrast (notional count nouns vs. aggregate nouns)	0.20876 (0.22525)	0.927	0.3540
Second contrast (notional count nouns and aggregate nouns vs. notional mass nouns)	- 0.07007 (0.11363)	-0.617	0.5375

†: $p < .1$, *: $p < .05$, **: $p < .01$, ***: $p < .001$

Table 2 Mixed effects modeling using Helmert contrasts – Results Study 1

The results of Study 1 support the hypothesis that all nouns have count denotations, as speakers did not differentiate (notional) count from (notional) mass nouns in their quantity judgements. Thus, all nouns can be interpreted as count nouns, even nouns that denote substances. This fact can be observed by in the significant preference in Number over Volume by adults. The results from quantity judgements in Yudja are different from the same studies in other languages, such as English (Barner and Snedeker 2005), Chinese (Cheung, Li and Barner 2012) and Japanese (Inagaki and Barner 2009), where noun type affects speakers' judgements and only objects (grammaticalized as count or fake mass nouns) were associated with Number, not substances (grammaticalized as mass nouns).

There is an explanation for this difference that was introduced in our discussion of the analysis. In languages like Yudja, different variations of concrete portions (that may vary in shape or size) can be an atom for a mass noun. For example, different types of concrete portions of water (bowls, drops, puddles) can be atoms and be counted. In languages like English, there are also a variety of concrete portions that may be considered for counting, but container or measure phrases restrict them. In languages like Chinese classifiers restrict them. Thus, the lack of the need for a container/measure phrase or classifier is correlated with the fact that all nouns can be treated as count in languages like Yudja. Therefore, we expect under this analysis different results in quantity judgement tasks when we compare languages like Yudja to languages like English and Chinese.

3.4.3 Quantity judgements and the count-quantifiers in Yudja

So far we have argued that Yudja is a language where all nouns can be constructed as count nouns without coercion. This is possible because the grammar of the language allows its speakers to treat concrete portions of a kind (i.e., maximal self-connected portions of the kind described by the root in the world of evaluation) as atoms, as observed in constructions with numerals.

Three predictions can be made based on this analysis. First, the answers of the Yudja speakers for the question ‘who has more x?’ can be determined by the number of portions, not volume, even for notional mass nouns. This prediction was confirmed by the results of the quantity judgement study presented in 3.4.2.

Second, when a notional mass noun such as *y’a* ‘water’ is combined with a count quantifier – such as *itxïbï* ‘many’ – it is expected that it will be interpreted as quantifying over the number of concrete portions of *x*. That is, this quantifier conveys that there are many portions of water (many bags, many piles, many pans, etc), not that there is a lot of water in a single container. This is different from a language like English, for example, where count-quantifiers only combine with count nouns. In languages like English, container/measure phrases are required in constructions with mass nouns and count-quantifiers:

(24a) * I bought many water

(24b) I bought many <u>bottles/cups/liters of</u> water

The distribution of mass nouns with count-quantifiers and numerals in English is similar: in both cases, we need to specify the concrete portions that are being counted or quantified. Thus, container or measure phrases are required. We should expect the same parallelism in the domain of numerals and count-quantifiers in a language like Yudja: if all nouns can be directly combined with numerals, the same should hold for constructions with count-quantifiers.

The third prediction of this hypothesis is that when we combine notional mass nouns and size adjectives like *urahu* ‘big’ in Yudja, the adjective will introduce the property of being big to a concrete portion of *x* (for nouns like *y’a* ‘water’) or to an individual (for nouns like *txarina* ‘chicken’).

On the basis of an experimental study with Yudja children and adults, in this section we test the second and third predictions for the interpretation of two words: the count-quantifier *itxïbï* 'many' and the size adjective *urahu* 'big'.

3.4.3.1 Study 2

Before we move to the quantity judgement task *per se,* it is important to show the possible interpretations of sentences that include notional count/aggregate nouns and the count-quantifier *itxïbï* 'many' or the size adjective *urahu* 'big'. In an elicitation task ('give me a sentence and a context' task) two Yudja speakers had two tasks. First, they had to create sentences given pairs of words that were provided to them (a noun and a count quantifier or a size adjective); second, they had to create a scenario where the sentence created by the other consultant could be used. From this task, it was observed that when combined with notional count nouns and aggregate nouns, the count-quantifier *itxïbï* 'many' always quantify over the number of individuals:

PAIR PROVIDED: *ali* 'child'/ *itxïbï* 'many'
CONTEXT PROVIDED BY THE CONSULTANT: A large group of children (more than 10, for example) took the canoe and paddled to the beach.

(25) Itxïbï ali eta be txa
Many child beach to go
'Many children went to the beach'

PAIR PROVIDED: *abeata* 'clothes' / *itxïbï* 'many'
CONTEXT PROVIDED BY THE CONSULTANT: You arrive in my house and you see a pile of new clothes.

(26) Una itxïbï abeata wã
1S many clothes buy
'I bought many pieces of clothing'

Object nouns
PAIR PROVIDED: *pïkaha* 'chair'/ *itxïbï* 'many'
CONTEXT PROVIDED BY THE CONSULTANT: We will have an assembly in the village, with all the members of the community, and we put all the school chairs outside the classrooms, in front of the school.

(27) Pïkaha itxïbï anu
chair many ASP

‘There are many chairs’

Conversely, when a notional count noun or an aggregate noun is combined with a size adjective such as *urahu* ‘big’ the adjective is always interpreted as modifying a noun and attributing the property of being a big individual, as illustrated below:

PAIR PROVIDED: *ali* ‘child’/ *urahu* ‘big’
CONTEXT PROVIDED BY THE CONSULTANT: A tall child ran to meet with her mother.

(28) Ali urahu yahã tahu
child big PRED.SG run
‘The big child ran’

PAIR PROVIDED: *abeata* ‘clothes’ / *urahu* ‘big’
CONTEXT PROVIDED BY THE CONSULTANT: I went to Canarana (a town) and I bought an article of clothing that is too big for my own size.

(29) Una urahu abeata wã
1S big clothes buy
‘I bought a big article of clothing’

PAIR PROVIDED: *pïkaha* ‘chair’/ *urahu* ‘big’
CONTEXT PROVIDED BY THE CONSULTANT: We are gathering chairs outside the school an we notice that there is a chair that is surprisingly big in comparison to the other ones.

(30) Urahu chair anu
big pïkaha ASP
‘There is a big chair’

If it is the case that all nouns have count denotations, the expectation is that the interpretation of *itxïbï* ‘many’ with notional mass nouns will be parallel to the interpretation of this quantifier with notional count and aggregate nouns: speakers will associate *itxïbï* ‘many’ with a number interpretation and *urahu* ‘big’ with a volume interpretation.

Materials and Methods Participants were the same 18 adults and 22 children (7 2-to-5-year-olds; 15 6-to-11-year-olds) that participated in the quantity judgement studies (Studies 1 and 2). In this study, the participants saw two different drawings in each trial: one of a big portion of *x* (Volume) and another of many different portions of *x* (Number). While the drawings were shown to them, the participants were asked to answer two questions. The order of questions was varied across two lists in a counterbalanced fashion:

Notional mass nouns (*asa* 'flour', *y'a* 'water', *kania atxa* 'meat'):

Number question (Count-quantifier)

(31a) Ma de itxïbï asa dju a'u?
who many flour have
'Who has many portions of flour?'

Volume question (Adjective)

(31b) Ma de urahu asa dju a'u?
who big flour have
'Who has a big portion of flour?'

Notional count nouns (*xaa* 'bowl', *txarina* 'chicken', *karaxu* 'spoon'):

Number question (Quantifier)

(32a) Ma de itxïbï xãã dju a'u?
who many bowl have
'Who has many bowls?'

(32b) Ma de urahu xãã dju a'u?
who big bowl have?
'Who has a big bowl?'

Aggregate nouns (*abeata* 'clothes', *wã'e* 'ceramic'):

Number question (Quantifier)

(33a) Ma de itxïbï abeata dju a'u?
who many clothes have
'Who has many articles of clothing?'

Volume question (Adjective)

(33b) Ma de urahu abeata dju a'u?
who big clothes have?
'Who has a big (article of) clothing?'

As illustrated in (31)-(33) three notional classes of nouns (mass, aggregate and count nouns) were tested. The control items for this study were the notional count nouns (*xãã* 'bowl') and aggregate nouns (*abeata* 'clothes'). These nouns denote individuals that are stable across different worlds of evaluation. Thus, the expectation is that speakers will always choose the Number answer when the question is formed by the count-quantifier *itxïbï* 'many' and count or aggregate nouns. Conversely, we expect that when the question includes the size adjective *urahu* 'big' the only possible interpretation is one associated with the size of the individual, not number of individuals. These results would corroborate the facts elicited in the 'give me a sentence and a context' task.

The critical items of this study are the ones that include notional mass nouns. If mass nouns have count denotations, they would be interpreted in constructions with count-quantifiers (e.g. *itxibï* 'many') as many concrete portions of *x*, not as a big portion of *x*. That is, if the constituent [count-quantifier + mass noun] is interpreted as many portions of *x*, then this would support our hypothesis that mass nouns in Yudja have count denotations as *itxïbï* 'many' quantifies over concrete portions of *x.* However, if the constituent [count-quantifier + mass noun] is interpreted as a big portion of *x*, then this would disconfirm our hypothesis. It would instead suggest that notional mass nouns do not have count denotations, since their distribution would be different from other nouns that have count denotations such as *txarina* 'chicken'.

In contrast with the predictions for the quantifier *itxibï* 'many', we expect that the adjective *urahu* 'big' can only be interpreted as referring to a big concrete portion, not to many portions of a substance *x*. If the constituent [adjective + mass noun] is interpreted as a big concrete portion of *x*, then this is compatible with our hypothesis that notional mass nouns in Yudja have count denotations.

If the predictions above are confirmed, that would support the analysis in which all nouns have count denotations. As such, the analysis we presented in this paper would not only explain the distribution of notional mass nouns with numerals but it would also account more broadly for other linguistic expressions that are associated with counting number of individuals or concrete portions in Yudja.

Results The results of Study 2 are presented in Tables 3 and 4. The two predictions tested in this study were confirmed. First, as predicted by our analysis, all participants associated *itxïbï* 'many' with many concrete portions of *x* (for notional mass nouns) or with many individuals (for notional count and aggregate nouns):

‘Noun category’	Adults	Children (2 – 5)	Children (6 - 11)
Notional mass noun	100%	89 %	91 %
Notional count noun	100%	92 %	100 %
Aggregate noun	100%	85 %	93 %

Table 3 Results for Study 2 *itxïbï* ‘many’ – presented in percentage of Number responses

The results of this study also confirmed that when a notional mass noun is in a construction with a size adjective such as *urahu* ‘big’, it can be interpreted as referring to a big concrete portion of *x* or a big individual:

'Noun category'	Adults	Children (2 - 5)	Children (6 -11)
Notional mass noun	0 %	28 %	33 %
Notional count noun	0 %	25 %	16 %
Aggregate noun	0 %	14 %	33 %

Table 4 Results for Study 2 *urahu* 'big' – presented in percentage of Number responses

These results confirm the two predictions that were born from the analysis presented in this paper. First, count-quantifiers are interpreted as quantifying over the number of individuals/concrete portions of a particular kind when combined with notional count and notional mass nouns. Second, as predicted by our analysis, the adjective *urahu* 'big' is necessarily interpreted relatively to the volume of a particular individual/concrete portion of *x* and it derives the same interpretation for all nouns regardless of their (notional) category.

In sum, the quantity judgements tasks support the hypothesis presented in this analysis: when notional mass nouns are directly combined with count-quantifiers in Yudja such as *itxïbï* 'many' the interpretation produced is a Number interpretation (as for all other nouns in the language). Conversely, when notional mass nouns such as *urahu* 'big' are combined with size adjectives, they are interpreted as referring to a big portion of *x* (again, as for all other nouns in the language). These facts are consistent with an analysis in which, because all nouns denote number neutral properties of concrete portions of stuff, we expect that all nouns can interact directly with the counting system without intervening container/measure phrases. Furthermore, the facts described in this paper confirmed that there are no expressions that select only notional count nouns in language.

Conclusions

In this paper we have shown that in Yudja all nouns have count denotations and, as such, concrete portions of a kind can be considered as atoms for counting. This proposal was based on the empirical fact that in this language all numerals can be directly combined with mass nouns. Experimental data have further supported this claim, as we have seem that Yudja speakers did not provide different quantity judgements based on notional noun types and, furthermore, adults based their quantity judgements significantly more on Number in contrast to Volume, supporting the claim that all nouns can be interpreted as count nouns in this language. Experimental tasks also supported a second claim of this study: that is, that nouns combined with the count-quantifier *itxïbï* 'many' are necessarily interpreted as referring to many portions of stuff and when combined with size adjectives such as *urahu* 'big' they are interpreted as big individuals or big concrete portions of stuff. As such, these results suggest that there are no expressions that only select notional mass nouns in the language and thus all nouns can interact with the counting system.

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