http://dx.doi.org/10.31513/linguistica.2024.v20n3a65504

Coercion and underspecification: bare nouns in English and in Brazilian Portuguese

Coerção e subespecificação: nomes nus no inglês e no português brasileiro

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ABSTRACT

This paper investigates the semantics of bare nouns in English and Brazilian Portuguese, analyzing the results of experiments in the count-mass domain in both languages. Specifically, it examines the results for English (Frisson; Frazier, 2005) and for Brazilian Portuguese (Lima, 2019; Lopes, 2024; Cardozo, 2024). In English, bare singulars are coerced into mass in mass contexts, and mass nouns are packed into units in count contexts (Frisson; Frazier, 2005). Thus, in English, nouns enter into the semantic derivation with the information that it is either mass or count. The experiments in Brazilian Portuguese show that this is not so in this language. Lima (2019) did not find any additional processing cost from mass to count nor from count to mass, pointing towards polysemy. Lopes (2024) found additional processing for bare singulars in count contexts with numerals but no additional processing with measure phrases. Cardozo (2024) only found additional processing for plural quantifiers combined with pluralized mass nouns. All of them refute the hypothesis that the bare singular in Brazilian Portuguese behaves like a count noun (against Schmitt; Munn, 1999), since, in all experiments, it is compatible with mass contexts. Thus, the bare singular in English does not carry the same grammatical ingredients as the bare singular in Brazilian Portuguese. It is still an open question whether the bare singular in Brazilian Portuguese is underspecified (Pires de Oliveira, 2022) or a mass noun (Pires de Oliveira; Rothstein, 2011).

KEYWORDS: Coercion. Bare nouns. Count-mass. Brazilian Portuguese. English.

RESUMO

Este artigo investiga a semântica dos nomes nus em inglês e português brasileiro, analisando os resultados de experimentos no domínio de contáveis e massivos em ambas as línguas. Especificamente, examina os resultados para o português brasileiro (Lima, 2019; Lopes, 2024; Cardozo, 2024) e para o inglês (Frisson; Frazier, 2005). Em inglês, nomes singulares nus passam por um processo de coerção para massivo em contextos de massa,

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Recebido em 09/09/2024 - Aceito em 23/01/2025

e nomes massivos passam por coerção para cardinal em contextos contáveis (Frisson; Frazier, 2005). Assim, em inglês, os nomes entram na derivação semântica com a informação de que são ou massivos ou contáveis. Em português brasileiro, Lima (2019) não encontrou nenhum custo adicional de processamento de massa para contável e de contável para massa, apontando para polissemia. Lopes (2024) encontrou um custo adicional de processamento para singulares nus em contextos contáveis com numerais, mas não encontrou custo adicional com expressões de medida. Cardozo (2024) encontrou um custo adicional de processamento apenas para quantificadores plurais combinados com nomes massivos pluralizados. Os resultados apoiam a conclusão de que o singular nu em inglês não carrega os mesmos ingredientes gramaticais que o singular nu em português brasileiro. Assim, o singular nu em português brasileiro não se comporta como um nome contável (contra Schmitt; Munn, 1999), já que, em todos os experimentos, é compatível com contextos de massa. Ainda é uma questão em aberto se o singular nu em português brasileiro é subespecificado (Pires de Oliveira, 2022) ou um nome massivo (Pires de Oliveira; Rothstein, 2011).
PALAVRAS-CHAVE: Coerção. Nominais nus. Contável massivo. Português brasileiro. Inglês.

1. Introduction

The paper aims to enhance our comprehension of the semantic underpinnings of bare nouns across languages. It draws upon the concepts of coercion and underspecification prevalent in the nominal domain and employs experimental data from English (Frisson; Frazier, 2005) and from Brazilian Portuguese (Lima, 2019; Lopes, 2024; Cardozo, 2024). More specifically, it focuses on bare singulars[5]. Bare singulars in English are rare, and they seem to occur in food contexts, where they are interpreted as mass. One of the most well-known examples comes from Link (1983):

(1) There is apple in the salad. (Link, 1983, p. 303)

In (1), *apple* is a bare singular phrase, since it is a count noun in argument position. In order to explain cases such as (1), Link defines homomorphic functions that apply to count nouns and moves their denotation to the mass domain, and vice-versa. Those are rescue operations. Rescue operations take time. This is the motivation underlying Frisson and Frazier's (2005) investigation on bare singulars in mass contexts and plural mass nouns in count contexts. Their aim is to determine whether the mass to count and the count to mass transformations are cases of coercion or polysemy. They conclude that they are cases of coercion, that is, it takes additional time to process them, indicating that a primary meaning is activated first, as predicted by the semantic theories for English.

In Brazilian Portuguese (BrP, from now on), bare singulars are grammatical in argument positions. This raises the question of whether *maçã* (apple) in (2), the word-by-word counterpart of (1), has the same semantics as *apple* in (1):

(2) Tem maçã na salada.
has apple in.the salad
'There is apple in the salad'

[5] In the literature, bare singulars are determiner phrases the nucleus of which is a noun without plural inflection.

This is a context where one may compare the semantics of English and BrP bare singulars as well as the main approaches to bare singulars in BrP, because each one of these approaches raises a particular prediction for (2). If the bare singular is a count noun (Schmitt; Munn, 1999), then it will show the same pattern as English bare singulars in (1). If they are mass nouns (Pires de Oliveira; Rothstein, 2011), (2) should not take longer to be interpreted. Moreover, each theory predicts a different behavior for the bare singular when in count contexts, for instance with numerals, as in '5 cadeira' (5 chair). For the count view, it should compose with numerals. For the mass view, it should take longer with numerals. If they are underspecified (Pires de Oliveira, 2022), the prediction is no time difference in mass and count contexts for the bare singular.

Experimental data for BrP (Lima, 2019; Lopes, 2024; Cardozo, 2024) show that the bare singular in BrP does not behave as the bare singular in English against Schmitt & Munn, 1999. In English, it is a count phrase that is coerced to mass. Thus, the interpretation of (1) in English involves coercion; the count meaning is computed and given the context – i.e. the absence of plural inflection in the noun – it is re-computed as denoting in the mass domain. That takes time. Given that, so far, there is no evidence of penalty in the processing of the bare singular in BrP, and, therefore, no evidence of coercion, we suggest that the bare singular is not a count noun in such language. Thus, the bare singular in BrP is either mass or underspecified. In this article, we discuss some experimental evidence available in BrP and in English to shed some light on the status of the bare singular in BrP in terms of its representation and processing.

The paper begins with the mass and count distinction. Then, it presents Frisson and Frazier's experimental data on English bare singulars and plural mass nouns. The third section introduces BrP bare singulars and experimental studies conducted to investigate their semantics. It concludes with a comparison between these two languages.

2. Mass and count in number-marking languages

The distinction between count and mass nouns, introduced into linguistics by Jespersen in 1924, has been an area of a heated debate in recent philosophy and linguistics (Pelletier *et al*., 2022). Although English speakers know that nouns such as *book*, *backpack*, and *notebook* are count nouns, and *blood*, *flour*, and *hay* are mass nouns, there is no one-to-one correspondence between nouns and things in the world. Our minds as well as the minds of very young toddlers, and also other species, know that objects and substances are two types of things.[6] However, in natural languages, there are words that behave as mass but that denote objects, such as *furniture*, the so-called fake mass nouns (Chierchia, 2021), or object mass nouns (Rothstein, 2010, 2017). Moreover, *shoes* and *footwear* do not seem to have the same denotation (Landman, 2020). Moreover, Rothstein (2010) claims that some count nouns do not correspond to particular objects; they correspond to things that do not have a unity on their own, such as *fence*, and *bouquet*.

[6] See Carey (1985), Soja *et al*. (1991) among others.

There is also language variation. Not only among the words – in English *lentils* is a count noun, whereas *lentilha* in BrP is mass –, but also among grammars. Languages like Mandarin do not have articles, so all noun phrases are bare, and, in order to count, one always needs measure phrases; numerals do not combine directly with any noun. This led to the hypothesis that, in Mandarin, all nouns are mass (Krifka, 1995; Chierchia, 1998), which was later shown to be wrong (Cheng; Sybesma, 1999). Moreover, in some languages, all nouns are counted directly; there are no measure phrases, as in Yudja (Lima, 2019).

Language variation is explained by Chierchia's most recent semantic parameter (2021), according to the way nouns are combined with numerals: languages that have plural inflection and numerals that distinguish count and mass nouns are Number Marking Languages, and languages where classifiers are obligatory with numerals are the Classifier languages. According to this parameter, BrP and English are Number Marking Languages, because plural inflection and numerals distinguish mass and count nouns. In these languages, count nouns can be directly combined with numerals, whereas mass nouns cannot, as exemplified in the contrast below – (3a-b) for English and (3c-d) for BrP. Notice, however, that plural inflection is optional in BrP:

(3) a. John bought two chairs.

b. *John bought two hays.

c. João comprou duas cadeira(s).
João bought two chair-s
'João bought two chairs.'

d. * João comprou dois fenos.
João bought two hay-s

Mass nouns cannot be directly counted and require classifiers or measure phrases to be quantified, as in (4a) for English, and (4b) for BrP. This is a syntactic property that characterizes the distinction between count and mass nouns in these two languages.

(4) a. John bought a package of hay.

b. João comprou um pacote de feno.
João bought a package of hay
'João bought a package of hay.'

Thus, the grammar of these languages distinguish mass and count nouns. However, in our everyday conversation, count nouns can be massified as in (1), and some mass nouns combine with numerals[7]:

[7] This is possible if there are conventional containers such as cups and bottles.

(5) Two coffees, please.

Link (1983) defined functions that moved the denotation of the noun from the count to the mass domain and vice-versa. Pelletier *et al*. (2022) define grinding as an operation that turns a count noun into mass, and packing, as the operation that packs substances into containers. Researchers such as Rothstein (2017) and Chierchia (2022) have delved into these processes, positing that these transformations are not mere accidents of language but rather provide deeper insights into the semantics of nouns. These shifts in noun categorization highlight the complex ways in which language interacts with cognition, enabling flexible interpretations based on context and usage.

A number of issues are raised by these shifts, but it clearly models English nominal phrases, in such a way that count nouns might have mass interpretation, and mass nouns may be counted. This is a hypothesis that may be experimentally verified, as Frizon and Frazier (2005) did, since it predicts that there is a primitive meaning, either count or mass, and a derived meaning, which should take time to be processed, as we are going to see in the next section.

3. Coercion and Underspecification in sentence processing: English

One of the main questions regarding the time course of sentence comprehension is whether the semantic processor – the computational system responsible for developing semantic representations for the linguistic input – always commits itself to a specific interpretation of a given word or constituent immediately, right upon encountering it on the sentential input. Two main answers have been proposed to this question in the psycholinguistic literature, namely: (1) sentence interpretation occurs in a word-by-word fashion – the semantic processor operates in an incremental way, immediately determining the meaning of a word or constituent as soon as it is encountered in the input (Crain; Steedman, 1985; Altmann; Steedman, 1988); (2) sentence interpretation encompasses semantic underspecification – the semantic processor does not always immediately attribute a specific meaning to a word or constituent, leaving, in some cases, the interpretation underspecified (Frazier; Rayner, 1990). The fact is that the investigation of the immediacy of sentence interpretation requires us to tackle many other questions, one of them being, given answer (2), in which cases semantic underspecification is allowed (Frazier, 1999).

Frazier and Rayner (1990) addressed the question of semantic underspecification investigating the processing of homonymy (multiple meanings) and polysemy (multiple senses). They looked at sentences such as:

(6) a. Of course the pitcher pleased Mary, being so elegantly designed.

b. Of course the pitcher pleased Mary, throwing so many curve balls.

c. Unfortunately the newspaper was destroyed, lying in the rain.

d. Unfortunately the newspaper was destroyed, managing advertising so poorly.

The relevant comparison here is between *the pitcher*, which is a case of homonymy (or ambiguity), involving two unrelated meanings, namely, an inanimate reading (a container) and an animate reading (a player), and *the newspaper*, which is a case of polysemy, where the meanings are related in the same lexical item, namely, a concrete reading (a printed newspaper) and an abstract reading (an organization). The question is whether the semantic processor would immediately attribute a specific reading in both cases: homonymy and polysemy. The results obtained through an eye tracking experiment revealed that the semantic processor behaves differently in such cases: upon encountering *the pitcher*, it determines the inanimate reading (which would be the most frequent one), causing (6b) to be demanding in terms of processing. However, upon encountering *the newspaper*, it leaves the interpretation underspecified, assigning a partial interpretation compatible with the alternative senses of this word, i.e., with the family of senses of the word *newspaper*, not causing (6d), which has the less frequent sense, to be particularly demanding in comparison to (6c): the disambiguating material simply determines the intended readings. Frazier and Rayner (1990) conclude that there would be a pressure to immediately attribute a specific interpretation to a word (or constituent) only when the alternative procedure would be not giving any interpretation to it; on the other hand, there would be no such a pressure when the alternative of giving a partial interpretation to the word is available. Thus, in the case of homonymy, the processor would immediately attribute a specific interpretation to the word because the alternative would be assigning no semantic analysis at all to it (which would harm the incremental processing/interpretation of the sentence it is part of). But, in the case of polysemy, the processor may not immediately commit itself to a specific interpretation of the word – leaving its analysis underspecified – because there would be the alternative of giving a partial interpretation to it, one that encompasses the whole family of senses of the word.

Frisson and Frazier's (2005) emerges here as an investigation of whether the process of interpreting a mass noun as a count noun (which the authors call portioning, but that is equivalent to packaging in the semantic literature) and the process of interpreting a count noun as a mass noun (grinding) would be instances of underspecification – the semantic processor would not immediately commit itself with the mass reading and the count reading, respectively – or whether such processes would be instances of coercion – the semantic processor would immediately commit itself to the mass reading and the count reading, respectively, applying, thereafter, a lexical derivational rule in order to achieve the target meanings: count reading and mass reading, respectively. The authors conducted two eye tracking experiments to carry out this investigation.

In the first experiment, they focused on portioning, i.e., on the interpretation of a mass noun as a count noun. They manipulated the noun type (mass and count) and the context (neutral, with no explicit linguistic cue leading to a count interpretation, and helping, with such a cue, which could be a numeral or a quantifier). They examined the following experimental conditions:

(7) a. Mass noun + Neutral context
Yesterday, I bought imported beers at the counter of the local supermarket.

b. Mass noun + Helping context
Yesterday, I bought three imported beers at the counter of the local supermarket.

c. Count noun + Neutral context
Yesterday, I bought imported pears at the counter of the local supermarket.

d. Count noun + Helping context
Yesterday, I bought three imported pears at the counter of the local supermarket.

Conditions (7a-7b) are the crucial ones here, as they make it possible to test, by comparing them with each other and with conditions (7c-7d), whether the count use of a mass noun such as *beer* involves an additional processing cost due to the processor immediately committing itself to the basic meaning – mass reading – and having to apply a lexical derivational rule (portioning) to achieve the intended meaning – count reading. If this is the case, condition (7a) should have a higher processing cost than condition (7c), which has the count reading as the basic meaning, and condition (7b), which contains a prior cue potentially facilitating the attainment of the count reading of the mass noun (the cost of this change might not be measurable).

Considering the noun itself (*beers* and *pears*) as the critical region and the immediately subsequent word (if it had at least five characters) or the two immediately subsequent words as the post-critical region, the results of the experiment, especially those corresponding to more immediate measures (such as the time of first fixation on the noun region), showed that condition (7a) was, in fact, more costly in terms of processing than conditions (7b) and (7c), as well as (7d), with no difference being found between conditions (7c) and (7d). The authors, therefore, argue that the processor, when interpreting the mass nouns in question, immediately commits itself to their basic meanings – mass reading – and then, given the mismatch between the basic type of the noun and the syntactic context (especially in the absence of a helping context), it applies the portioning rule to rescue the derivation and achieves the count interpretation that is intended in these cases, which amounts to a considerable processing cost. The process of interpreting a mass noun as a count noun, therefore, would not be an instance of underspecification, but of coercion.

In the second experiment, they focused on grinding, i.e., on the interpretation of a count noun as a mass noun. They also manipulated the noun type (mass and count) and the context (neutral, with no explicit linguistic cue leading to a mass interpretation, and helping, with such a cue – an amount phrase). They examined the following experimental conditions:

(8) a. Mass noun + Neutral context
Yesterday, John wanted imported beer after the rich main course. His girlfriend didn't want anything.

b. Mass noun + Helping context
Yesterday, John wanted just a small amount of imported beer after the rich main course. His girlfriend didn't want anything.

c. Count noun + Neutral context
Yesterday, John wanted imported pear after the rich main course. His girlfriend didn't want anything.

d. Count noun + Helping context
Yesterday, John wanted just a small amount of imported pear after the rich main course. His girlfriend didn't want anything.

The prediction, in this case, was that condition (8c) would be the most costly of all if the processor immediately committed itself to the count meaning of the noun, since an additional operation to derive the mass interpretation would then have to be performed afterwards in order to attribute an interpretation to the sentence, which would not occur in conditions (8a) and (8b) and could occur imperceptibly in experimental terms in (8d) due to the help of the context.

Based on the same logic for defining the critical region and the post-critical region as in the first experiment, the results of this experiment, especially those from later measures (such as the second reading time of the noun region), revealed a higher processing cost in condition (8c) than in condition (8d). The authors took as evidence that the processor immediately committed itself to the count meaning of the noun in condition (8c), then applying thereafter the grinding operation in order to achieve the mass reading interpretation targeted by the sentence. Thus, in the same vein as in the first experiment, the process of interpreting a count noun as a mass noun would not be an instance of underspecification, but of coercion.

In view of these general findings, Frisson and Frazier (2005) argue that the semantic processing of sentences that involve a count use of a mass noun and a mass use of a count noun is not subject to underspecification. Instead, it involves an immediate commitment to the basic meaning of mass and count nouns, and, under the realization of the mismatch between the basic type of the nouns and the syntactic contexts, as a last resort to save the derivation, it applies the lexical derivational rules – portioning, to derive a count reading, and grinding, to derive a mass reading – so that the sentences can be appropriately interpreted. It is coercion, therefore.

The results obtained by Frisson and Frazier (2005) are in line with what is proposed in the semantic literature (Rothstein, 2017; Chierchia, 2021, among others), namely, that in English the noun would already convey the information of being mass or count – so the noun would have a basic meaning. Thus, to achieve a count interpretation of a mass noun and a mass interpretation of a count noun, the application of rules – instances of coercion – would be necessary.

Frisson and Frazier's basic sentences in the second experiment are bare singulars, that are, according to the authors, quite rare, and, when used, would be interpreted as mass nouns via coercion. As mentioned in the Introduction, the question that arises is whether we would have the same behavior – coercion – when interpreting bare singulars in BrP. Pires de Oliveira (2022) proposes that bare singulars in BrP are underspecified. This semantic proposal makes a straightforward processing prediction for BrP: the semantic processor, upon encountering a bare singular in a sentence, would leave its analysis underspecified when the local context does not force a mass or a count interpretation. Moreover, in the presence of such a context, there would not be any additional processing cost coming from a potential mismatch between the basic type of the noun and the syntactic context: in a count context, the bare singular would simply be interpreted as cardinality, which is associated to count nouns, and, in a mass context, the bare singular would be interpreted according to measure, either volume or portion. Thus, the interpretation of bare singulars would be an instance of coercion in English and an instance of underspecification in BrP because of their grammars. We now move to a more specific discussion about bare singulars in BrP in order to address such predictions in theoretical and experimental terms.

4. Brazilian Portuguese Bare Singulars

Bare plurals and bare mass nouns are grammatical in both languages (9), the bare singular is ungrammatical in English (10) (Compare to (2)), but grammatical in BrP:

(9) a. Water is healthy.
b. Água é saudável.
c. Dogs bark.
d. Cachorros latem.

(10) a. * Woman cries.
b. * John bought book.
c. Mulher chora.
d. John comprou livro.

Thus, they differ with respect to the grammaticality of bare singulars. This has led to much research.

However, not all theoretical approaches to bare singulars in BrP (Ferreira, 2021) agree that they are kind-denoting. Müller (2002) understands that (11a) is ungrammatical, whereas Schmitt and Munn (1999), Munn and Schmitt (2002), Pires de Oliveira and Rothstein (2011), among others, understand that it is grammatical[8]. All theoretical approaches agree that sentences in (2) and (11b) are grammatical. Our intuition is that (11a) is grammatical, so in this paper we leave aside Müller's proposal:

[8] There is experimental evidence that bare singulars are grammatical with kind predicates in adult language. See Mariano (2018), and Santana (2019).

(11) a. Baleia está em extinção.
whale is in extinction
'The whale is in extinction.'

b. João comprou livro.
João bought book.
'João bought books.'

Schmitt and Munn (1999), Munn and Schmitt (2002), Pires de Oliveira and Rothstein (2011) and Pires de Oliveira (2022) claim that the bare singular denotes the kind, so they account for (11a). However, they disagree with respect to the denotation of the noun, and, consequently, about the derivation of the determiner phrase (DP). Schmitt and Munn (1999), and Munn and Schmitt (2002) understand that the noun is count; Pires de Oliveira and Rothstein (2011), that it is mass; and Pires de Oliveira (2022), that it is underspecified.

4.1. Theories for BrP bare singular

Almost immediately after the publication of the Semantic Parameters, by Chierchia (1998), Schmitt and Munn (1999) published a paper claiming that without some modification, Chierchia's proposal does not allow a language as BrP, which has both bare singulars and bare plurals:

(12) a. Cachorro late.
dog barks.
'The dog barks.'

b. Cachorros latem.
dogs bark.
'Dogs bark.'

They also noticed that the bare nouns in (12) do not have exactly the same meaning. According to them, the bare singular is syntactically a defective phrase, because it does not have a Number Phrase (NumP), whereas the bare plural has number projection. Bare singulars are not mass nouns. The authors compared sentences like those exemplified in (13) to conclude that the bare singular is count since it has atoms, otherwise it would not work with a predicate that distributes over the individuals, as in *ter 20 k* (weight 20 k). Mass nouns have no atoms, so they do not distribute:

(13) a. Criança nessa idade pesa 20 k.
child at.this age weighs 20 k.
'Children at this age weigh 20 k.'

b. * Ouro nessa loja pesa 20 g.
gold at.this store weights 20 g.

In their proposal, the noun, in the lexicon, starts as an inclusive plurality, that is it includes both atoms and sums. Since there is no number projection, the Determiner Phrase (DP) is defective, and a null article, represented below with e from empty, turns it into a proper name. Consequently, we end up with the following derivation:

(14) $[_{DP}$ e $[_{NP}$ Ncount]] = kind

The syntactic structure for bare plurals adds a Number Phrase (NumP) that is responsible for throwing away the atoms from the denotation; thus the bare plural is an exclusive plurality. However, if that were so, we should expect that the bare plural in negative contexts would be true in a situation where there is only one individual. This incorrectly predicts that (15) means that there is one horse in the yard:

(15) Não tem cavalos no jardim.
no has horse-s in.the yard.
'There are no horses in the yard.'

Moreover, they predict no difference between the bare singular and the bare plural, in particular in mass contexts.

Pires de Oliveira and Rothstein (2011) systematically compare bare singulars, bare plurals and bare mass in BrP, revising all contexts Carlson (1977) investigated regarding the bare plural and the indefinite phrase in English. They claim that the bare singular patterns with bare mass, and not with the bare plural. For instance, only the bare plural seems to give rise to a subkind interpretation:

(16) a. Baleia está em extinção.
whale is in extinction.
'The whale is on the verge of extinction.'

b. Baleias estão em extinção.
whale-s are in extinction.
'Whales are on the verge of extinction.'

c. Petróleo está acabando.
oil is ending.
'Oil is running out.'

Only (16b) can be interpreted as some sub kinds of whales. They also show that the bare singular combines with measure phrases and allows for volume reading:

(17) a. É muito livro para você carregar.
is much/many/a lot of book for you to carry
'This is too much book for you to carry.'

b. São muitos livros para você carregar.
are many/a lot of books for you to carry
'These are too many books for you to carry.'

The sentence (17a) can be interpreted as the weight of the book (one or more), whereas in (17b) refers to counting the books. Their proposal relies on Rothstein (2010), a model theoretic account that departs from an ontology that is massive, that is, it is not organized by atoms (Krifka, 1995). The nominal root delimitates a region in the realm of concepts without organizing the individuals into sums. Atomicity is a grammatical operation that is interpreted as counting as one. This explains why there are count nouns that do not have a unity without a context that establishes its unity, for instance *fence*. Thus, the bare singular in BrP is a root noun, the denotation of which is massive, i.e. it has no grammatical atoms. Therefore, it is kind-denoting as mass nouns are, and we end up with the following description:

(18) $[_{DP}$ Nroot] = kind

The proposal explains the data, and the differences between the bare singular and the bare plural, since the bare plural is just a plural predicate (Krifka, 1995). However, they run into a difficulty, because if the noun is mass, how do we explain that it combines with numerals? In colloquial BrP (19a) is grammatical, but (19b) is not:

(19) a. três cachorro.
three dog
'three dogs'

b. * três lama
three mud

One might argue that the bare singular is ambiguous between mass and count (Pires de Oliveira; Rothstein, 2011). However, ambiguity should be the last theoretical alternative.

Pires de Oliveira (2022), relying on experimental data (Pires de Oliveira; Beviláqua, 2020), argues that the bare singular only carries conceptual information (Rothstein, 2017); it does not carry information about atomicity, so it is underspecified for this value (no value is ascribed for atomicity). The bare plural carries information about atomicity; thus, it must be counted. The following are the representations for the bare singular and the bare plural, according to the author:

(20) a. $[_{DP}$ Nroot] = kind as a singularity
b. $[_{DP}$ Atomicity Nroot] = kinds as a plurality

Given that the noun does not carry information about atomicity, it is predicted to be good both in mass and in count contexts.

Therefore, each theory makes a different prediction concerning the interpretation of the bare singular when in count and when in mass contexts. In the next section, on experimental studies in BrP, we examine the experiments that aimed to verify these theories.

5. Experimental results in Brazilian Portuguese

5.1. Testing theories via experiments

Considering the discussion in section 3, if we assume that coercion entails a processing cost, indicating the presence of a primitive meaning of the noun, and that underspecification should not incur additional time, then we can design experiments to verify which of the theories discussed in the last section best accounts for the data.

The theories make different predictions concerning the interpretation of the bare singular. Schmitt and Munn (1999) and Munn and Schmitt (2002) claim that the noun is count, thus bare singulars in BrP should behave exactly as the bare singular in English when in mass context. Since the noun is count, it should take longer in mass contexts, and have no additional processing cost in count contexts. Bare singulars in mass context should be coerced to mass, and that should take more time. In Pires de Oliveira and Rothstein (2011) the noun is mass, so no penalty for the bare singular in mass contexts is predicted. If the noun is mass, then the prediction is that it will be penalized in count contexts. Thus, bare singulars in count context should coerce into count, and that should take more time. Finally, in Pires de Oliveira (2022), the noun is underspecified, so it predicts no processing cost in either context. The table 1 below represents the predictions according to the theories for the bare singular:

Table 1: Theories' predictions for bare singular processing

	Schimitt and Munn (1999)	**Pires de Oliveira and Rothstein (2011)**	**Pires de Oliveira (2022)**
Count context	*No penalty*	*Penalized (coercion)*	*No penalty*
Mass context	*Penalized (coercion)*	*No penalty*	*No penalty*

Source: Authors' elaboration.

As observed, each theory offers a distinct prediction about the behavior of the bare singulars in count and mass contexts. The studies presented in the following section challenge all of these theories through experimental methods.

5.2. Experimental evidence

5.2.1. Lima (2019)

One of the first studies to experimentally investigate the processing of BrP bare singulars was conducted by Lima (2019). The researcher partially replicated previous experiments by Frisson and Frazier (2005), specifically focusing on bare singulars in BrP. Lima (2019) examines the behavior of nouns in mass and count contexts to determine whether this would have an additional processing cost, as found by Frisson and Frazier for English, or if the lexical shifts in meaning would not incur a cost. She compared two hypotheses: the lexical shifts hypothesis, which posited that transforming a noun from mass to count and count to mass would have an additional processing cost, and the lexical pragmatic hypothesis that predicts no additional processing cost.

In order to verify these two hypotheses, a task was devised to measure the reading times of whole sentences containing bare nouns in BrP. On one hand, the lexical rule hypothesis suggests that one meaning of a word is considered standard, while the other meaning arises from derivation. On the other hand, the lexical pragmatic hypothesis predicts that the language user is not committed to a specific interpretation, and contextual cues drive it since they are not committed to a single interpretation. In fact, interpretation is not provided before the context. Only with context or pragmatic information would the language user be able to provide one or the other interpretation.

In the first experiment, Lima (2019) investigated bare singulars in both grinding and non-grinding contexts to evaluate potential processing costs between these conditions. The experimental conditions were: (i) investigating whether bare singulars in a grinding context would have longer processing times compared to bare singulars in a non-grinding context; (ii) determining if there were significant processing differences between bare singulars and mass nouns in a mass context; and (iii) examining if nouns of animal, artifact, and edible categories in bare singulars in a grinding context would have a significant effect on the processing. The sentences were divided into two levels: noun form and lexical type. Below are examples of sentences extracted from Lima's (2019) experiment:

(21) a. Bare singular + Count context

João viu galinha acordada na mesa.
João saw chicken wake in.the table
'João saw (a/the/some) chicken awake over the table.'

b. Bare singular + Mass context

João viu galinha espalhada na mesa.
João saw chicken spread in.the table.
'João saw chicken spread over the table.'

c. Mass noun + Mass context

João viu açúcar espalhado na mesa.
João saw sugar spread in.the table.
'João saw sugar spread on the table.'

(22) a. Bare singular + Mass context
João viu banana amassada na rua.
João saw banana kneaded in.the street.
'João saw mashed banana in the street'

b. Count context + Neutral context
João viu banana?
João saw banana?
'Did João see (a/the/some) banana?'

The results of the first experiment did not show a significant effect of processing in any of the above-investigated conditions, neither for the noun form nor for the lexical type. This means that the processing of bare singulars in both grinding and non-grinding contexts did not reveal any evidence of additional processing costs. Consequently, the results of the first experiment supported the lexical pragmatic hypothesis. In other words, language users of BrP are not committed to a specific interpretation; the interpretations are only available once the context or pragmatic information allows access to meaning.

In the second experiment, Lima aimed to replicate the study conducted by Frisson and Frazier (2005). The focus of this experiment was to examine the packaging process, and the same conditions and sentences from Frisson and Frazier's experiment were verified. Presented below are the experimental conditions to illustrate the packaging experiment 2:

(23) a. Plural mass + Neutral context
Ontem, Pedro comprou cervejas no mercado local.
yesterday, Pedro bought beers in.the market local.
'Yesterday, Pedro bought beers in the local market'

b. Plural count + Neutral context
Ontem, Pedro comprou laranjas no mercado local.
yesterday, Pedro bought oranges in.the market local.
'Yesterday, Pedro bought oranges in the local market'

c. Plural Mass + Helping context
Ontem, Pedro comprou três cervejas no mercado local.
yesterday, Pedro bought three beers in.the market local.
'Yesterday, Pedro bought three beers in the local market'

d. Plural count + Helping context
Ontem, Pedro comprou três laranjas no mercado local.
yesterday, Pedro bought three oranges in.the market local.
'Yesterday, Pedro bought three oranges in the local market'

In Frisson and Frazier's study, the above-mentioned conditions showed additional processing in the condition of a mass pluralized noun both with and without a helping context. However, the results for English from Frisson and Frazier were not replicated in Lima's study for BrP, as no additional processing was found in any of the conditions. Similar to the first experiment, the second experiment also provided support for the lexical pragmatic hypothesis. This time with respect to the mass noun.

In a nutshell, based on Lima's study, the bare singular in BrP does not seem to reflect the same processing patterns as the bare singular in English, since, in English, it takes more time to be processed in a mass context. Evidence for this primitive meaning comes, for example, from additional processing cost when turning a mass into a count noun and vice versa, resulting in coercion. However, speakers of BrP do not seem to activate a primitive meaning, that is, the lexical entry is underspecified. In other words, bare singular nouns in BrP do not have a default interpretation and, in this sense, they are underspecified, as proposed by Pires de Oliveira (2022).

5.2.2. Lopes (2024)

The research investigated the semantic aspects involved in the processing and representation of bare singulars in BrP. The study seeks to understand how speakers interpret and process these nouns, particularly in measure and count contexts. The objective of this study was to understand how the noun, headed by a measure phrase or numeral, is processed in contexts that allow for evaluating the theoretical hypotheses described in the last section. The experiment was conducted using a Self-Paced Reading Task (SPR).

It includes two independent variables with phrase type with two levels (measure phrase and numeral) and noun type with three levels (singular count noun, plural count noun, and singular mass noun), resulting in a 2X3 design with six conditions. It is important to note that, unlike Frisson and Frazier (2005), whose research served as the basis for Lopes (2024), the experiment did not use mass nouns exclusively related to food and drink, but also included nouns for objects, such as hay, mud, and clay. The following outlines the conditions of the experiment:

(24) a. Numeral + Plural Noun:

João comprou	vinte e cinco	camas	no	mercado	grande.
João bought	twenty-five	bed-s	in.the	market	big

'João bought twenty-five beds at the big market'.

b. Numeral + Singular Noun:

João comprou	vinte e cinco	cama	no	mercado	grande.
João bought	twenty-five	bed	in.the	market	big

'João bought twenty-five bed at the big market'.

c. Numeral + Mass Noun:

João comprou	vinte e cinco	feno	no	mercado	grande.
João bought	twenty-five	hay	in.the	market	big

'João bought twenty-five hay at the big market'.

d. Measure Phrase + Plural Noun:

João comprou	um	pouco	de	camas	no	mercado	grande.
João bought	a	few	of	bed-s	in.the	market	big

'João bought a little bit of beds at the big market.'

e. Measure Phrase + Singular Noun:

João comprou	um	pouco	de	cama	no	mercado	grande.
João bought	a	few	of	bed	in.the	market	big

'João bought a little bit of bed at the big market.'

f. Measure Phrase + Mass Noun:

João	comprou	um	pouco	de	feno	no	mercado	grande.
João	bought	a	few	of	hay	in.the	market	big

'João bought a little bit of hay at the big market.'

The predictions are the ones that are depicted in table 1 above: (a), if the nouns is count, then no penalty in counting contexts, and penalties in measure contexts (Schmitt; Munn, 1999; Munn; Schmitt, 2002); (b) If then noun is mass, then no penalties in mass contexts, but penalized in countable contexts (Pires de Oliveira; Rothstein, 2011); and (c) if the noun is underspecified, no penalties in any of the contexts (Pires de Oliveira, 2022).

In the condition of measure phrase with singular noun (24e) versus numeral phrase with singular noun (24b), the measure context was faster than the countable context. In other words, participants took longer to interpret the singular noun when it was under the scope of a numeral. Additionally, the conditions of measure phrase with plural noun (24d) versus numeral phrase with plural noun (24a) is also a significant comparison, the plural showed penalty, meaning longer reading times, in mass contexts. That is, participants took longer to interpret the plural in mass contexts.

In the post-critical segment, there was a spillover effect, where comparing the conditions of numeral phrase with singular noun (24b) versus numeral phrase with plural noun (24a), the plural is faster. That is, in mass contexts, plural nouns took longer, while in countable contexts, their reading times were faster. Analyzing the conditions of numeral phrases with singular nouns (24b) versus measure phrases with singular nouns (24e), the mass context is faster, meaning it takes longer to process the singular noun with numerals. Next, the experiment's results can be analyzed in light of the proposed theories.

Based on these results, the data do not support the hypothesis that the bare singular is an inclusive plurality (Schmitt; Munn, 1999; Munn; Schmitt 2002; Müller, 2002), nor do they support the underspecification hypothesis (Pires de Oliveira, 2022). The findings presented in this study align with the theory that the bare singular is a mass noun (Pires de Oliveira; Rothstein, 2011), as there is no penalty in mass contexts, but rather in countable contexts. However, the author emphasizes that normative grammar could be influencing the outcomes, particularly in the context of numeral phrase with singular noun (e.g. *vinte e cinco livro – twenty-five book*), as participants may find that the "correct" form should be the noun in the plural. This is especially relevant given that the input for the experimental tasks was written, not auditory.

In sum, Lopes (2024) shows that there is no difference in terms of processing cost between bare singulars and mass nouns in measure contexts. Additionally, there is no coercion when the singular noun is used in a mass context, which contrasts with the findings of Frisson and Frazier (2005) for English, but aligns with Lima (2019). Furthermore, the singular count noun, when combined with numerals, proves to be more costly, consistent with the theory proposed by Pires de Oliveira and Rothstein (2011).

5.2.3. Cardozo (2024)

Cardozo (2024) was an experimental study that is based on Frisson and Frazier (2005) and Lima (2019), as discussed in the previous subsections. It aimed to investigate potential syntactic-semantic mismatches between English and BrP in the nominal domain, in particular with their combination with quantifiers.

In English, *much* was used with mass nouns, and *many* with count nouns. In BrP, *muito*, the singular form, combines with mass and count nouns, *muita* água (much water) and *muita mesa* (much/many table), whereas the plural form does not combine with mass nouns **muitas* água(s), with or without plural inflection in the noun.

Through a SPR, Cardozo investigated quantifier phrases in argument position using a 2x2 experimental design, in which the independent variables were noun (count/mass) and quantifier (singular/plural), and the dependent variables were response type (cardinal/volume), response time, and reading time on the critical segment of the noun. The study did not include edible nouns nor mass nouns with conventionalized containers, in order to avoid this interference. The sentences presented were:

(25) a. Singular quantifier + Singular count
O homem vendeu muita pena em Madrid.
the man sold much feather in Madrid.
'The man sold a lot of feather in Madrid.'

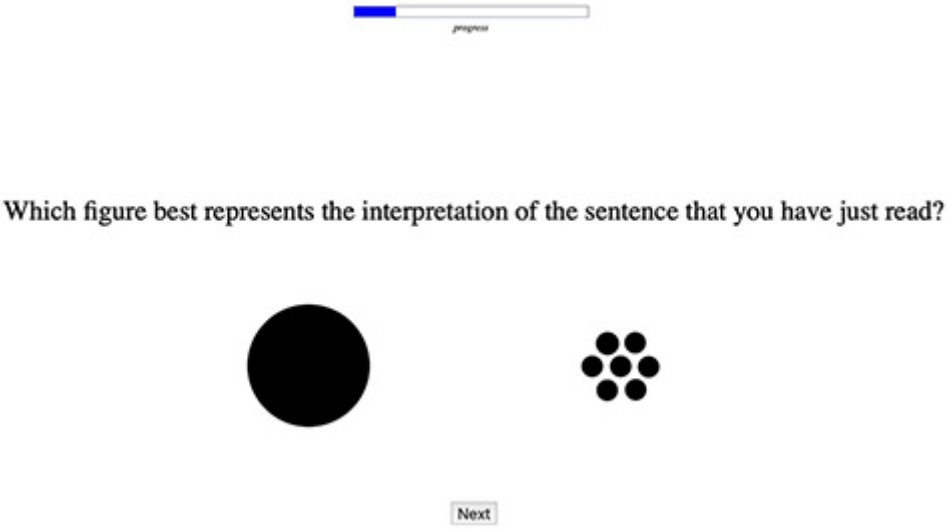
b. Plural quantifier + Plural count
O homem vendeu muitas penas em Madrid.
the man sold many feather-s in Madrid.
'The man sold many feathers in Madrid.'

c. Singular quantifier + Singular mass
O homem vendeu muita prata em Madrid.
the man sold much silver in Madrid.
'The man sold a lot of silver in Madrid.'

d. Plural quantifier + Plural mass
O homem vendeu muitas pratas em Madrid.
the man sold many silvers in Madrid.
'The man sold many silvers in Madrid.'

Cardozo's study incorporated an adapted version of the Quantity Judgment Task (QJT) from Bale and Snedeker (2005), referred to as the Interpretation Task (IT), which was designed by Bezerra, Pires de Oliveira, Lopes, and Cardozo (in preparation). Each IT was presented after the participant read each sentence. Figure 1 Interpretation Task illustrates Cardozo's version of the IT:

Figure 1: Interpretation Task



Source: Bezerra, Pires de Oliveira, Lopes, Cardozo.

After reading the sentence, if the participant selected the larger single ball, their interpretation was assumed to be based on volume, whereas selecting the smaller balls in greater quantity was interpreted as a choice based on cardinality.

The results of the IT task indicated a significant difference in the number of responses for cardinal and volume interpretations across each condition. There was an oscillation between cardinal and volume readings for the singular quantifier with count and mass nouns. Additionally, there was a preference for cardinal readings with plural quantifiers, both when combined with bare count and with mass plurals. Thus, plural quantifier phrases were always interpreted in terms of cardinality. Whereas the singular quantifier allowed volume and cardinality. The response time for the IT, measured in milliseconds, was recorded at the onset of the IT and captured the time participants took to decide whether they would select the larger ball or the smaller balls. Neither the singular nor the plural quantifier affected response times in any condition, but the response time for mass nouns was marginally slower when compared to count nouns. Taking into account the critical segment of the nouns, the time participants spent reading the critical segment only displayed additional processing times in the condition of a plural quantifier combined with a mass plural noun. No other comparison was significant, indicating an alignment with the underspecification hypothesis for the bare singular, as proposed by Pires de Oliveira (2022).

Based on these results, several aspects can be highlighted. The oscillation between cardinal and volume interpretations for bare singular nouns was reinforced, consistent with previous studies[9]. There was no additional processing cost in the noun region for bare singulars, as predicted by the underspecification hypothesis. However, the plural quantifier combined with a mass noun incurred additional processing time. This result goes against Lima's finding where mass nouns in count contexts were not penalized. As a result, participants are forced to interpret this combination driven by the plural inflection, reflecting a processing pattern of coercion, as discussed by Frisson and Frazier (2005).

6. Conclusion

The experimental data from English and from BrP show that coercion and underspecification have psycholinguistic correlates. While coercion takes time, underspecification has no processing cost. This allows an investigation into the semantic ingredients of a linguistic expression, besides being a helpful tool to evaluate competing theories and gain insight into the semantics of noun phrases. Experimental results for BrP and English show that the bare singular does not carry the same information in these languages.

In English, the bare singular is a count noun; so, when in a mass context, it is penalized and coerced into a mass denotation (Frisson; Frazier, 2005). In BrP, we have, so far, the results for the bare singular summarized in table 2 below. We added the predictions to compare the theories with the results:

[9] See Beviláqua and Pires de Oliveira (2014, 2017) and Pires de Oliveira and Beviláqua (2020).

Table 2: Theories' Predictions with Experimental Results

	Theories' predictions			**Experimental results**		
Count Context	Schimitt and Munn (1999)	Pires de Oliveira and Rothstein (2011)	Pires de Oliveira (2022)	Lima (2019)	Lopes (2024)	Cardozo (2024)
	No penalty	*Penalty*	*No penalty*	*No penalty*	*Penalty*	*No penalty*
Mass Context	Schimitt and Munn (1999)	Pires de Oliveira and Rothstein (2011)	Pires de Oliveira (2022)	Lima (2019)	Lopes (2024)	Cardozo (2024)
	Penalty	*No penalty*	*No penalty*	*No penalty*	*No penalty*	*No penalty*

Source: Authors' elaboration.

As can be seen in table 2, bare singulars in BrP do not take longer to be processed when in mass context, as found by Lima (2019), Lopes (2024) and Cardozo (2024). Thus, the grammatical information conveyed by the nominal phrase is not the same in BrP and in English. All the experiments show that the bare singular in BrP does not behave as a count noun, against Schmitt and Munn (1999), and Munn and Schmitt (2002). If it were, it should behave exactly as the bare singular in English, but it doesn't. If the bare singular denotes a sum of individuals including the atoms, as Schmitt and Munn propose, then it should not be good in mass context, and, as a last resort, it should be coerced into the mass domain, grinding the individuals. However, the experimental results refute this hypothesis.

More data is needed to verify whether the bare singular is mass (Pires de Oliveira; Rothstein, 2011) or underspecified (Pires de Oliveira, 2022), since the data so far seems to be contradictory. If the bare singular is mass, it should be penalized in count contexts, as found by Lopes (2024). However, if it is mass, then it should be penalized with the plural quantifier, *muitos*, but, according to Cardozo (2024), it isn't. More experiments are needed.

Acknowledgments

We would like to thank the anonymous reviewers for their comments and suggestions. Cardozo would like to thank *Programa de Bolsas Universitárias de Santa Catarina* (UNIEDU) for the financial support provided to develop Cardozo's study reported in this paper. Lopes would like to thank Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the financial support provided to develop Lopes's study reported in this paper.

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