

## RESEARCH

# Quantity judgment studies in Yudja (Tupi): Acquisition and interpretation of nouns

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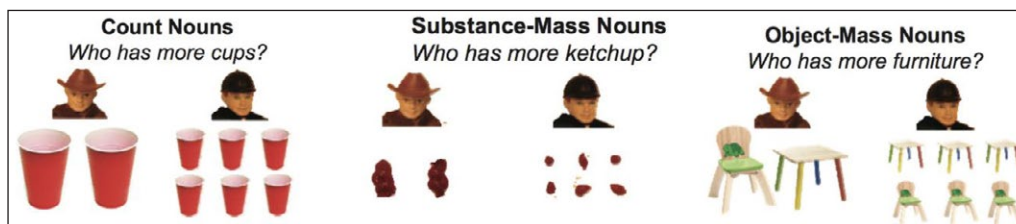
This paper explores the acquisition path and interpretation of substance and object nouns in Yudja, a Brazilian indigenous language. Based on quantity judgment tasks (Barner & Snedeker 2005), we show that children accept both cardinal and non-cardinal interpretations for all nouns (object and substance denoting nouns), while adults strongly favor a cardinal interpretation for all nouns, including substance nouns. We will use the results from these studies to support three theoretical claims from the literature. First, that the pattern observed for adults corroborates previous analyses of Yudja according to which maximal self-connected concrete portions of a kind can be considered as atoms and can be counted (Lima 2014). Second, that counting does not require natural atomicity (cf. Rothstein 2010). Third, that the definition of atoms for counting is the result of lexical, syntactic and pragmatic factors and does not depend solely on the lexical meaning of a noun (cf. Srinivasan & Barner 2016).

**Keywords:** Yudja; count/mass; numerals; quantity judgments

## 1 Introduction

Cross-linguistically, scholars have used quantity judgments in order to describe the properties of count and mass nouns in a language. In the quantity judgment task introduced in the literature by Barner & Snedeker (2005), participants had to compare two displays: one that had a greater volume of entities of some sort (henceforth “Volume”) and another that had a greater number of entities of that sort (henceforth “Number”) (Figure 1).

In English (Barner & Snedeker 2005) and Chinese (Cheung, Li & Barner 2012), participants (16 adults and 16 4-year-olds in English and 56 adults in Chinese) presented different quantity judgments depending on the noun being used in the comparison of these quantities. In English, the question ‘Who has more X?’ included either a pluralized count noun (*who has more shoes?*) or an unmodified noun (substance mass nouns: *who has more toothpaste?*; object mass nouns: *who has more furniture?*) (Barner & Snedeker 2005’s studies 1 and 2). In Mandarin Chinese, all questions included bare nouns, without classifiers (*Shui you bijiao duo [noun]?* ‘Who has more [noun]?’). In both languages, participants



**Figure 1:** Sample of experimental items from Quantity Judgment Tasks (Barner, Li & Snedeker 2010).

based their quantity judgments on Volume significantly more when they evaluated mass nouns (such as *toothpaste*) and they based their quantity judgments significantly more on Number when they evaluated count nouns (such as *shoes*) or object mass nouns (such as *furniture* – in English only).<sup>1</sup>

Results of quantity judgment tasks can be used to show that a distinction between objects and substances does not imply a distinction between count and mass nouns. In languages like English, object mass nouns (*furniture*) are encoded as mass nouns. Despite this fact, participants based their quantity judgments on Number when evaluating these nouns. As pointed out by Srinivasan & Barner (2016: 348), this shows that while count nouns “denote individuals, mass nouns can denote both individuated and non-individuated entities”. This claim is compatible with semantic theories such as the one proposed by Pires de Oliveira & Rothstein (2011) for Brazilian Portuguese’s bare singulars (*João trouxe livro* ‘João brought book(s)’) according to which bare singulars allow a cardinal interpretation (João brought one or more than one book) and a non-cardinal, volume interpretation (João brought a big/heavy book).

Another theoretical claim that we would like to highlight is that natural atomicity is not a requirement for counting in the grammar. This was carefully discussed by Rothstein (2010), who has shown that nouns such as *fence* and *wall* do not have natural atoms associated with them (what counts as a fence-atom and a wall-atom varies across contexts), nonetheless those nouns can interact with the grammar of counting just like nouns such as *dog* and *child*. This fact is also contemplated by Srinivasan & Barner (2016) who argue that the definition of atoms for counting (the criteria for individuation) involves more than one domain. In that sense, what a noun denotes – whether it is an object or a substance (its lexical meaning) – may play a role, but other aspects such as syntax (the constructions in which a noun may occur), as well as pragmatics, impact the definition of atoms for counting. At the pragmatic level, previous studies on language acquisition in the literature have shown that children count parts as wholes until they learn that pseudopartitives (e.g., *pieces of x*) are more informative descriptions than the bare noun by itself (cf. Shipley & Shepperson 1990; Srinivasan et al. 2013).

These two aspects, the absence of a one-to-one correspondence between ontological categories and grammar and the hypothesis that the definition of atoms is affected by different types of information (lexical, syntactic, pragmatic), is relevant for the discussion of nouns in Yudja. Yudja is a Brazilian language where all nouns can be directly combined with numerals and count-quantifier,<sup>2</sup> returning a cardinal interpretation (therefore, differently from languages like Chinese and English). In the next section, we introduce aspects of the Yudja language with respect to the grammar of countability.

## 2 The Yudja language

Yudja is a language spoken by a growing community of 800 speakers (Siasi/Sesai 2014).<sup>3</sup> Previous studies (cf. Lima 2014) have documented the distribution of object nouns and substance nouns in this language.<sup>4</sup> The description of constructions with numerals suggest that all nouns can be directly combined with numerals:

<sup>1</sup> Object mass nouns (a.k.a. fake mass nouns) are nouns that are cognitively count (Chierchia 2010) but syntactically mass (cf. Chierchia 2010; Grimm & Levin 2011; Schwarzschild 2011).

<sup>2</sup> In this paper, we are calling a quantifier a count-quantifier if it necessarily derives a count (cardinal) interpretation. In English, a quantifier that has this property is *many*.

<sup>3</sup> <https://pib.socioambiental.org/pt/povo/yudja>.

<sup>4</sup> In this discussion, we are using the term *object noun* in order to refer to nouns that denote objects/animals/people such as *chair*, *dog* and we are using the term *substance noun* in order to refer to nouns that denote substances such as *rice*, *water*.

- (1) (Lima 2014: 9 – examples 19 and 20)  
 Txabiũ pĩza dju wĩ.  
 three canoe bring  
 ‘(Someone) brought three canoes.’  
 # ‘Someone brought canoes three times.’

- (2) Txabiũ apeta dju wĩ.  
 three blood bring  
 ‘(Someone) brought three (quantities of) blood.’  
 # ‘Someone brought (portions of) blood three times.’

Example (1) is parallel to constructions with numerals and count nouns in most languages: a numeral is being directly combined with an object noun and we are talking about the number of canoes that someone brought. The example in (2) is critical as it shows that substance nouns can be directly combined with numerals, even when a container, which across languages can be expressed via a container/measure phrase (*bowls of x, kilos of x*) or as a classifier, is not expressed in the sentence. Note that this has also been attested in other languages unrelated to Yudja (cf. Gillon 2010; Gillon 2012; Mathieu 2012; Wiltschko 2012 among many others).

Also note that when container phrases do occur in construction with substance nouns in Yudja, they may be interpreted as referring to the location of the individual portions we are counting, rather than defining the portions we are counting or measuring. For example, the sentence in (3) can be interpreted both as referring to three bags of flour and as referring to three portions of flour (for example, three spoons of flour) located in bags.

- (3) (Lima 2014: 11 – example 21)  
 Txabiũ asa wĩ he [saku he] au.  
 three flour bank in bag in have  
 ‘There are three (portions of) flour in bags in the river’s bank.’

Constructions with the quantifier *itxibĩ* suggest that a cardinal interpretation is favored with both object nouns, as in (4), and substance nouns, as in (5). In (5), one cannot be referring to a big portion of blood, this sentence is only felicitous in a scenario where we are talking about portions of blood:

- (4) (Lima 2014: 12)  
 Itxibĩ pĩza dju wĩ.  
 many canoe bring  
 ‘(Someone) brought many canoes.’
- (5) Itxibĩ uda apeta dju wĩ.  
 many someone blood bring  
 ‘(Someone) brought many (clearly individuated quantities) of blood (e.g., tubes of blood for transfusion).’

In a previous analysis of this phenomenon in Yudja (cf. Lima 2014 for details) we claimed that bare nouns in the language denote kinds (based on the definition of Carlson 1977 and Krifka et al. 1995). From a kind  $k$ , we can derive the set of individuals that are specimens of  $k$  in a world  $w$  and we can derive the property of being a specimen of  $k$ . Following this approach, an atomic instance of a kind  $k$  in a particular world of evaluation  $w$  was defined as in (6):

- (6) 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<sup>5</sup> part of  $k(w)$  (Lima 2014 for Yudja based on Casati & Varzi 1999 and Grimm 2012).

This analysis predicts that instances of a kind can be treated as atoms as long as they do not overlap with other parts that are treated as different atoms. That is, the extension of nouns that describe substances such as *iya* ('water'), and the extension of nouns that describe objects such as *pakua* ('banana'), is relative to a specific situation or topic. It is defined as the closure under sum formation of the set of maximally strongly connected portions of the substance (e.g., portions of water of different types: bottles, puddles, drops, etc) or the object (whole bananas, parts of a banana, etc)<sup>6</sup> in that situation.

Following this analysis, in a scenario where one sees five drops of water on the floor, each drop will count as a maximal self-connected portion of a kind as long as they do not physically overlap. Even though this analysis predicts that non-overlapping portions of any kind (objects and substances) can count as atoms, we should emphasize that, as discussed by Srinivasan & Barner (2016), other factors will also influence what can be counted in a particular context. For example, the frequency with which instances of a certain kind occur as whole individuals in speakers' experience of reality (whole chairs, whole canoes) will increase the likelihood that speakers will use individual denoting nouns (chair, canoe) to refer to instances of this kind (cf. Samuelson & Smith 1999 – lexical statistics hypothesis). For the same reason, it is highly unlikely that a Yudja speaker would use a noun like *iidja* 'woman' to mean anything other than a whole woman. This factor also affects the interpretation of substance nouns. For example, in Yudja culture, bowls are probably the most frequent units used to count portions of water or flour. As a consequence, when counting portions of flour or water, Yudja speakers will most likely count bowls, if the unit of counting is not made explicit. Nevertheless, we can expect more variation in this domain than with object denoting nouns.

One of the predictions of the analysis presented in Lima (2014) for Yudja is that in quantity judgment tasks (based on Barner & Snedeker 2005), speakers could, in principle, associate substance nouns with a Number response, since atomic portions of a kind, defined in terms of maximal self-connectedness, are available for grammatical counting. In the next sections, we report the results of four quantity judgment tasks in Yudja that made use of the same methodology, with small changes in the stimuli. These studies were partially presented in Lima (2014) and Lima (2015). While in previous discussions of this data we focused on the theoretical consequences of this data for the semantic analysis presented in Lima (2014), in this paper we will expand on the language acquisition aspects of these studies.

### 3 Quantity judgment tasks in Yudja: The interpretation of nouns and the quantifier *bitu* (Studies 1 and 2)

Two quantity judgment tasks that included the quantifier *bitu* 'more' were performed in order to explore the interpretation of object and substance nouns in Yudja. We wanted not only to confirm that in these tasks adults would allow a cardinal interpretation of substance nouns, but also to investigate how children would perform the same tasks. More particularly, would response given by children be impacted by what the nouns denote (objects vs. substances) or would the apparent absence of a grammatical distinc-

<sup>5</sup> 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  $w$ .

<sup>6</sup> Follow-up studies that explored the interpretation of object-denoting nouns by Yudja children corroborated the claim of this proposal (cf. Lima, Li & Snedeker 2017).

tion between count and mass nouns in Yudja impact their judgments in early stages of language development?

### 3.1 Participants, materials and methods (Studies 1 and 2)

The first two studies we are presenting were performed with 18 adults and 22 children (7, 2-to-5-year-olds; 15, 6-to-11-year-olds). Children were divided into two groups according to schooling: 6-to-11-year-olds who had started to learn Brazilian Portuguese in school, and younger children who were monolingual or were in a very early stage of learning Brazilian Portuguese (cf. Lima 2014). The target questions included the quantifier *bitu*, which is a word that can be used to compare the volume of portions as well as the number of portions:

“Volume” interpretation:

Context: dividing flour with Pedro:

- (7) (Lima & Rothstein 2017)  
 Bitu na asa upadjihu yahã a hae.  
 more 1S flour half NMLZ want ASP  
 ‘I want more than half of the flour.’

“Number” interpretation:

Context (spontaneous speech): a child wants to know if Suzi has more hair clips to give:

- (8) (Lima 2014)  
 Suzi, au de bitu taba p̄dikaha.  
 Suzi have Q more hair clip  
 ‘Suzi, do you have more hair clips?’

To confirm that *bitu* ‘more’ could be used to refer to volume, we also did a pre-test where the participants had to answer *who has bitu x?* while being presented with a big pile of flour and a small pile of flour. 88% of the adults pointed to the big pile, indicating that it can be interpreted as referring to a single large portion of *x*.

In the other studies with *bitu* ‘more’ that are going to be presented next, the participants were shown two different drawings, one that was greater in dimension of volume (Volume) and another that was greater in dimension of cardinality (Number). Following Barner & Snedeker (2005), in the first study participants saw a contrast of one (volume) vs. three (cardinal) portions (Figure 2) and in the second study, participants saw the contrast of three vs. six portions (Figure 3).



**Figure 2:** Visual stimuli used in Study 1.



**Figure 3:** Visual stimuli used in Study 2.

In both studies, the target question was *Ma de bitu x dju au?* ‘Who has more *x*?’, where *x* could be a substance noun [notional mass noun] (*asa* ‘flour’, *iya* ‘water’, *kania atxa* ‘meat’), an object/animal noun [notional count noun] (*xaa* ‘bowl’, *txarina* ‘chicken’, *karaxu* ‘spoon’) or an aggregate (*abeata* ‘clothes’, *wã’e* ‘ceramics’). By “aggregate” we mean a naturally atomic individual whose instances can be of different types (e.g., *abeata* ‘clothes’ might refer to shirts, skirts, and *wã’e* ‘ceramics’ in Yudja might refer to different types of ceramic pans). The questions used in this study always had the same grammatical form (a bare noun in a question that included *bitu* ‘more’).

In tasks with children, a local teacher was always present in the room in order to facilitate the study and to make the children feel more comfortable. A local teacher researcher introduced the study by saying 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*?’).

## 3.2 Results

### 3.2.1 Study 1: One vs. three portions

The results for Study 1 are presented in Table 1.

A few considerations can be established based on the results. First, participants (children and adults) did not vary their quantity judgments according to the different noun types tested. Adults consistently favored the Number response for all nouns, school-aged children consistently favored the Volume response for all nouns, and pre-school-aged children presented a slight preference for the Number response, similarly to adults, but this preference was not as high as for adults.<sup>7</sup>

We analyzed these data by applying a mixed logit model. Mixed logit models are a generalization of logistic regression that include random effects. They are therefore appropriate for the analysis of categorical outcomes, and allow the inclusion of random effects, like subjects and items (Jaeger 2008). Our model was built using R (R Core Team 2017) and lme4 (Bates et al. 2017). As fixed effects, we entered age and noun type (without interaction term) into the model. As random effects, we had intercepts for subjects. We found no effect of noun type. However, there was a significant effect of Age on proportion of Number responses (Wald’s  $Z = 2.5$ ,  $p = 0.01$ ,  $\beta = 0.122$ ) (Lima 2014). 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

**Table 1:** Results of Study 1 – presented in percentage of “Number” responses.

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%

<sup>7</sup> Chi-square goodness of fit tests have shown that the results for adults are significant; adults are not answering at chance (count: p-value 0.0000009036; mass: p-value 0.0000002207; aggregate: 0.00006036). That is, if we take the null hypothesis to be that either answer is equally equivalent (answer at chance), then the results we found for adults are clearly indicating strong evidence against the null hypothesis. For 2-to-5 year old children, all the results could be analyzed as at chance given that we have weak evidence to reject the null hypothesis (count: p-value 0.2, mass: p-value 0.8, aggregate: 0.1) while for 6-10-11 year old children, the results are significant for count and mass nouns (count – p-value: 0.02; mass: 0.001) while for aggregates, the results could be analyzed at chance (aggregates – p-value: 0.4).

**Table 2:** Results of study 2 – presented in percentage of “Number” responses.

Noun “category”	Adults	Children (2–5)	Children (6–11)
Notional mass nouns	64%	57%	26%
Notional count nouns	76%	57%	20%
Aggregate nouns	76%	71%	26%

significant (Wald’s  $Z = 0.9$ ,  $p = 0.35$ ,  $\beta = 0.208$ ).<sup>8</sup> In the second contrast, notional mass nouns were contrasted with aggregate and notional count nouns (that is, notional count and aggregate nouns were considered together as 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  $Z = -0.617$ ,  $p = 0.53$ ,  $\beta = -0.070$ ) (Lima 2014).

### 3.2.2 Study 2: 2 vs. 6 portions

The results for Study 2 are presented in Table 2.

As in Study 1, mixed effects modeling using age as a predictor confirmed that there was a significant effect of Age on proportion of Number responses (Wald’s  $Z = 2.2$ ;  $p = 0.02$ ;  $\beta = 0.11$ ).

### 3.3 General discussion (Studies 1 & 2)

Three important conclusions can be drawn from Studies 1 and 2. First, there is no evidence that the categories Volume and Number tested above are grammaticalized as a distinction between count and mass nouns in Yudja. Second, the results for adults suggest that all nouns can indeed be associated with a cardinal interpretation, since concrete portions (as defined in 6) can be counted as atoms, as predicted by Lima’s 2014 hypothesis. This was especially clear for adults who based their quantity judgments on Number for the majority of trials. Third, (notional) noun type (notional count [object nouns] vs. notional mass [substance nouns]) did not influence the participants’ quantity judgments, neither for the children, nor for the adults.

As presented in Tables 1 and 2, there is a concentration of Volume responses in the group of 6-to-11-year-olds for all nouns. This pattern changes as participants grow older. One could hypothesize that the results for 6-to-11-year-olds can be explained as an effect of Brazilian Portuguese acquisition (L2), since Brazilian Portuguese has a grammatical distinction between count nouns and mass nouns. It is possible that the exposure to Brazilian Portuguese raises the likelihood of evaluating kinds in terms of volume, but, as pointed out by one anonymous reviewer, this fact does not raise the possibility of distinguishing nouns into those that are more naturally evaluated in terms of Number (notional count) and those that are more naturally evaluated in terms of Volume (notional mass).

In the next section, we present a follow-up study that tested whether bilingual Yudja speakers (L1 Yudja, L2 Brazilian Portuguese) would maintain the pattern observed in Studies 1 and 2 when answering quantity judgments in a language where notional mass nouns cannot be directly combined with numerals, such as Brazilian Portuguese.

<sup>8</sup> The numerical advantage of aggregates being associated with the cardinal answer was also observed in other languages such as Dutch (Van Witteloostuijn & Schaeffer, this volume) and Chinese (Lin & Schaeffer, this volume).

#### 4 Study 3: Quantity judgment studies in Brazilian Portuguese with Yudjabilingual adults

Unlike Yudja, Brazilian Portuguese is a language that grammaticalizes a distinction between count and mass nouns. In Brazilian Portuguese, just like in English, only count nouns can be pluralized and directly combined with numerals (*dois cachorros* ‘two dogs’/\* *duas areias* [two sand-PL]). Brazilian Portuguese is also known in the semantics literature for allowing bare singulars. That is, count nouns in argument position that are neither preceded by a determiner nor pluralized:

- (9) Eu vi cachorro na rua.  
 1s saw dog in.the street  
 ‘I saw (a/some) dog(s) in the street.’

Previous quantity judgments in Brazilian Portuguese have shown that count (*colher* ‘spoon’) and object mass nouns (*móvel* ‘furniture’) were more likely to be associated with the Number answer (99% and 97% of Number responses, respectively) while substance mass nouns (*farinha* ‘flour’) were more likely to be associated with the Volume answer (21% of Number responses) (cf. Lima and Gomes 2016). It is important to say that these results were obtained in tasks where count nouns appeared pluralized (*Quem tem mais colheres?* ‘Who has more spoons?’) as well as when they appeared in their bare form (*Quem tem mais colher?* ‘Who has more spoon(s)?’).

It is also the case that bare singulars nouns also allow mass interpretations, if the context favors that interpretation (cf. Beviláqua & Pires de Oliveira 2014), such as ‘who has more ball(s) to fill the basket?’, but in neutral contexts, speakers favored the Number response (cf. Lima & Gomes 2016).

Given that most adults in Yudja communities are either bilingual or multilingual, we conducted a follow-up study in order to check whether Yudja speakers would answer tasks in Brazilian Portuguese (L2) in the same way as in Yudja (L1), or whether they would present judgments similar to those of Brazilian Portuguese speakers. This would show a sensitivity to the fact that in this language, but not in Yudja, (notional) count and mass nouns have different grammatical properties.

##### 4.1 Participants, materials and methods (Study 3)

20 bilingual Yudja adults (9 men and 11 women; age range: 7 15-to-18-year-olds; 9 20-to-33-year-olds; 8 20-to-33-year-olds; and 4 40-to-50-year-olds) participated in this study.<sup>9</sup> The same methodology and stimuli (Figure 2) from Study 1 were used in Study 3. The only difference was that in Study 3 the questions were in Brazilian Portuguese. The nouns in the critical questions were always bare. As reported before, bare singulars (count nouns that are not pluralized) allow both a mass and a count interpretation in this language:

- (10) Mass nouns (*farinha* ‘flour’, *água* ‘water’, *carne* ‘meat’):  
 a. (Lima 2014; 2015)  
 Quem tem mais farinha?  
 who have more flour  
 ‘Who has more flour?’

<sup>9</sup> As previously reported in the literature (cf. Lima 2014; 2015) proficiency in Brazilian Portuguese is affected by gender and age. Young men are more frequently involved in interaction with people outside the village and tend to be more proficient in this language. Exposure to Portuguese and years of education was not controlled in this particular study. In future studies, we intend to investigate the effects of level of proficiency in tasks.



Count nouns (*cuia* ‘bowl’, *galinha* ‘chicken’, *colher* ‘spoon’):

- b. Quem tem mais cuia?  
 who have more bowl  
 ‘Who has more bowl?’

Aggregate nouns (*roupa* ‘clothes’, *cerâmica* ‘ceramics’):<sup>10</sup>

- c. Quem tem mais roupa?  
 who have more clothes  
 ‘Who has more cloth(es)?’

#### 4.2 Results and discussion (Study 3)

The results for Study 3 are presented in Table 3.

The performance of Yudja adults in Yudja was different from their performance in Brazilian Portuguese. Mixed effects modeling using Helmert contrasts confirmed that there was an effect of noun type when we contrasted count and mass nouns. In Study 3, one factor with three levels (count, mass and aggregate) was manipulated in two Helmert contrasts. In the first contrast, count nouns were contrasted with aggregate nouns. In the second contrast, mass nouns were contrasted with aggregate and notional count nouns (that is, in the second contrast count and aggregate nouns were considered a single category). It was observed that mass nouns are significantly less likely to be associated with Number responses in comparison to count nouns (Wald’s  $Z = -2.256$ ;  $p = 0.02408$ ;  $\beta = -0.48$ ). There was also a significant connection between Age and Number responses, as younger bilingual speakers tended to differentiate count nouns from mass nouns in most trials, in contrast to older bilingual speakers (Wald’s  $Z = -2.33$ ;  $p = 0.019$ ;  $\beta = -0.21$ ). Study 1 (cf. Table 1) also shows a significant effect of age, but with respect to noun type in Yudja (Lima 2014; 2015).

#### 4.3 General discussion (Study 3)

Two important conclusions should be drawn from these results. First, the quantity judgments of Yudja speakers in Yudja and Brazilian Portuguese are not the same. Table 4 contrasts the results of Yudja speakers in Yudja with those in Brazilian Portuguese and with the results of the control group.

We observe an overall bias for cardinality (including for substance nouns) in Yudja that is not observed in Brazilian Portuguese. That is, in Brazilian Portuguese, the responses by L1 Yudja/L2 Brazilian Portuguese speakers indicate that mass nouns are significantly less likely to be associated with a Number response. These results could suggest that Yudja bilingual speakers are sensitive to the fact that, while in Yudja all substance nouns can be encoded as count, in Brazilian Portuguese count and mass nouns have a different

**Table 3:** Results of Study 3 – presented in percentage of “Number” responses.

Noun category	Answers Yudja group (L2 speakers of Brazilian Portuguese)	Answers Control Group (Brazilian Portuguese L1 speakers)
Mass ( <i>farinha</i> ‘flour’, <i>água</i> ‘water’, <i>carne</i> ‘meat’)	55%	21%
Count ( <i>cuia</i> ‘bowl’, <i>galinha</i> ‘chicken’, <i>colher</i> ‘spoon’)	63%	86%
Aggregate ( <i>roupa</i> ‘clothes’, <i>cerâmica</i> ‘ceramics’)	65%	97%

<sup>10</sup> For the sake of consistency, we used in Study 3 (in Brazilian Portuguese) the same nouns used in Studies 1 and 2 (in Yudja).

**Table 4:** Results of Study 3 – presented in percentage of “Number” responses.

<b>Noun category</b>	<b>Answers Yudja group (Yudja, Study 1)</b>	<b>Answers Yudja group (Brazilian Portuguese)</b>	<b>Answers Control Group (Brazilian Portuguese L1 speakers)</b>
Mass	85%	55%	21%
Count	83%	63%	86%
Aggregates	79%	65%	97%

grammatical status, and therefore speakers are not simply transferring their quantity judgments from Yudja to Brazilian Portuguese.

The reader might notice that the results from the Yudja adults are not exactly parallel to those of the control group of 38 L1 Brazilian Portuguese speakers. More studies on bilingualism in the Yudja communities would be needed in order to evaluate why that is the case. What we know, based on interviews (reported in Lima 2014), on sociolinguistics evaluations of Yudja communities (Lima & Santos Ms.) and on-site observation of the Yudja community in the last 10 years, is that the large majority of Yudja speakers do not use Brazilian Portuguese in everyday interactions (even if they are fluent bilinguals). Yudja speakers of the Tuba Tuba village have a language policy, in order to preserve their language, according to which Yudja should be favored at all times. We observed that they were very consistent with their policy and indeed avoided Brazilian Portuguese in interactions among speakers of Yudja. Brazilian Portuguese is used mostly in interactions with outsiders and among inter-ethnic couples.

Even though, as previously stated, more controlled studies on bilingualism should be done in the Yudja communities, we can suggest some hypotheses that could be explored in order to explain the patterns presented by the L1 Yudja/L2 Brazilian Portuguese speakers. If we focus on the results for count and aggregate nouns, we can observe that the percentage of Number responses by L1 Yudja/L2 Brazilian Portuguese is smaller in comparison with L1 speakers of Brazilian Portuguese. However, the results of L1 Yudja/L2 Brazilian Portuguese are not exactly surprising if we recall that bare singulars in Portuguese allow Number and Volume responses. Pires de Oliveira & Rothstein (2011) suggest that bare singulars in Brazilian Portuguese would not particularly favor a cardinal interpretation over a non-cardinal interpretation. In Lima & Gomes (2016) and Beviláqua et al. (2016), it was suggested that the preference for cardinality over non-cardinal interpretations in neutral contexts in Brazilian Portuguese is due to the lexical frequency of bare singulars being interpreted with cardinal interpretation. As such, the preference for cardinality is not encoded in the semantics of the noun, but could be a pragmatic effect.

We should highlight that among the group of L1 Yudja/L2 BP speakers tested, a small group of participants (three female participants, age 44, 45 and 47) did not seem to be as sensitive to a differentiation between count and mass nouns in Brazilian Portuguese as the other participants in this study. These three participants favored a Volume answer, regardless the noun type (count/mass). In a follow-up interview, we learned that these three speakers were students of an adult education program (they were in their second year in their studies of Portuguese) and were less proficient speakers of Portuguese in comparison with the other participants in this study (recall that the more fluent bilingual speakers are concentrated in the group of young members of the community). These participants did not reproduce their pattern in Yudja where there was a clear and high probability of Number answers across noun types for adults. Recall also that the 6-to-11-year-olds, who were of the age when children start to be systematically exposed to

Brazilian Portuguese in school, also presented a preference for volume. Future investigations will explore whether there is a correlation between proficiency in Portuguese and a preference for volume in quantity judgment tasks.

## 5 Study 4: Quantifiers and adjectives in Yudja

In Studies 1 and 2 we have shown the results for quantity judgment tasks in Yudja, including the ambiguous quantifier *bitu* ‘more’. The results of these tasks suggested that Yudja speakers allow cardinal interpretations of substance denoting nouns.

In this section, we will show that the availability of a cardinal interpretation associated with substance nouns can be substantiated by tasks that include quantifiers that are not ambiguous and adjectives that denote size such as *big*.

In languages like English, we cannot combine mass nouns, such as *sand*, directly with count-quantifiers, such as *many* (\* *I saw many sands*). Furthermore, in English, we cannot combine a size adjective such as *big* with a mass noun directly. The sentence “I saw a big sand” is ungrammatical. In classifier languages (such as Chinese), a similar pattern is observed. Substance nouns cannot be directly combined with size adjectives (such as *da* ‘big’); a construction that involves a mass noun, such as *water*, and an adjective, such as *big*, necessarily includes a classifier (Li 2011: 47):<sup>11</sup>

- (11) (Li 2011: 47)  
 Yi da ping shui.  
 one big CL<sub>bottle</sub> water  
 ‘A big bottle of water.’

Given what we have seen so far for Yudja, namely that all nouns can be directly combined with numerals and that a cardinal interpretation is favored in quantity judgment tasks for all nouns when the task is performed in Yudja (adults), we would expect that when a substance noun such as *iya* ‘water’ is combined with a quantifier, such as *itxibi* ‘many’, it will be interpreted as quantifying 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. Conversely, when we combine substance 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 *iya* ‘water’) or to an individual (for nouns like *txarina* ‘chicken’).

### 5.1 Participants, materials and methods

The participants were the same 18 adults and 22 children (7 2-to-5-year-olds; 15 6-to-11-year-olds) that participated in Studies 1 and 2. The same methodology and stimuli (Figure 2) from Study 1 were used in Study 4. The only difference was that in Study 4 the questions included either the count-quantifier *itxibi* ‘many’ or the size adjective *urahu* ‘big’:

- (12) Notional mass nouns (*asa* ‘flour’, *iya* ‘water’, *kania atxa* ‘meat’):  
 “Number” question (Count-quantifier)  
 a. Ma de itxibi asa dju a’u?  
 who many flour have  
 ‘Who has many portions of flour?’

<sup>11</sup> As for constructions with quantifiers, when a substance-denoting noun is combined with a count-quantifier such as *xudou* it will be interpreted as referring to volume (much water) rather than cardinality. A classifier may optionally occur in constructions with *xudou* (*Xudou* + Classifier + N); with count nouns, only individual/group classifiers are allowed, and with mass nouns only measure words or container classifiers are allowed (Xuping Li, personal communication).

“Volume” question (Adjective)

- b. Ma de urahu asa dju a’u?  
 who big flour have  
 ‘Who has a big portion of flour?’

(13) Notional count nouns (*xãã* ‘bowl’, *txarina* ‘chicken’, *karaxu* ‘spoon’):

“Number” question (Count-quantifier)

- a. Ma de itxibĩ xãã dju a’u?  
 who many bowl have  
 ‘Who has many bowls?’

“Volume” question (Adjective)

- b. Ma de urahu xãã dju a’u?  
 who big bowl have  
 ‘Who has a big bowl?’

(14) Aggregate nouns (*abeata* ‘clothes’, *wã’e* ‘ceramics’):

“Number” question (Count-quantifier)

- a. Ma de itxibĩ abeata dju a’u?  
 who many clothes have  
 ‘Who has many articles of clothing?’

“Volume” question (Adjective)

- b. Ma de urahu abeata dju a’u?  
 who big clothes have  
 ‘Who has a big (article of) clothing?’

## 5.2 Results (Study 4)

The results of Study 4 are presented in Tables 5 and 6.

The two predictions tested in this study were confirmed. As we expected, in constructions with a size-adjective, speakers favored the interpretation where the adjective denotes one property of a discrete individual (big portion of  $x$ ), and in constructions with a count-quantifier, speakers consistently interpreted this quantifier as referring to the number of individual portions of  $x$ . Critically, the same interpretation (cardinal) was associated with all nouns (object and substance nouns) in constructions with *itxibĩ* ‘many’.

## 5.3 General discussion (Study 4)

Study 4 further upheld the results presented in Studies 1 and 2 and showed that a size adjective such as *big*, which can only modify directly count nouns in languages like English and Chinese, can be combined with all nouns in Yudja, returning a volume interpretation (big portion of  $x$ ). We also observed, as predicted, that count-quantifiers are similar to numerals in the language. All nouns can be directly combined with the quantifier *itxibĩ* ‘many’, and this quantifier necessarily drives a count/cardinal interpretation.

**Table 5:** Results for Study 4 *itxibĩ* ‘many’ – presented in percentage of “Number” responses.

“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 6:** Results for Study 4 *urahu* ‘big’ – presented in percentage of “Number” responses.

“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%

In sum, the adjective *urahu* ‘big’ is necessarily interpreted as specifying the volume of a particular individual/concrete portion of  $x$  (big  $x$  or big portion of  $x$ ). This interpretation is attested with all nouns regardless of their (notional) category. Likewise, the count-quantifier is necessarily interpreted as specifying the cardinality of portions of  $x$ , and this interpretation is attested with all nouns regardless of their (notional) category.

## 6 Conclusions

This paper discussed the acquisition path and interpretation of substance and object nouns in Yudja, a Brazilian indigenous language. We have shown that, in Yudja, all nouns can be directly combined with count-quantifiers, numerals and size adjectives.

We have presented an overview of the results of quantity judgment tasks in Yudja where the target questions included an ambiguous quantifier *bitu* ‘more’ (Studies 1 and 2), a count-quantifier *itxibi* ‘many’ (Study 4), or a size adjective *urahu* ‘big’ (Study 4). In the tasks (Studies 1 and 2) where the questions included the quantifier *bitu* ‘more’, we saw that the younger group of Yudja children allowed cardinal and non-cardinal interpretations for all nouns. This is predicted by theories such as Pires de Oliveira & Rothstein’s (2011), according to which kind denoting nouns allow quantification along both dimensions (non-cardinal and cardinal). This is also predicted by Lima’s analysis of Yudja (Lima 2014), according to which contextually determined portions of a kind can be taken to be semantic atoms. As children grow older (schooling age), a tendency for volume interpretations (instead of number) is observed. It is critical to highlight that children are not presenting different judgments for different noun types. In that sense, they are aware that these nouns are not grammatically distinct in the Yudja grammar.

In those tasks, adults strongly favored a cardinal interpretation for all nouns. The preference observed in these studies for counting portions of substances (instead of measuring their volume) was also suggested by Yudja speakers in interviews about the practices of exchanging goods in the community (cf. Lima 2014; Lima & Rothstein 2017). In trade among members of the community it is a common practice to compare the number of portions of a particular substance instead of comparing their volume as determined by a scale. This kind of preference could have also impacted the results from Studies 1 and 2, where no context was provided and participants had to compare quantities that two people owned.

It is important to highlight that the preference for cardinality does not mean that the Yudja do not measure by volume. For example, in the nominal and in the adjectival level, it is shown that Yudja speakers compare along continuous dimensions (Lima & Rothstein 2017):

- (13) Yakuha xāā he yahā upiide pīza he urahu.  
 Porridge bowl in NOM more canoe in big  
 ‘There is more porridge in the bowl than in the canoe.’

- (14) a. Yaba Karin upide **urahu**.  
 Yaba Karin COMP big  
 ‘Yaba is taller than Karin.’
- b. Yaba Karin **yau** **du-wa** ã kara yahã.  
 Yaba Karin two POSS-finger measure pass NMLZ  
 ‘Yaba is two fingers taller than Karin.’

We would also like to highlight that the results found in Study 3, where it was observed that L1 Yudja/L2 Brazilian Portuguese speakers do not transfer their quantity judgments from Yudja to Brazilian Portuguese, **should not** be taken as exemplifying that Yudja speakers perceive objects and substances differently in different languages. Instead, it shows that the question *Who has more N?*, as pointed out by an anonymous reviewer, is a different question when asked in Yudja or in Brazilian Portuguese, given the different grammatical properties of these languages with respect with the grammar of countability, and specifically the different semantics of nouns in both languages.

Finally, we saw that when answering quantity judgment tasks that included count-quantifiers and size adjectives, children showed a very early understanding of the semantics of these words. All children tested, presented similar results to the adults’ control group, showing a cardinal preference in the first case and a volume preference for the second case, as adults.

In conclusion, data from Yudja corroborate the hypothesis that the interpretation of nouns and the definition of what we can grammatically count result from a number of different information levels: the lexical denotation of nouns; the grammatical features of a language; and contextual information. In that sense, natural atomicity might influence what we count, but it is not the only information that is involved in defining atoms grammatically. Evidence for this claim is found beyond Yudja. First, as is widely known, in English, objects denoting nouns such as *furniture* are encoded as mass nouns, showing that there is not a one-to-one correspondence between ontology and grammar. Second, nouns such as *wall* and *fence* might have different atoms across contexts and contextual information impacts the definition of what we count. Third, language acquisition studies suggest that children can count parts of objects as whole objects until they realize that pseudopartitives are more informative descriptions for describing parts (cf. Srinivasan et al. 2013 for details), which suggests that pragmatics impact the interpretation of nouns in the same way as other phenomena, such as the acquisition of scalar quantifiers (*some* and *all* – cf. Foppolo, Guasti & Chierchia 2012).

### Abbreviations

1S = first person, CL = classifier, COMP = comparative, NMLZ = nominalizer, POSS = possessive, Q = question.

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### Competing Interests

The author has no competing interests to declare.

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