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Dionatan Bastos Cardozo

Language Mismatch and Bilingualism: Experiments in Psycho-Semantics

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Dionatan Bastos Cardozo

Language Mismatch and Bilingualism: Experiments in Psycho-Semantics

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Orientador(a): Prof.(a) Roberta Pires de Oliveira, Dr.(a)
Coorientador(a): Prof.(a) Gitanna Brito Bezerra, Dr.(a)

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Dionatan Bastos Cardozo

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Prof.(a) Elaine Grolla, Dr.(a)

Universidade de São Paulo

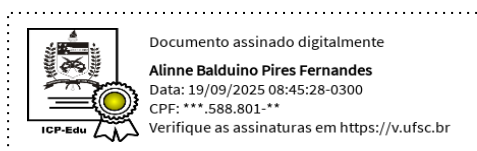
Prof.(a) Mailce Borges Mota, Dr.(a)

Universidade Federal de Santa Catarina

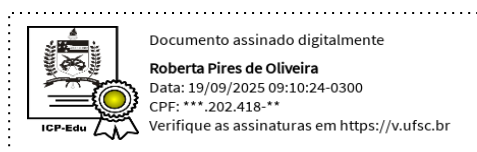
Prof.(a) Rosane Silveira, Dr.(a)

Universidade Federal de Santa Catarina

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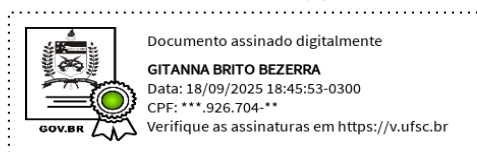


Coordenação do Programa de Pós-Graduação



Prof.(a) Roberta Pires de Oliveira, Dr.(a)

Orientador(a)



Prof.(a) Gitanna Brito Bezerra, Dr.(a)

Co-orientador(a)

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Dedico esta tese aos meus pais, Rosângela e Claudeni, minha família de sangue, a quem amo incondicionalmente. Dedico-a também a Carol, Rodrigo, Thomas e ao Oliver, minha família canadense do coração.

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Se tu entende que uma pessoa é só uma aglomeração dinâmica de estados mentais, a ideia de uma alma que pode reencarnar deixa de fazer sentido. O que renasce, arredondando de um jeito grosseiro pra tu entender, são esses estados mentais, que seguem em frente e se recombina até certo ponto. Assim como teu corpo alimenta plantas e vermes se tu for enterrado no chão. Assim como os átomos do teu corpo são poeira de estrelas.

Os átomos do meu corpo podem ser poeira de estrelas, mas isso não quer dizer que há estrelas em mim. (GALERA, 2012)

RESUMO

Esta pesquisa investiga uma não correspondência no domínio nominal entre o português brasileiro (PB) e o inglês, bem como seus efeitos sobre falantes bilíngues. O principal objetivo é fornecer evidências empíricas desse contraste entre as línguas, ao mesmo tempo em que se examina como bilíngues lidam com essas diferenças. Enquanto o status dos nomes singulares nus no PB tem sido amplamente debatido na literatura da área — dado que são gramaticais na língua —, o inglês, por outro lado, não os licencia. Para investigar essa não correspondência, realizamos dois experimentos principais com falantes nativos de PB e de inglês. Um desses experimentos consistiu em uma Tarefa de Julgamento de Aceitabilidade (TJA), que avaliou a aceitabilidade de nomes nus comestíveis e não comestíveis em três grupos: falantes nativos de PB, falantes nativos de inglês e aprendizes de inglês como L2. O outro combinou uma Leitura Automonitorada (LAM) com uma Tarefa de Interpretação (TI), voltadas à análise do processamento e da interpretação de sintagmas nominais quantificados, também com três grupos de falantes. Os resultados mostraram que o PB aceita todos os tipos de nomes nus, ao passo que o inglês rejeita nomes singulares nus. Além disso, a tarefa de LAM revelou que, no PB, os sintagmas nominais quantificados com nomes contáveis e de massa geralmente não desencadeiam custos adicionais de processamento — exceto nos casos em que o quantificador plural é combinado com nomes de massa pluralizados —, o que sugere que os nomes singulares nus são subespecificados. Em contraste, no inglês, os sintagmas nominais quantificados codificam lexicalmente a atomicidade, resultando em custos adicionais de processamento quando há incongruência entre o tipo de quantificador e o tipo de nome. Os dados da LAM também mostraram que o quantificador singular ‘muita’, no PB, é neutro quanto ao número, podendo combinar-se tanto com nomes contáveis quanto com nomes de massa. Seu correspondente em inglês, ‘much’, por sua vez, codifica lexicalmente uma preferência por nomes de massa. A TI revelou que a interpretação de nomes singulares nus no PB oscila entre leituras cardinais e de volume, enquanto, no inglês, o quantificador singular combinado com nomes contáveis resultou em respostas aleatórias, o que sugere a completa agramaticalidade dessas combinações. Para consolidar esses achados, realizamos comparações de grupo tanto para a TJA quanto para a LAM, o que confirmou a não correspondência entre essas duas línguas em termos de aceitabilidade e processamento. Por fim, os dados dos bilíngues PB–inglês mostraram que, embora haja transferência da L1 para a L2 onde há essa não correspondência, esses bilíngues também adquirem traços semânticos específicos da língua-alvo. Duas comparações de grupo adicionais foram realizadas para verificar evidências de transferência do

PB (língua-fonte) para o inglês (língua-alvo). As comparações revelaram um padrão claro de transferência na TJA, enquanto a LAM indicou que também havia sinais de aquisição de traços semânticos próprios da L2 nos padrões de processamento. Em conjunto, os resultados sustentam a hipótese de que certas propriedades semânticas, como a atomicidade, são adquiridas como parte da gramática do inglês, e que a gramática do bilíngue, embora inicialmente moldada pela transferência da L1, pode adquirir traços semânticos ao longo da aquisição para refletir restrições específicas da L2.

Palavras-chave: não-correspondência; bilinguismo; psicolinguística; semântica.

ABSTRACT

This research investigates a mismatch in the nominal domain between Brazilian Portuguese (BrP) and English, as well as its effects on bilingual speakers. The main goal is to provide empirical evidence of this contrast between the two languages while examining how bilinguals handle these differences. While the status of bare singular nouns in BP has been widely discussed in the literature — given that they are grammatical in the language — English, on the other hand, does not license them. To investigate this mismatch, we conducted two main experiments with native speakers of BrP and English. One of these experiments consisted of an Acceptability Judgment Task (AJT), which assessed the acceptability of edible and non-edible bare nouns across three groups: native speakers of BrP, native speakers of English, and learners of English as an L2. The other combined a Self-Paced Reading Task (SPR) with an Interpretation Task (IT), aimed at analyzing the processing and interpretation of quantified noun phrases, also across three groups of speakers. The results showed that BrP accepts all types of bare nouns, whereas English rejects bare singular nouns. Furthermore, the SPR task revealed that in BrP, quantified noun phrases with count and mass nouns generally do not trigger additional processing costs — except in cases where a plural quantifier is combined with pluralized mass nouns — which suggests that bare singular nouns are underspecified. In contrast, in English, quantified noun phrases lexically encode atomicity, resulting in additional processing costs when there is a mismatch between the type of quantifier and the type of noun. The SPR data also showed that the singular quantifier ‘*muita*’ in BrP is number-neutral, being able to combine with both count and mass nouns. Its English counterpart, ‘*much*’, by contrast, lexically encodes a preference for mass nouns. The IT revealed that the interpretation of bare singular nouns in BrP oscillates between cardinal and volume readings, whereas in English, the combination of a singular quantifier with count nouns led to random responses, suggesting the complete ungrammaticality of such combinations. To consolidate these findings, we conducted group comparisons for both the AJT and the SPR, which confirmed the mismatch between the two languages in terms of acceptability and processing. Finally, the data from BrP–English bilinguals showed that although there is transfer from L1 to L2 where the mismatch occurs, these bilinguals also acquire semantic features specific to the target language. Two additional group comparisons were carried out to investigate evidence of transfer from BrP (source language) to English (target language). The comparisons revealed a clear pattern of transfer in the AJT, while the SPR indicated that, although there was evidence of transfer in conditions with singular quantifiers, there were also signs of the acquisition of L2-specific semantic

features in interpretation patterns. Taken together, the results support the hypothesis that certain semantic properties, such as atomicity, are acquired as part of English grammar, and that the bilingual grammar, although initially shaped by L1 transfer, can acquire semantic features during acquisition to reflect L2-specific constraints.

Keywords: mismatch; bilingualism; psycholinguistics; semantics.

LIST OF ABBREVIATIONS

AJT	Acceptability Judgment Task
AIC	Akaike Information Criterion
ANOVA	Analysis of Variance
BH	Bottleneck Hypothesis
BIC	Bayesian Information Criterion
BrP	Brazilian Portuguese
BrPL1	Native Speakers of Brazilian Portuguese
CAD	Canadian Dollar
CCE	Centro de Comunicação e Expressão
CEFR	Common European Framework of Reference for Languages
CEPSH	Comitê de Ética em Pesquisa com Seres Humanos
CLMM	Cumulative Link Mixed Model
CLI	Cross-Linguistic Influence
CSV	Comma-Separated Values
DF	Degrees of Freedom
DP	Determiner Phrase
E	Edible
E+P	Edible + Plural
E+S	Edible + Singular
EngL1	Native Speakers of English
EngL2	Native Speakers of Brazilian Portuguese who are learners of English as an Additional Language (Bilinguals)
FWER	Family-Wise Error Rate
GLMM	Generalized Linear Mixed Model
H	Hypothesis
ICC	Intraclass Correlation Coefficient
IQR	Interquartile Range
IT	Interpretation Task
L1	Native Language
L2	Additional Language
LMMs	Linear Mixed Models
Log	Logarithmic Transformation

M	Mass
ML	Maximum Likelihood
NMP	Nominal Mapping Parameter
NP	Noun Phrase
P	Plural
P+C	Plural Quantifier + Plural Count Noun
PCIbex	Penn Controller Ibex Farm
PDF	Portable Document File
PI	Principal Investigator
Q1	First Quartile
Q3	Third Quartile
QJT	Quantity Judgment Task
REB	Research Ethics Board
RE	Restructuring Hypothesis
ROI	Region of Interest
RQ	Research Questions
RT	Response Time
S	Singular
SD	Standard Deviation
S+C	Singular Quantifier + Singular Count Noun
S+M	Singular Quantifier + Plural Mass Noun
SE	Standard Error
SLA	Second Language Acquisition
SPR	Self-Paced Reading Task
T1	Time One
T2	Time Two
TCLE	Termo de Consentimento Livre e Esclarecido
U+P	Non-Edible + Plural
U+S	Non-Edible + Singular
U of T	University of Toronto
UFSC	Universidade Federal de Santa Catarina

LIST OF SYMBOLS

+	Statistically significant effect for longer reading time
–	Statistically significant effect for shorter reading time
.	Marginal effect
=	No statistically significant effect
$\wedge$	Logical “AND” operator (conjunction)
α	Significance level (typically 0.05)
β	Regression coefficient
χ^2	Chi-square test statistic
$\cap$	Intersection operator (Down Operator)
λ	Lambda — parameter or expected value, depending on the context

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1 CHAPTER I — INTRODUCTION

This chapter provides an overview of the research developed in this dissertation. It begins with a brief background of the study, followed by the statement of the problem, the research objectives, and the guiding questions. The chapter also outlines the significance and scope of the investigation, concluding with a description of the structure of the dissertation.

1.1 BACKGROUND OF THE STUDY

Bilingualism offers a unique window into cognition (BIALYSTOK; CRAIK; GREEN; GOLLAN, 2009) and into the grammatical structure of language. Bilingual speakers provide a valuable source of data through which we can investigate linguistic phenomena, especially when the languages involved exhibit contrasts. These cross-linguistic differences allow us to uncover how languages are processed and represented. One such case involves a mismatch between Brazilian Portuguese (BrP) and English: as shown experimentally by Beviláqua and Pires de Oliveira (2021), these two languages diverge in the nominal domain, revealing a lack of one-to-one correspondence.

BrP is a language that accepts bare singular nouns in argument positions (or object position) (PIRES DE OLIVEIRA; SILVA; BRESSANE, 2010; BRAGA; SENA; MARIANO; PIRES DE OLIVEIRA, 2010), as in:

1. a) João comprou muita maçã.
- b) * John bought much apple.

In (1.a), the noun ‘maçã’ (apple) can be interpreted in terms of cardinality, meaning that João bought a large number of apples — more than one and more than what is normally expected in a given context. Alternatively, it can be interpreted as referring to volume or weight, meaning that he bought too many kilograms of apple (e.g., apple as a mass, possibly chopped or juiced).

Theoretically, the literature still disputes whether bare singular nouns (e.g. ‘maçã’ in BrP) refer to count nouns (SCHMITT; MUNN, 1999; MÜLLER, 2002), mass nouns (PIRES DE OLIVEIRA; ROTHSTEIN, 2011), or are semantically underspecified (PIRES DE OLIVEIRA, 2019; 2020; 2022; 2025). Experimentally, two competing studies have provided evidence on the processing of bare nouns: one suggests that bare singular nouns are interpreted

via pragmatics (LIMA, 2019), while the other argues that bare singular nouns are, in fact, mass nouns (LOPES, 2024). Needless to say, the status of bare singular nouns remains disputed in the literature.

In contrast, English is a language that does not accept bare singular nouns in argument position (IONIN; SANTOS; MONTRUL, 2011; IONIN; MONTRUL; SANTOS; GROLLA, 2014). However, studies conducted with edible — nouns that represent items that we can eat — have shown that, even though such constructions are processed and interpreted, they incur additional processing costs (FRISSON; FRAZIER, 2005), serving as evidence that these structures are not entirely felicitous in English.

The acceptability pattern and processing are not the only places where this mismatch seems to occur. It appears to spread across the system, as indicated by Pires de Oliveira (2022), and shows up in quantity quantifiers. The plural quantifier in English, ‘many’, seems to combine only with count nouns, while ‘much’ appears to prefer mass nouns. The BrP plural quantifier counterpart ‘muitas’ seems to require count nouns, while ‘muita’, on the other hand, seems to combine with both mass and count nouns, showing no preference for either.

This possible mismatch may generate a bottleneck in the acquisition of English, especially in areas where BrP and English differ. Slabakova (2016) proposed the Bottleneck Hypothesis (BH), according to which functional morphology — represented in our study by bare nouns and quantity quantifiers — carries semantic information that may differ across languages. If one language does not have a semantic feature that the other language does, then this feature may be difficult to acquire. Language learners at the intermediate stage of acquiring English often rely on knowledge from their first language, thereby transferring it unconsciously. In this way, intermediate bilinguals, who have some extent of knowledge of English grammar, may still lack knowledge of functional morphology, which encodes language-specific information. Therefore, examples such as the one in (1.b) may be judged as acceptable by native speakers of BrP who are learning English as an Additional Language (L2).

According to the BH, functional morphology encodes complex and abstract semantic properties that are not always transparently available in the input, making them less accessible to L2 learners. This view aligns with the Feature Reassembly Hypothesis (LARDIERE, 2008), which suggests that acquiring an L2 involves reconfiguring how grammatical features are bundled or mapped to morphology — an especially demanding task when the Native Language (L1) and L2 diverge in their expression of these features.

1.2 STATEMENT OF THE PROBLEM

While BrP allows bare singular nouns in argument positions, English does not license such constructions. This property is, according to Pires de Oliveira (2022), related to quantifiers, since ‘muita’ in BrP is neutral. This cross-linguistic mismatch raises questions about how bilingual speakers accept, process, and interpret nominal structures when learning English as an L2. Despite existing research on L1 transfer, little is known about how such nominal mismatch show up in bilingual acceptability, processing and whether specific semantic features are transferred from L1 to L2. This study addresses this gap while also examining how BrP—English bilinguals navigate this mismatch, using experimental evidence to assess whether L1 semantic information influence L2 interpretation.

1.3 OBJECTIVES

The current research has two main objectives: the first is to investigate a mismatch in the nominal domain between BrP and English involved in the bare nouns and in the quantifier phrases; the second is to verify whether this mismatch results in bilinguals transferring L1 semantic information from the source language to the L2 target language.

1.4 MAIN RESEARCH QUESTIONS

The following main Research Questions (RQ) guide this entire dissertation and are listed below:

RQ1. Is there a mismatch between BrP and English in the distribution and interpretation of bare nouns and quantity quantifiers?

RQ2. How do bilinguals process and resolve the mismatch between bare nouns and quantity quantifiers?

1.5 GENERAL HYPOTHESIS

The general hypothesis that nurtures this whole dissertation can be found in the following:

H0. No differences should be found between BrP and English. Both languages should be processed and represented in the same way. Therefore, no differences should be expected among bilinguals either.

H1. BrP and English differ in terms of representation and processing, and this difference leads to bilingual transfer. According to Pires de Oliveira (2019, 2020, 2022, 2025), BrP is a language that is underspecified. That is, bare nouns are interpreted both as volume and as cardinal. This lack of primitive meaning results in no additional processing costs when a bare noun is interpreted during the derivation. As a result, this extends throughout BrP grammar, and the singular quantifier is neutral, not providing any compositional clues as to whether the following noun without plural inflection will be interpreted as cardinal or as mass. When the singular quantifier is combined with both noun types, no processing effects are expected.

On the other hand, Chierchia (1998) argues that English lexically encodes semantic features that grammatically determine whether a noun is interpreted as cardinal or as volume. Because of this, English does not license bare singulars, which are therefore not accepted. The same applies to quantity quantifiers, which provide compositional clues in advance as to whether the following nouns in the derivation should be count or mass. Considering the results from Frisson and Frazier (2005), when the singular quantifier is combined with both noun types, count nouns should involve additional processing compared to the same quantifier combined with a mass noun. As a result, bilinguals are expected to be affected by this difference.

According to Slabakova (2016), bilinguals tend to rely on the knowledge they have from their first language in contexts where their native grammar and the additional one diverge, thereby transferring knowledge from their L1 to their L2. In this way, bilinguals should transfer the acceptability patterns while also displaying processing and representation patterns that align more closely with their L1 than with their L2.

1.6 SIGNIFICANCE OF THE RESEARCH

The importance of this research lies in its multiple contributions to the field. First, the findings presented here help to clarify the nature of the nominal domain in BrP, as investigated through measures of acceptability, processing, and representation. Second, the same aspects are examined in English, allowing us to explore how both languages are, at once, similar and different — thereby revealing the nature of their grammars. Third, we shed light on how bilinguals adjust to this cross-linguistic mismatch and acquire (or not) language-specific restrictions in the nominal domain.

1.7 SCOPE OF THE RESEARCH

This research spans three interconnected areas: formal semantics, psycholinguistics, and bilingualism. Specifically, it investigates in the intersection of these fields by focusing on bare nominals and quantity quantifier phrases — both of which are central to the structure of the nominal domain. In BrP and English, we aim to uncover how bare nouns are judged for acceptability and how quantifier phrases are processed and represented, with the ultimate goal of identifying a cross-linguistic mismatch in the nominal domain between these two languages.

To address this objective, we designed and implemented an Acceptability Judgment Task (AJT) in both BrP and English to assess the acceptability status of bare nouns among native speakers of each language. The resulting data will allow us to conduct a group comparison to verify whether this mismatch could be statistically confirmed. In addition, we will carry out a Self-Paced Reading Task (SPR), combined with an Interpretation Task (IT), to investigate the processing and representation of quantity quantifier phrases. These tasks will also serve to evaluate whether the hypothesized mismatch manifests at the processing level.

Our second objective is to assess how bilinguals respond to this mismatch. To this end, we will conduct an AJT and a SPR with IT with native speakers of BrP who are at an intermediate stage of acquiring English as an L2. The bilingual data will allow us to evaluate whether the mismatch between BrP and English affects bilingual acceptability, processing, representation and possibly manifesting through transfer — that is, the influence of L1 features that are available in their native language but are absent in the L2.

This study that will be reported in this dissertation involved a total of 246 participants: 86 participated in a computer lab at the *Universidade Federal de Santa Catarina* (Brazil), 32

participated in the Indigenous Room at the University of Toronto (Canada), 35 participated online in Canada, and 90 participated online in Brazil between 2023 and 2024.

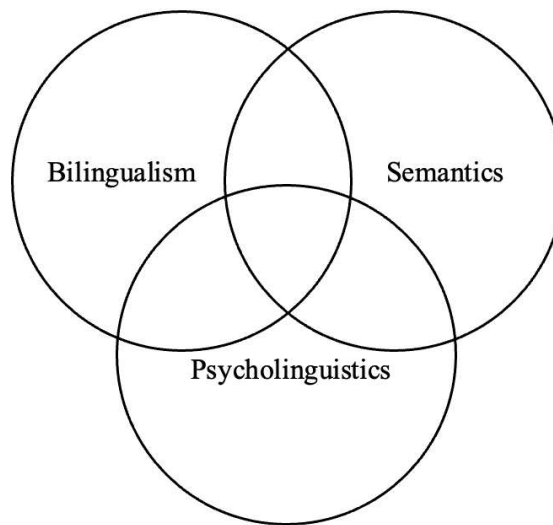
1.8 ORGANIZATION OF THE DISSERTATION

This dissertation is organized into seven chapters. Chapter I — *Introduction*, presents an outline of the research and its main components. Chapter II — *Theoretical Background*, reviews the literature that supports and motivates this study. Chapter III — *Method*, offers an overview of the methodological procedures adopted, detailing the instruments employed and the rationale behind each choice. In Chapter IV — *Experiments on the Acceptability of Bare Nouns*, the first set of three experiments is introduced, along with two group comparisons. Each of these studies is presented including its own motivation, RQs, hypotheses, methods, results, and discussion. Chapter V — *Experiments on the Processing and Representation of Quantifier Phrases*, presents the final set of three experiments and two group comparisons, following the same structure as the previous chapter. Chapter VI — *Language Mismatch and Bilingualism*, brings together the findings from the previous chapters and proposes a theoretical explanation for the phenomena observed in the study. Finally, Chapter VII — *Final Remarks, Limitations, and Pedagogical Implications*, summarizes the main findings, discusses the study's limitations, and reflects on its broader implications, thus bringing the dissertation to a close, following by its Appendix in which the materials used in this study can be found.

2 CHAPTER II — THEORETIC BACKGROUND

Chapter II introduces the theoretical foundations that support this research. This dissertation engages in with three interconnected areas of linguistics, as illustrated by the diagram below: Bilingualism, Semantics, and Psycholinguistics.

Figure 2.1 — Diagram



Source: designed by the researchers.

For structural clarity, this chapter is divided into three main sections, following the logic of the Venn diagram. In Part I — *Bilingualism*, we begin with an overview of bilingualism from an internalist perspective, which is our focus throughout this entire dissertation — focusing on cross-linguistic influence and the mismatches that emerge between the speaker’s linguistic systems. In Part II — *Grammar*: the section explores the syntactic and semantic properties of the constructions under investigation, with a particular focus on bare nouns and quantity quantifier — two domains where BrP and English display notable grammatical differences; and in Part III — *Semantic Processing (interface with Psycholinguistics)* we examine how these syntactic and semantic mismatches affect real-time language processing, drawing on existing psycho-semantic literature that bridges linguistic theory and bilingual processing research.

In summary, this chapter reviews literature that demonstrates how Brazilian Portuguese (BrP) and English each have their own grammatical systems, which differ in key areas. A central observation is that bare nouns and quantity quantifier phrases constitute a site of structural mismatch between the two languages. These mismatches are not merely

theoretical; they have processing consequences for bilingual speakers, who must integrate the grammar of their native language while acquiring and managing an additional system with distinct semantic representations.

This interface between bilingualism, grammar, and processing represents the core of our Venn diagram and the focus of this dissertation. The cross-linguistic mismatches — particularly at the syntax—semantics interface — function as a bottleneck in second language acquisition, creating processing challenges that are central to our investigation.

Part I — *Bilingualism*

This section, titled *Bilingualism*, explores the definition of bilingualism and briefly discusses how bilingual individuals manage multiple languages in their minds. Addressing these topics is essential for introducing the present study, which aims to shed light on bilingual language representation and processing, particularly for second language learners. Additionally, this section provides a comprehensive review of previous research on Cross-Linguistic Influence (CLI), as one of the goals of this dissertation is to examine whether linguistic transfer occurs in L2 acquisition. It offers an overview of investigations into how two or more languages interact and influence one another in the bilingual mind. Finally, the discussion turns to linguistic variation between languages, with a focus on areas where mismatches occur between syntax and semantics.

2.1 BILINGUALISM AND THE BILINGUAL MIND

The study of bilingualism has been approached from distinct perspectives, broadly divided into internalist and externalist perspectives. While externalist perspectives privilege social, pragmatic, and interactional dimensions of bilingualism (see GROSJEAN, 2008; VALDES; FIGUEROA, 1994; BUTLER, 2013, among many others), internalist approaches focus on the mental representation of grammar, examining how two linguistic systems coexist in the mind and how they are constrained by universal cognitive principles. Within this tradition, bilingual competence is seen not primarily as a matter of performance or social practice, but as a question of how grammars are mentally represented, accessed, and restructured across the lifespan.

Among the scholars working within the internalist framework, Slabakova (2008, 2013, 2016, 2019) has offered some important contributions. Her key work that nurtures this

dissertation is the Bottleneck Hypothesis, according to which functional morphology constitutes the greatest difficulty in second language acquisition, whereas syntax and semantics are more easily acquired. The hypothesis is grounded in a modular view of grammar and highlights that the internal architecture of the bilingual mind is not uniformly accessible: while certain components are readily acquired, others present persistent challenges (SLABAKOVA, 2008).

In later work, Slabakova (2019) updated the hypothesis by suggesting that functional morphology is difficult because it bundles syntactic, semantic, and phonological features, thereby creating a bottleneck that learners must navigate to reach full grammatical competence. Importantly, she also demonstrated that semantic distinctions lexically encoded in the L2 can be acquired successfully, challenging claims that bilingual competence is permanently constrained by the L1 (SLABAKOVA, 2019). This aligns with her broader research at the syntax–semantics interface, showing that bilingual learners are capable of developing subtle interpretive knowledge when it is anchored in the grammar of the target language.

Slabakova’s work illustrates an internalist commitment to distinguishing competence from performance. Rather than focusing solely on communicative output, her studies employ grammaticality judgments, controlled experimental tasks, and processing data to uncover the underlying representations of bilinguals, some of which will be explored in the latter sections. This methodological stance situates her within the generative tradition and emphasizes that bilingualism must be studied as a mental phenomenon.

While Slabakova’s Bottleneck Hypothesis (2008, 2016, 2019) identifies functional morphology as a particularly vulnerable domain in bilingual acquisition, her account remains anchored in the idea that bilingual competence is shaped by the internal architecture of grammar. This focus on representational constraints opens the path to other internalist perspectives that, while differing in emphasis, share the same commitment to explaining bilingual development through Universal Grammar. Another example is the proposal by Schwartz and Sprouse (1996, 2000), whose Full Transfer/Full Access Hypothesis highlights the role of the learner’s L1 as the starting point for L2 acquisition while maintaining that UG continues to regulate the restructuring of the grammar.

Their proposal occupies a central place in internalist accounts of bilingualism. Their Full Transfer/Full Access Hypothesis (SCHWARTZ; SPROUSE, 1996, 2000) posits that the initial state of L2 acquisition is the fully represented grammar of the L1 (Full Transfer). At the same time, learners retain full access to Universal Grammar (Full Access), enabling them to

restructure their grammars in response to L2 input. This model captures both the role of cross-linguistic influence and the universal constraints on bilingual grammar formation.

Compared to Slabakova's Bottleneck Hypothesis, which focuses on the relative difficulty of morphological acquisition, the Full Transfer/Full Access model provides a dynamic account of the initial state and subsequent restructuring of bilingual grammars. Both approaches, however, share the internalist conviction that bilingual competence must be explained in terms of internalized grammatical knowledge.

Taken together, the contributions of Slabakova and Schwartz and Sprouse help us to cover the central issue investigated in this dissertation encompassing on a shared internalist vision of bilingualism. They differ in emphasis since Slabakova focus on morphological bottleneck and interface phenomena while Schwartz and Sprouse focus on the role of transfer in the initial state of additional language acquisition. However, both of which share a the same view that bilingualism is a cognitive and representational phenomenon. This perspective situates bilingual competence within the broader architecture of language, constrained by Universal Grammar, shaped by transfer and input, and accessible through experimental methods that probe underlying grammatical knowledge which is central to our dissertation.

The internalist perspective, therefore, provides a coherent and theoretically solid framework for our research on how bilinguals develop and represent two linguistic systems. Although it might be criticized by externalist perspectives, which claim that we should not compare monolinguals with bilinguals, the exploratory nature of this study and its central focus on understanding possible representational differences between languages make such comparisons essential. In this sense, we emphasize mental representation over social practice, foregrounding the central question of bilingualism as not only how languages are used, but also how languages are represented in the mind.

2.2 CROSS-LINGUISTIC INFLUENCE STUDIES

As explored in the previous section, the bilingual mind has to deal with two or more distinct linguistic systems interacting at all times. The constant interaction between languages in bilingual speakers often raises questions about cross-linguistic influence — that is, the ways in which one language can affect the structure, use, or acquisition of another (ODLIN, 1989). This influence can manifest in various forms, including transfer, interference, or convergence, and may affect both the L1 and the L2, depending on factors such as proficiency, context of use, and dominance (JARVIS; PAVLENKO, 2008). Some research in the field of bilingualism

has examined the interaction between languages within the broader framework of CLI, which refers to any language influencing the other languages a bilingual possesses. In fact, much of the research emphasizes multidirectional influence among languages.

Some studies have investigated issues related to this cross-linguistic influence between languages, including Jarvis (2016), which is a study that argues that transfer can be observed in three distinct stages of language acquisition: semantic transfer, linguistic transfer, and conceptual transfer. According to the author, CLI occurs when the proficiency of an individual in one language is influenced by another language. However, in his study, it remains unclear from what linguistic system CLI originates.

Booth, Clenton, and Van Herwegen (2018) argue that there are three levels of influence between languages and provide experimental evidence for language processing in bilinguals. They argue that even intermediate learners retain ongoing access to L1 representations while processing the L2. Booth et al.'s study involved measuring reaction times and accuracy regarding selecting strings of sentences that were syntactically correct over the ungrammatical ones and words that were semantically related versus unrelated words. The study showed that language proximity is an important factor to consider when analyzing L1-L2 influences, as their findings revealed that language proficiency and proximity were related to reaction times.

Tytus and Rundblad (2017) investigated bilinguals and monolinguals in their judgment of animals and emotions, where participants had to rank the similarity or difference of each concept. Their findings indicated that bilinguals ranked animals and emotions differently when compared to monolinguals. These results led the researchers to propose that bilinguals possess a semantic interlanguage, as their two languages are constantly interacting within each other in the bilingual's mind. In this regard, they claim that bilinguals are unique individuals who do not resemble either a monolingual from their L1 nor a monolingual from the L2, but rather they develop an interlanguage that is unique to them. According to the authors, this semantic interlanguage is associated with the mapping between specific conceptual meanings and linguistic forms — or encyclopedic knowledge. This is more related to lexical semantics, which differs from the functional semantics being conducted in this dissertation.

Assuming a more discursive approach, Ghafarpour and Dabaghi (2017) analyzed narrative biographical texts shared on a website by immigrants living as refugees in a different country. Throughout the texts produced by the immigrants, the researchers observed a pattern of grammatical structures derived from their second language that is not available in the

grammar of their L1, despite the fact that they were writing in their L1. This evidence allowed them to assume that there is an L2 influence on the L1 as well.

Carvalho and Da Silva's (2006) study is related to negative transfer during the process of acquiring a third language. Their study adopts a syntactic perspective and focuses on Spanish-English bilinguals acquiring Portuguese. The study revealed that language proximity influences transfer, as the participants heavily relied on their Spanish while performing tasks in Portuguese. Finally, Anderssen and Bentzen (2013) conducted a case study on a bilingual individual acquiring definiteness in the syntax-pragmatics interface of English and Norwegian. They revealed syntactic transfer in relation to definiteness and argued that the transfer patterns observed reflected similarities between the two languages under investigation.

It is worth highlighting that these above-mentioned studies are not closely related to the study being conducted in this dissertation. However, they provide us with a cutout of what has been developed so far in CLI studies and also indicate an area of research that has room for further investigation, which is the semantic influence between languages. As demonstrated by the evidence presented by Ghafarpour and Dabaghi (2017), there is the influence of the L2 over the L1, which appears to be a field of study that is even less explored. However, for the present research, the focus is solely on the syntactic-semantic influence from the L1 to the L2. Our interest lies specifically in the unidirectional influence from the source language, the L1, to the target language, the L2, which is referred in this dissertation as transfer.

Building on Slabakova (2016), the term most widely used by the author is, indeed, transfer, which refers to the influence that a speaker's first language (L1) exerts during the acquisition of an additional language (L2). This transfer can affect multiple domains of linguistic knowledge, including phonology, syntax, semantics, and pragmatics. A research strands that emerges from transfer is Slabakova's Bottleneck Hypothesis (BH), which specifically addresses the difficulties L2 learners face in acquiring functional morphology — a domain that is often less successfully transferred compared to other areas of linguistic knowledge. That is, while learners may transfer certain grammatical features from their L1, the difficulty of acquiring functional morphology in the L2 often constrains overall language development. Transfer is generally understood as an unconscious process and is considered a key component of the initial stages of L2 grammar acquisition. The BH and the effects of transfer outline an internalist, grammar-oriented view of language acquisition and processing. This perspective serves as the main line of reasoning and provides the theoretical background for the present dissertation.

As discussed, transfer from one language to another occurs when bilinguals resort to the linguistic knowledge they have about their L1 and unconsciously transfer it to the L2. This phenomenon might be observable when there are differences between the first and second languages, resulting in mismatches between grammars. As White (2003) emphasizes, L1 transfer plays a central role in shaping the initial state of second language acquisition, especially when L1 and L2 grammars diverge. Similarly, Slabakova (2008) highlights that transfer effects are particularly salient at the syntax–semantics interface, where learners rely on features encoded in their L1 to interpret and produce structures in the L2 mostly salient at intermediate stages of second language acquisition.

The transfer can be observable in the context of our research by the mismatches that arise between the first language, which the bilingual acquired in childhood, and the subsequent language learned after the first language has been established. In this regard, the next subsection addresses the non-correspondence between languages and reviews relevant literature on syntax and semantics for the current investigation, since it is precisely where languages differ that the phenomenon of transfer is observed.

2.3 MISMATCHES BETWEEN LANGUAGES

The mismatch or non-correspondence¹ is where the differences among languages emerge. Languages differ from each other, and these differences are spotted in terms of phonology and phonetics, as they involve the production of sounds that correspond to different words. However, these differences are not only present at the word level; languages also differ in their syntactic structures. One example of a syntactic mismatch is the pro-drop² parameter demonstrating a non-correspondence between the BrP and English, as shown in the example provided in (4) below:

2.	a) It rains.	[English]
	b) Chove.	[Brazilian Portuguese]

¹ The terms *mismatch* and *non-correspondence* are used interchangeably throughout the current research.

² A pro-drop language is one in which pronouns do not need to be overtly expressed. Pro-drop is widespread in Brazilian Portuguese (BrP) grammar, with the example in (3.a) serving as one case where this phenomenon is observed.

As we can observe by the examples provided in (2.a), in the English example, we have a subject that is phonetically present. In this language, the subject is always required. However, in BrP, the subject is not phonetically mandatory and can be recovered by the context or morphologically marked on the verb through functional morphology.

Based on Slabakova (2016), these syntactic differences between languages pose the learner an additional task since they have to learn, in the author's own words, *painstakingly* the new grammar. During the process of acquiring this new grammar, native speakers of BrP may produce or consider sentences like the one in (3.a) to be grammatically acceptable.

3. a) * rains.
- b) Chove.

In the abovementioned case, the learner uses unconsciously his/her grammatical knowledge from their L1 to evaluate that the sentence in (3.a) is acceptable, as the grammar of BrP generates the sentence in (3.b). However, English is not a pro-drop language. As a result, when the learner has not fully acquired the English grammar concerning this parametric difference or has not reset the parameter yet, they would rely on the knowledge they already have available from their L1. The example in (3.a) illustrates the phenomenon of syntactic (or structural) transfer when a native speaker of BrP as a first language, who is acquiring English as a second language (L2), produces the sentence in (3.a) or considers it acceptable.

The non-correspondence between languages can extend beyond syntactic mismatches, as mentioned earlier. There are also semantic and pragmatic differences between languages, where linguistic forms are mapped onto distinct semantic or pragmatic representations. According to Slabakova, the syntax-semantics interface is where we can most find variation among languages (SLABAKOVA, 2010, p. 235).

Some studies have been investigating non-correspondences between and among languages. An example of mismatch between languages that is located in this syntax-semantics interface is the aspectual tense system between English and Spanish. Slabakova and Montrul (1999) investigated the acquisition of Preterit and Imperfect tenses in Spanish from native speakers of English. While the Preterit tense in Spanish does not encode the habitual interpretation, its counterpart in English is the Simple Past tense, which can have both the habitual interpretation and indicate a single completed event in the past. Additionally, the Imperfect tense in Spanish has both the ongoing meaning in the past and habitual interpretation, whereas its counterpart in English, the Past Progressive tense, only expresses the meaning of

in English is acceptable and has a generic reading, denoting the kind. The bare plural in English always denotes species (kind), which refers to individuals that exist in many places at a given moment (PIRES DE OLIVEIRA, 2021, p. 168).

As an example, an animal called dodo birds which belong to the species of dodo and this animal has the property of being extinct. Kinds are generalizations used to refer to a species. This is achieved for the bare plural through a semantic operation in which the plural shifts the interpretation to the species, requiring a cumulative predicate (CHIERCHIA, 1998 APUD PIRES DE OLIVEIRA, 2021, p. 173). This semantic denotation also applies to bare plurals in English and also to BrP. Nevertheless, Spanish does not accept bare plurals in the Determiner Phrase (DP) position, and they also lack the generic interpretation. In this sense, the generic reading is not available in Spanish, and neither denotes the kind since the construction of bare plurals are ungrammatical in Spanish and it is not generated by its grammar (IONIN; MONTRUL; SANTOS, 2011). Below, there is another example that specifically illustrates the differences between English, Spanish, and BrP through bare singulars:

5.	a) * Dodo bird is extinct.	[bare singular]
	b) * Pájaro dodo está en extinción.	[bare singular]
	c) Pássaro dodô está extinto.	[bare singular]

Now, the absence of a determiner and of the plural inflection reflect a difference between these three languages. In English, just like in Spanish, bare singulars count nouns are ungrammatical and cannot occur in NP position. However, in BrP, bare singulars count nouns can occur in the NP position. Additionally, according to their findings, bare singulars in NP position in BrP have a generic reading, but it is inconclusive whether they also denote the kind (IONIN; MONTRUL; SANTOS, 2011). However, according to Pires de Oliveira (2020, 2021) and Pires de Oliveira and Beviláqua (2020), the bare plurals do denote the kind, presenting a proposal in which the bare singular would be similar to the bare plural regarding the denotation of the kind. In other words, the bare singular also denotes the species, as shown in (5.c), when it is in an argument position.

Delving deeper in the language differences, Ionin, Grolla, Montrul, and Santos (2014) reported a study regarding the transfer of semantics and acceptability. Their study investigated an interface between syntax and semantics, focusing on the interpretation of determiner phrases between English, Spanish, and BrP. The following examples were extracted from Ionin et al. (2014), p. 369:

6. a) The hummingbird is a bird.
- b) A hummingbird is a bird.
- c) * Hummingbird is a bird.
- d) The hummingbirds are birds.
- e) Hummingbirds are birds.

According to the authors, English allows for a definite singular as in (6.a), indefinite singular as in (6.b), and bare plural as in (6.e). All these three have generic readings. These generic readings can describe a behavior of specific species or a property (KRIFKA et al., 1995 APUD IONIN et al., 2014). This generic reading implies that hummingbirds around the world are birds. Furthermore, the bare plural in (6.e) and the definite singular in (6.a) in English denote the kind, in this case, the species. However, definite plurals do not carry generic readings, and (6.d) has only the interpretation of a specific group of hummingbirds. The sentence in (6.c) is ungrammatical since English grammar does not produce bare singular count nouns (IONIN et al., 2014).

In Spanish and most Romance languages, a difference arises when nouns phrases are compared to English, as observed in the examples provided by Ionin et al. (2014, p. 369-370):

7. a) El picaflor es un pájaro.
- b) Un picaflor es un pájaro.
- c) * Picaflor es un pájaro.
- d) Los pica-flores son pájaros
- e) * Picaflores son pájaros.

Now the differences between these two languages are presented in terms of the bare plurals. While bare plurals, as shown in (6.e), are grammatical in English and have generic readings, Spanish does not accept bare plurals, as seen in (7.e), and they are ungrammatical in this language. In (7d), the definite plural is the most common expression of genericity in Spanish, but in English the definite plural encodes specific readings. However, the other examples such as (7.a), (7.b), and (7.c), reflect similar pattern between these languages, and no additional mismatches between syntax and semantics are found.

BrP present a behavior that differs from the two aforementioned languages, which is also different from other Romance languages. The following examples were also extracted from Ionin et al. (2014) p. 370:

8. a) O beija-flor é uma ave.
- b) Um beija-flor é uma ave.
- c) Beija-flor é ave.
- d) Os beija-flores são aves.
- e) Beija-flores são aves.

All of the constructions provided in example (8) are grammatical in BrP. The grammaticality of the definite singular, as in (8.a), the indefinite singular, as in (8.b), and the definite plurals, as in (8.d), among these three languages is similar, indicating a syntactic similarity. In English, definite plurals, as in (8.d), have specific readings, in BrP, as in (8.e), also have generic readings, which differs from Spanish where bare plurals are ungrammatical. Definite singulars, such as (8.a), and definite plurals, as in (8.d), also denote the kind. Additionally, bare singulars are grammatical in BrP and have generic readings (IONIN et al., 2014). This latter characteristic is unique to BrP. Below in table 2.2, the mapping between form and meaning is summarized based on Ionin et al., (2014):

Table 2.2 — Mapping between form and meaning between English, Spanish, and BrP

Language	Definite Singular	Indefinite Singular	Bare Singular	Definite Plural	Bare Plural
English	Generic reading		Ungrammatical	Specific reading	Generic reading
Spanish	Generic reading		Ungrammatical	Generic reading	Ungrammatical
BrP	Generic reading				

Source: designed by the researchers based on Ionin et al., 2014.

On the one hand, definite singulars across these three languages have the same behavior in denoting the kind. Indefinite singulars can occur in generic sentences but cannot denote kinds (IONIN et al., 2014). On the other hand, English and BrP are the only languages

to allow for generic to kind readings for bare plurals, while Spanish only allows generic to kind readings in definite plurals. Furthermore, BrP is the only language whose grammar generates bare singular nouns and allows them to receive generic readings (IONIN et al., 2014).

With the highlighted differences between these three languages, the researchers proposed two experiments to investigate the semantics of genericity in bilinguals. To that end, they examined native speakers of Spanish and native speakers of BrP who were learning English. Additionally, they investigated native speakers of Spanish and native speakers of English who were learning BrP. Their main hypothesis was that they would observe semantic influence from the L1 to the L2 in contexts where distinct semantic features are present, using an Acceptability Judgment Task (AJT).

The results indicated very little influence from the Spanish and BrP groups acquiring English, which was not statistically significant. They interpreted this as a lack of effect as no transfer from L1 to the L2 English. Contrary to expectations, native speakers of BrP did not rate bare singulars in English highly as they have predicted. The researchers argued that while there may be L1 influence on the L2, this influence played a limited role and can potentially be overcome with extensive exposure to the target language. The Ionin et al. (2014) acknowledged that the small sample size might have limited their findings and also noted that the acceptability and interpretation of bare singulars remain somewhat unclear for their first experiment. The results from Ionin et al. (2014) are particularly relevant to our study because, although they focused on generic sentences in argument position, they also investigated bare singular nouns and did not find evidence of transfer from BrP to English.

By contrast, the influence of the L1 was noticeable when native speakers of English and native speakers of Spanish were learning BrP as an L2; therefore, losing the distinction seems to be harder. These groups rated bare singulars with low acceptability judgment values. As discussed, bare singulars are productive in English, nor of Spanish. Consequently, these groups appeared to transfer their knowledge from the L1, leading them to rate bare singulars in BrP negatively, following the patterns of their native grammars.

Although the study presented additional findings, these other findings are not closely related to the research topic and will not be discussed further at this point. While the study did not provide evidence of transfer from Spanish L1 or BrP L1 to English L2, it did find transfer effects from English L1 and Spanish L1 to BrP L2. However, the mechanisms underlying the transfer of bare singular nouns remain inconclusive.

Beviláqua and Pires de Oliveira (2021) conducted a crosslinguistic pilot study examining the behavior of bare singular nouns in comparative constructions across English,

Rioplatense Spanish, BrP, and Cape Verdean Creole. Their results reveal that while bare singulars are ungrammatical and coerced to mass interpretations in English and Rioplatense Spanish, they are fully grammatical and interpreted as cardinal in Cape Verdean. BrP, however, displayed a mixed behavior: bare singular nouns were both accepted and interpreted flexibly, allowing for cardinal, volume, and partitive readings. This supports the hypothesis that the BrP bare singulars are not ambiguous *per se*, but allow both interpretations. Importantly, the absence of significant contrast between bare singulars and flexible singulars nouns in BrP reinforces the idea that grammatical number marking does not rigidly constrain semantic interpretation in this language. These findings have significant implications for bilingual acquisition and processing, especially in light of potential semantic transfer from BrP, a more flexible language to more rigid languages like English.

The reviewed studies highlight differences between languages, which can involve variations in aspectual tenses that carry distinct semantic interpretations in each language, as demonstrated by Slabakova and Montrul's study (1999). Additionally, syntactic disparities between languages can influence semantic interpretations, as observed in the studies conducted by Ionin et al. (2011) and Ionin et al. (2014). These disparities are considered mismatches between the languages.

In this respect, as suggested by previous studies, transfer can be defined as the unconscious reliance of L2 learners on the linguistic knowledge already available from their L1. Learners tend to transfer grammatical rules and semantic features from their L1 to the L2 (Slabakova, 2016). This phenomenon can be observed in the findings presented by Ionin et al. (2014) from native speakers of English and Spanish to BrP L2.

The data discussed in this part shows that native speakers of English and Spanish who are learning BrP rated bare singulars in BrP as having low acceptability. This syntactic and semantic difference between the learners' native languages and BrP appears to have led to transfer effects, resulting in the rejection of bare singulars — even though they are acceptable in BrP and receive generic interpretations. Importantly, these syntactic mismatches also entail semantic differences, as observed in studies by Ionin et al. (2011) and Ionin et al. (2014). These studies indicate that in English, the absence of a determiner and the presence of plural inflection in bare plurals convey generic readings and denote kinds. In contrast, in Spanish, bare plurals are ungrammatical and do not belong to the language's grammar.

In summary, syntactic differences are identifiable, as they manifest in the surface structure of language and are observable in both spoken and written discourse. By contrast, semantic mismatches between languages are more difficult to detect, as they pertain to how

meaning is encoded in linguistic representations, although they remain closely linked to syntax. These mismatches at the syntax—semantics interface raise an important question: *How do L2 learners acquire non-correspondences that exist between the syntactic and semantic systems of two languages?*

According to the findings of Slabakova and Montrul (1999), L2 learners are capable of acquiring interpretations of aspectual tenses as their proficiency increases. Similarly, Ionin et al. (2014) found that greater L2 proficiency facilitates the acquisition of semantic properties not available in the learners' native language. However, they also observed that learners are influenced by their L1, particularly regarding the acceptability or unacceptability of certain sentence structures. This can lead L2 learners to make judgments that diverge from those of native speakers of the target language.

Slabakova (2016) argues that advanced language learners can reassemble linguistic features in the L2 that are not present in their L1, enabling them to overcome cross-linguistic mismatches. In this regard, the results of the aforementioned studies offer exploratory insight into the interplay between semantic influence and syntactic transfer — underscoring the need for further investigation. Therefore, the primary aim of this dissertation is to examine whether semantic properties that differ between languages can lead to native-language influence during second language acquisition.

In summary, we have discussed the concept of bilingualism and how we can define whether a person is bilingual or not. Additionally, we presented some empirical studies that investigated cross-linguistic influences, where one language affects another. Thus, we introduced the concept of mismatch, which refers to cases where one language differs from another, possibly resulting in transfer — that is, the reliance on aspects of the native language when using the additional language. In the next section, we delve specifically into two aspects in which BrP and English seem to differ: bare nouns and quantity quantifiers.

Part II — *Grammar (an interface between syntax and semantics)*

In Part II — *Grammar (an interface between syntax and semantics)*, the aim is to give close attention to bare nouns and quantity quantifier phrases, highlighting their syntactic constructions and their interpretations in English and BrP since, as we have observed, they are a location when a mismatch between these two languages can be located. Additionally, this section discusses the theoretical and empirical studies conducted so far in the literature and how bare singular count nouns are regarded as a source of mismatch between these languages.

2.4 BARE NOMINALS

As we have seen, bare nouns are one of the sources of mismatch between the syntax and semantics of English, Spanish and BrP. Our hypothesis is that this is precisely where the semantic influence may be observed during the acquisition of English by L2 learners which is specifically our interest in this research. Therefore, this subsection takes a closer look at the bare nouns investigated in this study.

Bare nouns are characterized by the absence of a determiner³ in a phrase that denotes an individual, that is a Determiner Phrase (DP) (PIRES DE OLIVEIRA, 2010). Below there is an example extracted from Pires de Oliveira (2022), comparing both languages:

9. a) Cachorros latem.
- b) Dogs bark.

The predicate ‘bark’ is a one place predicate and ‘dogs’, a bare plural, takes this place. Both definite and indefinite articles can be in this position, for example:

10. a) O cachorro late.	[definite article — singular]
b) The dog barks.	[definite article — singular]
c) Um cachorro late.	[indefinite article — singular]
d) A dog barks.	[indefinite article — singular]

According to Ferreira (2018), count nouns such as ‘dogs’ can be combined with numerals as in ‘4 dogs bark’, or with a plural quantifier, as in ‘many dogs bark’. In BrP, we can also have ‘3 cachorro’ (3 dog) or ‘os cachorro’ (thePL dogSIG). In addition, in BrP, we can also have singular count nouns without a determiner, namely bare singular, and they can be combined with quantity expressions such as in the example from Ferreira (2018):

11. a) Eu vi muito cachorro.
- b) * I saw many dog.

³ The terms *article* and *determiner* are used interchangeably.

Now, observe that in (11.a), the sentence is acceptable in BrP since, apparently, its grammar generates bare singulars. However, in English, such construction in (11.b) is ungrammatical as the count quantifiers require a plural count noun as argument. In the examples provided in (11.a) and (11.b), we can observe a mismatch between both grammars at the syntactic and semantic interface level.

2.4.1 Bare Plurals

Bare plurals exhibit a parallelism in BrP and English, as their syntactic distribution and interpretation are the same. The bare plural is characterized by the absence of a determiner in a count noun but presence of plural inflection. Below are some examples extracted from Ferreira (2018) in which bare plurals appear in argument position:

12. a) Cachorros latem (quando estão bravos).
b) Dogs bark (when they are angry).

In the examples provided in (12), both languages exhibit a generic sentence with a generic reading. This means that normally when we have angry dogs, their common behavior is to bark. In the following example extracted from Ferreira (2018), we observe the same syntactic construction but with a kind predicate:

13. a) Baleias estão em extinção.
b) Whales are on the verge of extinction.

In (13), we have a kind sentence. The kind predicate refers to a predicate “that does not apply to ordinary individuals, but rather to the species or the totality of its members” (FERREIRA, 2018, p. 3). The kind-level interpretation appears to apply to both BrP and English when it comes to bare plurals. In this case, there is a match between syntax and semantics in both languages. As noted by Ferreira (2018), bare plurals are suggested to be commonly used in formal discourse and are rarely found in spoken registers in BrP.

2.4.2 Bare Singulars

According to Ferreira (2018), the distribution of bare singulars is more constrained compared to bare plurals. The literature discussion begins with Schmitt and Munn (1999) and Müller (2002) rejecting the use of bare singular in argument position in kind predicates in BrP, as exemplified by:

14. a) Baleia está em extinção.
 b) * Whale is on the verge of extinction.

However, Pires de Oliveira, Silva, and Bressane (2009) provide empirical evidence that bare singulars, as in (14.a), are acceptable with kind predicates. In English, bare singulars count nouns cannot occupy the position of an argument, which leads to the ungrammaticality of the sentence in (14.b). Here, we observe a mismatch between both grammars, as the distribution of bare singulars between BrP and English are different. Table 2.3 presents a summary of bare nouns in both languages.

Table 2.3 — Summary of grammaticality of bare nouns between English and BrP

Language	Bare Plurals	Bare Singulars
English	Grammatical	Ungrammatical
BrP	Grammatical	

Source: designed by the researchers.

In BrP, bare singular nouns are acceptable and have generic readings. However, English grammar does not allow bare singular nouns in argument position, as seen in (16b). This mismatch leads to different interpretations of bare singular, which will be explored in depth in section 2.4.4. This difference between grammars resulted in a stream of theoretical and experimental research trying to unveil the interpretation of bare singular nouns in BrP. These studies will be reviewed in the upcoming subsection.

On the one hand, Ionin et al. (2011) and Ionin et al. (2014) argue that sentences like (14.a) in BrP have generic readings, but, for the authors, it remains unclear whether they denote the kind. For Schmitt and Munn (1999), the bare singular does denote the kind. Rothstein and Pires de Oliveira (2011) argue that the bare singular is, in fact, a mass noun. On the other hand, Pires de Oliveira (2020, 2021) and Pires de Oliveira and Beviláqua (2020) propose an

explanation for the behavior of bare singular nouns in BrP, suggesting that bare singulars do denote the kind. Mariano (2018) and Santana (2019) has shown that bare singular nouns in BrP are accepted with episodic predicates. Further research is still in need to provide evidence for the kind-denoting property of bare singular nouns in BrP.

2.4.3 Theoretical Discussion About Bare Singular Nouns in BrP

The debate around whether bare singular nouns in BrP should be interpreted as count or mass emerges from a seminal paper by Chierchia (1998), in which the author proposes a conjecture known as the Nominal Mapping Parameter (NMP). The NMP outlines how languages map noun phrases onto semantic types based on the availability and interpretation of bare nominals. Chierchia proposes that while some languages allow bare nouns and others do not, if a language does permit bare nouns, it will only allow bare plurals or bare mass nouns — never bare singular count nouns. This is grounded in a typology where languages like English allow both kinds and properties to serve as arguments, while Romance languages, such as Italian or French, do not allow bare nouns as arguments due to their syntactic and semantic restrictions.

The debate begins with the observation that BrP does not neatly fit into the typology proposed by Chierchia (1998). While it is a Romance language, BrP permits both bare plural and bare singular nouns in argument positions — an unexpected pattern under the NMP. According to Chierchia’s proposal, the co-occurrence of both types in the same system should be categorically ruled out. However, Schmitt and Munn (1999) present a major challenge to this generalization by providing evidence that BrP exhibits exactly this combination. They show that BrP allows bare singular nouns to appear in argument positions across a variety of syntactic environments and interpretative contexts, including generic and kind-level readings. This finding contradicts the core prediction of the NMP and opens up the question of how such bare singulars should be semantically analyzed.

To account for these data, Schmitt and Munn (1999) propose that the BrP bare singular is semantically number-neutral — that is, it does not encode singularity or plurality in the syntax or morphology. Instead, it denotes a property that can be mapped onto either atomic individuals or sums, depending on context. From this perspective, the bare singular shares interpretive properties with the bare plural, particularly in generic and kind-level uses. In other words, BrP bare singulars behave like count nouns that lack explicit number marking. Müller (2002) builds on this insight but takes a more radical stance. Rejecting the label bare singular, she proposes

the term *bare numberless* to emphasize the idea that these nouns are not singular in a formal sense. According to Müller, bare numberless nouns are inclusive in nature: they encompass both atomic and plural reference. She argues that while these forms contain elements of atomicity and summation, they are fundamentally number-neutral, contrasting with BrP bare plurals, which she considers exclusive plurals — nouns that refer only to sums and exclude atomic individuals. Thus, for Müller, bare numberless nouns represent a distinct grammatical category that blurs the line between singular and plural semantics.

Challenging the count-based view of these forms, Pires de Oliveira and Rothstein (2011) offer a competing analysis in which BrP bare singulars are treated as mass nouns. They argue that these nouns do not display canonical count noun behavior: they resist pluralization, are generally incompatible with numerals, and exhibit cumulative reference — a diagnostic property of mass terms. Moreover, they point out that these bare singulars lack individuation, another distinctive feature of mass semantics. From this perspective, BrP bare singulars should not be seen as underspecified count nouns, but rather as true mass nouns within the grammar. Their analysis positions BrP as a language that has grammaticalized mass bare singulars, rather than as one that operates with a number-neutral count system.

Taken together, these competing accounts — number-neutrality vs. mass interpretation — highlight the unique behavior of BrP bare singulars and challenge the universality of the NMP. The BrP data not only expose the limitations of Chierchia’s original typology, but also raise deeper questions about the nature of grammatical number, the count—mass distinction, and how nominal meanings are compositionally derived across languages.

2.4.4 Empirical Evidence of Bare Singular Nouns’ Behavior in BrP

Due to the theoretical debate, empirical evidence is brought by Pires de Oliveira, Silva, and Bressane (2009) who provide experimental evidence of the acceptability of bare singular nouns in BrP. This evidence shows that bare singulars and definite articles are in a competition in the language and might indicate that BrP is changing, as both forms were accepted in generic sentences. Most importantly, contrary to the literature, bare singulars were more acceptable compared to sentences with definite articles. This result was a preview of further discussion regarding mass and count nouns as bare nouns, which later would become widely debated in the literature.

Beviláqua and Pires de Oliveira (2014) started to examine bare nouns, specifically count and mass nouns. The researchers provided empirical evidence to discuss whether bare

singular nouns would have cardinal interpretation or volume interpretations. Their results supported the hypothesis that bare singular nouns are interpreted as volume in volume-biased contexts, suggesting that bare singulars are different from bare plurals, which could only be interpreted as cardinal. In contrast, bare singular nouns could be interpreted as volume. However, they also noted that bare singular nouns could be interpreted as cardinal, although this interpretation would not be preferred due to context.

Lima and Gomes (2016) presented experimental evidence of bare singulars being interpreted as cardinal nouns in contexts that do not specifically favor either volume or cardinal interpretations. They explained this preference based on the assumption that these nouns have natural bias towards atomicity. Supporting this study, Beviláqua, Lima, and Pires de Oliveira (2016) provided experimental evidence that bare singulars would have a cardinal interpretation by default, whereas it could only be interpreted as mass once we have a context that favors such interpretation is present.

Challenging these views, Beviláqua and Pires de Oliveira (2017) conducted an experiment in which bare nouns were tested in neutral and biased contexts. The results showed that the interpretation of bare singulars is not dependent on context. Interestingly, these nouns exhibit a characteristic behavior of both mass and count nouns. In contrast, bare plurals behave differently, as they can only be interpreted as cardinal and do not allow mass interpretations even if the context forces such interpretation, contradicting the claims made by Pires de Oliveira and Rothstein (2011) which argues that the bare singular is a mass noun. Consequently, the researchers argue that bare singulars in BrP are underspecified, allowing both mass and count interpretations.

Based on the empirical evidence of the above-mentioned studies, Pires de Oliveira (2019, 2020) analyzes the nominal system of BrP, aligning it to Chierchia's conjecture. According to the author, both BrP and English can be considered number-marking languages. The explanation for the distinct behavior of bare singulars between them would lie in the location of the atomization process. In English, the process occurs at the noun once the lexically encodes whether the noun is atomic or a cumulative predicate. In BrP, however, the operation may take place at the determiner level, as the BrP syntax does not provide such information. Consequently, the bare singular count nouns in BrP would not carry any element of atomization and would remain underspecified for number. Importantly, underspecification has psycholinguistics consequences since it does not provide additional processing time, which differs from coercion (later we will go back to these terms). As a result, this hypothesis leads

to differing interpretations of bare nouns between these two languages, resulting in semantic differences in the interpretation of count and mass nouns.

In summary, there is no doubt regarding bare plurals having a cardinal interpretation in both English and BrP. However, the same cannot be said for bare singular nouns, as their interpretation may vary between volume or cardinal in BrP. This is not the case for English, where bare singulars are interpreted solely as mass in food-related sentences with edible count nouns or in contexts that impose a mass interpretation through a coercion process (FRISSE; FRAZIER, 2005), which will be discussed in Part III.

2.4.5 Empirical Evidence of Bare Singular Nouns' Behavior in English

Although bare singulars do typically occur in English, with the exception of highly restricted contexts in which leads to coercion, there is a growing body of research on the topic. One such study is Scontras, Davidson, Deal, and Murray (2017), which investigates bare nouns and quantity judgments, and is discussed in detail in this section. This research contributes to our understanding of English grammar regarding bare nouns and, by extension, offers valuable insights into the nature of bare nouns in BrP as well.

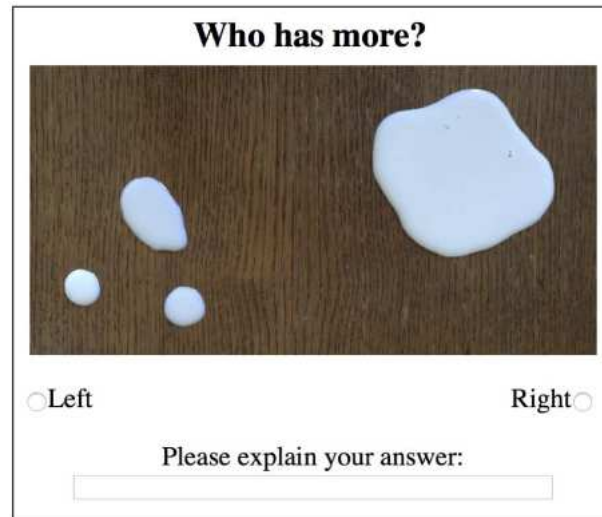
Scontras et al. (2017) were interested in investigating the influence of the linguistic form in a study conducted with a Quantity Judgment Task (QJT). Their aim was to investigate two exceptional cases that deviate from count and mass distinctions found in the literature: (1) the *fake mass nouns* or *object-mass nouns*, such as 'furniture', which cannot be combined with numerals but exhibit cardinal behavior, and (2) the Yudjá language, which consistently exhibits a cardinality interpretation pattern across all nouns.

To test their hypothesis, Scontras et al. (2017) designed two experiments utilizing a classical QJT. The first experiment involved a QJT without linguistic cues, while the second experiment in which participants would provide the cues themselves. Their hypothesis proposed that linguistic form would influence the interpretation of the nouns. According to Scontras et al. (2017, p. 3), English nouns come inherently specified for atomicity in their denotation.

In the first experiment, two variables were manipulated: the no-noun condition and the two-noun condition. In the no-noun condition, participants were presented with a question 'Who has more?' along with a picture with two objects from the same type. The picture could either show a larger size to indicate interpretations driven by volume or a smaller scale with

more items to indicate interpretations driven by cardinality. Figure 2.1, taken from Scontras et al. (2017), illustrates their experiment 1.

Figure 2.2 — Example of no-noun condition extracted from Scontras et al. (2017)



Source: extracted from Scontras et al. (2017).

After viewing the picture, participants were required to select either the left or right option. If the participants selected the left option, their interpretation of the picture representing a mass noun was based on cardinality. If the participants selected the right option, it meant that the picture representing the mass noun received an interpretation based on volume.

In the two-noun condition, the participants were presented with the bare mass nouns and plural count nouns alongside pictures representing the two possible interpretations. The results from this experiment in the two-noun condition were categorical: when participants encountered a plural count noun in the QJT, they consistently interpreted it in terms based on cardinality, while for mass nouns, they consistently assigned volume interpretations. However, the behavior exhibited some variability in the no-noun condition, as participants displayed an oscillation in their responses. Scontras et al. (2017) argument based on Grimm and Levin (2012) that with the absence of morphosyntactic cues for atomicity, participants are free to decide whether their interpretation is based on cardinality or volume, similar to the behavior observed with object-mass nouns (SCONTRAS et al., 2017, p. 9). This result confirms that English nouns either come fully specified for atomicity in their denotation, as is the case with count nouns, or they do not come specified for atomicity, as with mass nouns.

In the second experiment, the same conditions as in experiment 1 were replicated, but with the addition of an extra trial. In this trial, participants were asked to fill in the blank with

the noun before making the comparison. For example, they were presented with the question ‘Who has more _____?’ and had to provide the noun themselves before proceeding with the comparison. Additionally, participants were also asked to provide answers for a wide range of nouns, including singular count nouns (e.g., ‘Who has more cup?’) and plural mass nouns (e.g., ‘Who has more waters?’).

The results of the second experiment supported the notion that linguistic cues play a crucial role in driving participants’ behavior in quantity judgments, similar to the findings of experiment 1. Interestingly, plural mass nouns were often interpreted with some form of portioning noun, such as ‘pieces’ or ‘drops,’ indicating a tendency to consider them in terms of discrete units. On the other hand, singular count nouns were more significantly interpreted in relation to volume, suggesting a focus on the overall size.

The study conducted by Scontras et al. offers a valuable insight into the influence of morphosyntactic and semantic features on the interpretation of nouns in a QJT. The absence of linguistic cues in the no-noun condition results in an underspecified context for interpreting the figures as either cardinal or volume. In such cases, participants rely on available contextual hints and employ individual strategies to determine an interpretation, which leads to oscillations between the two possible interpretations. This highlights the importance of morphosyntactic signals in guiding the interpretations of nouns in a QJT.

2.5 QUANTITY QUANTIFIER PHRASES

As we have seen so far, bare singular nouns are a source of mismatch between the two languages not only in the syntax interface with the absence of productive bare singulars in English, but productive structures in BrP which generated theoretical implications about its status in BrP. Pires de Oliveira (2022) claims that bare singular nouns are underspecified for atomicity in BrP, and if this hypothesis is correct, the underspecification would spread over BrP grammar also appearing in quantifier phrases. The quantifier phrases that are investigated in our research are headed by a determiner quantifier and followed by a bare noun. For example, in English, we have:

15. a) Many chairs are heavy.

In (15.a) we have a determiner plural quantifier ‘many’ and a plural predicate ‘chairs.’ For Chierchia (1998) and Pires de Oliveira (2011) the noun in this position may be analyzed as

a bare singular or a bare plural, depending on the literature. Here, we consider them quantifier phrases since the noun is headed by a quantity quantifier. As discussed in Pires de Oliveira and Rothstein (2011) and Chierchia (1998), the interpretation of quantifier phrases in BrP may involve bare nouns, whose number marking and semantics vary depending on the quantifier, context, and agreement. Additionally, Chierchia (1998) refers to ‘many’ as a plural quantifier and ‘much’ as a singular quantifier; therefore, we adopt this terminology throughout our study.

The sentence in (15.a) informs us that there is a certain number of chairs that are heavy, and this number of tables that are heavy is bigger in quantity than other chairs that are light. In other word, the quantifier heads the cardinal interpretation for English, informing us in advance that the following noun that we are going to encounter is a count noun. In other words, ‘many’ is cumulative, informing that we need more than one item to establish a comparison between the amount of the following item that is given by the context (PIRES DE OLIVEIRA; CARDOZO, in preparation; CHIERCHIA, 1998).

The plural quantifier ‘many’ presupposes that the following noun encountered in the derivation is a count noun, that should also be pluralized (PIRES DE OLIVEIRA; CARDOZO, in preparation). If the following noun encountered in the derivation is an atomic predicate, the derivation crashes, generating the ungrammaticality of (16.a):

16. a) * Many chair are heavy.

As we can observe, not only in the quantifier, but the whole sentence structure is atomized, requiring a plural count noun in the derivation, and a plural argument. If we change the count noun for a pluralized mass noun, we also have the ungrammaticality of (17.a):

17. a) * Many waters are heavy.

Now we have a pluralized mass noun that also does not combine with ‘many’, and neither to the main argument. This informs us the plural quantifier ‘many’ is specified for atomicity, and it requires that the following noun encountered in the derivation is a count noun that should also be pluralized. That is, ‘many’ requires that the following noun should have discrete units that are sums, so it is possible to count them. Based on this description, we can identify why the following sentence in (18.a) is also ungrammatical:

18. a) * Many water are heavy.

The sentence in (18.a) is ungrammatical since we have a plural quantifier combined with a singular mass noun, which does not denote discrete units, so cannot be counted. Although in (18.a) we have a syntactic mismatch between the quantifier type and the noun type, it is also a semantic mismatch since the quantifier is informing us that we need discrete divisible units to count, while the noun is informing that we do not have a discrete indivisible unit (CHIERCHIA, 1998; PIRES DE OLIVEIRA, CARDOZO, in preparation).

For BrP, the plural quantifier ‘muitas’ seems to have a parallel behavior, as we can observe for the examples translated to BrP:

19. a) Muitas cadeiras são pesadas.
- b) Muitas cadeira são pesadas.
- c) * Muitas águas são pesadas.
- d) * Muitas água são pesada.

With the exception of (19.b), the behavior observed in (19.a), (19.c), and (19.d) shows that BrP patterns similarly to English. That is, the plural quantifier ‘muitas’ carries features of atomicity, requiring the following noun to be a count one (CHIERCHIA, 1998; PIRES DE OLIVEIRA; ROTHSTEIN, 2011). However, (19.b) behaves somewhat differently. In BrP — especially in the oral register — plurality is often marked on the leftmost element of the noun phrase, in this case, the quantifier. This allows the noun that follows to remain in singular form. Therefore, while ‘muitas’ selects for a count noun, the noun does not necessarily need to appear in the plural form, unlike in English. In both languages, however, the plural quantifier does not compose with a mass noun or a pluralized mass noun, unless coercion is involved (CHIERCHIA, 1998), as we will discuss in the Part III subsection.

If we look at the singular quantifier ‘much’ we are going to notice that the opposed behavior of ‘many’ is expected for English:

20. a) Much water is heavy.
- b) * Much waters is heavy.
- c) * Much book is heavy.
- d) * Much books is heavy.

Once again, the singular quantifier ‘much’ is negatively specified for atomicity operating over a mass predicate, presupposing a non-atomic predicate. That is, it requires that the following noun should be a mass noun that is in its singular form. The atomization spreads across the sentence and the following verb should be singular, agreeing with the quantifier and the noun. Now looking at BrP, the singular quantifier presents a different behavior regarding count and mass nouns:

21. a) * Muita cadeiras é pesada.
 b) Muita cadeira é pesada.
 c) Muita água é pesada.
 d) * Muita águas é pesada.

Now the behavior of the singular quantifier ‘muita’ differs from that of ‘much’. First, it is similar with respect to mass nouns, since ‘muita’ allows it to be combined with a mass noun in its singular form, as in (21.c). Second, the singular quantifier can also be combined with a singular count noun, as in (21.b). And finally, the ungrammaticality of (21.a) and (21.d) is due to the obligation of the plural inflection should be in the leftmost element of the sentence.

In a nutshell, the singular quantifier ‘muita’ in BrP seems to be underspecified for atomicity, since it does not give the grammatical information that the following noun encountered in the derivation should be a count or a mass noun. In this sense, the underspecification spreads over grammar (PIRES DE OLIVEIRA, 2022), not only showing up in the bare singular count nouns, but also in other positions in the nominal domain.

Additionally, this suggests that such mismatches may also appear in other areas of BrP grammar, provided that the divergence between the two languages can also be observed in the quantifier system. The singular quantifier in BrP does not align with its English counterpart: while ‘much’ only combines with singular mass nouns, ‘muita’ can occur with both count and mass nouns in the derivation.

It is essential to note that our focus is on quantified singular and plural phrases — in other words, structures formed by a quantifier followed by a noun. Depending on the theoretical approach, the noun in this position can be treated as a bare singular or bare plural. In this context, we treat them as quantified phrases. As argued by Pires de Oliveira and Rothstein (2011) and Chierchia (1998), the interpretation of such phrases in BrP may involve bare nouns, with number marking and semantic interpretation varying according to the quantifier and the surrounding context.

2.6 LANGUAGE REPRESENTATION AND GRAMMAR

In the context of our research, the term representation refers to the way linguistic knowledge is mentally encoded and organized in the grammar. As White (2003) argues, L2 acquisition involves the establishment of new syntactic and semantic representations, which may initially be influenced by the properties of the L1 grammar. Slabakova (2008) further emphasizes that representation is especially crucial at the syntax–semantics interface, where learners must acquire abstract features and interpretive properties that may not be directly instantiated in their L1. Thus, investigating representation in bilingual grammars provides insight into whether learners successfully encode L2-specific features, or whether transfer leads to persistent mismatches between L1- and L2-based mental representations.

Taking in to account this aforementioned discussion about representation, the literature suggests that bare singular nouns present syntactic and semantic differences between BrP and English (PIRES DE OLIVEIRA, 2019; 2020; PIRES DE OLIVEIRA; BEVILÁQUA, 2020, among others). According to the hypothesis being tested in our research, native speakers of BrP who are learning English as an L2 need to *reset* the semantic representation with respect to bare singular count nouns. In order to reset, this semantic feature, the bilingual has to suppress the triad system that has count, mass, and neutral nouns and operate in a polar system that has count and mass, only. This reset is necessary to account for the different syntactic and semantic properties of bare singulars in English compared to BrP.

Pires de Oliveira and Beviláqua (2020) provide an interpretation of the results from Scontras et al. (2017) in the context of BrP grammar. They highlight that English grammar is specified for atomicity. As the example provided by Pires de Oliveira and Beviláqua (2020), the noun ‘table’ is atomic and cannot be in the argument position in comparative syntactic constructions since it denotes an atomic predicate. This leads the participant to coerce the object into partitioned portions of it. (PIRES DE OLIVEIRA; BEVILÁQUA, 2020, p. 206). On the other hand, if BrP the noun ‘mesa’ was an atomic predicate, then the same behavior from English would be observed in the QJTs. However, their study shows that in BrP the bare noun can appear in an argument position and its interpretation is not led by a coercion process, it lacks cues to atomicity since in BrP atomicity is not mandatory on the noun, allowing both cardinal and volume interpretation while also not behaving as plural (PIRES DE OLIVEIRA; BEVILÁQUA, 2020; PIRES DE OLIVEIRA, 2020).

In this sense, the following table helps to illustrate the interpretations of mass and count nouns between both languages as discussed by the studies from Beviláqua and Pires de Oliveira (2014), Lima e Gomes (2016), Beviláqua, Lima, and Pires de Oliveira (2016), Beviláqua and Pires de Oliveira (2017), Pires de Oliveira and Beviláqua (2020), among others.

Table 2.4 — Interpretation of mass nouns between English and BrP

Language	Cardinal	Volume
BrP	-	+
English	-	+

Source: designed by the researchers.

The table above helps to illustrate a match between the semantic interpretation of BrP and English regarding mass nouns. The signal ‘-’ indicates that the semantic interpretation is not available, while the signal ‘+’ indicates that the semantic interpretation is available. According to Chierchia (1998), mass nouns have atoms that do not consist of discrete, countable units. They refer to substances such as ‘clay’ or ‘water’, which retain their identity even when divided into parts⁴. For example, if we take a jar of water and pour some into a glass, both the portion in the glass and the portion remaining in the jar are still referred to as ‘water’. That is, we still have ‘water’, regardless of the division. Therefore, mass nouns have a cumulative property. Now, the table below helps to illustrate the semantic interpretations of singular count nouns between these both grammars.

Table 2.5 — Interpretation of singular count nouns between English and BrP

Language	Cardinal	Volume
BrP	+	+
English	-	+

Source: designed by the researchers.

Now as displayed by the table above, we have different semantic interpretation between these two grammars. This is headed by the singular count noun in BrP, which is a kind; therefore, as the derivation unfolds, either the cardinal interpretation is accessed, or the volume interpretation is incorporated. This reasoning is based on Pires de Oliveira (2019,

⁴ This is also consistent for nouns such as ‘furniture’; however, they represent a different class of nouns that will not be discussed in this dissertation.

2020, 2022, 2025), who argues that at the beginning of the derivation, the participant accesses the kind, at which point neither the cardinal nor the volume interpretation is available. In English, the only interpretation available for singular count nouns is that they denote atomic individuals, thereby triggering coercion with mass nouns and partition or massification applies. Following Chierchia (1998), count nouns such as ‘chair’ and ‘cat’ denote sets of discrete and individuated entities built from atoms. These nouns have the cardinality interpretation, meaning they can be counted. For example, if we combine one chair with another chair, we obtain two chairs, forming a sum of chairs. However, if we take a chair and break it into pieces, it loses its original identity as a ‘chair’ and becomes, for instance, an pieces of a chair or amount of wood (assuming the chair is made of wood). This illustrates a key difference: while mass nouns retain their identity when divided (e.g., ‘water’ remains ‘water’ even when split), singular count nouns do not — they lose their referential integrity when broken down.

For Chierchia (1998), this difference between count and mass nouns is not ontological, but it is governed by cognition. These differences refer to how we perceive and categorize entities. The task for the bilingual individuals here is to restrict (or suppress) the semantic interpretation of volume for count nouns during the course of acquisition of English as an L2. Although the acquisition of BrP as a second language is not discussed in this dissertation, it is possible to hypothesize that the task for a native speaker of English learning BrP is to acquire the triadic system. The same process is required to quantifiers, which is the same source of mismatch and appears in a different position within the sentence structure.

In sum, the observed syntactic mismatch between BrP and English — particularly in the use of determiners — has broader implications, extending to other areas of the grammar and resulting in a semantic mismatch. This supports the view that cross-linguistic variation can shape how meaning is structured and interpreted. Bare singular nouns, in particular, illustrate a clear mismatch at the syntax–semantics interface within the nominal domain. In BrP, singular nouns can occupy argument positions, whereas in English they cannot. As a result, the bare singular functions as an atomic predicate in English, but not in BrP. English thus enforces a single, atomic interpretation, giving rise to a process known as coercion — a phenomenon that will be examined in detail in Part III: *Semantic Processing (an interface with Psycholinguistics)*.

Part III — *Semantic Processing (an interface with Psycholinguistics)*

In this final Part III — *Semantic Processing (an interface with Psycholinguistics)*, we delve into the semantic processing field, which is in fact, an interface with psycholinguistics or,

more specifically, psycho-semantics. The concept of ambiguity and polysemy are explored, alongside with the studies that have investigated coercion in both English and BrP, thus concluding the discussion of Chapter II.

2.7 AMBIGUITY, POLYSEMY, AND COERCION

Ambiguity, polysemy, and coercion are key semantic concepts in this study. Clarifying them is essential, as the current investigation developed in this dissertation seeks to provide empirical evidence related to semantic processing.

Breaking down each term, we start with ambiguity, which refers to a word, phrase, or sentence that has more than one interpretation (HURFORD; HEASLEY; SMITH, 2007; LYONS, 1995). There are two main types: (1) lexical ambiguity or homonymy, which occurs when a word has more than one meaning that are not related — such as ‘bank’, which can refer to a financial institution or the object that we use to sit in (LYONS, 1995); those are two lexical entries in our lexicon; and (2) structural ambiguity, which arises from sentence structure⁵. For example, in the sentence ‘Mary saw the man with the binoculars’, it is unclear whether the man used the binoculars to see the woman, or the woman had the binoculars and was seen by the man (FRAZIER; RAYNER, 1982).

While ambiguity refers to any instance of multiple interpretations — whether lexical or structural — polysemy is restricted to cases where a single word has multiple related meanings (LYONS, 1995; CRUSE, 2000). For instance, as noted earlier, the word ‘bank’ can refer to both a financial institution and the building where such services are provided — meanings that are conceptually linked. Polysemy is lexical and involves related senses that are generally available in the mental lexicon simultaneously (MURPHY, 2010).

Importantly, Frazier and Rayner (1990) found that polysemous words do not necessarily lead to increased processing costs, especially when context supports a specific sense. In contrast, ambiguous words can incur processing delays when context does not clearly disambiguate their meaning. In such cases, the absence of processing difficulty may reflect a strategy of semantic underspecification, in which the semantic processor does not immediately commit to a specific interpretation of the word. Instead, the meaning is temporarily left open, allowing later information in the sentence or discourse to determine a more specific interpretation (FRAZIER; RAYNER, 1990).

⁵ There are other types of ambiguity but they are left aside from this discussion since they are not closely related to our research

Now, to define coercion as investigated in this study, we refer back to Frisson and Frazier (2005), who help clarify this phenomenon. Broadly speaking, coercion involves changes in meaning that are required when a word's default semantic interpretation does not align with the expectations imposed by the grammatical or discourse context. While Frazier (2012) maintains that syntax is typically the primary driver of linguistic processing, she also acknowledges that coercion may involve interpretations not directly licensed by overt morphology or syntax, but rather developed to maintain compositional coherence (FRAZIER, 2012, p. 2705).

As an illustration, Frisson and Frazier (2005) discuss lexical derivation rules — processes by which a word's interpretation is modified due to morphological changes. For example, the word 'water' is a mass noun, typically interpreted in terms of volume. However, when a plural morpheme is applied (i.e., 'waters'), the noun becomes countable and receives a cardinal interpretation. This shift from a mass to a count reading represents a form of coercion, specifically involving lexical reinterpretation prompted by morphological structure.

Such shifts of meaning are not cognitively neutral; they incur additional processing cost. This is because the parser — the mental mechanism that incrementally assigns syntactic representations as linguistic input becomes available — is initially committed to the default mass interpretation of the noun. When the structure later forces a reinterpretation, the semantic processor — a mental component of the comprehension system that maps lexical items and syntactic structures that compute meaning in real time — must revise its earlier commitment, resulting in extra processing effort (FRISSEON; FRAZIER, 2005; BEZERRA, 2017; BEZERRA, 2025). The temporal correlation reflects cognitive mechanisms involved in reanalyzing the syntax–semantics mappings between form and meaning, as a way of rescuing the derivation. This reanalysis is associated with an additional processing cost.

This aligns with research showing that sentence interpretation proceeds incrementally and bottom-up — that is, meaning is assigned word by word, as each element becomes available in the sentence derivation (CRAIN; STEEDMAN, 1985; ALTMANN; STEEDMAN, 1988). Thus, when a plural inflection is applied mid-derivation, the semantic processor is required to reanalyze the word's category and meaning. This reinterpretation is what triggers the additional processing cost.

The notion of underspecification plays a central role in explaining how we process lexical ambiguity. According to Frazier and Rayner (1990), when encountering polysemous words — those with related senses — the semantic processor adopts an underspecification strategy, temporarily delaying commitment to a specific interpretation until contextual

information becomes available. This strategy is less viable for homonymous words, which have unrelated meanings; in such cases, the parser tends to commit early to one meaning, often incurring processing costs if reanalysis is required. Building on this view, Frazier (1999) further argues that underspecification is a context-sensitive and economy-driven parsing strategy. Rather than resolving ambiguity immediately, the parser may opt to maintain a semantically underspecified representation when the cost of committing prematurely is high, or when context does not demand immediate disambiguation. Together, these studies suggest that the human parser strategically navigates ambiguity by balancing interpretive demands, contextual support, and processing economy.

Differently from underspecification, nominal coercion takes additional processing costs and it is a complex concept to understand and we can break it down in two processes⁶, namely portioning⁷ (or packaging) and grinding. The former concept refers to the transformation of a mass noun into a count noun, while the latter refers to the transformation of a count noun into a mass noun (FRISSE; FRAZIER, 2005). These two concepts serve to explain the processes involved in these two specific types of coercion. Although Link (1983) does not talk about coercion, the example provided in (22.a) helps us to understand the process.

22. a) There is apple in the salad.

Grinding occurs when the count noun is shifted into a mass noun, receiving a volume interpretation. In other words, the ‘apple’ in the salad in sentence (22.a) refers to massified instances of an apple. Whenever a native speaker of English encounters this structure, they typically convert the edible count noun into a mass noun, and this process incurs additional processing times, as demonstrated by online studies in semantics as in Frisson and Frazier’s (2005) study. In the following example extracted from Frisson and Frazier (2005), we observe the opposite scenario:

23. a) Yesterday, I bought imported beers at the counter of the local supermarket.

⁶ Here we will not delve into aspectual coercion since it is not the focus of our research.

⁷ There is a slight difference between packaging and portioning. The former would refer to the use of a count noun in a mass context in which we would have a standardized package as in ‘two coffees’, referring to cups of coffee. The latter would refer to subkinds as in ‘three wines’ referring to three types of wines (LIMA, 2019).

In sentence (23.a), the internal argument of ‘bought’ is a mass noun with plural inflection. The transformation of the noun ‘beers’ in this case involves a coercion process — more specifically, portioning, in which the mass noun is shifted into a count noun and may receive a cardinal interpretation. This occurs due to conventionalized containers; that is, we infer that the reference is to bottles (or units) of beer. In other words, ‘beers’ is coerced to bottles of beers. Once again, when native speakers of English encounter this structure, their typical behavior is to convert the mass noun into a count noun, and this process also takes additional processing times. We will specifically examine the study conducted by Frisson and Frazier (2005) in the next subsection, which focused on coercion in English.

2.7.1 Semantic Processing in English

One of the most influential studies on coercion in English is Frisson and Frazier (2005). This work provides important insights into how native speakers of English process coercion in constructions, making it a key reference for research on language processing. In what follows, we examine this study in detail, as it serves as one of the main inspirations for the processing studies presented in this dissertation.

Frisson and Frazier (2005) employed eye-tracking technology with the aim of investigating the processing involved when a mass noun is treated as a count noun (portioning) and when a count noun is treated as a mass noun (grinding) through lexical derivational rules. Their assertion, supported by existing literature, is that these shifts commonly occur in food and drink contexts. To examine this, linguistic items related to food and drinks were investigated in both derived (‘beers’ — mass / ‘pears’ — count) and underived forms (‘beer’ — mass / ‘pear’ — count), that is, with and without plural inflection. Furthermore, the researchers manipulated syntactic construction that provides context. According to their hypothesis, without biasing evidence, the underived form would be given priority. As a result, the derived forms would incur additional processing costs once the biasing evidence would trigger coercion.

In their initial experiment, Frisson and Frazier (2005) examined portioning. The objective was to gather information on whether the derived form of a mass noun is harder to process when compared to the underived form. To achieve this, they manipulated the context of the sentence by including or excluding cues to assess whether the context could prevent the activation of the portioning process. The researchers identified the noun region and the spillover region as the Regions of Interest (ROIs). Here are examples taken from Frisson and Frazier’s (2005) first experiment:

24. a) Yesterday, I bought imported beers at the counter of the local supermarket. [mass noun, neutral context]
- b) Yesterday, I bought three imported beers at the counter of the local supermarket. [mass noun, helping context]
- c) Yesterday, I bought imported pears at the counter of the local supermarket. [count noun, neutral context]
- d) Yesterday, I bought three imported pears at the counter of the local supermarket. [count noun, helping context]

When the context was neutral, as in (24.a) and (24.c), additional processing time was observed, which can be taken as evidence of coercion. However, when the mass noun was preceded by a numeral, as in (24.b) and (24.d), participants also took more time to read the sentence, but they were slightly faster than in comparison to the neutral context. In other words, when the mass noun is forced to be transformed into a count noun, the lexical derivational rule is applied, resulting in portioning. Eye-tracking data provided evidence for this process, showing that it took more time and regressions in the noun region. This indicates that the noun is specified in the lexicon as mass, but since the context is a count structure, it requires the noun to be reanalyzed, leading to additional processing time that spread over the spill-over region. The researchers noted that once the reanalysis was made, the processing of the rest of the sentence proceeded unimpaired. This provided evidence that the processor has a tendency to commit itself to the underived form of a word and is not lexically driven (FRISSEON; FRAZIER, 2005). In other words, a mass noun in a count syntax is harder to process since the mass noun already carries the semantic feature of mass. Once the mass noun is encountered in a count syntax, the semantic feature has to be shifted through coercion from mass to count, reanalyzing the interpretation, therefore assigning a cardinal one, in a portioning process.

In their second experiment, Frisson and Frazier (2005) investigated grinding. This experiment is the opposite from the first experiment. Now, count nouns are treated as mass nouns with and without context. Note that in this experiment, there are bare singular nouns, as in 'pear' in examples (25.c) and (25.d). Once again, the ROIs were the noun region and the spillover region. Below are some examples extracted from Frisson and Frazier (2005) second experiment:

25. a) Yesterday, John wanted imported beer after the rich main course. His girlfriend didn't want anything. [mass noun, neutral context]
- b) Yesterday, John wanted just a small amount of imported beer after the rich main course. His girlfriend didn't want anything. [mass noun, helping context]
- c) Yesterday, John wanted imported pear after the rich main course. His girlfriend didn't want anything. [count noun, neutral context]
- d) Yesterday, John wanted just a small amount of imported pear after the rich main course. His girlfriend didn't want anything. [count noun, helping context]

When the mass noun was preceded by an amount phrase, as in (25.b), participants showed faster reading times compared to mass nouns in a neutral context, as in (25.a). Additionally, When the count noun was after the helping context as in (25.d), fewer regressions was observed when compared to count noun in a neutral context, as in (25.c). Importantly, when the count noun was in a mass syntax, extra processing time was observed, providing evidence of grinding. In other words, the count noun, which carried the semantic feature of count, had its interpretation shifted by coercion to mass through a grinding process. Additionally, the researchers observed that amount phrases played a more facilitative role by providing contextual cues, as these amount phrases indicated that the following noun to be encountered in the structure would be an edible noun.

In summary, the authors acknowledge that, in English, word processing tends to commit to the underived sense of a noun. In other words, the lexicon already specifies whether a noun is count or mass — even in the absence of contextual cues — because English nouns are specified for atomicity. However, once syntactic cues are available, processing becomes somewhat facilitated.

2.7.2 Semantic Processing in BrP

To date, two studies have examined the interpretation and processing of bare nouns in BrP, both inspired by the influential work of Frisson and Frazier (2005). These studies offer valuable insights into how coercion operates in BrP and provide the foundation for the present investigation.

One of the earliest experimental studies examining the processing of bare singulars in BrP was carried out by Lima (2019). This research focused specifically on the behavior of bare singular nouns in BrP, exploring how these nouns function in both mass and count contexts to assess whether there would be an additional processing cost in interpreting these nouns — similar to what Frisson and Frazier observed for English — or whether the shifts in interpretation would occur without added cognitive effort. The researcher tested two competing hypotheses: the lexical shifts hypothesis, which claims that converting a noun from mass to count (or vice versa) entails additional processing costs, and the lexical pragmatic hypothesis, which argues that no extra cost is involved in such interpretive shifts.

To test these hypotheses, Lima designed a task that measured reading times for the whole sentences containing bare nouns in BrP. The lexical shift's view assumes that one interpretation is basic and the other is derived, while the lexical pragmatic view maintains that interpretation is guided by context rather than fixed lexical rules. According to the latter, speakers are not committed to one reading upfront; instead, contextual information plays a crucial role in determining meaning, which only becomes available when context is provided.

In the first experiment, Lima investigated how bare singulars are processed in both grinding and non-grinding contexts to identify any differences in processing cost. The study assessed: (i) whether bare singulars in grinding contexts take longer to process than in non-grinding contexts; (ii) whether there's a significant processing difference between bare singulars and mass nouns when both appear in mass contexts; and (iii) whether the semantic class of nouns — such as animals, artifacts, and edibles — influences processing when used as bare singulars in grinding contexts. Sentences were categorized according to noun form and lexical type. Some examples from the experiment include:

26. a) João viu galinha acordada na mesa.
 b) João viu galinha espalhada na mesa.
 c) João viu açúcar espalhado na mesa.
 d) João viu banana amassada na rua.
 e) João viu banana?

The findings from this first experiment revealed no significant processing differences across the various conditions. Neither the type of noun form nor its lexical category appeared to influence processing effort. This suggests that the interpretation of bare singulars in BrP — whether in grinding or non-grinding contexts — does not involve additional cognitive cost. These results align with the lexical pragmatic hypothesis, implying that BrP speakers do not adhere to a predetermined interpretation; rather, interpretation arises through contextual or pragmatic information.

Lima's second experiment aimed to replicate Frisson and Frazier's (2005) findings, this time focusing on the packaging process. She adopted the same conditions and sentence types used in their study. The experimental conditions included:

27. a) Ontem, Pedro comprou cervejas no mercado local.
 b) Ontem, Pedro comprou laranjas no mercado local.
 c) Ontem, Pedro comprou três cervejas no mercado local.
 d) Ontem, Pedro comprou três laranjas no mercado local.

In the original study by Frisson and Frazier, these conditions involving mass nouns — especially pluralized ones — led to increased processing times, even when helping contexts were provided. However, Lima's replication did not yield the same results for BrP. Her findings showed no significant processing costs in any of the conditions. This second experiment also supported the lexical pragmatic hypothesis, extending its applicability to the processing of pluralized mass nouns.

Lima's (2019) research suggests that bare singulars in BrP do not follow the same processing patterns as the bare singular in English. In English, coercing a noun from mass to count (or vice versa) incurs an additional cognitive cost, suggesting the presence of a default or primitive meaning. However, BrP speakers do not appear to access such default interpretations.

Instead, their understanding of bare singulars is context-dependent, supporting the idea that these nouns might be underspecified for atomicity, as argued by Pires de Oliveira (2022).

More recently, Lopes (2024) investigated the semantic dimensions involved in the processing and representation of bare singulars in BrP. Specifically, the study aimed to examine how native speakers of BrP comprehend and process these nouns when they appear in measure and count contexts. To achieve this, a Self-Paced Reading (SPR) Task was employed, with the primary goal of analyzing how nouns — preceded by either a measure phrase or a numeral — are processed and represented. A key methodological distinction from the foundational study by Frisson and Frazier (2005) — which informed Lopes (2024) — is that this experiment did not restrict itself to mass nouns related to food and beverages. Instead, it also incorporated object-related mass nouns, such as ‘hay’, ‘mud’, and ‘clay’.

The experimental design included two independent variables: 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). This resulted in a 2x3 factorial design, yielding six experimental conditions. The conditions of the experiment are outlined below:

28. a) João comprou vinte e cinco camas no mercado grande.
[numeral, plural count noun]
- b) João comprou vinte e cinco cama no mercado grande.
[numeral, singular count noun]
- c) João comprou vinte e cinco feno no mercado grande.
[numeral, singular mass noun]
- d) João comprou um pouco de camas no mercado grande.
[measure phrase, plural count noun]
- e) João comprou um pouco de cama no mercado grande.
[measure phrase, singular count noun]
- f) João comprou um pouco de feno no mercado grande.
[measure phrase, singular mass noun]

Lopes’s study aimed to verify (a) if the noun was count, it should not incur a processing cost in counting contexts but should be penalized in measure contexts (in line with the count hypothesis from Schmitt and Munn, 1999; Munn and Schmitt, 2002); (b) if the noun was mass, it is expected to show no penalty in mass contexts but should be penalized in count contexts (in line with the mass view from Pires de Oliveira and Rothstein, 2011); and (c) If the noun was

underspecified, no processing penalties are anticipated in any context (in line with Pires de Oliveira, 2022).

In the comparison between the measure phrase with a singular noun (28.e) and the numeral phrase with a singular noun (28.b), the measure context yielded faster reading times than the count context. In other words, participants took longer to process the singular noun when it was preceded by a numeral. Another important contrast was between the measure phrase with a plural noun (28.d) and the numeral phrase with a plural noun (28.a). Here, the plural noun showed a higher processing cost in the mass context, indicated by longer reading times — suggesting that participants found it more difficult to interpret plural forms in measure (mass) contexts.

In the post-critical region, a spillover effect was observed. When comparing the numeral phrase with a singular noun (28.b) to the numeral phrase with a plural noun (28.a), plural nouns were read more quickly. In other words, while plural forms took longer to process in mass contexts, they were processed more efficiently in count contexts. Additionally, comparing numeral phrases with singular nouns (28.b) to measure phrases with singular nouns (28.e) revealed that the mass context resulted in faster reading times. This suggests that singular nouns are harder to process when preceded by numerals.

Lopes' results did not support the hypothesis that the bare singular represents an inclusive plurality (against SCHMITT; MUNN, 1999; MUNN; SCHMITT, 2002; MÜLLER, 2002), nor do they lend support to the underspecification hypothesis (contradicting PIRES DE OLIVEIRA, 2022). Instead, the findings are consistent with the view that the bare singular functions as a mass noun (in line with PIRES DE OLIVEIRA; ROTHSTEIN, 2011), as no processing cost was observed in mass contexts, while a penalty was evident in count contexts. Nonetheless, the author points out that prescriptive grammar norms may have influenced the results — particularly in the case of numeral phrases with singular nouns (e.g., *vinte e cinco livro*) — since participants might have considered the plural form to be the grammatically correct one. The researcher claims that the factor is especially relevant given that the experimental stimuli were presented in written form rather than spoken discourse.

In conclusion, Lopes (2024) demonstrated that there is no processing cost difference between bare singulars and mass nouns in measure contexts. Moreover, no coercion effect is observed when a singular count noun appears in a mass context — contrary to the results reported by Frisson and Frazier (2005) for English, but in agreement with Lima (2019). Additionally, the combination of singular count nouns with numerals leads to greater processing

difficulty, supporting the theoretical framework proposed by Pires de Oliveira and Rothstein (2011).

In a nutshell, the processing patterns of bare singular nouns remain a subject of ongoing investigation, as their processing and representation are still debated. A key point to highlight is that, when comparing English and BrP, nouns appear to be processed differently. These potential differences are explored in the following final subsection.

2.8 FINAL CONSIDERATIONS OF THE CHAPTER

Based on the discussion brought, we assume that BrP is underspecified for atomicity (PIRES DE OLIVEIRA, 2019, 2020, 2022, 2025), whereas English is specified for atomicity — each of which leads to different processing correlates, highlighting a mismatch between the two grammars (PIRES DE OLIVEIRA; BEVILÁQUA, 2020; BEVILÁQUA; PIRES DE OLIVEIRA, 2021). This mismatch is expected to be confirmed through studies on the acceptability of bare nouns, specifically in Experiment 1 for BrP, Experiment 2 for English, and Group Comparison 1 between BrP and English. Additional experiments will further explore these possible mismatches by examining the processing and representation of quantified phrases in Experiment 4 for BrP, Experiment 5 for English, and Group Comparison 2 between BrP and English.

If the experiments and group comparisons confirm mismatches between the two languages, a key remaining question is how bilinguals would behave in instances of non-correspondence between these two languages. As seen in Slabakova and Montrul (1999), Spanish-speaking intermediate learners of English were able to acquire the semantics of aspectual tenses that are not available in their native language. Additionally, as observed in Ionin, Grolla, Montrul, and Santos (2014), native speakers of BrP intermediate learners of English judging the acceptability of bare nouns in English were also able to give lower acceptability ratings to bare singular nouns in English, even though such forms are grammatical in their native language. These studies provide evidence of an absence of transfer between languages. In other words, language learners are able to acquire the semantics of the additional language in intermediate stages of language acquisition, even when this semantic information was not present in their native language.

In the opposite direction, Ionin et al. (2014), in the same study previously mentioned, also provided evidence of transfer. In another experiment, native English speakers learning BrP gave low acceptability ratings to bare singular nouns. This effect was interpreted as evidence

of transfer, since bare singular nouns are generally ungrammatical in English but are acceptable in BrP — yet participants still rated them lower, reflecting influence from their native language.

It is crucial to emphasize that all of these studies involved bilinguals who were intermediate learners of the additional language. To deepen our understanding of transfer mechanisms, we examine bilingual acceptability of edible bare nouns in English as judged by native speakers of BrP in Experiment 3, followed by Group Comparison 2, in order to further assess the presence of transfer in these contexts. Moreover, we explore the processing and representation of quantifier phrases in English by native speakers of BrP in Experiment 6, thereafter conducting a Group Comparison 4, to investigate whether such mismatches result in transfer effects.

3 CHAPTER III — METHOD

This chapter presents and discusses the instruments used for data collection in this dissertation. Our research involves two main experiments: (1) an Acceptability Judgment Task and (2) a Self-Paced Reading (SPR) Experiment combined with an Interpretation Task. In what follows, we outline the participant profile, recruitment procedures, and the ethical considerations involved in the study. Additionally, we introduce the instruments used to collect data, providing a detailed description of each tool, as well as the pilot studies and the proposed data treatment and analysis.

3.1 PARTICIPANTS

The study included a total of 243 participants, distributed across six experiments conducted at the *Universidade Federal de Santa Catarina* (UFSC) and the University of Toronto. In Chapters IV and V, we present the number of participants in each experiment, along with relevant demographic information, including mean age, results of the power analysis, and linguistic background. Participants were required to meet two inclusion criteria: (1) be at least 18 years old, and (2) be a native speaker of either Brazilian Portuguese (BrP) or English.

3.1.1 Recruitment

In Brazil, the study was advertised through multiple channels, including flyers distributed in classrooms at the *Centro de Comunicação e Expressão* (CCE), in dining hall lines, posters placed around campus, emails sent via undergraduate and graduate departmental mailing lists, and online ads on Instagram. Participants in the SPR Experiment completed the study in the Computer Laboratory at CCE, located on the 5th floor (room 516B) of the UFSC, Trindade Campus. All participants in Brazil took part voluntarily and did not receive any compensation for their participation.

In Canada, the study was advertised through the Department of Linguistics participant pool and via online ads on Instagram. Participants completed the study at the University of Toronto (U of T), St. George campus, in room 6027F on the 6th floor of Sidney Smith Hall. Those recruited through the participant pool received course credit, while participants from outside the pool were compensated with \$10 Canadian Dollar (CAD) in cash.

3.1.2 Ethical Considerations

Since the experiments proposed in this Ph.D. research involved human participants, it underwent an ethics review by the Ethics Review Board of the *Universidade Federal de Santa Catarina (Comitê de Ética em Pesquisa com Seres Humanos — CEPESH-UFSC)* on March 3, 2023, in accordance with Resolution 510/16 of the Brazilian Ministry of Health. The project was approved under protocol number 67809923.1.0000.0121 on May 11, 2023, without any further recommendations. The CEPESH-UFSC approval and the *Termo de Consentimento Livre e Esclarecido* (TCLE) are available in Appendix A and Appendix C, respectively.

In addition, the study was also reviewed by the Research Ethics Board (REB) of the University of Toronto under protocol number 45982. The approval letter and the English version of the Consent Form are available in Appendix B and Appendix D, respectively. At the University of Toronto, the recruitment materials were also subject to ethical review.

All participants had access to the consent form in their native language, which was displayed online on the platform used for data collection. To proceed with the study, participants were required to check a box indicating that they had read the consent form and agreed to the collection of their data for further analysis. They were informed that they could request a Portable Document File (PDF) copy of the consent form via email if they wished to retain a copy for themselves. Participants were also informed that all data collected would remain anonymous and that only the Principal Investigator (PI) would have access to their information.

3.1.3 Briefing

In Brazil, participants attended the computer lab and received preliminary instructions. These included an explanation of the tasks they would complete on the laptop. The PI informed them that they would first complete a leveling task, at the end of which the platform would assign a letter and number indicating their English proficiency level. Upon reaching the final screen of the leveling task, participants were instructed to call the PI for further guidance.

Upon completing the leveling task, the PI reviewed each participant's results and assigned the experimental task accordingly, either in English or BrP based on their proficiency level. Participants were then informed that the upcoming task would be in the assigned language and that the first screen would display the consent form. They were instructed to read the form carefully and, if they agreed, to check the box at the end of the page. Participants were also informed that they could request a PDF copy of the consent form via email if they wished.

The PI also informed participants that all necessary instructions would appear on the screen and emphasized the importance of reading them carefully. Additionally, the PI explained that they would encounter a questionnaire, a practice task to help familiarize themselves with the experiment, the main task, and a final screen. Upon reaching the final screen, participants were instructed to call the PI. At this point, the PI debriefed them and advised participants to note their participant number if they wished to keep it for future reference. Questions from the participants were also welcomed at this final stage.

In Canada, participants scheduled a meeting with the PI via email to take part in data collection. A mutually convenient time was agreed upon by both parties. Upon arrival at the Indigenous Room, participants completed the same procedure used in Brazil, except that the leveling task was not conducted in Canada.

Although it was not a formal instrument, the principal investigator also maintained a digital data collection diary. This tool was useful for standardizing the briefing process across participants and for recording any unusual behavior observed during or after data collection.

3.2 INSTRUMENTS

In this section, we present the instruments selected for data collection. In addition, we discuss the rationale supporting the use of each instrument.

3.2.1 Language and Social Background Questionnaire

The Language and Social Background Questionnaire (LSBQ) was used to document participants' backgrounds, particularly their language experiences. The questionnaire is an adaptation of Birdsong, Gertken, and Amengual (2012) and was designed to gather information about participants' linguistic backgrounds and exposure to foreign languages. The questionnaire in BrP is available in Appendix E and in English in Appendix F.

Since we are comparing different linguistic experiences, it is crucial to keep track of participants' backgrounds in order to accurately interpret the data from the proposed experiments. In particular, individuals with expertise in language education, linguistics, or those studying in the Arts may possess conscious knowledge about language, which could potentially influence the results. Therefore, to ensure the validity of the study, these groups were also

controlled for and reported accordingly in each experiment, even though not all personal information collected was discussed in the analysis.

3.2.2 Placement Test

To complement the information collected from the LSBQ, participants were also asked to complete an online placement test to assess their English proficiency. The Cambridge English Placement Test was selected since it is a standardized online assessment developed by Cambridge Assessment English that evaluates general English proficiency. The test measured grammar, vocabulary, and reading comprehension, and assigned a Common European Framework of Reference for Languages (CEFR) level (ranging from A1 to C2) based on participants' performance. This test was administered prior to the experiment to all native speakers of BrP to ensure accurate placement. Participants at levels A1, A2, C1, and C2 were invited to complete the tasks in BrP, while those at levels B1 and B2 completed the tasks in English, since these B levels represented the intermediate participants we were targeting since is where most transfer effects occur in bilinguals. The advantages of this placement test were that it was free, online, and easy to access, providing the level at the end of the placement task, requiring only a computer with an internet connection for the participant complete the placement.

3.2.3 Acceptability Judgment Task

The AJT evaluates the intuitions that language users have about certain structures they are asked to read. It is an offline instrument that depends on sentence comprehension (DE SÁ; CÍRIACO; GODOY, 2022) and reflects participants' reasoning about whether the sentences are acceptable or not, according to their own judgment. It allows us to infer whether the sentences judged as acceptable (or not) are part of the participants' internal grammar, and to generalize — through statistical tests — whether they are part of a given language. Although its nature is mainly qualitative, when combined with other data collection methods, it can also yield quantitative data.

In an AJT, the participant is presented with a sentence and asked to judge it based on a question that typically varies depending on the purpose of the study. In this dissertation, we used the question “Would you say such a sentence?” accompanied by a 5-point Likert scale.

Only the first and last points on the scale had labels: the first was “I would never say that,” and the last was “I would totally say that.”

As mentioned, some adaptations can be made to this instrument to capture additional sources of data. In our study, the AJT was programmed in PCIBex, which also allowed us to record response times. To do so, each sentence was initially presented with a button labeled “Rate.” Once participants clicked this button, the question and the scale appeared, and the response time measurement began. Response time was recorded until the participant clicked the “Next” button, which only became available after they had selected a point on the scale.

One of the main strengths of this instrument that explains our use by it is that we can test any sentence, regardless of theoretical constructs (DE SÁ; CÍRIACO; GODOY, 2022) or grammaticality, since the goal is to assess participants’ perceptions of whether a sentence sounds acceptable to them. However, one limitation we may have encountered in our study is that participants might have judged the sentences based on their grammatical correctness, allowing explicit grammar instruction to influence their perception of acceptability. We will discuss the experimental design for each experiment on acceptability in Chapter IV — *Experiments on the Acceptability of Bare Nouns* along with the dependent and independent variables of the study. The list of sentences for BrP version can be found in Appendix G (target sentences), Appendix I (filler sentences) and Appendix K (practice sentences). The list of sentences in English can be found in Appendix H (target sentences), Appendix J (filler sentences) and Appendix L (practice sentences). The programming codes for the SPT and IT are all available at GitHub.⁸

⁸ AJT for the BrP experiment: <https://github.com/deardiones/AJT-BRPL1-PCIBEX.git>
 AJT for the English experiment: <https://github.com/deardiones/AJT-ENGL1-PCIBEX.git>
 AJT for the Bilingual experiment: <https://github.com/deardiones/AJT-Bilinguals-PCIBEX>

3.2.4 Self-Paced Reading Task

The SPR is an online measure of language processing that records the time participants spend reading each segment of a sentence. It allows researchers to program software to display sentences in various formats while capturing participants' reading behavior based on the time spent on each segment (in milliseconds), as reading pace is self-monitored. To do this, participants must press a key on the computer — usually the space bar — to move from one segment to the next.

This method was selected because our study examined the processing of specific regions as it is going to be discussed further. Although the instrument gathered data from all segments, these highlighted regions are crucial, as increased reading time in a particular segment can indicate processing difficulty related to those sentence parts (JEGERSKI, 2014; MCDONOUGH; TROFIMOVICH, 2012).

In our study, we used a non-cumulative and non-linear presentation method. Sentence display was initiated by a fixation cross at the center of the screen. A key point in this dissertation is that the critical, post-critical, and final segments used in the SPR were controlled for number of syllables. Specifically, in our study, segments 4, 5, and 7 each contained two syllables in both BrP and English, while segment 6 consisted of a single syllable in both languages. Each time the participant pressed the space bar, a new segment appeared at the center of the screen. Details regarding the presentation procedure for the experiment will be provided in Chapter V — *Experiments Regarding the Processing and Representation of Quantifier Phrases*, along with the dependent and independent variables of the study. The list of sentences for BrP version can be found in Appendix M (target sentences), Appendix O (filler sentences) and Appendix Q (practice sentences). The list of sentences in English can be found in Appendix N (target sentences), Appendix P (filler sentences) and Appendix R (practice sentences). The programming codes for the SPR and IT are all available at GitHub.⁹

⁹ SPR for the BrP experiment: <https://github.com/deardiones/Self-Paced-Reading-BrP-L1-.git>
 SPR for the English experiment: <https://github.com/deardiones/Self-Paced-Reading-Eng-L1.git>
 SPR for the Bilingual experiment: <https://github.com/deardiones/Self-Paced-Reading-BrP-L1-Eng-L2-.git>

3.2.5 Interpretation Task

The IT was a Quantity Judgment Task (QJT) devised by Bezerra, Pires de Oliveira, Lopes, and Cardozo (in preparation) designed to capture the interpretation of sentences. Its use was combined with the SPR, that is, the participants read the sentences and right after pressing the spacebar after reading the last segment, the IT would appear. This instrument is based on Bale and Snedeker's (2005) QJT, and since it is a newly devised experiment, we will delve deeper into its underpinnings.

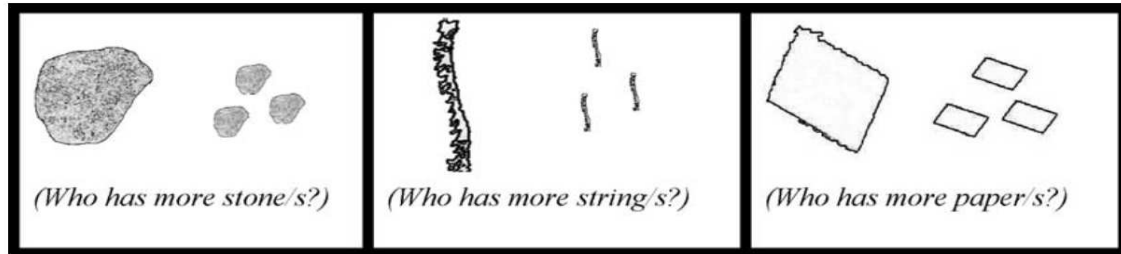
3.2.5.1 *The Quantity Judgment Task*

The QJT is an offline experimental tool used to investigate how speakers represent and interpret quantity sentences as a way to determine the meaning of words, particularly in relation to quantity, providing us access to language representation. In this task, a picture is presented depicting the noun under investigation along two contrasting dimensions. Participants are then asked the comparative question 'Who has more X?', where 'X' is replaced by the target noun phrase. The participant must select, from the provided images, the one that best corresponds to their interpretation of the noun.

Responses typically reflect either a cardinal-based interpretation — when participants choose the image with more individual items of smaller size (i.e., cardinality) — or a volume-based interpretation — when they choose the larger item, even if it appears only once, suggesting an interpretation based on volume or substance.

The Quantificational Judgment Task (QJT) is a canonical method in experimental linguistics used to assess speakers' semantic representations of nouns across languages. (BALE; SNEDEKER, 2005; BALE; BARNER, 2009; LIMA; GOMES, 2016; BEVILÁQUA; PIRES DE OLIVEIRA, 2017). Below, we present an example of a QJT trial as used by Bale and Snedeker (2005).

Figure 3.1 — Example of Quantity Judgment Task from Bale and Snedeker (2005)



Source: figure extracted from Bale and Snedeker (2005).

This instrument not only captures whether a noun phrase is interpreted in terms of volume or cardinality but also records response times and accuracy. This enables the investigation of both cross-linguistic semantic patterns and speakers' mental representations (BALE; SNEDEKER, 2005; BALE; BARNER, 2009; LIMA; GOMES, 2016; BEVILÁQUA; PIRES DE OLIVEIRA, 2017).

3.2.5.2 Critiques of the Quantity Judgment Task

While the QJT is a widely used and informative method for investigating the semantics of nouns, it is not without limitations. One key concern is that the stimuli can be ambiguous, particularly when both volume and count interpretations are visually plausible. In such cases, participants may rely on perceptual cues — such as the size or salience of objects — rather than on true semantic representation. Additionally, the task's forced-choice design may encourage the development of response strategies that do not necessarily reflect linguistic competence but rather performance under experimental pressure. Contextual flexibility also poses a challenge: many nouns are not strictly count or mass, and the binary nature of the QJT may oversimplify this gradient semantic phenomenon. Furthermore, participants' world knowledge and cultural expectations can influence how they interpret certain nouns or images, potentially introducing variability that is not due to grammar or semantics alone (BEVILÁQUA, 2020; LIMA, 2014). That is, the selection of one image against the other may be a result of the participant reflecting on two inputs: the linguistic one, composed by the nouns, and the other composed by the images.

Scontras, Davidson, Deal, Murray (2017) adapted the QJT in two experiments to investigate noun semantics in English. In the first, participants saw only visual stimuli with the question ‘Who has more?’ and showed variable interpretations based on cardinality or volume. In the second, they completed the questions ‘Who has more ____.’ and were asked to choose between the two images, yielding more categorical responses. The results suggest that linguistic form — specifically the presence of nouns — drives interpretation in QJTs, supporting the idea that English nouns are specified for atomicity. We have seen this study in depth in the previous chapter.

3.2.5.3 Overview of the Interpretation Task

Taking into consideration the discussion presented in the previous subsections, we devised the IT, inspired in the QJT, in order to avoid one of the key criticisms of the QJT which is the influence of the images on participant’s response. That is, in the IT, the linguistic input was the main source guiding participants response.

3.2.5.4 The Linguistic Input

Unlike the QJT, our study did not use a standard quantity question as ‘Who has more X?’ Instead, we employed sentences with quantifiers as exemplified below¹⁰:

29. a) The beautician ordered many tables in Dallas.
- b) The driver got much rainfall in Praga.
- c) The maid cleaned many horsehair in Dublin.
- d) The fireman found much ballon in Oslo.

As can be observed by the sentences, the nouns are the main driver of the interpretations in the following IT. After reading the sentence, the participant is asked the following standardized question “Which picture best represents your interpretation of the sentence that you have just read?” alongside with the visual stimuli.

¹⁰ The structure of the sentences — and their potential oddness — is due to their combination with the SPR, which required a strict syllable count, as well as to the replication of these sentences in BrP, where all versions are grammatical.

3.2.5.5 Visual Stimuli

The visual stimuli are the key element in our IT as it allows us to capture the interpretation of the sentence. The visual stimuli can be adapted according to the nature of the study as we will further discuss. The key element in the visual stimuli of the IT is the dimensional geometrical figures. The geometrical figures can be adapted accordingly to the purpose of the study below we present the following figure used in our target sentences:

Figure 3.2 — Example of the visual stimuli for the IT



Source: designed by Bezerra, Pires de Oliveira, Lopes, and Cardozo (in preparation).

After reading the sentence, the participant was presented with the figure shown above. They had two options: to click either on the large circular shape on the left, which represents a volume-based interpretation, or on the smaller individual circles on the right, which represent a cardinality-based interpretation.

At the onset of the IT, participants' response times were recorded up to the moment they clicked the "Next" button at the bottom of the screen. These response times provided us with a continuous variable, allowing us to infer whether participants experienced any difficulty in deciding which figure best represented the noun presented in the sentence, or whether they were activating prior knowledge and reasoning to inform their response. Additionally, their selection was also recorded, providing us with a categorical variable.

Due to the nature of IT, we can also design other geometrical figures to use as control conditions or as filler images. One filler example used in our experiment is the bars below:

Figure 3.3 — Example of the filler visual stimuli for the IT



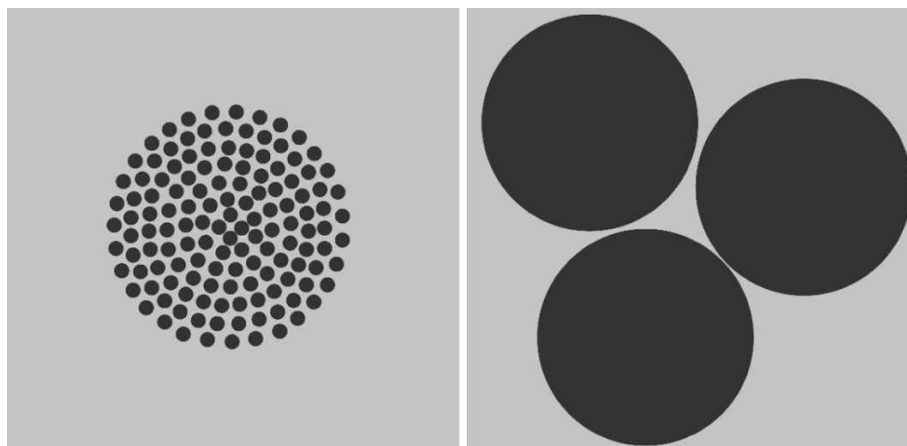
Source: designed by Bezerra, Pires de Oliveira, Lopes, and Cardozo (in preparation).

Although the figure above is for a filler item, it could also be used for investigating comparative structures, also gathering cardinality information and judging size/area for volume interpretations.

3.2.5.6 Initial Applications of the Interpretation Task

Lopes (2024) used an adapted version of the IT. In his study, the IT was also combined with a SPR which would be presented with sentences that would trigger the interpretation of the sentence. Additionally, the researcher applied a different standard question which was “Qual imagem é mais compatível com a sua interpretação para a sentença?” Figure 3.6 is from Lopes’ experiment:

Figure 3.4 — Example of Lopes (2024) visual stimuli for the IT



Source: figure extracted from Lopes (2024).

If the participant selected the left option, with smaller geometrical circles but a greater quantity, then the interpretation would be cardinality-based. However, if the participant selected the right option, with larger circular images, the participant's interpretation would be volume-based.

As we have seen, the IT appears to be a useful and flexible tool that can be adapted to the specific phenomenon under investigation — particularly at the interface between semantics and cognition — since it allows for integration with various experimental instruments. This makes it especially valuable for exploring how linguistic meaning interacts with cognitive processes such as categorization, inference, and decision-making. The following aspects that we will discuss in this subsection are also the main reasons on why we have decided to utilize such instrument.

Additionally, it is informative in terms of response times, providing a continuous variable useful for psycholinguistic research, and also in terms of answer types, as it allows us to capture polarized interpretations of nouns, whether they receive cardinal or volume-based interpretations, giving us information about the semantics of the nouns.

The images are relatively simple to design, as they require single-dimensional geometrical figures. These figures can be easily designed on any computer using common software such as Google Slides, Google Docs, Keynote, Pages, Word, or PowerPoint. Different quantity measurements can be easily adapted according to the purpose of the study. The figures used in the distractor items provided evidence in our study that the instrument worked since we were certain about the interpretation of the sentences.

Since the linguistic input is the main factor guiding participants' responses, the task allows us to minimize potential pragmatic influences that could favor one interpretation over another. Moreover, because participants are not required to identify a new image representing the noun in each trial, there is no delay in response time due to object recognition. That is, the geometrical figures remain constant throughout the experiment. As the linguistic input might trigger a mental image, participants do not need to identify the object in the IT. For example, if the sentence contains the word 'computer', this might trigger a mental image of a personal computer with a wired mouse, a tube monitor, a white color, and a wired keyboard. However, if the following task presents the participant with a black, flat-design laptop, it breaks the expectation and requires the participant to update their mental image of the object — thus taking a bit more time to decide whether their interpretation is based on cardinality or volume.

Finally, since geometrical figures represent the interpretation of the nouns, this allows the use of such a tool for any language, even for auditorial stimuli — especially indigenous languages — since it captures deeper semantic meaning that goes beyond visual input.

3.2.5.7 Summary

In our study, we used Figure 3.2 for 16 target items and 8 filler items, while the Figure 3.3 was used for 24 filler items. The list of target items was the same for the SPR since it was combined with this tool. The details regarding the presentation procedure for the experiment will be provided in Chapter V — *Experiments Regarding the Processing and Representation of Quantifier Phrases*, along with the dependent and independent variables of the study.

3.3 NORMING TASK AND PILOT STUDIES

The pilot study of the SPR was conducted with five native speakers of BrP, including language students, who completed the experimental task in BrP. This preliminary phase aimed to verify the clarity, naturalness, and overall feasibility of the stimuli and procedure. None of the participants reported any issues, including potential oddness or unnaturalness in the BrP sentence versions. Their feedback confirmed that the task was well understood and the materials appropriate, allowing the study to proceed without any adjustments for native BrP speakers and bilingual participants.

At the University of Toronto, the target sentences underwent a norming task designed to ensure the linguistic acceptability and naturalness of the stimuli in English. A native English speaker evaluated the sentences. The criteria focused on fluency, clarity, and cultural appropriateness. Based on this evaluation, several sentences required modification to improve their comprehensibility and naturalness before data collection could begin. The specific changes can be seen contrasting the Appendix M and Appendix N for the SPR. The norming task was also conducted for the AJT prior to data collection in English.

In parallel, a norming task was conducted in Canada with native speakers of BrP to confirm the suitability of the stimuli in that language variant for the AJT. The results indicated that no further revisions were necessary prior to data collection.

These norming and pilot studies were essential to ensure that the experimental materials were linguistically and culturally appropriate for all participant groups. By addressing potential issues before the main data collection, these preliminary steps strengthened the

reliability and validity of the experimental results. Any minor limitations identified during the pilot phase were carefully considered and did not affect the overall experimental design.

3.4 DATA ANALYSIS

In the following subsection, we discuss how the data were treated and the statistical analyses conducted.

3.4.1 Data Treatment

For both the AJT and SPR, the data treatment was conducted in RStudio. Data from response times and reading times all received five treatments from the original dataset. The first dataset corresponded to the quantifier region, the second to the noun region, the third to the post-critical region, the fourth to the IT answer type, and the fifth to the IT response time. Data processing was carried out five times for each dataset, meaning that each time a new region was analyzed, we applied a new filter to the data from the original dataset. Two additional datasets were analyzed with raw data: one to generate the processing times for the entire sentence, and another to gather information from the questionnaires.

During data filtering, we checked the raw data to check for distribution and normality. We considered the data to be well-distributed when the graph of the histogram visually formed a bell curve, with the data clusters concentrated near the center, representing the mean. The closer the clusters were to the center and the fewer they were at the edges, the more well-distributed the data should appear — a common method for assessing approximate normality (FIELD, 2018; GHASEMI; ZAHEDIAS, 2012; TABACHNICK; FIELD, 2019).

To achieve the aforementioned distribution, we proceeded to cut outliers based on the Interquartile Range (IQR) in which we measured statistical dispersion, calculating the difference between the Third Quartile (Q3) and the First Quartile (Q1). The equation for the IQR is $Q3 - Q1$. Two cuts were performed in all datasets. The first was the most conservative one with the range 3, and the second with the less conservative with the range 1.5.

If the data was not well distributed after performing the outlier's cut, we would then proceed to the Logarithmic Transformation (log) as our last resource to improve the distribution of the data. A log-transformation is a mathematical operation applied to data to stabilize variability and make the distribution more symmetric. It compresses larger values more than

smaller ones, making the data more manageable and often more suitable for analysis (BAAYEN, 2008; FIELD, 2018; LO; ANDREWS, 2015).

Additionally, we proceeded to check whether the data was normal considering the Shapiro-Wilk Test. For the data to be normal, the Shapiro-Wilk test should yield a p-value greater than 0.05, indicating that the null hypothesis of normality could not be rejected. Since linear models do not require the data to be normally distributed, we prioritized examining the distribution over assessing normality (FIELD, 2018; PINHEIRO; BATES, 2000; GELMAN; HILL, 2007). If the data appeared normal, it was merely a result of the underlying distribution.

3.4.2 Statistical Analysis

For the statistical analysis of the SPR and IT, we used Mass nouns [M] as our reference value for Noun alongside Plural quantifiers [P] for Quantifier while for the AJT we used singular [S] as our reference value for Number and Edible [E] for our reference value for Noun. Whenever a different reference value is used, it will be clearly stated in the text.

For the online measurements of the SPR and the response times of the IT, we used Linear Mixed Models (LMMs) fitted by Maximum Likelihood (ML), with t-tests computed using Satterthwaite's method. LMMs were chosen since our data included both fixed effects, determined by the experimental conditions, and random effects, associated with participants and items. This model type is well suited for analyzing data with repeated measures and hierarchical structures (BAAYEN, 2008; PINHEIRO, BATES, 2000). ML estimation was employed to estimate both fixed and random effects by maximizing the likelihood of the observed data. It is advantageous since it provides efficient parameter estimates, particularly in studies with small sample sizes (GELMAN; HILL, 2007). Additionally, Satterthwaite's method estimates degrees of freedom by accounting for random effects and correlations between observations — often adjusting for unequal variances — thereby producing more accurate p-values for hypothesis testing in mixed models (KUZNETSOVA; BROCKHOFF; CHRISTENSEN, 2017).

For the IT, we resorted on Generalized Linear Mixed Model (GLMM) fit by maximum likelihood with Laplace Approximation. A GLMM fit by maximum likelihood with Laplace approximation is used to analyze non-normal outcome data (e.g., binary responses) while accounting for random variability across participants and items (BOLKER, 2009; MCCULLOCH; NEUHAUS, 2005). The maximum likelihood method estimates model parameters that best explain the observed data, and the Laplace approximation provides a

computationally efficient and accurate way to handle the complex integration over random effects (BATES; MÄCHLER; BOLKER; WALKER, 2015).

For the acceptability scale, we used a Cumulative Link Mixed Model (CLMM) fitted with the Laplace approximation. CLMMs are used to analyze ordinal response data — data in which the outcome variable consists of ordered categories — while accounting for random effects. This applies to our acceptability scale, which uses ordered response categories (BOJEEN, 2019).

Thus, we conducted Analysis of Variance (ANOVA) in nested model's comparisons. In cases in which none of the models showed a significant improvement in model fit, we considered the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values to decide which model would be a better fit. While the differences in AIC and BIC are usually small and should be interpreted cautiously, the principal of parsimony states that among compelling hypothesis and explanations, we should choose the simplest one that adequately explains our data or phenomenon. Based on this principle, and accounting the AIC and BIC values, we would always resort on simpler models since they may offer a better balance between fit and complexity (AKAIKE, 1974; SCHWARTZ, 1978; BURNHAM; ANDERSON, 2002).

When an interaction was observed in the statistical analysis, we further explored the interaction by conducting pairwise comparisons. For this, we used the Bonferroni correction for multiple comparisons. This method adjusts the significance threshold by dividing the original alpha level ($\alpha = 0.05$) by the number of comparisons conducted, ensuring a more stringent criterion for significance (ARMSTRONG, 2014). While adjustments to the alpha level can help control the Family-Wise Error Rate (FWER), they can also increase Type II errors (false negatives), particularly when the number of comparisons is large or the sample size is limited (PERNEGER, 1998) — both of which were factors in our study. Given the nature of this study and the importance of identifying potential patterns, the significance level was maintained at $\alpha = 0.05$. Therefore, we acknowledge that the results should be interpreted with caution, recognizing the potential Type I error (false positive) rates due to multiple comparisons.

3.5 FINAL CONSIDERATIONS OF THE CHAPTER

This chapter has presented and discussed the instruments employed for data collection in this dissertation. It outlined the participant profiles and recruitment procedures, as well as the ethical considerations that guided the study. Furthermore, the chapter introduced the various instruments used to gather data, providing detailed descriptions of each tool. Pilot studies conducted to validate the materials were also described, along with an overview of the proposed data treatment and analysis procedures. Together, these elements establish a solid foundation for the empirical investigations presented in the following chapters.

4 CHAPTER IV — EXPERIMENTS ON THE ACCEPTABILITY OF BARE NOUNS

This chapter presents and discusses three experiments designed to investigate the acceptability of edible bare nouns in three different linguistic contexts: among native speakers of Brazilian Portuguese (BrP), native speakers of English, and BrP speakers who are learning English as a second language. In addition to these three core studies, the chapter also includes two group comparisons to explore cross-linguistic and bilingual differences more deeply.

Although each experiment is presented as an independent study with its own rationale, Research Questions (RQ), hypotheses, methods, data analysis, and discussion, it is important to emphasize that the overall methodological framework remains consistent throughout all three experiments. This consistency ensures that differences in results can be attributed more confidently to language and participant group rather than procedural variations.

Specifically, the experiment involving native speakers of BrP was conducted entirely in Brazilian Portuguese, reflecting the participants' first language. The experiment with native English speakers was conducted in English. The bilingual group — consisting of BrP speakers learning English — completed the experiment in English, aligning their testing language with their target language. Any language-specific adaptations or considerations pertinent to each experiment are detailed in the respective method sections. It is worth highlighting that in all Acceptability Judgment Task (AJT) experiments we used only count nouns in episodic sentences and as internal argument in object position.

By maintaining a uniform methodological approach across these experiments while varying the language context and participant profiles, this chapter aims to provide a comprehensive view of how edible and non-edible bare nouns are judged across different linguistic and bilingual populations. The following sections present each experiment in detail, followed by comparative analyses that elucidate the cross-linguistic patterns and bilingual processing effects observed.

4.1 EXPERIMENT 1 — ASSESSING THE ACCEPTABILITY OF EDIBLE BARE NOUNS IN BRAZILIAN PORTUGUESE

4.1.1 Introduction

The rationale for this experiment is based on a series of studies that will be discussed throughout this introduction. The literature about bare singular nouns in BrP shows that they are accepted. Many studies have explored bare singulars theoretically (see MUNN; SCHMITT, 1999, 2005; MÜLLER, 2000, 2002, 2003; FERREIRA, 2010, 2021), experimentally (see PIRES DE OLIVEIRA; SILVA; BRESSANE, 2010; BRAGA; SENA; MARIANO; PIRES DE OLIVEIRA, 2010), and experimentally across other languages (see IONIN; MONTRUL; SANTOS, 2011; IONIN; GROLLA, MONTRUL; SANTOS, 2014).

Bare singulars are characterized by the morphological absence of a determiner and the plural morphology. They can occur as external arguments, as in ‘Cachorro late’ (dog barks) in which the bare singular noun ‘cachorro’ (dog) fulfills the valency of the verb ‘late’ (barks) and as internal arguments, as in ‘Tem gato pra todo lado’ (there is cat all over the place), in which the bare singular noun ‘gato’ (cat) fills the internal valency of the existential verb ‘tem’ (there is) functioning as kind predicate (PIRES DE OLIVEIRA, 2025). Bare plurals are also accepted in these positions, with the difference that they are marked for plurality, such as in ‘Cachorros latem’ (dogs bark) in which the bare noun ‘cachorro’ (dog) comes pluralized. What is puzzling about this phenomenon is that BrP allows both bare singular and bare plurals, whereas other Romance languages, such as Spanish, allow only bare plurals in very restricted cases. Although in English edible bare singulars are interpreted in restricted edible contexts, bare singulars are generally ungrammatical. Bare plurals, on the other hand, are grammatical.

Edible nouns are predicates of things that we are able to eat, such as, apple, banana, chicken, and so on. In BrP, we can easily accept sentences like ‘João comprou pera importada’ (John bought imported peach) and ‘João comprou cerveja importada’ (John bought imported beer) in which ‘pera’ (peach) and ‘cerveja’ (beer) are in argument positions, in singular form, and without plural inflection. However, in English, they are possible, but their acceptability might be low in some sense. Processing studies as Frisson and Frazier (2005) showed that the processing of these nouns is hindered when edible bare singular nouns are in these positions, which might reflect low acceptability by native speakers of English. In the following we can take a look at the specific RQs that guide this experiment.

4.1.1.1 Specific Research Questions

RQ1. Are bare singular nouns accepted in internal argument position of episodic predicates in BrP?

RQ2. Is there a difference in acceptability of edible and non-edible nouns in BrP?

RQ3. Is there a difference in acceptability between plural and singular edible nouns in BrP?

RQ4. Are response times longer for edibles or non-edibles?

RQ5. Are response times longer for bare singulars or bare plurals?

4.1.1.2 Hypothesis (H) and Predictions (P) Regarding the Acceptability of Bare Singular Nouns in BrP

H0. There are no differences in acceptability judgments or response times between bare singular and bare plural nouns in BrP, regardless of whether the nouns are edible or non-edible.

P0. If the null H is true, acceptability judgments for bare singular and bare plural nouns in BrP should not differ across conditions, and response times should be similar for edible and non-edible nouns, showing no statistically significant differences.

H1. Following Ionin, Montrul, and Santos (2011) and Ionin, Grolla, Montrul, and Santos (2014), bare nouns are generally accepted in BrP, but their interpretation depends on the syntactic and semantic context. Evidence from Pires de Oliveira, Silva, and Bressane (2010) and Braga, Sena, Mariano, and Pires de Oliveira (2010) suggests that bare singulars differ in acceptability depending on noun type, with edible nouns being more acceptable than non-edible ones. Ionin, Grolla, and Santos (2018) further indicate that explicit

access to grammatical knowledge may reduce acceptability of bare singulars relative to bare plurals.

P1. Bare singulars are expected to be less acceptable than bare plurals, with non-edible bare singulars showing the lowest acceptability. Response times should reflect these differences, with non-edible bare singulars yielding the slowest judgments.

H2. An alternative hypothesis is that BrP does not allow bare singulars, but does allow bare plurals.

P2. Response times should increase for edible singulars and be even higher for non-edible singulars. Bare plurals, by contrast, should show high acceptability and faster response times.

In summary, we adopt Hypothesis 1 as our working hypothesis, as it suggests a difference in acceptability between bare singulars and bare plurals in BrP. This difference might be influenced by both the task itself and participants' grammatical knowledge. We also expect a difference between edible and non-edible nouns, with edible nouns likely receiving higher acceptability ratings than non-edibles. Furthermore, acceptability may be reflected in response times, with edible plurals being the fastest condition, and non-edible singulars the slowest. This pattern may indicate a degree of conscious linguistic reasoning on the part of the participants.

All materials used in this experiment, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub¹¹.

4.1.2 Method

4.1.2.1 Participants

A total of 62 voluntary native speakers of BrP took part in this experiment, with a mean age of 30.9 years ($SD = 11.8$). Of these participants, 7 reported having previously studied linguistics, while 56 had not. All participants took part on the study online in which they received the link to participate in the study through e-mail. Additionally, 2 participants

¹¹ Data analysis materials and raw results are available at <https://github.com/deardiones/AJT-BRPL1.git>

indicated in the questionnaire that BrP was not their first language, though they considered themselves Brazilians. We decided to remove these participants from the data analysis, resulting in a final total sample of 60 participants. Participants from the study were all voluntary, therefore, they did not receive any compensation for their participation in the study and took part in this experiment in BrP.

4.1.2.2 Instruments

The main instrument in this study was an AJT programmed in Penn Controller Ibex Farm (PCIbex), as discussed in the Method section. This experiment followed a 2x2 factorial design, in which we manipulated the independent variables: number (singular/plural) and noun type (edible/non-edible). In this study, all nouns under investigation were countable. The dependent variables were the acceptability judgment value (ordinal) and response time (in milliseconds). This resulted in a total of 4 lists with 16 target sentences, randomized with 32 distractor items in a within-subject design in which the singular nouns were the experimental while the plural nouns were the control ones. The set of experimental conditions for this study is presented below:

30. Experimental Condition: Edible Singular (E+S)

a) A aluna trouxe pera da feira.

Experimental Condition: Non-Edible Singular (U+S)

b) A aluna trouxe livro da feira.

Control Condition: Edible Plural (E+P)

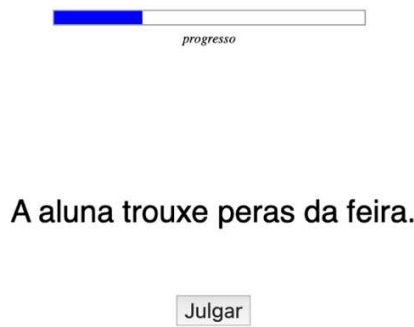
c) A aluna trouxe peras da feira.

Control Condition: Non-Edible Plural (U+P)

d) A aluna trouxe livros da feira.

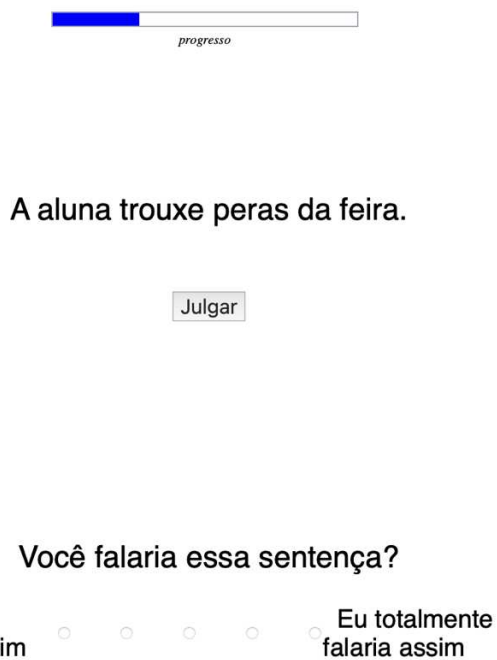
Each sentence was displayed alone, without the scale, but with a “Julgar” button below. After reading the sentence, the participant had to click on the button for the Likert scale with five points to appear with a “Próximo” button below. At the onset of the scale, up to the point the participant clicked on the “Next” button, the response time was recorded. Figures 4.1 and 4.2 display an example on how the sentences and scale appeared on the screen for the participant:

Figure 4.1 — Sentence display



Source: designed by the researchers and extracted from the experiment at PCIBex.

Figure 4.2 — Scale display



Source: designed by the researchers and extracted from the experiment at PCIBex.

The scale would include information only at the extreme points, such as “Eu jamais falaria assim” and “Eu totalmente falaria assim”, indicating the chance of the participant utter sentences as the ones displayed in the experiment.

Additionally, we introduce the concept of *speakability*. In our experiments, participants were asked to judge how likely they were to say each sentence, using a 5-point Likert scale. They were instructed to click on a point on the scale indicating whether or not they

would naturally say the sentence in everyday conversation. If they believed the sentence was something they would utter in a normal context, they gave it a higher rating; if not, they gave it a lower one. Although the task was an acceptability task, we believed this type of question would prompt participants to imagine themselves using the sentence in language use situations. Next, we move to the predictions of this experiment.

4.1.2.3 Predictions

We present Table 4.1 below, which summarizes the predictions for the acceptability of the investigated sentences and the response time for each condition of this experiment.

Table 4.1 — Predictions for acceptability and response time for each condition

Condition	Speakability	Response Time
Edible + Singular	4 to 5	Fast
Non-edible + Singular	3 to 4	Slower
Edible + Plural	4 to 5	Fast
Non-edible + Plural	4 to 5	Fast

Source: designed by the researchers.

Although all forms of bare nouns under investigation are accepted in BrP, as proposed by Hypothesis 1, there should be an interference of linguistic awareness that might be triggered by the task influence. That is, participants might notice the absence of morphological inflection in non-edible bare singulars since they are exposed to non-edible bare plurals as well, therefore rating them lower than the other conditions, generating longer response times, when compared to the other three conditions. In this way, the current study is characterized as a control group to observe possible differences that might emerge when we compare to other speaking groups.

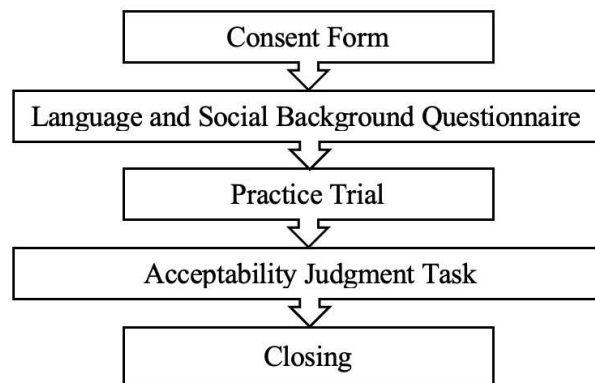
4.1.2.3 Procedures

Each participant voluntarily contacted the researcher by e-mail, signaling their willingness to take part in the study. In the first e-mail, the researcher asked if s/he were 18 years old or above and if they spoke English as a second language. If they did not speak English, they would receive the link to take the AJT in the following e-mail. If the participant were a second language speaker of English, in the following email, s/he would receive a leveling task

from the Cambridge Website and they would be instructed to send a print of their result to the researcher by email. If the level fell between A1, A2, C1, or C2, the participant took the test in BrP. If the level fell between B1 and B2, the participant was invited to take the task in English. The English task will be reported in Experiment 2 section.

After the leveling task, the participant received a link from PCIBex in which the study would occur. Upon clicking the link, the following sequence of the study was presented to them:

Flowchart 4.1 — Presentation order



Source: designed by the researchers.

The first prompt on the laptop screen was the *Termo de Consentimento Livre e Esclarecido* TCLE (Appendix C). After that, a brief instruction screen prepared participants for the upcoming Language and Social Background Questionnaire (Appendix E). As participants selected options on the questionnaire, the next question appeared automatically. After completing the nine questions, participants were presented with the task instructions.

The first eight trials served as practice trials (Appendix K), allowing participants to become familiar with the AJT experiment. After the practice phase, the final instructions were given, followed by 48 trials with 16 being experimental (Appendix G) and 32 distractors (Appendix I).

Upon completing the task, participants saw a thank-you screen, which also provided final instructions on how to save their data. Additionally, participants were shown their participant number, which had been randomly generated by the platform at the beginning of their session.

4.1.2.4 Data Analysis

Data processing and analysis were all conducted in RStudio.

4.1.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon.

We assumed a Cohen's *d* of 0.8 for small groups where a large effect is expected. After adjusting the alpha level to 0.05 and using a sample size of 60, the resulting power was 0.9914811. Thus, we interpret this result as indicating that 99.1% of the outcomes are expected to represent the phenomenon investigated.

4.1.3 Acceptability Judgment Task

The AJT is our main instrument for investigating the acceptability of bare nouns. In the next subsection, we present how the data was processed, along with the statistical analysis.

4.1.3.1 Data Filtering

We began adding two additional columns in the results. One column was called Judgment feed by the Likert scale. That is, the number 1 in the scale was named "Totally Unspeakable", number 2 was named "Unspeakable", number 3 was named "Neutral", number 4 was named "Speakable", and number 5 was named "Totally Speakable". The second column was added for the Number variable that was feed by the Condition column. That is, the condition edible plural and non-edible plural feed the Number column with the [P] label, representing the plural condition, while the edible singular and non-edible singular feed the column with the [S] label, representing the singular condition. This had to be done manually since the original file with the target items did not include such column.

After that, two participants were removed from the study, as they reported not being native speakers of BrP in the questionnaires. Apart from removing these two participants, no

one else was excluded from the study; that is, no outliers were removed from the AJT. Below, we present the mean and standard deviation for each condition, based on the scale ratings.

Table 4.2 — Means and standard deviation for each condition

Condition	Mean	Standard Deviation
Edible + Singular	4.125000	1.231134
Non-edible + Singular	3.325000	1.487254
Edible + Plural	4.383333	1.020159
Non-edible + Plural	4.366667	1.077991

Source: designed by the researchers.

The table above displays the mean ratings and standard deviations provided by participants for each condition. There is a tendency for edible bare plurals and non-edible bare plurals to be equally well accepted, alongside edible bare singulars. However, the acceptability of non-edible bare singular nouns is lower than the other three conditions, although there is a slight positive tendency toward their acceptance. Additionally, we observe more variation in this condition, as reflected in the standard deviation values, indicating uncertainty regarding the acceptability of non-edible bare singulars. Next, we present two additional tables with the means for each variable from the study:

Table 4.3 — Means for the variable Noun

Noun	Value
Edible	4.254167
Non-Edible	3.845833

Source: designed by the researchers.

Table 4.4 — Means for the variable Number

Number	Value
Plural	4.375
Singular	3.725

Source: designed by the researchers.

In general, edible nouns are accepted while non-edible nouns show a neutral acceptance with a tendency of being accepted. In addition, bare plurals are more accepted than

bare singulars. Now, we present the chances of bare singular being uttered in each condition in terms of speakability in percentage:

Table 4.5 — Percentage of speakability per condition

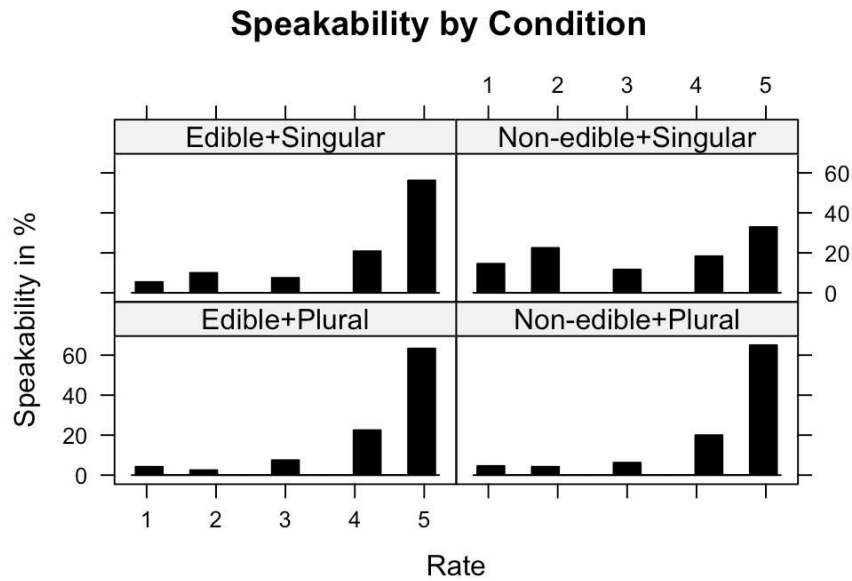
Condition	Totally Unspeakable	Unspeakable	Neutral	Speakable	Totally Speakable
Edible + Singular	5.4%	10%	7.5%	20.8%	56.3%
Non-edible + Singular	14.6%	22.5%	11.7%	18.3%	32.9%
Edible + Plural	4.2%	2.5%	7.5%	22.5%	63.3%
Non-edible + Plural	4.6%	4.1%	6.3%	20%	65%

Source: designed by the researchers.

The table above shows that more than half of the participants judged edible bare singulars as totally speakable 56.3% or speakable 20.8%. Taken together, these percentages indicate that edible bare singular nouns are 77.1% acceptable in BrP, while 15.4% of participants did not consider the structure acceptable. Non-edible bare singulars were judged as totally speakable by 32.9% of participants and as speakable by 18.3%, resulting in a 51.2% acceptance rate. In contrast, 37.1% of participants did not view this structure as part of their language.

When examining bare plurals, edible bare plurals were rated as totally speakable by 63.3% of participants and as speakable by 22.5%, resulting in an overall acceptability rate of 85.8%, with only 6.7% finding them unacceptable. Non-edible bare plurals were judged as totally speakable by 65% and as speakable by 20%, totaling 85% acceptability, while 8.7% considered them unacceptable. Below, we present the first graph which illustrates the rate of speakability per condition.

Graph 4.1 — Speakability per condition in percentages



Source: designed by the researchers on RStudio.

By observing the graph data, we can identify the distribution of the judgments across each condition. Visually, we can observe that the condition with a non-edible noun in its singular form has most variation regarding their acceptability, while the other conditions are close to more categorical rating. This behaviour might be in line with our prediction that the presence of bare plurals in the task might be influencing rating of non-edible bare singulars. Thus, the plural inflection seems to be insensitive to edibility. In the next subsection, we present the statistical analysis regarding the acceptability of bare nouns in BrP.

4.1.3.2 Statistical Analysis

The statistical analysis was also conducted on RStudio and we used a Cumulative Link Mixed Model fitted with LaPlace approximation, which is mostly used for ordinal response data for Likert scale studies. In addition, we used the [S] Singular as our reference value for the Number variable, [E] Edible as our reference value for the Noun variable, and [E+S] Edible + Singular as our reference value for condition.

A Cumulative Link Mixed Model (CLMM) was fitted using the Laplace approximation to examine the effect of Noun and Number on Judgment Value. The model included random intercepts for Participants and Items. The model used can be seen below:

```

model1 <- clmm (Value ~ Noun * Number + (1 | Participant) + (1
| Item), data = dataajt1)

model2 <- clmm (Value ~ Noun + Number + (1 | Participant) + (1
| Item), data = dataajt1)

```

To assess whether the interaction between Noun and Number significantly improved model fit, we compared a model 1 with the interaction to model 2 with only the main effects using a likelihood ratio test. The comparison revealed that including the interaction significantly improved the model fit ($\chi^2 = 34.95$, $p < 0.001$). This suggests that the effect of Number on acceptability ratings depends on the type of Noun, supporting the presence of an interaction between these two factors. The model's results can be checked below:

Table 4.6 — Model's results

<i>Predictors</i>	Value		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Noun [U]	0.20	0.14 – 0.29	<0.001
Number [P]	1.65	1.11 – 2.47	0.014
Noun [U] × Number [P]	5.45	3.08 – 9.63	<0.001
Random Effects			
σ^2	3.29		
τ_{00} Participant	2.02		
τ_{00} Item	1.12		
ICC	0.49		
$N_{\text{Participant}}$	60		
N_{Item}	16		
Observations	960		
Marginal R^2 / Conditional R^2	0.108 / 0.544		

Source: designed by the researchers on RStudio.

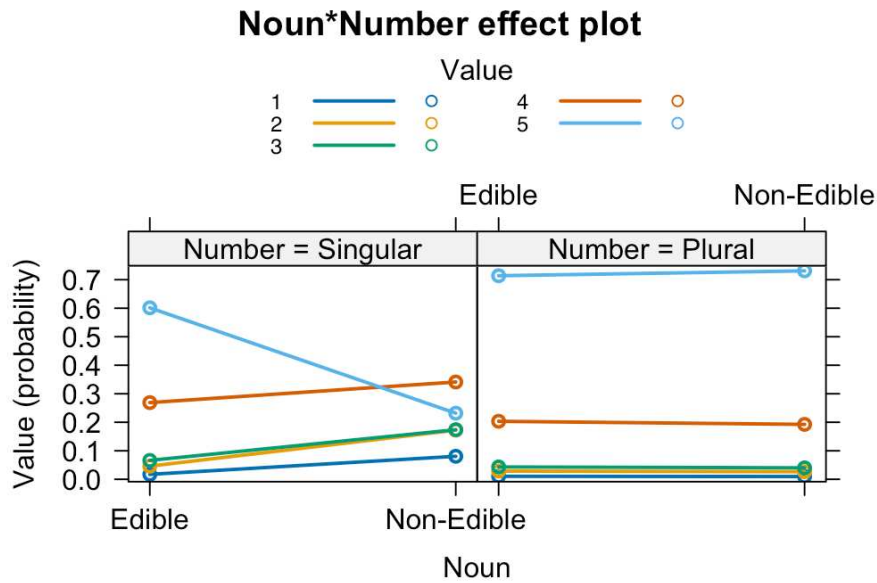
The model's results highlights that besides the interaction effects between Noun and Number, there were also main effects for Noun ($\beta = -1.61$, $SE = 0.20$, $z = -8.22$, $p < 0.001$) indicating that non-edible nouns were rated as less acceptable than edible noun, and also a

significant main effect for Number ($\beta = 0.50$, $SE = 0.20$, $z = 2.47$, $p < 0.014$) showing that plural forms were rated more acceptable than singular forms across conditions. A Bonferroni correction was carried out to further explore the interaction between Noun and Number and can be checked below:

contrast	estimate	SE	df	z.ratio	p.value
E S - U S	1.6096	0.196	Inf	8.223	<.0001
E S - E P	-0.5031	0.204	Inf	-2.466	0.0821
E S - U P	-0.5886	0.204	Inf	-2.882	0.0237
U S - E P	-2.1127	0.208	Inf	-10.164	<.0001
U S - U P	-2.1982	0.211	Inf	-10.430	<.0001
E P - U P	-0.0855	0.212	Inf	-0.404	1.0000

Pairwise contrasts among the four conditions revealed several significant differences. The comparison between Edible + Singular (E+S) and Non-Edible + Singular (U+S) was significant ($\beta = 1.61$, $SE = 0.20$, $z = 8.22$, $p < .0001$), indicating that edible singular nouns were rated as more acceptable than non-edible singular nouns. Additionally, the comparison between Non-Edible + Singular (U+S) and Non-Edible + Plural (U+P) revealed a significant effect of number ($\beta = -2.20$, $SE = 0.21$, $z = -10.43$, $p < .0001$), showing that non-edible nouns received higher acceptability ratings when presented in the plural form compared to the singular form. The other pairwise comparisons either did not reach statistical significance or were not theoretically relevant. Next, we present graph 4.2 with the probability of getting higher ratings for each condition.

Graph 4.2 — Probability of getting higher rating by condition

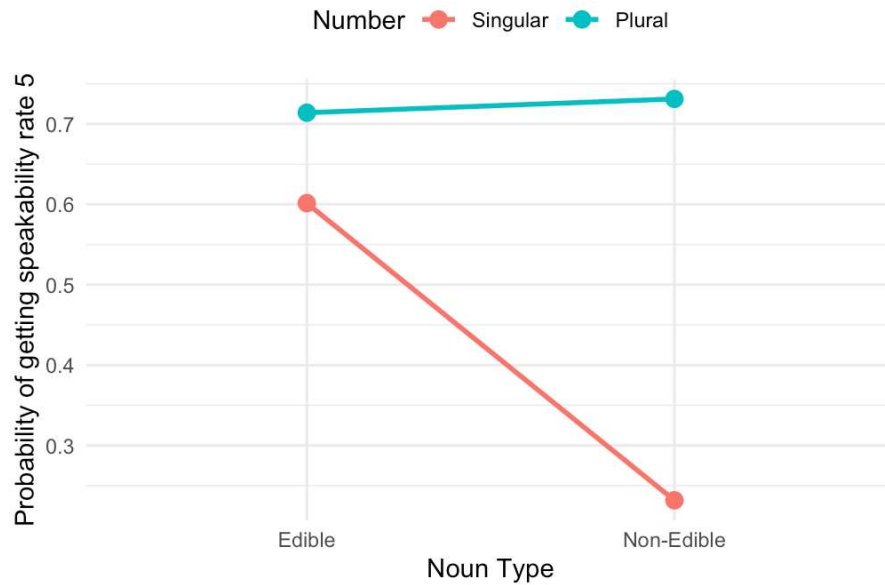


Source: designed by the researchers on RStudio.

The graph visually displays the values predicted by the model, showing how the acceptability of the nouns, as measured by response probabilities, varies according to both Number (singular and plural) and Noun Type (edible and non-edible).

In singular condition, there is a marked distinction between edible and non-edible nouns, particularly for value 5, which shows a high probability for edible noun but sharp decrease for non-edible ones of being spoken. This suggests that participants were more sensitive to the edibility distinction when judging singular nouns. In contrast, the plural condition, responses were more uniform with value 5 remained consistently across both edible and non-edible categories, while all other responses value were relatively infrequent and flat. This pattern indicates a possible default presence for value 5 in plural contexts, suggesting that plurality may reduce sensitivity to fine-grained semantic distinctions such as edibility in the context of our study. In order to better explore the interaction effect from the model, we plotted an additional graph isolating the rate 5, since it appears to be more informative. The graph can be checked below:

Graph 4.3 — Probability of getting rating 5 for each condition



Source: designed by the researchers on RStudio.

This graph shows the probability of receiving a speakability rating of 5 as a function of Noun type and Number. For singular nouns, there is a strong effect of noun type: edible nouns have a noticeably higher probability of being rated as highly speakable compared to non-edible nouns. In contrast, for plural nouns, the probability of receiving a speakability rating of 5 remains consistently high across both edible and non-edible categories, with only a slight increase for non-edibles. This suggests that noun type plays an important role when nouns are singular, but that plural nouns are judged highly speakable regardless of their semantic category. The interaction indicates that plurality may neutralize sensitivity to semantic distinctions like edibility when participants evaluate noun speakability. Next, we present the response time.

4.1.4 Response Time Analysis

The response time in the AJT allows us to infer aspects of language acceptability after processing, as it indicates the time taken by participants to determine whether the sentences they have read are speakable or not, a conscious decision. This data may enhance our understanding of BrP and the acceptability of the edible and non-edible bare nouns.

4.1.4.1 Data Filtering

The data treatment was divided into two parts. In the first phase, we removed two non-native speakers of BrP and added the two columns as we did for the AJT. Next, we isolated the necessary information from the raw table extracted from PCIBex. This information included: participant, group, label, item, condition, number, noun, Time One (T1), Time Two (T2), and Response Time (RT). T1 was the onset of the Likert scale display, up to the point of the participant clicked on “Próximo” and the RT was the time that the participant took to make his/her decision.

In the second phase, we checked the filtered data to check for distribution and normality. We considered the data to be well-distributed when the graph visually formed a bell curve, with the data clusters concentrated near the center, representing the mean. The closer the clusters were to the center and the fewer they were at the edges, the more well-distributed the data appeared. Thus, we considered the data to be normal if the Shapiro-Wilk Test yielded a p-value greater than 0.05, indicating that the null hypothesis of normality could not be rejected. Since linear models do not require the data to be normally distributed, we prioritized examining the distribution over assessing normality. If the data appeared normal, it was merely a result of the underlying distribution.

The filtered data did not meet the criteria for neither for normality nor distribution. Therefore, the first treatment was done with the interquartile range (IQR)¹² in which we measured statistical dispersion, calculating the difference between the third quartile (Q3) and the first quartile (Q1) with the first treatment with a more conservative range 3 resulting in an upper limit of 12468. After checking the distribution and the normality tests, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 8431.5. After reviewing the graphs and conducting normality tests, we concluded that the data still did not follow a normal distribution, nor was it normal according to the tests. We then proceeded with a logarithmic transformation. A logarithmic transformation (log) is a mathematical operation applied to data to stabilize variability and make the distribution more symmetric. It compresses larger values more than smaller ones, making the data more manageable and often more suitable for analysis. Following the transformation, the data distribution improved, but the data was still not normal (Shapiro-Wilk: $W = 0.97792$, $p\text{-value} = 2.25e-10$)¹³. In this way, we decided to keep with the log transformed data,

¹² The equation for the IQR is $Q3 + X*(Q3 - Q1)$

¹³ Kolmogorov-Smirnov: $D = 0.057039$, $p\text{-value} = 3.163e-07$

prioritizing the distribution. Removing the outliers from the sample resulted in 892 observations from the original 960, a reduction of 68 observations, representing 7.08% of the sample. The condition that lost the most data was edible + plural, with 19 data points lost, followed by edible + singular and non-edible + plural, which both lost 17 data points. The conditions that preserved more data were non-edible + singular, losing 15 data points. After this treatment, we plotted the table with the means and standard deviations in milliseconds, which can be reviewed above for each condition:

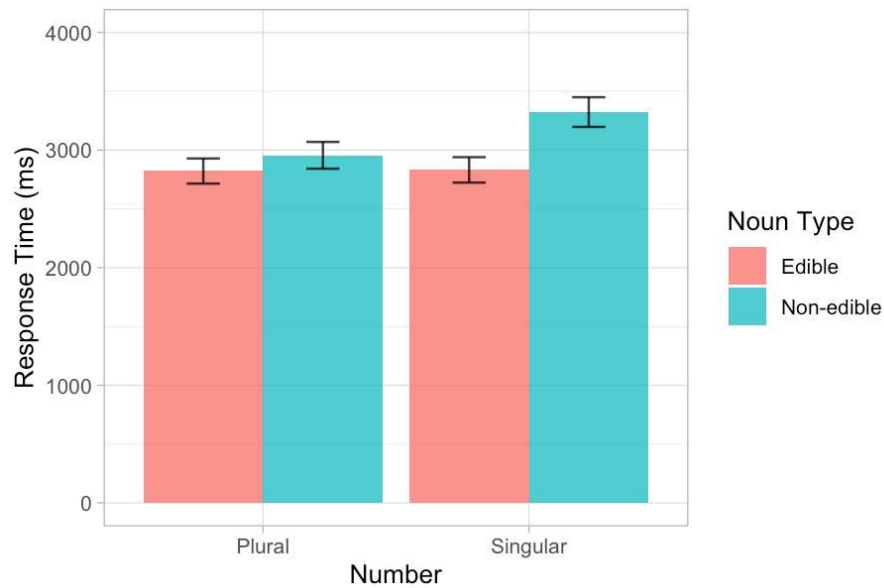
Table 4.7 — Treated means and standard deviation for each experimental condition in the response time in milliseconds

Condition	Mean	Standard Deviation
Edible + Singular	2831.744	1615.497
Non-edible + Singular	3323.480	1889.324
Edible + Plural	2821.882	1588.054
Non-edible + Plural	2955.673	1699.012

Source: designed by the researchers.

By checking the table above, we can observe that the means in the conditions are quite close, with the fastest being the Edible + Plural being 133.791 milliseconds faster than the Non-Edible + Plural condition, while the Edible + Singular condition is 491.736 milliseconds faster than the Non-Edible + Singular condition, being the slowest condition in terms of response time. Additionally, this latter condition also shows that there was more variation in response times as observed by the standard deviation. After that, we plotted the first graph in which the means and standard deviation of the response time are visualized. The graph is available below:

Graph 4.4 — Response time means and standard deviation in milliseconds



Source: designed by the researchers on RStudio.

Based on the above graph, we can observe that the non-edible singular condition seems to stand out as triggering the slowest response times, this reflects the acceptability patterns observed in the previous section. Although it is neutral to acceptable, the pattern reflects that participants were facing some doubt while judging the sentences. The plural forms have few differences between them, indicating that little difference is found in response times between edible and non-edibles, but there is a clear difference between edibles and non-edible singulars, with the latter triggering lower response times. We will check that in the Statistical Analysis subsection.

Finally, we checked the residuals for normality (Shapiro-Wilk: $W = 0.97901$, $p\text{-value} = 4.971e-10$)¹⁴ which shows that the data is not normal. Additionally, we checked distribution, which signaled that somewhat the data was well distributed. Next, we move to the statistical analysis.

4.1.4.2 Statistical Analysis

The statistical analysis was conducted in RStudio, where we used a linear mixed model fit by maximum likelihood to account for both fixed and random effects across groups. Additionally, a t-test using Satterthwaite's method was applied to compare the means between

¹⁴ Kolmogorov-Smirnov: $D = 0.060973$, $p\text{-value} = 2.576e-08$

two groups and determine if they were significantly different from each other. In addition, we kept using the [S] Singular as our reference value for the Number variable, [E] Edible) as our reference value for the Noun variable. Next, we can check the models used for response time:

```
model1 <- lmer (log ~ Number * Noun + (1|Participant) +
  (1|Item), data = datart, REML = FALSE)
```

```
model2 <- lmer (log ~ Number + Noun + (1|Participant) +
  (1|Item), data = datart, REML = FALSE)
```

```
model3 <- lmer (log ~ Number + (1|Participant) + (1|Item), data
  = datart, REML = FALSE)
```

```
model4 <- lmer (log ~ Noun + (1|Participant) + (1|Item), data
  = datart, REML = FALSE)
```

Using the logarithm of response time as a dependent variable, we fitted a mixed linear model with Noun, Number, and the interaction between these two factors as fixed effects, alongside random intercepts for each participant and item. A comparison of nested models with ANOVA indicated that neither the interaction between Noun and Number and including the two independent variables without the interaction showed an improvement in model fit ($\chi^2 = 2.4014$, $p = 0.121$). However, including only Number alone ($\chi^2 = 9.893$, $p < 0.007$) showed an improvement in fit and including only the Noun also showed an improvement in fit in the limit of significance ($\chi^2 = 1330.2$, $p < 0.057$). Therefore, the best-fitting model included only the Number as a fixed effect. The model's result can be checked below:

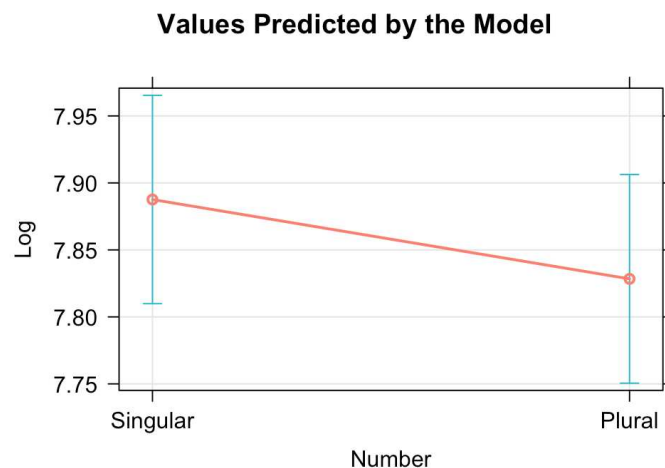
Table 4.8 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.89	7.81 – 7.97	<0.001
Number [P]	-0.06	-0.12 – 0.00	0.070
Random Effects			
σ^2	0.24		
τ_{00} Participant	0.05		
τ_{00} Item	0.00		
ICC	0.19		
N _{Participant}	60		
N _{Item}	16		
Observations	892		
Marginal R ² / Conditional R ²	0.003 / 0.197		

Source: designed by the researchers on RStudio.

This table presents the results of a mixed-effects regression model predicting log-transformed response times based on number, contrasting singular and plural items. The coefficient for number indicates that response times were lower for plural nouns, meaning that participants responded faster to plural nouns than for singular nouns. This suggests that judgments involving bare plurals were easier for participants to make than those involving bare singulars, revealing a marginal effect of number on response times. Below we can check the values predicted by the model:

Graph 4.5 — Values predicted by the model for the response time in log



Source: designed by the researchers on RStudio.

This graph visually displays the data from the model's results. It shows that nouns that were singular have higher log values when compared to pluralized nouns, indicating that singular nouns have increased response than plurals. Therefore, number (singular and plural, in this case) is a predictor for response times. It is important to highlight that there was not an effect between edible singular and non-edible singular, therefore, not having an effect for noun. Next, move forward for the general discussion of the results.

4.1.5 Summary of Key Findings from Experiment 1

The table below provides an overview of the data collected for Experiment 1.

Table 4.9 — Summary of key findings from experiment 1 (BrPL1)

Number	Noun	Mean Rate	Percentage	Probability	Response Time
Bare Singular	Edible	4.1	77.1%	Higher probability between Edibles	Marginally slower
	Non-Edible	3.3	52.2%	Low probability between Edibles	Marginally slower
Bare Plural	Edible	4.3	85.8%	Low probability between Non-Edibles	=
	Non-Edible	4.3	85%	High probability between Non-Edibles	=

Source: designed by the researchers.

Observations: The symbols mean: (=) we did not find statistical effect; (+) we found statistically significant effect indicating higher probability of receiving higher judgment values. When it comes to edibility, singular edibles have higher probability of receiving higher judgment values than non-edible singular, while non-edible plural nouns have higher probabilities of receiving higher judgment values than edible plurals. Singular nouns are generally marginally slower than plural ones ($p < 0.07$).

- There was an interaction between noun type and number in the AJT;

- Post hoc analysis revealed that edible singulars have higher probability of getting high acceptability ratings when compared to non-edible singulars — that is, only when the variable Number was singular;
- Post hoc also revealed that the effect for number, with non-edible plurals receiving higher acceptability ratings than non-edible singular;
- In response times, the level of the variable Number had a marginal effect. That is, the plural forms were responsible on triggering marginally faster response times when compared to singular forms. In other words, although it has more morphology, it makes it easier to interpret.

4.1.6 General Discussion

The results of this experiment are quite clear: edible bare singular nouns are acceptable in BrP in object position, which is consistent with the literature, with an acceptability percentage of 77.1%. Additionally, non-edible bare singular nouns are also acceptable, but they are less accepted than edible nouns, with an acceptability percentage of 51.2% with a rejection rate of 37,1%.

These results are consistent with previous studies on acceptability by Pires de Oliveira, Silva, and Bressane (2010), and Braga, Sena, Mariano, and Pires de Oliveira (2010). The study by Braga et al. (2010) included bare singulars as individuating predicates in external arguments in generic sentences. The overall acceptability rate of bare singular count nouns in their study was 38%, with a rejection rate of 48%. In the study by Pires de Oliveira et al. (2010), they included episodic sentences and sentences with kind predicates, which had an acceptability rate of 43%, while 38% of participants did not consider bare singulars natural in their language. This might indicate that bare singulars are gradually gaining ground in BrP, as suggested by Pires de Oliveira et al. (2010), who argue that we may be witnessing a linguistic change. However, this claim should be interpreted with caution, since Pires de Oliveira et al. (2010) and the present study employed different judgment scales and examined distinct linguistic phenomena. Our study included episodic sentences in which bare singular nouns appeared in argument position as internal arguments. For a more robust conclusion, a replication of Pires de Oliveira et al.'s study would be necessary.

Overall, the results indicate that bare singular edible nouns are readily accepted in internal argument positions in BrP. Additionally, our acceptability task revealed differences between edible and non-edible nouns, as well as between bare singulars and bare plurals in BrP. These differences were statistically significant for the acceptability task.

Although not all effects reached statistical significance in our tests, the response time data captured further nuance. Specifically, participants took longer to rate non-edible bare singulars, suggesting greater indecision when choosing a point on the scale. This additional response time may reflect participants' reasoning about what structure they should assign grammaticality, and possibly a reflection on whether the sentence should include plural inflection, as was evident in the bare plural sentences. This marginal effect might have to do with underspecification that although it facilitates early processing commitments, it can result in delayed processing costs that might be captured in the response times.

With these reasoning in mind, we retake our hypothesis. The results refute our Null Hypothesis, but partially not refute our Hypothesis 1. Several reasons support our Hypothesis 1. Our study brings additional support to the literature which shows that bare singulars are accepted in BrP. In addition, we also observed a difference between non-edible bare singular and non-edible bare plurals, that might be due to conscious access to grammatical knowledge since the explicit access to bare plurals and bare singulars might hinder acceptability of bare singulars over bare plurals, as already observed in Ionin, Grolla, and Santos (2018) study. Our working hypothesis gets weaker as we observe response times since we did not get enough statistical power to claim that non-edible bare singular nouns have higher response times. Although marginal, we found effect for number, with pluralized bare nouns triggering faster response times than singular ones. Although pluralized nouns have more morphology, the presence of the plural inflection makes it easier to interpret.

While the literature in BrP consistently claims that bare singulars are grammatical, our study provides novel and refined results about this phenomenon as it presents a clear investigation between edible and non-edible count nouns as a variable, while singular and plural is another variable. Additionally, to our knowledge, it is the first to combine an AJT with response time for BrP, providing a quantitative psycholinguistic depth to our results. Next, we retake our RQs and answer them in light of the results of our study.

RQ1. Are bare singular nouns accepted in internal argument position of episodic predicates in BrP? *Yes, they are and it is statistically significant.*

Bare singular nouns are accepted as internal arguments of episodic predicates in BrP.

RQ2. Is there a difference in acceptability of edible and non-edible nouns in BrP? *Yes, there is. Edible bare singular nouns have higher acceptability rates than non-edible bare singular nouns. For bare plurals, there is not a difference between edible and non-edibles. Plurality is insensible to this distinction.*

RQ3. Is there a difference in acceptability between plural and singular edible nouns in BrP? *Yes, there is only when we compare singular and plural non-edible nouns. Although both are accepted, non-edible plurals receive higher acceptability judgment values when compared to non-edibles singulars.*

RQ4. Are response times longer for edibles or non-edibles? *Although the statistical results did not reach significance, there was a tendency of edible bare singulars receive faster ratings in response times than non-edible bare singulars.*

RQ5. Are response times longer for bare singulars or bare plurals? *Although the statistical analysis did not provide significance, bare plurals received faster rating times.*

To conclude, we retake our predictions' table, contrasting with our results. Note that, despite the lack of statistical significance for response times, we chose to include the observed trend in the table to illustrate the data pattern.

Table 4.10 — Predictions vs results for acceptability and response time for each condition

Condition	Speakability	Speakability	Response Time	Response Time
	<i>Prediction</i>	<i>Results</i>	<i>Prediction</i>	<i>Results</i>
Edible + Singular	4 to 5	4.1	Fast	Fast
Non-edible + Singular	3 to 4	3.3	Slower	Slower
Edible + Plural	4 to 5	4.3	Fast	Fast
Non-edible + Plural	4 to 5	4.3	Fast	Fast

Source: designed by the researchers.

4.1.7 Conclusion

The results of this study provide evidence that bare singular nouns are accepted as internal arguments of episodic predicates in BrP, confirming the acceptability of these structures. Moreover, acceptability judgments reveal a nuanced pattern regarding noun type and number. Specifically, edible bare singular nouns receive higher acceptability judgments than non-edible bare singular nouns, indicating that semantic properties influence judgments in the singular form. In contrast, for bare plurals, acceptability does not differ between edible and non-edible nouns, suggesting that plurality neutralizes this semantic distinction. Interestingly, while both singular and plural non-edible nouns are accepted, non-edible plurals receive higher acceptability ratings compared to their singular counterparts. Regarding response time, differences did not reach statistical significance with trends suggesting that edible bare singular nouns tend to be rated more quickly than non-edibles, and bare plurals tend to receive faster ratings than bare singulars.

4.2 EXPERIMENT 2 — ASSESSING THE ACCEPTABILITY OF EDIBLE BARE NOUNS IN ENGLISH

4.2.1 Introduction

The literature about bare nouns in English shows that there is only one type of bare nouns accepted and they are the bare plurals (IONIN; MONTRUL; SANTOS, 2011; IONIN; GROLLA; MONTRUL; SANTOS, 2014; BEVILÁQUA; PIRES DE OLIVEIRA, 2021). Bare singular nouns are not accepted in English in argument position. Usually when they appear in this position, such as in ‘there is apple in the salad’ they are interpreted as mass through a coercion process. Edible nouns are somewhat accepted, but they undertake a semantic process which overload the system in terms of processing in order to save the derivation of these nouns. This cognitive load is a result of coercion, as seen in Frisson and Frazier (2005) and indicates the ungrammaticality of edible bare nouns due to the additional processing for the nouns.

In English, sentences like ‘Yesterday, John wanted imported pear after the rich main course. His girlfriend didn’t want anything’ and ‘Yesterday, John wanted imported beer after the rich main course. His girlfriend didn’t want anything’ from Frisson and Frazier (2005) are possible, but their acceptability might be low in some sense. Processing studies, such as those by Frisson and Frazier, showed that the processing of these nouns is hindered when edible bare singular nouns appear in these positions, which might reflect low acceptability by native speakers of English.

With these reasoning in mind, and considering that bare singular nouns are not accepted in English, the current experiment serves as a control group to compare sentences with edible and non-edible bare nouns across native BrP speakers and intermediate learners of English who speak BrP as their first language. The role of this experiment will become clearer as we compare the results with BrP, and also with bilinguals. To the best of our knowledge, no study has examined differences in acceptability between edible and non-edible nouns bare singulars in English and neither investigated bare plural and bare singular edible nouns accounting for response times as well. Additionally, English lacks studies investigating bare singular nouns in edible contexts, even though sentence processing in this domain has been explored (see FRISSEON; FRAZIER, 2005). The RQs that guide this specific experiment can be found below.

4.2.1.1 *Specific Research Questions*

RQ1. Are bare singular nouns accepted in internal argument position of episodic predicates in English?

RQ2. Is there a difference in acceptability of edible and non-edible nouns in English?

RQ3. Is there a difference in acceptability between plural and singular edible nouns in English?

RQ4. Are response times longer for edibles or non-edibles in English?

RQ5. Are response times longer for bare singulars or bare plurals in English?

4.2.1.2 *Hypothesis (H) and Predictions (P) Regarding the Acceptability of Bare Singular Nouns in English*

H0. No differences in response time or acceptability judgments between conditions are expected. That is, there should be no difference in acceptability between bare singular nouns, whether edible or non-edible, nor between bare plurals, which should be equally accepted. This equality in acceptability should also be reflected in response times, which are not expected to increase for any condition.

P0. If the null H is true, we should not observe any statistically significant differences in acceptability judgments or response times between bare singular and bare plural nouns, nor between edible and non-edible nouns.

H1. An alternative hypothesis is that English will not accept bare singulars but will accept bare plurals. Bare singulars are ungrammatical in English but may be processed via coercion in edible contexts, reflecting reduced acceptability in argument positions, as observed in Frisson and Frazier's study.

P1. If this hypothesis is correct, bare singulars should show low acceptability,

with edible singulars producing slower response times and non-edible singulars producing the slowest. Bare plurals should show high acceptability and faster response times.

H2. Considering the possibility that English might behave like BrP, bare singular nouns could be accepted. Differences between bare singulars and bare plurals may arise due to conscious access to grammatical knowledge, which could slightly hinder the acceptability of bare singulars relative to bare plurals, as reported by Ionin, Grolla, and Santos (2018). *P2.* Response times might be longer for non-edible bare singulars than for edible bare plurals, but all bare nouns are expected to be generally acceptable.

In summary, we adopt Hypothesis 1 as our working hypothesis, as it suggests a difference in acceptability between edible and non-edible bare singulars and bare plurals in English. We expect a difference between edible and non-edible nouns, with edible nouns likely receiving slightly higher acceptability ratings than non-edibles, that should not be accepted at all. Furthermore, acceptability may be reflected in response times, with edible plurals being the fast, and non-edible singulars being the fastest among all conditions. This pattern may indicate a degree of conscious linguistic reasoning on the part of the participants.

All materials used in this experiment, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub¹⁵.

4.2.2 Method

4.2.2.1 Participants

A total of 36 voluntary native speakers of English took part in this experiment, with a mean age of 22.2 years ($SD = 5.1$). Of these participants, 2 reported having previously studied linguistics, while 34 had not. All participants took part on the study online in which they received the link to participate in the study through e-mail. Additionally, 6 participants indicated in the questionnaire that English was not their first language, though they considered

¹⁵ Data analysis materials and raw results are available at <https://github.com/deardiones/AJT-ENGL1.git>

themselves Canadians. We decided to remove these participants from the data analysis, resulting in a final total sample of 30 participants who participated in the English version of experiment. Participants from the Department of Linguistics of University of Toronto received credit course as a compensation from taking part in the study. Participants that were not from the department received a \$10 CAD via e-transfer.

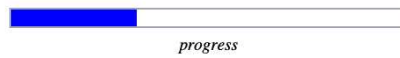
4.2.2.2 Instruments

The main instrument in this study was an AJT programmed in PCIBex, as discussed in the Method section. This experiment followed a 2x2 factorial design, in which we manipulated the independent variables: number (singular/plural) and noun type (edible/non-edible). In this study, all nouns under investigation were countable. The dependent variables were the acceptability judgment value (ordinal) and response time (in milliseconds). This resulted in a total of 4 lists with 16 target sentences, randomized with 32 distractor items in a within-subject design in which the singular nouns were the experimental while the plural nouns were the control ones. The set of experimental conditions for this study is presented below:

31. Experimental Condition: Edible Singular (E+S)
 - a) The student brought pear from the fair.
 Experimental Condition: Non-Edible Singular (U+S)
 - b) The student brought book from the fair.
 Control Condition: Edible Plural (E+P)
 - c) The student brought pears from the fair.
 Control Condition: Non-Edible Plural (U+P)
 - d) The student brought books from the fair.

Each sentence was displayed alone, without the scale, but with a “Rate” button below. After reading the sentence, the participant had to click on the button for the Likert scale with five points to appear with a “Next” button below. At the onset of the scale, up to the point the participant clicked on the “Next” button, the response time was recorded. Figures 4.3 and 4.4 display an example on how the sentences and scale appeared on the screen for the participant:

Figure 4.3 — Sentence display

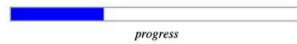


The student bought pears at the fair.

Rate

Source: designed by the researchers and extracted from the experiment at PCibex.

Figure 4.4 — Scale display



The student bought pears at the fair.

Rate

Would you say such sentence?

I would never say that ☐ ☐ ☐ ☐ ☐ I would totally say that

Source: designed by the researchers and extracted from the experiment at PCibex.

The scale would include information only at the extreme points, such as “I would never say that” and “I would totally say that”, indicating the chance of the participant uttering sentences as the ones displayed in the experiment. Next, we move to the predictions of this experiment.

4.2.2.3 Predictions

We present Table 4.11 below, which summarizes the predictions for the acceptability of the investigated sentences and the response time for each condition of this experiment.

Table 4.11 — Predictions for acceptability and response time for each condition

Condition	Speakability	Response Time
Edible + Singular	2 to 3	Slow
Non-edible + Singular	1 to 2	Fastest
Edible + Plural	4 to 5	Fast
Non-edible + Plural	4 to 5	Fast

Source: designed by the researchers.

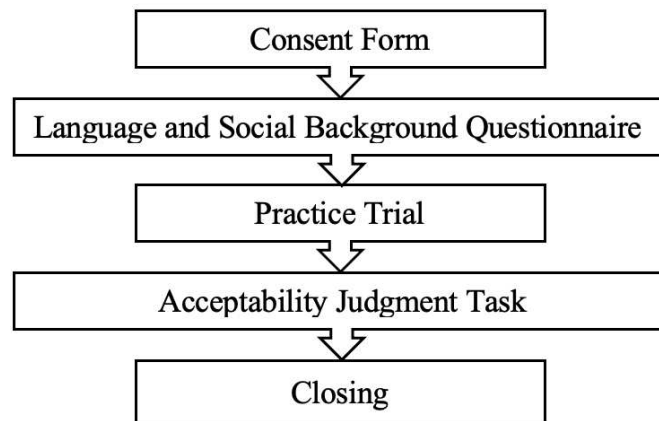
The table above is a result of our working hypothesis 1, predicting the behavior of English. We expect that Non-Edible + Singular would be the hardest condition since it would be totally ungrammatical, while Edible + Singular would be hard to process as well as a reflect of the ungrammaticality. Thus, Edible and Non-Edible + Plurals would be the easiest to process since both occur in English. In this way, the current study is characterized as a control group to observe possible differences that might emerge when we compare to other speaking groups.

4.2.2.4 Procedures

Each participant voluntarily contacted the researcher by e-mail, signaling their willingness to take part in the study. In the first e-mail, the researcher asked if they were 18 years old or above and if they spoke English as their first language. If they did not speak English, they would be dismissed from participating in the study. If they were native speakers of English and also were above 18, they would receive the link to take the AJT in the following e-mail.

The participant received a link from PCIBex, in which the study would occur. Upon clicking the link, the following sequence of the study was presented to them:

Flowchart 4.2 — Presentation order



Source: designed by the researchers.

The first prompt on the laptop screen was the Consent Form (Appendix D). After that, a brief instruction screen prepared participants for the upcoming Language and Social Background Questionnaire (Appendix F). As participants selected options on the questionnaire, the next question appeared automatically. After completing the nine questions, participants were presented with the task instructions.

The first eight trials served as practice trials (Appendix L), allowing participants to become familiar with the AJT experiment. After the practice phase, the final instructions were given, followed by 48 trials with 16 being experimental (Appendix H) and 32 distractors (Appendix J).

Upon completing the task, participants saw a thank-you screen, which also provided final instructions on how to save their data. At the end of the experiment, the platform displayed the participant's ID, which they were asked to save and send to the researcher for double-check if the data were correctly saved on the platform, later on allowing for the compensation process.

4.2.2.5 Data Analysis

Data processing and analysis were all conducted in RStudio.

4.2.2.6 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. We assumed a Cohen's *d* of 0.8 for small groups where a large effect is expected. After adjusting the alpha level to 0.05 and using a sample size of 30, the resulting power was 0.8614225. Thus, we interpret this result as indicating that 86.14% of the outcomes are expected to represent the phenomenon investigated.

4.2.3 Acceptability Judgment Task

The AJT is our main instrument for investigating the acceptability of bare nouns. In the next subsection, we present how the data was processed, along with the statistical analysis.

4.2.3.1 Data Filtering

We began adding two additional columns in the results. One column was called Judgment feed by the Likert scale. That is, the number 1 in the scale was named “Totally Unspeakable”, number 2 was named “Unspeakable”, number 3 was named “Neutral”, number 4 was named “Speakable”, and number 5 was named “Totally Speakable”. The second column was added for the Number variable that was feed by the Condition column. That is, the condition edible plural and non-edible plural feed the Number column with the [P] label, representing the plural condition, while the edible singular and non-edible singular feed the column with the [S] label, representing the singular condition. This had to be done manually since the original file with the target items did not include such column.

Although speaking English as their first language was a requirement for receiving the link to take part in the study, six participants were removed from the sample, as they reported not being native speakers of English in the questionnaires. Apart from removing these participants, no one else was excluded from the study; that is, no outliers were removed from the AJT. Below, we present the mean and standard deviation for each condition, based on the scale ratings.

Table 4.12 — Means and standard deviation for each condition

Condition	Mean	Standard Deviation
Edible + Singular	2.808333	1.5410126
Non-edible + Singular	1.683333	0.9256688
Edible + Plural	4.358333	1.0752825
Non-edible + Plural	4.191667	1.1760626

Source: designed by the researchers.

The table above displays the mean ratings and standard deviations provided by participants for each condition. There is a tendency for edible bare plurals and non-edible bare plurals to be equally well accepted. However, the acceptability for bare singular nouns is lower than the bare plural conditions, but edible bare singular nouns are more accepted than non-edible bare singular nouns. Additionally, we observe more variation in edible bare singulars, as reflected in the standard deviation values, indicating uncertainty regarding the acceptability of edible bare singulars while low deviation is observed for the non-edible bare plurals. Next, we present two additional tables with the means for each variable from the study:

Table 4.13 — Means for the variable Noun

Noun	Value
Edible	3.583333
Non-Edible	2.937500

Source: designed by the researchers.

Table 4.14 — Means for the variable Number

Number	Value
Plural	4.275000
Singular	2.245833

Source: designed by the researchers.

In general, bare plurals are accepted while bare singulars show low acceptance. In addition, edible nouns show a neutral rate of acceptance while non-edibles show neutral to low acceptance. Now, we present the chances of bare singular being uttered in each condition in terms of speakability in percentage:

Table 4.15 — Percentage of speakability per condition

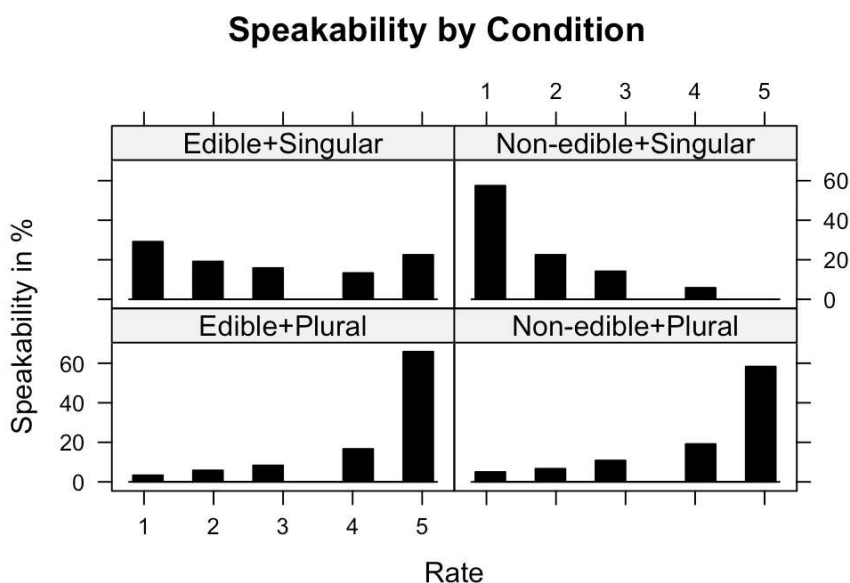
Condition	Totally Unspeakable	Unspeakable	Neutral	Speakable	Totally Speakable
Edible + Singular	29.2%	19.2%	15.8%	13.3%	22.5%
Non-edible + Singular	57.5%	22.5%	14.2%	5.8%	0.0%
Edible + Plural	3.3%	5.8%	8.3%	16.7%	65.9%
Non-edible + Plural	5.0%	6.6%	10.9%	19.2%	58.3%

Source: designed by the researchers.

The table above shows that more than half of the participants judged edible bare singulars as totally speakable 22.5% or speakable 13.3%. Taken together, these percentages indicate that edible bare singular nouns are 35.8% acceptable in English, while 48.4% of participants did not consider the structure acceptable. Non-edible bare singulars were judged as totally speakable by 0.0% of participants and as speakable by 5.8%, resulting in a 5.8% acceptance rate. In contrast, 80.0% of participants did not view this structure as part of their language. Taken these raw values, we can already observe a tendency that edible bare singulars are not grammatical in English even though these nouns may be processed via coercion. Non-edible bare singulars are rejected, clearly being ungrammatical.

When examining bare plurals, edible bare plurals were rated as totally speakable by 65.9% of participants and as speakable by 16.7%, resulting in an overall acceptability rate of 82.6%, with only 9.1% finding them unacceptable. Non-edible bare plurals were judged as totally speakable by 58.3% and as speakable by 19.2%, totaling 77.5% acceptability, while 11.6% considered them unacceptable. Below, we present the first graph which illustrates the rate of speakability per condition.

Graph 4.6 — Speakability per condition in percentages



Source: designed by the researchers on RStudio.

By observing the graph data, we can identify the distribution of the judgments across each condition. Visually, we can observe that edible bare singulars have more variation distributed over the 5 scale ratings while the non-edible have more categorical values, being rated mostly as 1, being highly unacceptable. In contrast bare plurals (edibles and non-edibles) are both mostly rated at 5, indicating that they are grammatical in English. In the next subsection, we present the statistical analysis regarding the acceptability of bare nouns in BrP.

4.2.3.2 Statistical Analysis

The statistical analysis was also conducted on RStudio and we used a cumulative link mixed model fitted with LaPlace approximation, which is mostly used for ordinal response data for Likert scale studies. In addition, we used the [S] Singular as our reference value for the Number variable, [E] Edible as our reference value for the Noun variable, and [E+S] Edible + Singular as our reference value for condition. We decided to follow these reference values since there is no doubt that non-edible nouns that are pluralized are acceptable structures in both BrP and English, in which there is no difference between them (IONIN; MONTRUL; SANTOS, 2011; IONIN; GROLLA, MONTRUL; SANTOS, 2014). Differences in acceptability in these conditions are not expected, though if it occurs, might indicate a problem with the study.

A Cumulative Link Mixed Model (CLMM) was fitted using the Laplace approximation to examine the effect of Condition on Judgment Value. The model included random intercepts for Participants and Items. The model used can be seen below:

```
model1 <- clmm (Value ~ Noun * Number + (1 | Participant) + (1
| Item), data = dataajt1)

model2 <- clmm (Value ~ Noun + Number + (1 | Participant) + (1
| Item), data = dataajt1)
```

To assess whether the interaction between Noun and Number significantly improved model fit, we compared a model 1 with the interaction to model 2 with only the main effects using a likelihood ratio test. The comparison revealed that including the interaction significantly improved the model fit ($\chi^2 = 18.882$, $p < 0.001$). This suggests that the effect of Number on acceptability ratings depends on the type of Noun, supporting the presence of an interaction between these two factors. The model's results can be checked below:

Table 4.16 — Model's results

<i>Predictors</i>	Value		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Noun [U]	0.13	0.08 – 0.22	<0.001
Number [P]	17.00	9.54 – 30.32	<0.001
Noun [U] × Number [P]	5.41	2.51 – 11.66	<0.001
Random Effects			
σ^2	3.29		
τ_{00} Participant	1.07		
τ_{00} Item	0.76		
ICC	0.36		
$N_{\text{Participant}}$	30		
N_{Item}	16		
Observations	480		
Marginal R^2 / Conditional R^2	0.434 / 0.636		

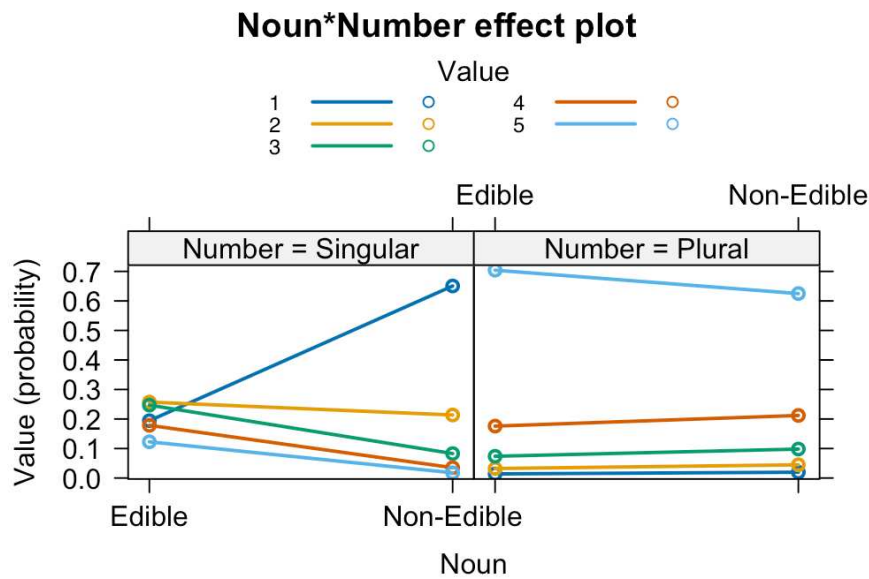
Source: designed by the researchers on RStudio.

The model's results highlights that besides the interaction effects between Noun and Number, there were also main effects for Noun ($\beta = -2.04$, $SE = 0.28$, $z = -7.38$, $p < 0.001$) indicating that non-edible nouns were rated as less acceptable than edible noun, and also a significant main effect for Number ($\beta = 2.83$, $SE = 0.30$, $z = 9.60$, $p < 0.001$) showing that plural forms were rated more acceptable than singular forms across conditions. A Bonferroni correction was carried out to further explore the interaction between Noun and Number and can be checked below:

contrast	estimate	SE	df	z.ratio	p.value
E S - U S	2.044	0.277	Inf	7.382	<.0001
E S - E P	-2.833	0.295	Inf	-9.604	<.0001
E S - U P	-2.477	0.286	Inf	-8.665	<.0001
U S - E P	-4.877	0.356	Inf	-13.685	<.0001
U S - U P	-4.521	0.346	Inf	-13.076	<.0001
E P - U P	0.356	0.282	Inf	1.265	1.0000

Pairwise contrasts among the four conditions revealed several significant differences. The comparison between Edible + Singular (E+S) and Non-Edible + Singular (U+S) was significant ($\beta = 2.04$, $SE = 0.27$, $z = 7.38$, $p < .0001$), revealing an effect for Noun, indicating that edible singular nouns were rated as more acceptable than non-edible singular nouns. Additionally, the comparison between Edible + Singular (E+S) and Edible + Plural (E+P) revealed an effect for Number ($\beta = -2.83$, $SE = 0.29$, $z = -9.60$, $p < .0001$), indicating that singulars have lower probability of getting higher judgment values when compared to plural ones. Thus, the comparison between Non-Edible + Singular (U+S) and Non-Edible + Plural (U+P) revealed a significant effect of Number as well ($\beta = -4.52$, $SE = 0.34$, $z = -13.07$, $p < .0001$), showing that non-edible nouns received higher acceptability ratings when presented in the plural form compared to the singular form; therefore, the plural conditions are not affected by edibility. The other pairwise comparisons either did not reach statistical significance or were not theoretically relevant. Next, we present graph 4.7 with the probability of getting higher ratings for each condition.

Graph 4.7 — Probability of getting higher rating condition



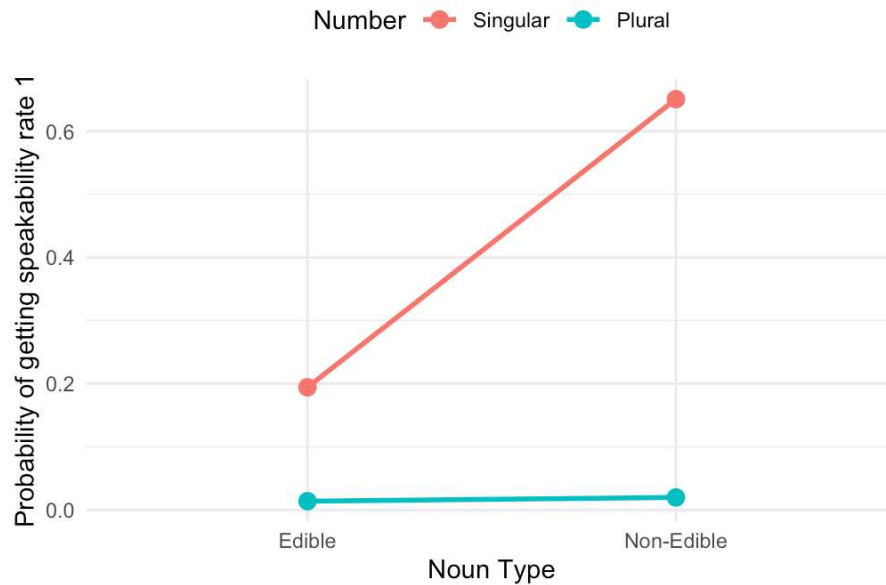
Source: designed by the researchers on RStudio.

The graph visually displays the values predicted by the model. Graph 4.7 presents the predicted probabilities for each response level of the ordinal variable Value (ranging from 1 to 5), as a function of Noun type (Edible vs. Non-Edible) and Number (Singular vs. Plural).

In the singular panel, a sharp divergence is visible between noun types. Specifically, for non-edible singular nouns, the probability of getting rate value 1 increases substantially, while probabilities for higher rates decrease. This pattern suggests that participants are more likely to give lower ratings to non-edible singular nouns, particularly when compared to edible singular nouns, for which the distribution is more even across values.

In contrast, in the plural panel, the effect of Noun is much less pronounced. The highest rating, which is value 5, dominates across both edible and non-edible nouns, and the distribution of lower values is relatively stable between conditions, although the plural is better with non-edibles. Overall, the interaction pattern reveals that Noun type has a stronger effect when the noun is singular, with a marked shift toward lower ratings for non-edible items. Since the interaction is not clear cut in the graph above, we decided to isolate the probability of getting a low rate 1 for all conditions. The graphs can be checked below:

Graph 4.8 — Probability of getting rating 1 for each condition



Source: designed by the researchers on RStudio.

This time the graphs indicates that we have higher probabilities of getting rate 1 for edible nouns for both plural and singular, alongside with high rates for non-edible (singular and plural). For singular nouns, the probability of receiving a rating of 1 is relatively low for edible bare singular but sharply increases for non-edible bare singular. In contrast, edible and non-edible bare plurals is close to zero in both conditions, highlighting a clear interaction between noun type (edible and non-edible) nouns across number.

This pattern visually highlights the significant interaction between Noun Type and Number found in model 1. While plural nouns are generally more likely to receive a high speakability rating regardless of edibility, singular non-edible nouns are especially likely to receive the lowest rating. This asymmetry suggests that non-edibility increases low ratings more drastically in singular contexts, aligning with the significant interaction found in the model. Next, we present the response time.

4.2.4 Response Time Analysis

The response time in the AJT allows us to infer aspects of language acceptability after processing, as it indicates the time taken by participants to determine whether the sentences they have read are speakable or not. This data may enhance our understanding of English and the acceptability of the edible and non-edible bare nouns.

4.2.4.1 Data Filtering

The data treatment was divided into two parts. In the first phase, we removed six non-native speakers of English and added the two columns as we did for the AJT. Next, we isolated the necessary information from the raw table extracted from PCIBex. This information included: participant, group, label, item, condition, number, noun, T1, T2, and RT. T1 was the onset of the Likert scale display, up to the point of the participant clicked on “Next” and the RT was the time that the participant took to make his/her decision.

In the second phase, we checked the filtered data to check for distribution and normality. We considered the data to be well-distributed when the graph visually formed a bell curve, with the data clusters concentrated near the center, representing the mean. The closer the clusters were to the center and the fewer they were at the edges, the more well-distributed the data appeared. Thus, we considered the data to be normal if the Shapiro-Wilk Test yielded a p-value greater than 0.05, indicating that the null hypothesis of normality could not be rejected. Since linear models do not require the data to be normally distributed, we prioritized examining the distribution over assessing normality. If the data appeared normal, it was merely a result of the underlying distribution.

The filtered data did not meet the criteria for neither for normality nor distribution. Therefore, the first treatment was done with the IQR¹⁶ in which we measured statistical dispersion, calculating the difference between the Q3 and the Q1 with the first treatment with a more conservative range 3 resulting in an upper limit of 10417. After checking the distribution and the normality tests, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 7094.5. After reviewing the graphs and conducting normality tests, we concluded that the data still did not follow a normal distribution, nor was it normal according to the tests. We then proceeded with a logarithmic transformation. A logarithmic transformation (log) is a mathematical operation applied to data to stabilize variability and make the distribution more symmetric. It compresses larger values more than smaller ones, making the data more manageable and often more suitable for analysis. Following the transformation, the data distribution improved, but the data was still not normal (Shapiro-Wilk: $W = 0.98235$, $p\text{-value} = 2.993e-05$)¹⁷. In this way, we decided to keep with the log transformed data, prioritizing the distribution.

¹⁶ The equation for the IQR is $Q3 + X*(Q3 - Q1)$

¹⁷ Kolmogorov-Smirnov: $D = 0.053166$, $p\text{-value} = 0.004224$

Finally, we checked the residuals for normality (Shapiro-Wilk: $W = 0.98547$, $p\text{-value} = 0.0001939$)¹⁸ which shows that the data is not normal. Additionally, we checked distribution, which signaled that somewhat the data was well distributed.

Removing the outliers from the sample resulted in 446 observations from the original 480, a reduction of 34 observations, representing 7.08% of the sample. The conditions that lost the most data was non-edible + plural and non-edible singular, with 11 data points lost, followed by edible + plural, which lost 7 data points. The conditions that preserved more data were edible + singular, losing 5 data points. After this treatment, we plotted the table with the means and standard deviations in milliseconds, which can be reviewed above for each condition:

Table 4.17 — Treated means and standard deviation for each experimental condition in the response time

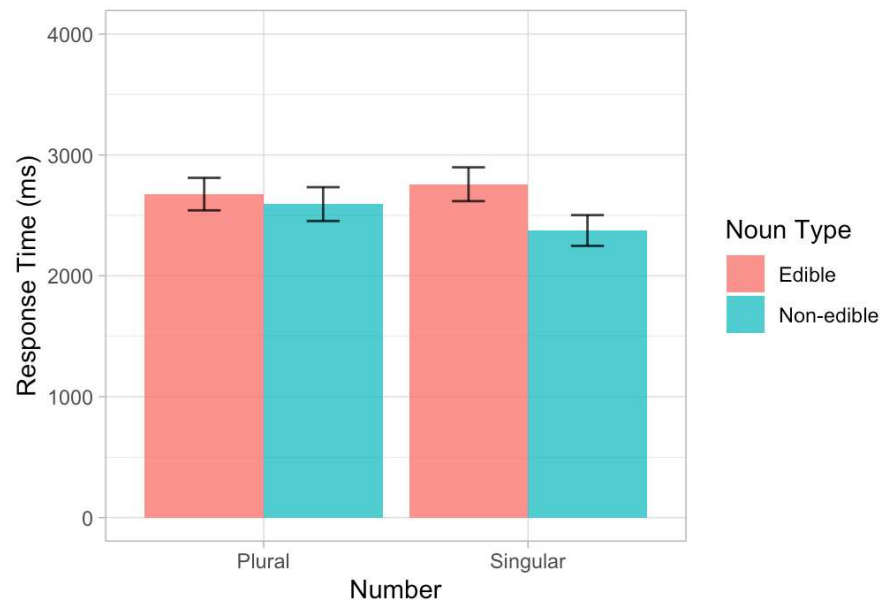
Condition	Mean	Standard Deviation
Edible + Singular	2757.930	1499.786
Non-edible + Singular	2375.110	1329.502
Edible + Plural	2676.106	1430.587
Non-edible + Plural	2593.532	1460.248

Source: designed by the researchers on RStudio.

By checking the table above, we can observe that the means are quite stable across conditions, with the fastest being the Non-Edible + Singular taking 384.820 milliseconds less time than the Edible + Singular condition. This indicates that the ungrammatical structure, namely the non-edible singular is quickly rejected by participants, while the edible singular undertakes a coercion process, that is, participants take more time to interpret edible bare singulars since they are probably saving the derivation via a coercion process, even though our instrument cannot capture this phenomenon online, it might indicate a residual process that might have shown up in the RTs. Additionally, non-edible singulars condition shows that there was less variation in response times as observed by the standard deviation, indicating that participants did not had doubt in assigning low acceptability rates for the condition. The Edible + Plural condition is 82.574 milliseconds slower than the Non-Edible + Plural condition. After that, we plotted the first graph in which the means and standard deviation of the response time are visualized. The graph is available below:

¹⁸ Kolmogorov-Smirnov: $D = 0.060973$, $p\text{-value} = 2.576e-08$

Graph 4.9 — Response time means and standard deviation in milliseconds



Source: designed by the researchers on RStudio.

Based on the above graph, non-edible nouns were associated with faster response times compared to edible nouns. This difference becomes clear in singular condition: non-edible singulars triggered the shorter response times, while edible singular nouns resulted in the slowest response times. For plural nouns, the difference in response times between edible and non-edible nouns was more balanced, though still present. This pattern suggests that the semantic feature of edibility interacts with number marking, potentially influencing response times, especially for the singular form. For plural nouns, the response time difference between edible and non-edible items was smaller but still present. We will check this potential influence in the Statistical Analysis subsection.

4.2.4.2 Statistical Analysis

The statistical analysis was conducted in RStudio, where we used a linear mixed model fit by maximum likelihood to account for both fixed and random effects across groups. Additionally, a t-test using Satterthwaite's method was applied to compare the means between two groups and determine if they were significantly different from each other. In addition, we kept using the [S] Singular as our reference value for the Number variable, [E] Edible as our reference value for the Noun variable.

Using the logarithm of response time as a dependent variable, we fitted a mixed linear model with Noun, Number, and the interaction between these two factors as fixed effects, alongside random intercepts for each participant and item. To assess whether the interaction between Noun and Number significantly improved model fit, we compared a model 1 with the interaction to model 2 with only the main effects using a likelihood ratio test. The comparison revealed that including the interaction did not significantly improve the model fit ($\chi^2 = 1.2562$, $p = 0.262$).

Additional nested models were carried out. Removing the Noun variable as fixed effect and comparing it to the model without the interaction which also did not improve model fit ($\chi^2 = 2.4236$, $p = 0.1195$) and neither removing the Number variable did not show an improvement in fit ($\chi^2 = 0.1857$, $p = 0.6666$). In this way, to find the best fitting model we decided to check the model which showed the lower AIC and BIC values. Therefore, the best fitting model included only the Noun as fixed effect (AIC = 646.92, BIC = 667.42). Next, we can check the models and the table with the model's results for response time:

```
model1 <- lmer (log ~ Number * Noun + (1|Participant) +
  (1|Item), data = datart, REML = FALSE)
```

```
model2 <- lmer (log ~ Number + Noun + (1|Participant) +
  (1|Item), data = datart, REML = FALSE)
```

```
model3 <- lmer (log ~ Number + (1|Participant) + (1|Item), data
= datart, REML = FALSE)
```

```
model4 <- lmer (log ~ Noun + (1|Participant) + (1|Item), data
= datart, REML = FALSE)
```

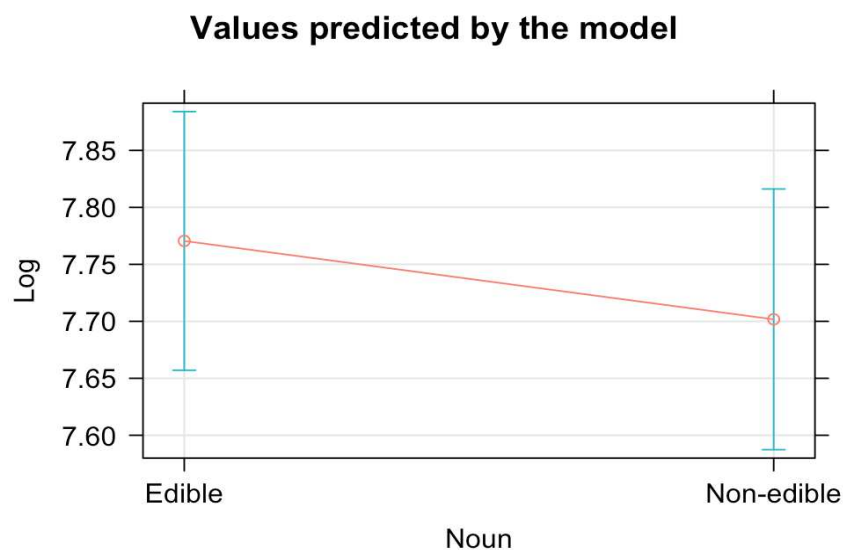
Table 4.18 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.77	7.66 – 7.88	<0.001
Noun [U]	-0.07	-0.16 – 0.02	0.120
Random Effects			
σ^2	0.22		
τ_{00} Participant	0.07		
τ_{00} Item	0.00		
N Participant	30		
N Item	16		
Observations	446		
Marginal R^2 / Conditional R^2	0.005 / NA		

Source: designed by the researchers on RStudio.

The model's result on Noun type is not statistically significant, suggesting that the difference in response times between edible and non-edible was not statistically reliable. Below we can check the graph of the values predicted by the model.

Graph 4.10 — Values predicted by the model for the response time in log



Source: designed by the researchers on RStudio.

This graph visually displays the data from the model's results for Noun in log-transformed values response times. While the model predicts slightly faster responses for non-edible nouns, the difference is minimal. Overall, although there is a small numerical decrease in predicted log RTs for non-edible nouns, this pattern does not support a reliable effect of Noun Type on response time. It worth highlighting that there was not an effect for Number on response times. Next, we move forward for the summary of the key findings of this experiment along with general discussion of the results.

4.2.5 Summary of Key Findings from Experiment 2

The table below provides an overview of the data collected for Experiment 2.

Table 4.19 — Summary of key findings from experiment 2 (EngL1)

Number	Noun	Mean Rate	Percentage	Probability	Response Time
Bare Singular	Edible	2.8	35.8%	Higer probability between singulars	=
	Non-Edible	1.6	5.8%	Less probability among all conditions	=
Bare Plural	Edible	4.3	82.6%	Higer probability between Edibles	=
	Non-Edible	4.1	77.5%	Higher probability between Plurals	=

Source: designed by the researchers.

Observations: The symbols mean: (=) we did not find statistically significant effect.

- There is an interaction between noun type and number in the AJT;
- Post hoc analysis revealed a significant noun effect, with edible singular nouns receiving significantly higher acceptability ratings than non-edible singulars;
- Plural forms were rated as significantly more acceptable than singular forms for both edible and non-edible nouns;

- There was not a difference between edible and non-edible in plural forms;
- The results from the AJT suggests that edible bare singular nouns are not grammatical in English, but they are more acceptable than non-edible bare singulars;
- Non-edible bare singulars are not grammatical in English;
- Response times did not get statistical power; however, the response times in milliseconds indicated that non-edible singulars are quickly assigned lower ratings with low standard deviation. This points toward the total unacceptability of the structure in English;
- Additionally, edible bare singulars take longer to receive the ratings and show the most variability across responses and also in response times. This suggests that the structure is not grammatical in English;
- The results from the response times were not statistically powerful for us to draw more categorical conclusions in terms of response times.

4.2.6 General Discussion

The result of this experiment enlightens bare nouns in English with results that are straightforward to interpret: Bare plurals are grammatical in English, no matter if they are edible or not, in line with previous studies that contrasted English with other languages (IONIN; MONTRUL; SANTOS, 2011; IONIN; GROLLA; MONTRUL; SANTOS, 2014; BEVILÁQUA; PIRES DE OLIVEIRA, 2021). Overall, edible bare plurals are accepted by 82.6% of the participants, while 77.5% accept non-edible bare plurals.

Another result is very clear which is the ungrammaticality of non-edible bare singulars, being the condition which received the lowest ratings, being rejected by 80% of the participants being the fastest among all others. The result provides evidence that the structure is completely ungrammatical, leaving no room for doubt, and is quickly assigned a low rating.

When it comes to edible bare singulars we have interesting results. Edible bare singular nouns have an overall 48.4% of rejection while it has a 35.7% overall acceptability. This result leans towards the ungrammaticality of bare singular nouns since there is more rejection than acceptability. Additionally, it is the condition with the highest response times as well as the highest standard deviation.

A possible explanation for the behavior of edible bare singulars is that these types of nouns, in their singular form and in argument position, can undergo coercion — even though the AJT cannot capture such phenomenon. This additional response times may be a result of the English grammar forcing it, since count nouns have a primitive interpretation related to cardinal while mass nouns have a primitive interpretation related to volume or weight. Frisson and Frazier (2005) have also shown that edible bare nouns take additional processing time in their processing study. With these reasoning in mind, and the results of the acceptability and response times, we understand that count edible bare singulars nouns in argument position of episodic sentences are ungrammatical in English.

Delving deeper into the acceptability of edible bare singular nouns against non-edible bare singular nouns, edible count nouns may be more accepted since they can be turned into mass ones. For example, ‘apple’ which is a count noun, and has a cardinal interpretation, may be transformed into mass in sentences like ‘there is apple in the salad’. In addition, some nouns are used interchangeable between count and mass such as ‘chicken’ that may refer to the animal — having a cardinal interpretation — or may refer to the meat — having a weight interpretation (BUNT, 1985). This might be due to the flexibility of using edible nouns in different context assigning them different interpretations, therefore, reflecting in acceptability.

In general, the results from the acceptability showed an interaction between the noun type and number. The effect for number showed that edible singular nouns are overall less rejected than non-edible singular nouns. Additionally, the effect for number showed that plural nouns have a higher tendency of getting high rates, when compared to singular nouns. In contrast, response times did not get any statistically significant effect.

Based on this discussion, we have enough evidence to refute the Null Hypothesis and to support our working hypothesis. Several points discussed support Hypothesis 1, but the main point is the unacceptability of bare singulars. Bare plurals, by contrast, had high acceptability rates, as predicted by our hypothesis.

Our study provides novel and refined results about this phenomenon as it presents a clear investigation between edible and non-edible count nouns as a variable, while singular and plural as another variable. Additionally, to our knowledge, it is the first to combine an AJT with

response time for English in an investigation with bare nouns, providing a quantitative psycholinguistic depth to our results. Next, we retake our RQs and answer them in light of the results of our study.

RQ1. Are bare singular nouns accepted in internal argument position of episodic predicates in English? *No, they are not. Bare singular nouns are ungrammatical in English not being accepted in internal argument position of episodic predicates.*

RQ2. Is there a difference in acceptability of edible and non-edible nouns in English? *Yes, there is for bare singulars. Edible bare singular nouns are less rejected than non-edible bare singulars. Bare plurals are equally accepted, not showing an effect for noun. Overall, bare singulars are ungrammatical while bare plurals are grammatical.*

RQ3. Is there a difference in acceptability between plural and singular edible nouns in English? *Yes, there is. Edible bare plurals are more accepted than edible bare singulars.*

RQ4. Are response times longer for edibles or non-edibles in English? *Although we did not get statistical significance, based on Table 4.19, there is a tendency that edible nouns trigger higher response times.*

RQ5. Are response times longer for bare singulars or bare plurals in English? *We did not find a statistically significant effect, but looking at Table 4.19, we can observe an overall trend for the response times.*

To conclude, we retake our predictions' table, contrasting with our results. Note that, despite the lack of statistical significance for response times, we chose to include the observed trend in the table to illustrate the data pattern.

Table 4.20 — Predictions vs results for acceptability and response time for each condition

Condition	Speakability	Speakability	Response Time	Response Time
	<i>Prediction</i>	<i>Results</i>	<i>Prediction</i>	<i>Results</i>
Edible + Singular	2 to 3	2.8	Slow	Slowest
Non-edible + Singular	1 to 2	1.6	Fastest	Fastest
Edible + Plural	4 to 5	4.3	Fast	Fast
Non-edible + Plural	4 to 5	4.1	Fast	Fast

Source: designed by the researchers.

4.2.7 Conclusion

In summary, the results confirm that bare singular nouns are ungrammatical in English when used as internal arguments of episodic predicates, aligning with existing literature. While bare plurals are consistently accepted regardless of their edibility status, bare singulars show a gradient effect: edible bare singulars are less rejected than non-edible ones, suggesting a subtle semantic influence despite their overall ungrammatical status. Additionally, edible bare plurals are more accepted than their singular counterparts, further emphasizing the role of number in acceptability judgments. Although response time differences were not statistically significant, trends indicate that non-edible bare singulars were rejected more categorically, likely due to their clear ungrammaticality, while edible bare singulars elicited a trend towards longer processing times — possibly reflecting interpretive effort favoring a possible coercion effect. These findings suggest that noun type and number affect judgment in English. The next section builds on these results by comparing responses across languages to determine whether bare nouns represent a locus of syntactic and semantic mismatch between BrP and English.

4.3 GROUP COMPARISON 1 — INVESTIGATING POSSIBLE MISMATCHES BETWEEN EDIBLE BARE NOUNS ACCEPTABILITY IN BRAZILIAN PORTUGUESE L1 AND ENGLISH L1

4.3.1 Introduction

As evidenced by the results of Experiment 1 in BrP and Experiment 2 in English, the two languages show a notable difference, which this study investigates within the nominal domain. Although both languages exhibit a sensibility to noun type and number, there is a difference in acceptability patterns between them.

In summary, the AJT results for BrP indicate that all conditions tested were judged as grammatical: Edible + Singular (E+S) received 77.1% acceptability, Non-edible + Singular (U+S) 51.2%, Edible + Plural (E+P) 85.7%, and Non-edible + Plural (U+P) 85%. In contrast, the English data exhibit a divergent pattern, particularly with respect to bare singular nouns: E+S was rated 35.7% acceptable, U+S only 5.8%, E+P 82.6%, and U+P 77.5%. These results reveal a cross-linguistic asymmetry driven by the ungrammaticality of bare singular count nouns in English. While BrP allows bare singulars in argument positions under certain interpretive conditions (e.g., as kind or quantity-denoting), English strictly prohibits such forms due to their failure to satisfy argument structure requirements. This mismatch suggests that the two languages encode distinct syntactic and semantic constraints on nominal expressions, particularly in relation to number and quantification.

When it comes to response times, we found few statistical significances in both studies. That is, In BrP, response times were marginally significant, with an effect for number only with the singular being marginally slower, while in English we did not find any significant effect in response times.

Given these two studies conducted, there is evidence of mismatches between these two languages. Theoretical works have suggested that there are differences in the processing between BrP and English as suggested by Beviláqua and Pires de Oliveira (2019) and Pires de Oliveira (2020, 2022) and an empirical study conducted by Beviláqua and Pires de Oliveira (2021) has shown that there is a mismatch between these two languages in terms of acceptability. Based on that, we present our RQs that guide this specific group comparison:

4.3.1.1 *Specific Research Questions*

RQ1. Are there differences (or mismatches) in the acceptability patterns between BrP and English?

RQ2. Are there differences (or mismatches) in response times patterns between BrP and English?

4.3.1.2 *Hypothesis (H) and Predictions (P) for Bare Singular Nouns Acceptability*

H0. There are no differences in the acceptability of bare singular nouns between BrP and English. Likewise, no differences are expected in response times between the two languages. If this hypothesis is true, both languages would behave similarly under the investigated conditions, showing no semantic or grammatical distinction in the processing of bare singular nouns.
P0. If H0 holds, we should not observe any statistical differences in acceptability judgments for bare singular nouns between BrP and English, nor should there be differences in response time patterns across the two languages.

H1. In BrP, bare singular nouns are acceptable and part of the grammar (PIRES DE OLIVEIRA; SILVA; BRESSANE, 2010; BRAGA; SENA; MARIANO, 2010; PIRES DE OLIVEIRA; 2010). In contrast, bare singular nouns are not accepted in English (IONIN; MONTRUL; SANTOS, 2011; IONIN; GROLLA; MONTRUL; SANTOS, 2014; BEVILÁQUA; PIRES DE OLIVEIRA, 2021). Theoretically, we have a mismatch between the acceptability of bare singular nouns between BrP and English. This reflects a semantic difference between these two languages. In BrP, bare singular nouns come into the derivation as underspecified for atomicity (PIRES DE OLIVEIRA, 2025) while in English they come specified for atomicity, having a primitive meaning as cardinal, for count nouns and volume/weight for mass nouns (FRISSEON; FRAZIER, 2005).

P1. With the above proposition being true, we should observe statistical difference between the acceptability of bare singular nouns between BrP and

English. This difference should be pronounced as well in response times, with bare singular nouns generating longer response times in BrP than in English, as we have observed for Experiments 1 and 2.

In summary, we can already observe that there are differences in the acceptability of bare nouns between BrP and English. However, now we will further explore whether this difference is statistically significant in both domains: acceptability judgment values and response times. Since Experiment 1 and 2 were identical, only having the languages changed, this allows us to compare the two groups and further explore a statistical difference between these language groups. For that, we assume Hypothesis 1 as our working hypothesis. Additionally, this group comparison allows us to statistically verify whether there are mismatches between BrP and English, by comparing BrP L1 and English L1 groups, two native speakers' groups.

All materials used in this group comparison, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub¹⁹.

4.3.2 Method

4.3.2.1 Participants

A total of 90 participants' data was analysed in this group comparison, comprising 60 voluntary participants from *Universidade Federal de Santa Catarina* (UFSC) and 30 paid participants from the University of Toronto. The mean age of these 90 participants was 28.1 years old (SD = 10.9).

4.3.2.2 Instruments

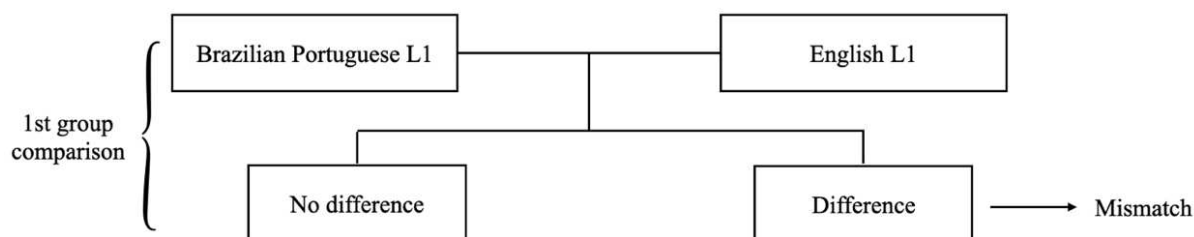
The instruments used in the study are the same as the ones reported in Experiment 1 and 2. Therefore, this is just a group comparison with the data of the participants from the native speakers' groups to investigate the possible mismatches between BrP and English.

¹⁹ Data analysis materials and raw results are available at <https://github.com/deardiones/AJT-Group-Comparison.git>

4.3.2.3 Procedures

The procedures adopted to conduct this group comparison can be summarized by the flowchart below:

Flowchart 4.3 — Group comparison flowchart



Source: designed by the researchers.

The flowchart 4.3 helps to illustrate the procedures adopted to conduct the groups comparison, as it follows: The first group comparison aims to compare the groups BrP L1 and English L1 (two groups comparison — native speakers) as independent variable. This analysis was carried out for the AJT, while also comparing response times. If no difference is found between these two groups, we do not have evidence of a mismatch between these two languages, therefore no further analysis in the data is necessary. If there is a difference between these two groups, then we have evidence of a mismatch between these two languages, therefore the second group comparison will be carried out adding the bilingual group in a following group comparison.

4.3.2.4 Data Preparation

Data processing was conducted in RStudio. For the group comparison, we gathered all the final sets that received data analysis on a single file directly as a new Comma-Separated Values (CSV) file. A new column was added for each CSV file naming each group: the native speakers of BrP was named [BRPL1], the native speakers of English were named as [ENGL1].

Since in the other two group comparisons we decided to use English as our reference value group, we decided to keep the pattern. Additionally, we can clearly observe a difference in the acceptability of bare nouns in this language, while in BrP the acceptability patterns are not so evident. Therefore, in the statistical analysis, we decided to include the [ENGL1] as our

reference value for the variable Speaker since the literature is more categorical regarding the representation of the nouns in English, therefore, allowing us to compare it against the native speakers of Brazilian Portuguese [BRPL1]. Additionally, we kept using the singular [S] as our reference value for the variable Number and edible [E] as our reference value for the variable Noun.

4.3.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. For the BrP L1 and English L1 comparison, we assumed a Cohen's *d* of 0.5 for medium groups. After adjusting the alpha level to 0.5 and using a sample size of 90, the resulting power was 0.9155872. Thus, we interpret this result as indicating that 91,55% of the outcomes are expected to represent the phenomenon investigated in the native speakers group comparison.

4.3.3 Acceptability Judgment Task

The AJT was our main instrument for investigating language acceptability. In the next subsection, we present how the treat data was analyzed in this group comparison, along with the statistical analysis. This comparison directly challenges our working hypothesis regarding the acceptability pattern of this structure across languages, prompting us to re-evaluate it in relation to other groups. The data was unaltered from the data filtering reported for Experiments 4 and 5. Next, we will focus on the data preparation and analysis for the AJT. It is worth highlighting that in both groups we got a statistically significant interaction between the conditions investigated.

4.3.3.1 Data Preparation

For the noun region, we gathered the dataset named *ajtl1* of the two groups and tabled all the data in a single CSV file. The BRPL1 and ENGL2 final data sets of response times were both in log. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1440 observations, nested within 90 participants and 16 items.

4.3.3.2 Statistical Analysis

A Cumulative Link Mixed Model (CLMM) was fitted using the Laplace approximation to examine the effect of Noun, Number, and Speaker on judgment value. The model included random intercepts for Participants and Items. The models used in the comparison can be seen below, alongside the model's results:

```
model1 <- lmer (Log ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = s5, REML = FALSE)

model2 <- lmer (Log ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = s5, REML = FALSE)
```

A comparison of nested models with ANOVA²⁰ revealed that including a three-way interaction show a statistically significant better fit when compared to the model without interaction ($\chi^2 = 155.79$, $p < 0.0001$). The model's result can be checked below:

²⁰ Other models were also done in order to explore possible effects for noun alone and quantifier alone, but these can be checked on GitHub.

Table 4.21 — Model's results

<i>Predictors</i>	Value		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Noun [U]	0.12	0.07 – 0.20	<0.001
Number [P]	18.74	10.72 – 32.78	<0.001
Speaker [BRPL1]	11.79	5.75 – 24.20	<0.001
Noun [U] × Number [P]	5.57	2.59 – 12.01	<0.001
Noun [U] × Speaker [BRPL1]	1.79	0.95 – 3.37	0.072
Number [P] × Speaker [BRPL1]	0.08	0.04 – 0.17	<0.001
(Noun [U] × Number [P]) × Speaker [BRPL1]	0.95	0.37 – 2.43	0.916
Random Effects			
σ^2	3.29		
τ_{00} Participant	1.57		
τ_{00} Item	0.91		
ICC	0.43		
N Participant	90		
N Item	16		
Observations	1440		
Marginal R^2 / Conditional R^2	0.293 / 0.597		

Source: designed by the researchers on RStudio.

The model revealed significant main effects of Noun Type, Number, and Speaker Group. Non-edible nouns were less likely to receive top acceptability ratings ($p < 0.001$), while plural nouns ($p < 0.001$) and BrP speakers ($p < .001$) were associated with higher ratings. Significant interactions included Noun × Number and Number × Speaker, indicating that the acceptability of plurals varied across noun types and speaker groups. The three-way interaction was not significant.

A Bonferroni correction was applied in the post-hoc analysis to account for multiple comparisons. Since we may find many significant effects in the post hoc, we will only focus on the source of the mismatch between BrP and English which is the acceptability of Edible +

Singular (E+S) and Non-Edible + Singular (U+S) between Brazilian Portuguese (BRPL1) and English (ENGL1). The other two conditions with bare plurals are not relevant since they are equally well accepted in both languages. Below, we present the pairwise comparison:

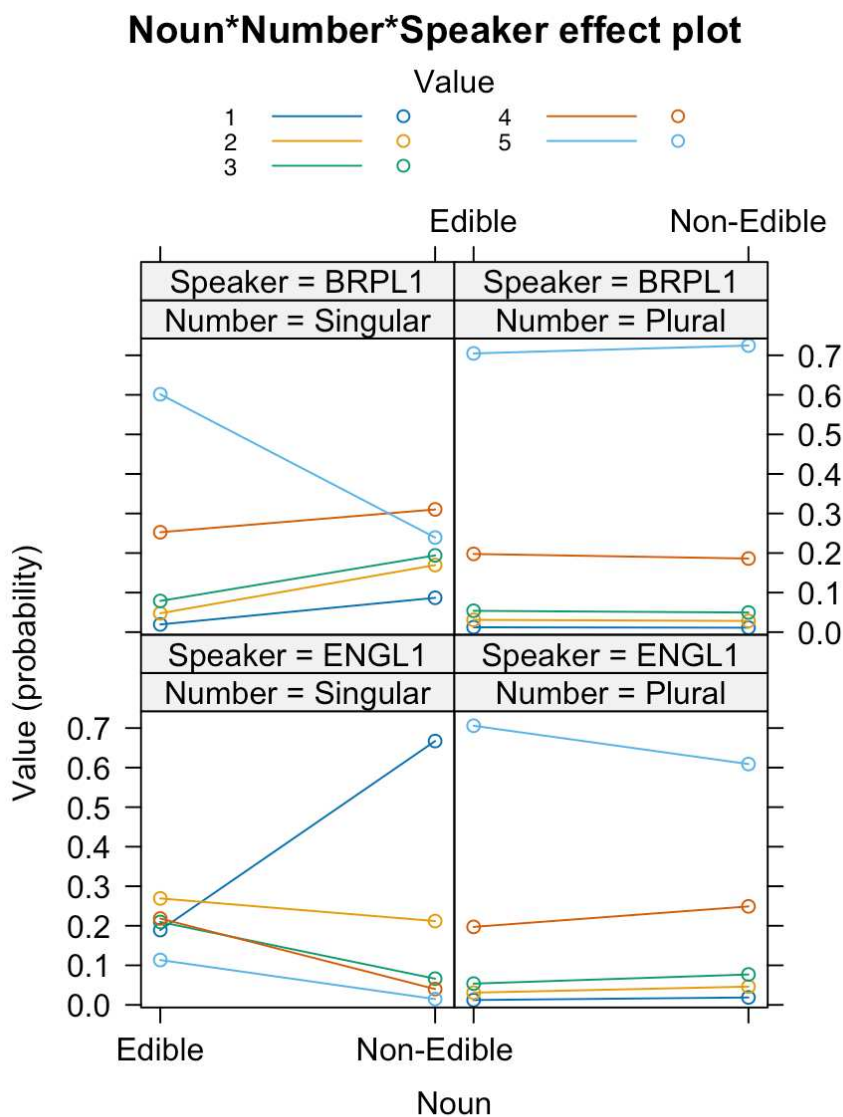
contrast	estimate	SE	df	z.ratio	p.value
E S ENGL1 - U S ENGL1	2.15020	0.270	Inf	7.953	<.0001
E S ENGL1 - E P ENGL1	-2.93077	0.285	Inf	-10.275	<.0001
E S ENGL1 - U P ENGL1	-2.49838	0.275	Inf	-9.070	<.0001
E S ENGL1 - E S BRPL1	-2.46737	0.367	Inf	-6.727	<.0001
E S ENGL1 - U S BRPL1	-0.89795	0.357	Inf	-2.515	0.3335
E S ENGL1 - E P BRPL1	-2.92555	0.373	Inf	-7.847	<.0001
E S ENGL1 - U P BRPL1	-3.02340	0.374	Inf	-8.081	<.0001
U S ENGL1 - E P ENGL1	-5.08096	0.316	Inf	-16.078	<.0001
U S ENGL1 - U P ENGL1	-4.64858	0.306	Inf	-15.197	<.0001
U S ENGL1 - E S BRPL1	-4.61757	0.388	Inf	-11.887	<.0001
U S ENGL1 - U S BRPL1	-3.04815	0.373	Inf	-8.173	<.0001
U S ENGL1 - E P BRPL1	-5.07574	0.395	Inf	-12.850	<.0001
U S ENGL1 - U P BRPL1	-5.17360	0.397	Inf	-13.043	<.0001
E P ENGL1 - U P ENGL1	0.43238	0.285	Inf	1.517	1.0000
E P ENGL1 - E S BRPL1	0.46339	0.377	Inf	1.230	1.0000
E P ENGL1 - U S BRPL1	2.03281	0.375	Inf	5.420	<.0001
E P ENGL1 - E P BRPL1	0.00522	0.380	Inf	0.014	1.0000
E P ENGL1 - U P BRPL1	-0.09263	0.381	Inf	-0.243	1.0000
U P ENGL1 - E S BRPL1	0.03101	0.371	Inf	0.084	1.0000
U P ENGL1 - U S BRPL1	1.60043	0.368	Inf	4.344	0.0004
U P ENGL1 - E P BRPL1	-0.42716	0.375	Inf	-1.139	1.0000
U P ENGL1 - U P BRPL1	-0.52501	0.375	Inf	-1.398	1.0000
E S BRPL1 - U S BRPL1	1.56942	0.190	Inf	8.258	<.0001
E S BRPL1 - E P BRPL1	-0.45817	0.200	Inf	-2.288	0.6202
E S BRPL1 - U P BRPL1	-0.55602	0.201	Inf	-2.772	0.1562
U S BRPL1 - E P BRPL1	-2.02759	0.200	Inf	-10.162	<.0001
U S BRPL1 - U P BRPL1	-2.12544	0.202	Inf	-10.507	<.0001
E P BRPL1 - U P BRPL1	-0.09785	0.208	Inf	-0.471	1.0000

Pairwise contrasts among the four conditions revealed several significant differences. The comparison between Edible + Singular (E+S) nouns between BrP and English was significant ($\beta = -2.46737$, $SE = 0.367$, $z = -6.727$, $p < 0.0001$) revealing that the rating of bare singular edible nouns is different between English and BrP, with BrP receiving higher

acceptability ratings than English. This indicates that edible bare singular nouns are more accepted in BrP than in English.

Additionally, there was a significant effect when comparing Non-edible + Singular (U+S) nouns between BrP and English ($\beta = -3.04815$, $SE = 0.373$, $z = -8.173$, $p < 0.0001$), revealing that non-edible bare singular nouns also tend to be more accepted in BrP than in English. In a nutshell, bare singular nouns are accepted in BrP while in English they are not. Below, we present the values predicted by the model:

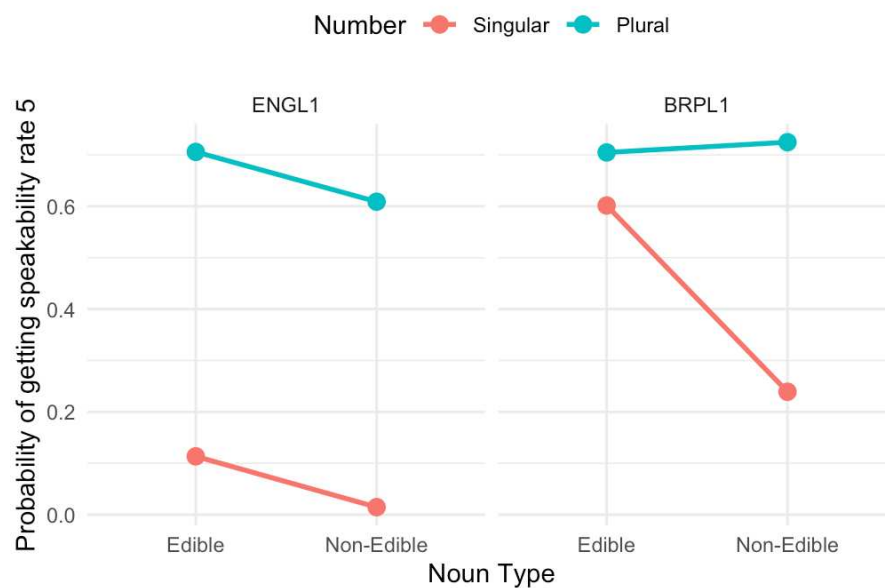
Graph 4.11 — Values predicted by the model for the noun region for both language groups



Source: designed by the researchers on RStudio.

Graph 4.11 displays the interaction between noun type, number, and speaker group on acceptability ratings. BrP speakers show higher acceptability for bare singular nouns, especially when the noun is edible. In contrast, English speakers rate non-edible bare singular nouns lower than edible ones. Across both groups, bare plurals receive consistently high ratings. In order to better explore the interaction effect, we isolated ratings 5 and plotted a new graph:

Graph 4.12 — Values predicted by the model for the acceptability of bare nouns with rate 5 for both language groups



Source: designed by the researchers on RStudio.

Graph 4.12 shows the predicted probability of receiving the highest acceptability rating 5 across noun type and number for English and BrP speakers. English speakers consistently prefer plural forms, regardless of whether the noun is edible or non-edible, while singular forms are generally dispreferred. In contrast, BrP speakers show a clear sensitivity to noun semantics: edible singular nouns receive higher judgment values, but non-edible singulars receive low tendency of receiving higher judgment values. This indicates that bare singulars are more acceptable in BrP, particularly when the noun corresponds to an edible item when compared to English. In the next section we explore the Response Times between groups.

4.3.4 Response Time Analysis

The response time in the AJT allow us to infer on aspects of language, as it indicates the time taken by participants to rate any of the investigated conditions. This data may enhance our understanding of bare singular nouns representation between English and BrP. It is worth highlighting that response time for BrP was only marginally significant while in English it was not significant.

4.3.4.1 Data Preparation

For the response time, we gathered the data set *ajtrtl1* in log of the two groups and tabled all the data in a single CSV file, all of which were already in log. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1338 observations, nested within 90 participants and 16 items.

4.3.4.2 Statistical Analysis

In the response time, we used Reading Time as the dependent variable and fitted a linear mixed-effects model using maximum likelihood, with t-tests computed via Satterthwaite's method with Noun, Number, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used in the comparison can be seen below:

```
model1 <- lmer (Log ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)

model2 <- lmer (Log ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)
```

A comparison of nested models with ANOVA²¹ revealed that including a three-way interaction and without interaction showed that the best fitting model included the three-way

²¹ Other models were also done in order to explore possible effects for noun alone and quantifier alone, but these can be checked on GitHub.

interaction between noun, number, and speaker ($\chi^2 = 13.647$, $p < 0.008$). The model's results are displayed below:

Table 4.22 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.78	7.66 – 7.91	<0.001
Noun [U]	-0.12	-0.24 – 0.01	0.063
Number [P]	-0.03	-0.15 – 0.10	0.644
Speaker [BRPL1]	0.03	-0.12 – 0.18	0.674
Noun [U] × Number [P]	0.10	-0.08 – 0.28	0.274
Noun [U] × Speaker [BRPL1]	0.26	0.10 – 0.41	0.001
Number [P] × Speaker [BRPL1]	0.02	-0.13 – 0.17	0.787
(Noun [U] × Number [P]) × Speaker [BRPL1]	-0.20	-0.42 – 0.02	0.073
Random Effects			
σ^2	0.23		
τ_{00} Participant	0.06		
τ_{00} Item	0.00		
ICC	0.21		
$N_{\text{Participant}}$	90		
N_{Item}	16		
Observations	1338		
Marginal R^2 / Conditional R^2	0.021 / 0.225		

Source: designed by the researchers on RStudio.

The model above assessed the effects of Noun, Number, and Speaker on log transformed Response Times. The main effect of Noun Type (edible vs. non-edible) approached marginal significance ($p < 0.063$), suggesting a possible trend for faster response times with non-edible nouns. The interaction between Noun and Speaker was significant ($p <$

0.001), indicating that the effect of noun type differed between BRPL1 and ENGL1 speakers. The three-way interaction was marginally significant ($p < 0.078$). No other main effects or interactions were statistically significant.

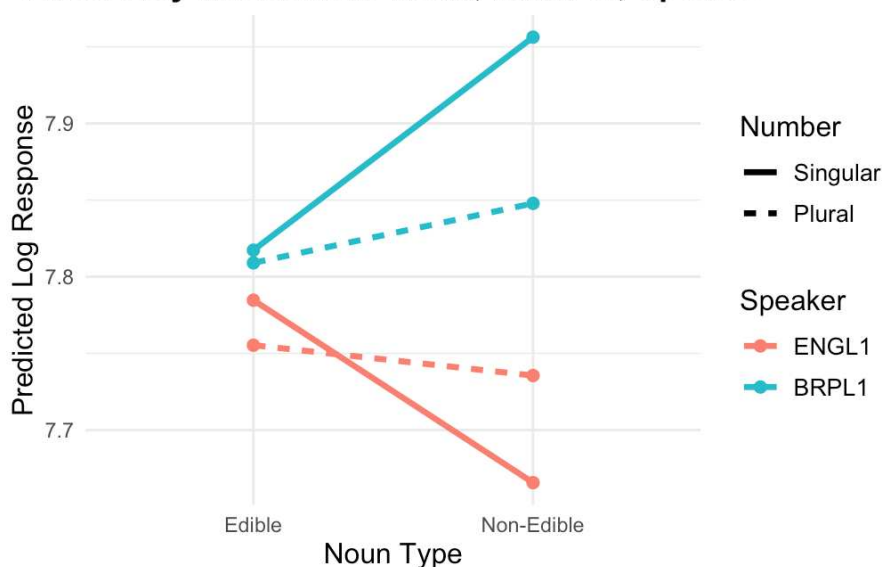
A Bonferroni correction was applied in the post-hoc analysis to account for multiple comparisons. Once again, we will only focus on the source of the possible mismatch between BrP and English which is the acceptability of Edible + Singular (E+S) and Non-Edible + Singular (U+S) between Brazilian Portuguese (BRPL1) and English (ENGL1). The other two conditions with bare plurals are not relevant. Below, we present the pairwise comparison:

contrast	estimate	SE	df	t.ratio	p.value
E S ENGL1 - U S ENGL1	0.11903	0.0642	1245	1.854	1.0000
E S ENGL1 - E P ENGL1	0.02936	0.0636	1244	0.462	1.0000
E S ENGL1 - U P ENGL1	0.04914	0.0642	1247	0.765	1.0000
E S ENGL1 - E S BRPL1	-0.03263	0.0782	228	-0.417	1.0000
E S ENGL1 - U S BRPL1	-0.17160	0.0782	228	-2.195	0.8173
E S ENGL1 - E P BRPL1	-0.02436	0.0783	229	-0.311	1.0000
E S ENGL1 - U P BRPL1	-0.06316	0.0782	228	-0.807	1.0000
U S ENGL1 - E P ENGL1	-0.08967	0.0645	1244	-1.390	1.0000
U S ENGL1 - U P ENGL1	-0.06989	0.0651	1245	-1.074	1.0000
U S ENGL1 - E S BRPL1	-0.15166	0.0790	236	-1.919	1.0000
U S ENGL1 - U S BRPL1	-0.29063	0.0790	236	-3.681	0.0081
U S ENGL1 - E P BRPL1	-0.14339	0.0791	237	-1.813	1.0000
U S ENGL1 - U P BRPL1	-0.18219	0.0790	236	-2.306	0.6159
E P ENGL1 - U P ENGL1	0.01979	0.0645	1245	0.307	1.0000
E P ENGL1 - E S BRPL1	-0.06199	0.0785	231	-0.790	1.0000
E P ENGL1 - U S BRPL1	-0.20095	0.0784	230	-2.562	0.3090
E P ENGL1 - E P BRPL1	-0.05371	0.0785	232	-0.684	1.0000
E P ENGL1 - U P BRPL1	-0.09252	0.0785	231	-1.179	1.0000
U P ENGL1 - E S BRPL1	-0.08178	0.0790	236	-1.035	1.0000
U P ENGL1 - U S BRPL1	-0.22074	0.0790	236	-2.795	0.1571
U P ENGL1 - E P BRPL1	-0.07350	0.0791	237	-0.930	1.0000
U P ENGL1 - U P BRPL1	-0.11230	0.0790	236	-1.421	1.0000
E S BRPL1 - U S BRPL1	-0.13896	0.0454	1250	-3.060	0.0632
E S BRPL1 - E P BRPL1	0.00828	0.0456	1250	0.182	1.0000
E S BRPL1 - U P BRPL1	-0.03053	0.0455	1249	-0.671	1.0000
U S BRPL1 - E P BRPL1	0.14724	0.0455	1251	3.235	0.0350
U S BRPL1 - U P BRPL1	0.10844	0.0454	1255	2.387	0.4801
E P BRPL1 - U P BRPL1	-0.03880	0.0456	1248	-0.851	1.0000

Pairwise contrasts among the four conditions revealed few significant differences. The comparison between Non-edible + Singular (E+U) nouns between BrP and English was significant ($\beta = -0.29063$, $SE = 0.0790$, $z = -3.681$, $p < 0.008$) revealing that non-edible bare singular nouns has longer response times in BrP. This effect might reveal that the non-edible bare singular nouns are still receiving wrap-up reasoning in which the participant in assessing other sources of information, such as pragmatic ones while assigning that the structure is acceptable in the language. In contrast, the effect for English might reveal the assigning the rate of the acceptability of the non-edible bare singular noun in English has shorter response times since the structure is totally ungrammatical, leaving no doubts regarding the acceptability of the nouns. Additionally, the condition E+S between BrP and English did not reach statistical significance, indicating that there was not a difference between the time both groups took to assign the rating value. Next, we take a look at the values predicted by the model.

Graph 4.13 — Values predicted by the model for the response time in log for English and BrP

Three-Way Interaction: Noun, Number, Speaker



Source: designed by the researcher on RStudio.

The graph above displays the three-way interaction among Noun, Number, and Speaker on the predicted Response Times in log values. By observing the behaviour of English speakers, non-edible nouns have lower response times than edible nouns, especially in the singular form, represented by the solid lines, which shows a noticeable drop in the predicted log response times. This suggests that non-edible singular nouns, and bare singular in general,

are less acceptable for this group. The plural forms, represented by the dashed lines, show a smaller difference between edible and non-edible nouns.

Now, looking at the behaviour of BrP speakers, the opposite trend is observed. They show higher response times for non-edible nouns, especially in singular form. Singular non-edible nouns receive the highest predicted reading times overall, indicating that native speakers of BrP are more receptive to this structure than native speakers of English. The plural forms also show higher response times for non-edible nouns compared to edible ones, but the difference is less pronounced.

In summary, the three-way interaction suggests that language modulates the interaction between semantics, represented by the noun type, and morphosyntax, represented by number. While English speakers penalize bare singular nouns, BrP speakers do not — and even show a reversed pattern. This could reflect cross-linguistic differences in how quantity and individuation are encoded in these two languages.

Next, we take a look on the summary of the findings for this group comparison.

4.3.5 Summary of the Key Findings from Group Comparison 1

The table below provides an overview of the statistical analysis results for Group Comparison 1.

Table 4.23 — Summary of key findings from group comparison 1 (Native Speakers)

Number	Noun	Probability	Response Time
Bare Singular	Edible	It has greater probability of being accepted in BrP than English	=
	Non-Edible	It has greater probability of being accepted in BrP than English	It is slower for BrP
Bare Plural	Edible	=	=
	Non-Edible	=	=

Source: designed by the researchers.

Observations: The symbols mean: (=) we did not find statistically significant effect. The reference value for comparison is English.

- The model including the interaction between noun type, number, and speaker was not statistically significant for the acceptability judgment, but it showed a better fit than the model without interactions. Post hoc analyses revealed that edible bare singular nouns were more acceptable in BrP than in English. Additionally, non-edible bare singular nouns were also more acceptable in BrP. Both effects were statistically significant, indicating a mismatch between BrP and English;
- Regarding response times, only the non-edible singular noun had a statistically significant effect, showing that non-edible bare singular nouns generated longer response times in BrP than in English;
- In a nutshell, there is a mismatch between the acceptability of edible and non-edible bare singular nouns in BrP and English;
- The effect of this mismatch was noticeable in the response times only when contrasting non-edible bare singular nouns between the two groups.

4.3.6 General Discussion

Statistical analysis comparing native speakers of BrP and native speakers of English revealed sufficient power to support the claim that there is a mismatch between the two languages with respect to the bare singular. This difference is evidenced in the acceptability ratings, which show a distinct pattern across the two groups. At the surface level, the results indicate that the acceptability of bare singular nouns differs significantly between the two languages.

In English, edible bare singular nouns are ungrammatical, though they can be interpreted via coercion. Although acceptability judgments do not directly reflect the online processing involved in coercion, the effects are evident in acceptability patterns. Nouns in English enter the derivation already carrying atomicity (BEVILÁQUA; PIRES DE OLIVEIRA, 2019; PIRES DE OLIVEIRA; BEVILÁQUA, 2020; PIRES DE OLIVEIRA, 2020, 2025). That

is, a noun like ‘apple’ is atomic, while nouns such as ‘water’ — which was not tested in the acceptability task — is mass. When we ask a native speaker of English to interpret a sentence such as ‘The student brought apple from school’ using the bare singular, we force him/her to interpret ‘apple’ as a mass noun, thereby assigning it a volume interpretation. This *change* from a cardinal to a volume reading, disrupts acceptability because it conflicts with the noun’s primitive meaning. Frisson and Frazier (2005) claim that this change from count to mass and vice versa is a lexical derivational rule, while for Chierchia (1998) is a semantic operation.

The coercion of nouns based on edibility is well documented, even though it is a costly process (LINK, 1983; FRISSEON; FRAZIER, 2005), and it reflects the ungrammaticality of the structure. Accordingly, the acceptability of non-edible nouns is even lower when we examine the results from English, indicating that such structures are completely ungrammatical.

The scenario is different for BrP. In BrP, acceptability ratings show little variation across conditions in the percentages, reflecting that the semantics of bare singular nouns differ from those in English. Bare singular nouns in BrP are grammatical and come underspecified for atomicity (PIRES DE OLIVEIRA, 2025). When participants encounter a bare singular noun in the sentence, the interpretation remains underspecified for atomicity — that is, the root remains underspecified waiting to receive a cardinal or volume interpretation latter on in the derivation (PIRES DE OLIVEIRA, 2020, 2022, 2025). The higher response times for singular non-edible nouns may serve as evidence that underspecification for atomicity is not costly in terms of processing. However, later stages of reasoning — such as generating a response — may involve a trade-off, ultimately requiring more time for the speaker to interpret such structures.

Even though response times contributed little to each individual study in the group comparison, a post hoc analysis revealed a clear difference for non-edible bare singular nouns between BrP and English. This suggests that, in BrP, participant’s reasoning come into play after a non-edible bare singular noun is encountered in a sentence. The additional time spent deciding where on the acceptability scale to rate the sentence may reflect that conscious access to linguistic knowledge and grammar is activated, and might also capture pragmatic reasoning. In English, the fast response times for this condition indicate that the structure is entirely ungrammatical, and little can be done to save the interpretation of the sentence.

These differences between the two languages reflect a semantic contrast, which was captured by the AJT and made explicit in this Group Comparison through statistically significant differences between the language groups. Specifically, our results show that BrP does not encode atomicity in bare singular nouns, as both edible and non-edible bare singulars

were accepted by BrP speakers. In contrast, English appears to encode atomicity, as native speakers of English quickly reject bare singulars in argument positions

Taken together, our findings provide sufficient evidence to reject the null hypothesis, as we identified semantic differences between the two languages that are reflected in the nature of nouns and in their acceptability patterns. Therefore, the results do not refute our working hypothesis, since edible and non-edible bare singular nouns in BrP are accepted while in English the acceptability of edibles are lower and even lower for non-edibles. This goes in line with the mismatch proposal that is prominent in the nominal domain investigated in this study, reflecting semantic distinctions between BrP and English, as discussed. The mismatch between BrP and English is headed by bare singular nouns. Next, we revisit our RQs in the light of our results and discussion:

RQ1. Are there differences (or mismatches) in the acceptability patterns between BrP and English? *Yes, there are. Bare singular nouns have higher tendency of being accepted and receive higher ratings in Brazilian Portuguese than in English. More specifically, edible bare singular and non-edible bare singular nouns are more accepted in BrP than in English. This difference is statistically significant.*

RQ2. Are there differences (or mismatches) in response times patterns between BrP and English? *Yes, there is. Non-edible bare singular nouns generate longer response times in Brazilian Portuguese than in English. In Brazilian Portuguese, different sources of information might be playing a role in the post processing decision of response times. In contrast, English generates faster response times since non-edible bare singular nouns are not grammatical, reflecting a fast rejection of the structure.*

4.3.7 Conclusion

This group comparison reveals differences between BrP and English bare nouns, particularly in the acceptability bare singular nouns. The results show that bare singulars — both edible and non-edible — are significantly more accepted in BrP than in English, confirming a grammatical mismatch between the two languages. These acceptability differences are mirrored in trend of response time patterns: while English speakers quickly

reject ungrammatical non-edible bare singulars, BrP speakers take longer to process them, possibly due to the involvement of additional interpretive mechanisms during post-processing. Overall, these findings provide empirical support for a cross-linguistic contrast in how bare nouns are evaluated, contributing to our understanding of how languages encode semantic distinctions such as atomicity.

4.4 EXPERIMENT 3 — ASSESSING THE ACCEPTABILITY OF BARE NOUNS FOR BILINGUALS

4.4.1 Introduction

The literature behind this experiment is supported by a series of studies, including Pires de Oliveira (2022) and Frisson and Frazier (2005), but draws primarily on Slabakova (2016) and Grosjean (2008), which provide a theoretical foundation for understanding the bilingual interface of the phenomenon under investigation. As observed in Group Comparison 1, our statistical tests showed an effect with bare nouns — more specifically, edible and non-edible bare nouns have higher probabilities of being accepted in BrP than in English. This provided statistical support for our mismatch claim. As a result, we continue to investigate the phenomenon through the lens of bilingualism, aiming to verify whether the mismatch between these two languages results in L1-to-L2 transfer — that is, whether native speakers of BrP learning English as an L2 exhibit acceptability judgment behavior in English that is similar to that of BrP native speakers. This would provide evidence of transfer in the context of the observed cross-linguistic mismatch.

Based on the theoretical support of Slabakova's hypothesis, we expect that bilinguals, in their early and intermediate stages of L2 acquisition, will behave according to their L1 in respect to the acceptability of bare singular nouns in English — which is the source of the mismatch between these two languages. According to the author, when mismatches between languages occur, beginners and intermediate learners will rely on their existing knowledge of their L1, effectively transferring it. The RQs guiding this specific experiment are presented as it follows.

4.4.1.1 Specific Research Questions

RQ1. Are bare singular nouns in English accepted by bilinguals?

RQ2. Is there a difference in acceptability of edible and non-edible nouns by bilinguals?

RQ3. Is there a difference in acceptability between plural and singular edible nouns by bilinguals?

RQ4. Are response times longer for edibles or non-edibles for bilinguals?

RQ5. Are response times longer for bare singulars or bare plurals for bilinguals?

4.4.1.2 Hypothesis (H) and Predictions (P) Regarding the Acceptability of Bare Singular Nouns

H0. Our null hypothesis is based on the expected effect of the linguistic manipulation within the bilingual group. In this sense, no differences between edible and non-edible nouns in English are predicted when judged by bilinguals. Accordingly, no differences in response times between conditions should be observed. In other words, we expect no effect of the manipulated variables.²²

P0. If the null H is true, bilingual participants should not show statistically significant differences in acceptability judgments or response times between edible and non-edible nouns in English.

H1. Assuming the Bottleneck Hypothesis (BH) from Slabakova (2016), bilinguals transfer their L1 knowledge to their L2 when mismatches between languages occur. Consequently, bilinguals are expected to maintain L1 acceptability patterns when encountering the same structure in L2. In other words, bare singular nouns would be considered acceptable in English.

P1. We predict a difference in acceptability between edible and non-edible bare singular nouns, with edible nouns being more acceptable than non-edible ones (PIRES DE OLIVEIRA; SILVA; BRESSANE, 2010; BRAGA; SENA; MARIANO; PIRES DE OLIVEIRA, 2010). Additionally, a difference in acceptability is expected between bare singulars and bare plurals due to conscious access to grammatical knowledge, such that bare singulars may be slightly less acceptable than bare plurals (IONIN; GROLLA; MONTRUL; SANTOS, 2018). Longer response times are also anticipated for non-edible bare singulars compared to edible bare plurals, reflecting increased response

²² We acknowledge that differences were found for native speakers of BrP in Experiment 1 and for English in Experiment 2, and thus differences in the manipulated conditions are to be expected. However, to maintain the coherence and rigor of our experimental design, we retain the null hypothesis expecting no effect for the manipulated variables.

times. Despite these differences, all bare nouns are generally expected to be accepted.

H2. An alternative hypothesis is that bilinguals will not accept bare singulars but will accept bare plurals. In English, bare singulars are ungrammatical, though they may undergo coercion in edible contexts, reflecting reduced acceptability in argument positions (FRISSEON; FRAZIER, 2005).

P2. We predict low acceptability for bare singular nouns as arguments, while bare plurals should show high acceptability. No significant differences in response times are expected across conditions, consistent with the results from Experiment 2.

In summary, we adopt Hypothesis 1 as our working hypothesis, as it suggests that there will be no major differences in acceptability between bare singulars and bare plurals. This is one of the most important experiments of the current research, being the experimental group, as it helps to investigate the bilingual acceptability of bare singular nouns; therefore, enabling us to infer whether there is a transfer in the nominal domain from the L1 to the L2 where there is language mismatch. In the next subsection, we present the specific method used to run this experiment.

All materials used in this experiment, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub²³.

4.4.2 Method

4.4.2.1 Participants

A total of 29 voluntary native speakers of BrP took part in this experiment, with a mean age of 30.8 years ($SD = 8.9$). Of these participants, six reported having previously studied linguistics, while 23 had not. All participants took part in the study online, receiving the link to participate via e-mail. Additionally, all participants indicated in the questionnaire that BrP was their first language. Participation was voluntary, and no compensation was provided. All

²³ Data analysis materials and raw results are available at <https://github.com/deardiones/AJT-Bilinguals.git>

bilingual participants were intermediate learners of English, as determined by the placement test, and in this experiment, they completed the study in English.

4.4.2.2 Instruments

The main instrument in this study was an AJT programmed in PCIBex, as discussed in the Method section. This experiment followed a 2x2 factorial design, in which we manipulated the independent variables: number (singular/plural) and noun type (edible/non-edible). In this study, all nouns under investigation were countable. The dependent variables were the acceptability judgment value (ordinal) and response time (in milliseconds). This resulted in a total of 4 lists with 16 target sentences, randomized with 32 distractor items in a within-subject design in which the singular nouns were the experimental while the plural nouns were the control ones. The set of experimental conditions for this study is presented below and are the same as the ones used for the native speakers of English, which is Experiment 2:

32. Experimental Condition: Edible Singular (E+S)

a) The student brought pear from the fair.

Experimental Condition: Non-Edible Singular (U+S)

b) The student brought book from the fair.

Control Condition: Edible Plural (E+P)

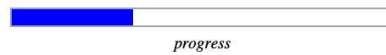
c) The student brought pears from the fair.

Control Condition: Non-Edible Plural (U+P)

d) The student brought books from the fair.

Each sentence was displayed alone, without the scale, but with a “Rate” button below. After reading the sentence, the participant had to click on the button for the Likert scale with five points to appear with a “Next” button below. At the onset of the scale, up to the point the participant clicked on the “Next” button, the response time was recorded. Figures 4.5 and 4.6 display an example on how the sentences and scale appeared on the screen for the participant:

Figure 4.5 — Sentence display



The student bought pears at the fair.

Rate

Source: designed by the researchers and extracted from the experiment at PCIBex.

Figure 4.6 — Scale display



The student bought pears at the fair.

Rate

Would you say such sentence?

I would never say that ○ ○ ○ ○ I would totally say that

Source: designed by the researchers and extracted from the experiment at PCIBex.

The scale would include information only at the extreme points, such as “I would never say that” and “I would totally say that”, indicating the chance of the participant utter sentences as the ones displayed in the experiment. Next, we move to the predictions of this experiment.

4.4.2.3 Predictions

We present Table 4.24 below, which summarizes the predictions for the acceptability of the investigated sentences and the response time for each condition of this experiment. Note that the predictions are based on our working hypothesis in which we might observe transfer from the L1 to the L2, therefore, the predictions are the results from Experiment 1 for BrP.

Table 4.24 — Predictions for acceptability and response time for each condition

Condition	Speakability	Response Time
Edible + Singular	4	Fast
Non-edible + Singular	3	Slower
Edible + Plural	4	Fast
Non-edible + Plural	4	Fast

Source: designed by the researchers.

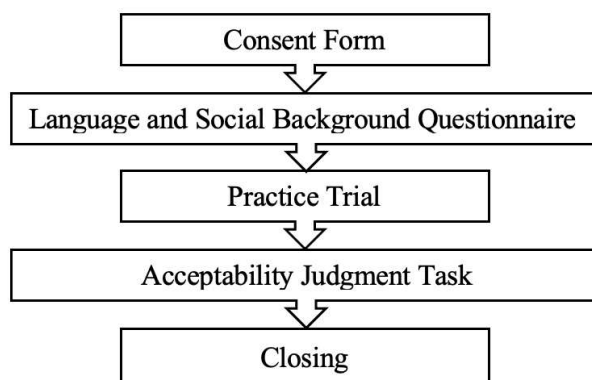
Assuming Slabakova (2016), we do not expect bilinguals to behave differently from their L1. Since the proficiency level of the bilingual group is intermediate, according to the Bottleneck Hypothesis, at this level of language acquisition, the mismatches between syntax and semantics are not fully acquired. Therefore, their language acceptability patterns and response times may resemble the same patterns of their first language.

4.4.2.4 Procedures

Each participant voluntarily contacted the researcher by e-mail, signaling their willingness to take part in the study. In the first e-mail, the researcher asked if s/he were 18 years old or above and if they spoke English as a second language. If they did not speak English, they would receive the link to take the AJT in the following e-mail. If the participant were a second language speaker of English, in the following email, s/he would receive a leveling task from the Cambridge Website and they would be instructed to send a print of their result to the researcher by email. If the level fell between A1, A2, C1, or C2, the participant took the task in BrP. If the level fell between B1 and B2, the participant was invited to take the task in English.

After checking the English level corresponding to B1 or B2, the participant received a link from PCIBex, in which the study would occur. Upon clicking the link, the following sequence of the study was presented to them:

Flowchart 4.4 — Presentation order



Source: designed by the researchers.

The first prompt on the laptop screen was the Consent Form (Appendix C) in which the participant encountered the TCLE²⁴, which is Consent Form approved by the CEPESH-UFSC²⁵ in their first language. The participant was invited to read it and agree by clicking in a checkbox at the end of the page. After that, all the information on the platform was displayed in English. After that, a brief instruction screen prepared participants for the upcoming Language and Social Background Questionnaire (Appendix F). As participants selected options on the questionnaire, the next question appeared automatically. After completing the nine questions, participants were presented with the task instructions.

The first eight trials served as practice trials (Appendix L), allowing participants to become familiar with the AJT experiment. After the practice phase, the final instructions were given, followed by 48 trials with 16 being experimental (Appendix H) and 32 distractors (Appendix J).

Upon completing the task, participants saw a thank-you screen, which also provided final instructions on how to save their data. At the end of the experiment, the platform displayed the participant's ID, which they were asked to save and send to the researcher for double-check if the data were correctly saved on the platform.

²⁴ *Termo de Consentimento Livre e Esclarecido*

²⁵ *Comitê de Ética em Pesquisas com Seres Humanos* from *Universidade Federal de Santa Catarina*

4.4.2.5 Data Preparation

Data processing and analysis were all conducted in RStudio.

4.4.2.6 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. We assumed a Cohen's *d* of 0.8 for small groups where a large effect is expected. After adjusting the alpha level to 0.05 and using a sample size of 29, the resulting power was 0.8493645. Thus, we interpret this result as indicating that 84.93% of the outcomes are expected to represent the phenomenon investigated.

4.4.3 Acceptability Judgment Task

The AJT is our main instrument for investigating the acceptability of bare nouns. In the next subsection, we present how the data was processed, along with the statistical analysis.

4.4.3.1 Data Filtering

We began adding two additional columns in the results. One column was called Judgment feed by the Likert scale. That is, the number 1 in the scale was named "Totally Unspeakable", number 2 was named "Unspeakable", number 3 was named "Neutral", number 4 was named "Speakable", and number 5 was named "Totally Speakable". The second column was added for the Number variable that was feed by the Condition column. That is, the condition edible plural and non-edible plural feed the Number column with the [P] label, representing the plural condition, while the edible singular and non-edible singular feed the column with the [S] label, representing the singular condition. This had to be done manually since the original file with the target items did not include such column. Additionally, there was no outliers were removal from the AJT. Below, we present the mean and standard deviation for each condition, based on the scale ratings.

Table 4.25 — Means and standard deviation for each condition

Condition	Mean	Standard Deviation
Edible + Singular	3.094828	1.537804
Non-edible + Singular	2.767241	1.551200
Edible + Plural	4.172414	1.166756
Non-edible + Plural	4.327586	1.125019

Source: designed by the researchers.

The table above displays the mean ratings and standard deviations provided by participants for each condition. There is a tendency for edible bare plurals and non-edible bare plurals to be equally well accepted. However, the acceptability for bare singulars nouns is lower than the bare plural conditions. Additionally, we observe variation in bare singulars, as reflected in the standard deviation values, indicating uncertainty regarding the acceptability of bare singulars. Next, we present two additional tables with the means for each variable from the study:

Table 4.26 — Means for the variable Noun

Noun	Value
Edible	3.633621
Non-Edible	3.547414

Source: designed by the researchers.

Table 4.27 — Means for the variable Number

Number	Value
Plural	4.250000
Singular	2.931034

Source: designed by the researchers.

In general, bare plurals are accepted while bare singulars do not show acceptance. Now, we present the chances of bare singular being uttered in each condition in terms of speakability in percentage:

Table 4.28 — Percentage of speakability per condition

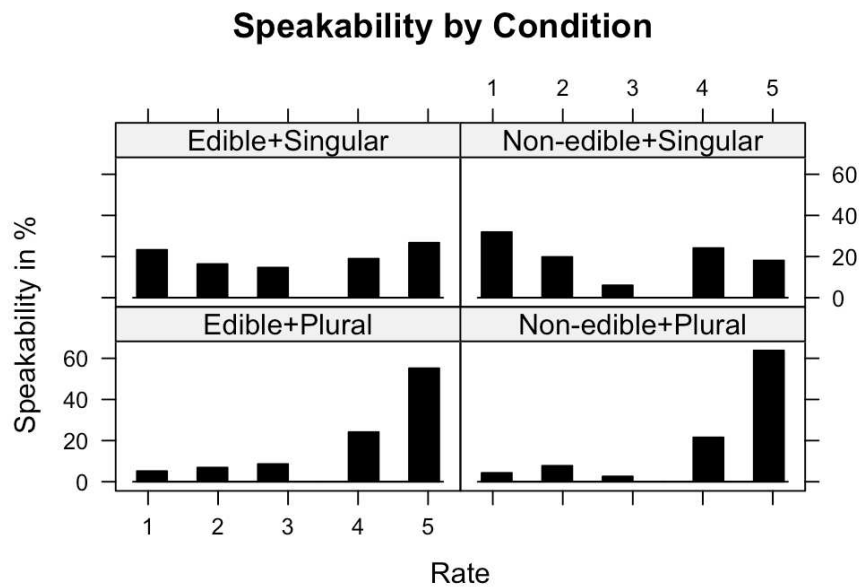
Condition	Totally Unspeakable	Unspeakable	Neutral	Speakable	Totally Speakable
Edible + Singular	23.3%	16.4%	14.6%	19.0%	26.7%
Non-edible + Singular	31.9%	19.9%	6%	24.1%	18.1%
Edible + Plural	5.1%	6.9%	8.7%	24.1%	55.2%
Non-edible + Plural	4.4%	7.8%	2.5%	21.6%	63.7%

Source: designed by the researchers.

The table above shows that less than half of the participants judged edible bare singulars as totally speakable 26.7% or speakable 19.0%. Taken together, these percentages indicate that edible bare singular nouns are 45.7% acceptable by bilinguals, while 39.7% of participants did not consider the structure acceptable. Non-edible bare singulars were judged as totally speakable by 18.1% of participants and as speakable by 24.1%, resulting in a 42.2% acceptance rate. In contrast, 51.8% of participants did not view this structure something they would say. Taken these raw values, we can already observe a tendency that bare singulars are somewhat accepted in English through the lenses of a bilingual. However, the percentages are balanced whether or not they consider grammatical, showing a level of uncertainty.

When examining bare plurals, edible bare plurals were rated as totally speakable by 55.2% of participants and as speakable by 24.1%, resulting in an overall acceptability rate of 79.3%, with only 12% finding them unacceptable. Non-edible bare plurals were judged as totally speakable by 63.7% and as speakable by 21.6%, totaling 85,3% acceptability, while 12.2% considered them unacceptable. Below, we preset the first graph which illustrates the rate of speakability per condition.

Graph 4.14 — Speakability per condition in percentages



Source: designed by the researchers on RStudio.

By observing the graph data, the percentages suggest that Number (singular vs. plural) has a stronger effect on perceived speakability than Edibility. Plural nouns, whether edible or not, were consistently rated as more speakable than their singular counterparts. Edibility, in contrast, did not lead to substantial differences in the distribution of ratings. In the next subsection, we present the statistical analysis regarding the acceptability of bare nouns in English.

4.4.3.2 Statistical Analysis

The statistical analysis was also conducted on RStudio and we used a cumulative link mixed model fitted with LaPlace approximation, which is mostly used for ordinal response data for Likert scale studies. In addition, we used the [S] singular as our reference value for the Number variable, [E] edible as our reference value for the Noun variable, and [E+S] Edible + Singular as our reference value for condition.

A Cumulative Link Mixed Model (CLMM) was fitted using the Laplace approximation to examine the effect of Condition on Judgment Value. The model included random intercepts for Participants and Items. The model used can be seen below:

```

modell1 <- clmm (Value ~ Noun * Number + (1 | Participant) + (1
| Item), data = dataajt1)

modell2 <- clmm (Value ~ Noun + Number + (1 | Participant) + (1
| Item), data = dataajt1)

```

To assess whether the interaction between Noun and Number significantly improved model fit, we compared a model 1 with the interaction to model 2 with only the main effects using a likelihood ratio test. The comparison revealed that including the interaction significantly improved the model fit ($\chi^2 = 5.27$, $p < 0.022$). This suggests that the effect of Number on acceptability ratings depends on the type of Noun, supporting the presence of an interaction between these two factors. The model's results can be checked below:

Table 4.29 — Model's results

<i>Predictors</i>	Value		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Noun [U]	0.60	0.37 – 0.96	0.034
Number [P]	5.19	3.06 – 8.80	<0.001
Noun [U] × Number [P]	2.34	1.13 – 4.86	0.022
Random Effects			
σ^2	3.29		
τ_{00} Participant	0.84		
τ_{00} Item	0.26		
ICC	0.25		
$N_{\text{Participant}}$	29		
N_{Item}	16		
Observations	464		
Marginal R^2 / Conditional R^2	0.204 / 0.403		

Source: designed by the researchers on RStudio.

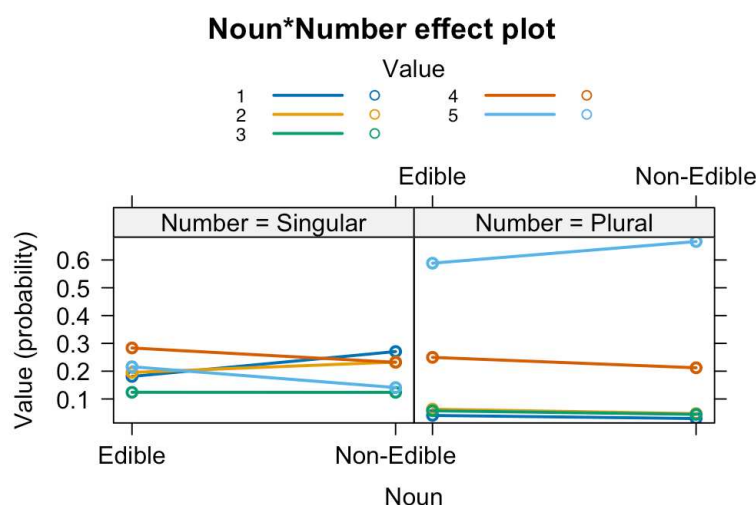
The model's results highlights that besides the interaction effects between Noun and Number, there were also main effects for Noun ($\beta = -0.52$, $SE = 0.24$, $z = -2.12$, $p < 0.034$)

indicating that non-edible nouns were rated as less acceptable than edible noun, and also a significant main effect for Number ($\beta = 1.65$, $SE = 0.27$, $z = 6.12$, $p < 0.001$) showing that plural forms were rated more acceptable than singular forms across conditions. A Bonferroni correction was applied to further explore the interaction between Noun and Number and can be checked below:

contrast	estimate	SE	df	z.ratio	p.value
E S - U S	0.517	0.244	Inf	2.121	0.2037
E S - E P	-1.647	0.269	Inf	-6.121	<.0001
E S - U P	-1.982	0.276	Inf	-7.177	<.0001
U S - E P	-2.164	0.274	Inf	-7.903	<.0001
U S - U P	-2.499	0.284	Inf	-8.804	<.0001
E P - U P	-0.335	0.278	Inf	-1.203	1.0000

Pairwise contrasts among the four conditions revealed several significant differences, showing a clear effect for number. The comparison between Edible + Singular (E+S) and Edible + Plural (E+P) expresses the effect for Number ($\beta = -1.647$, $SE = 0.269$, $z = -6.121$, $p < .0001$), indicating that singulars have lower probability of getting higher judgment values when compared to plural ones. Thus, the comparison between Non-Edible + Singular (U+S) and Non-Edible + Plural (U+P) expresses the effect of Number as well ($\beta = -2.499$, $SE = 0.284$, $z = -8.804$, $p < .0001$), showing that non-edible nouns received higher acceptability ratings when presented in the plural form compared to the singular form. The other pairwise comparisons either did not reach statistical significance or were not theoretically relevant. Next, we present Graph 4.15 with the probability of getting higher ratings for each condition.

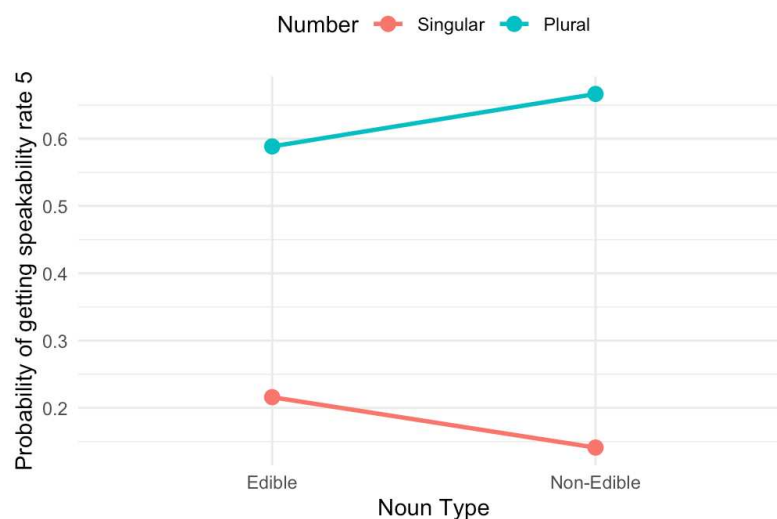
Graph 4.15 — Probability of getting higher rating condition



Source: designed by the researchers on RStudio.

This plot above shows the predicted probabilities of speakability ratings (from 1 to 5) Noun types (Edible vs. Non-edible) and Number (Singular vs. Plural). For bare singular nouns, the ratings are fairly evenly distributed, with no strong preference for any specific value. In contrast, for plural nouns, there is a clear preference for rating 5, especially with non-edible items. This suggests that the plural inflection of nouns increases the probability of a bare plural to be spoken, while edibility has little effect. Since the interaction is not clear cut in the graph above, we decided to isolate the probability of getting a rate 5 for all conditions. The graphs can be checked as it follows:

Graph 4.16 — Probability of getting rating 5 for each condition



Source: designed by the researchers on RStudio.

This time the graphs indicates that we have higher probabilities of getting rate 5 for edible nouns than for non-edible plural nouns. The interaction reveals that when the noun is singular, the edible noun is better than the non-edible nouns; while when the noun is plural, the non-edible is better than the edible. Plural nouns show higher probabilities of receiving a speakability rating of 5, especially for non-edible items. In contrast, singular non-edible nouns are least likely to be rated as highly speakable. This indicates a crossover interaction: plurality enhances. Next, we present the response time.

4.4.4 Response Time

The response time in the AJT allows us to infer aspects of language acceptability after processing, as it indicates the time taken by participants to determine whether the sentences they have read are speakable or not. This data may enhance our understanding of English and the acceptability of the edible and non-edible bare nouns.

4.4.4.1 Data Treatment

The data treatment was divided into two parts. In the first phase, we removed six non-native speakers of English and added the two columns as we did for the AJT. Next, we isolated the necessary information from the raw table extracted from PCIBex. This information included: participant, group, label, item, condition, number, noun, T1, T2 and RT. T1 was the onset of the Likert scale display, up to the point of the participant clicked on “Next” and the RT was the time that the participant took to make his/her decision.

In the second phase, we checked the filtered data to check for distribution and normality. We considered the data to be well-distributed when the graph visually formed a bell curve, with the data clusters concentrated near the center, representing the mean. The closer the clusters were to the center and the fewer they were at the edges, the more well-distributed the data appeared. Thus, we considered the data to be normal if the Shapiro-Wilk Test yielded a p-value greater than 0.05, indicating that the null hypothesis of normality could not be rejected. Since linear models do not require the data to be normally distributed, we prioritized examining the distribution over assessing normality. If the data appeared normal, it was merely a result of the underlying distribution.

The filtered data did not meet the criteria for neither for normality nor distribution. Therefore, the first treatment was done with the interquartile range (IQR)²⁶ in which we measured statistical dispersion, calculating the difference between the third quartile (Q3) and the first quartile (Q1) with the first treatment with a more conservative range 3 resulting in an upper limit of 14708. After checking the distribution and the normality tests, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 9854. After reviewing the graphs and conducting normality tests, we concluded that the data still did not follow a normal distribution, nor was it normal according to the tests. We then proceeded with a logarithmic transformation. Following the transformation, the data distribution improved, but the data was still not normal (Shapiro-Wilk: $W = 0.98512$, $p\text{-value} = 0.0002477$)²⁷. In this way, we decided to keep with the log transformed data, prioritizing the distribution.

Finally, we checked the residuals for normality (Shapiro-Wilk: $W = 0.98515$, $p\text{-value} = 0.0002517$)²⁸ which shows that the data is not normal. Additionally, we checked distribution, which signaled that somewhat the data was well distributed.

Removing the outliers from the sample resulted in 423 observations from the original 464, a reduction of 41 observations, representing 8.83% of the sample. The conditions that lost the most data was edible + plural and non-edible + singular, with 13 data points each, followed by edible + singular, which lost 10 data points. The conditions that preserved more data were non-edible + plural, losing 5 data points. After this treatment, we plotted the table with the means and standard deviations in milliseconds, which can be reviewed above for each condition:

Table 4.30 — Treated means and standard deviation for each experimental condition in the response time

Condition	Mean	Standard Deviation
Edible + Singular	3410.425	2180.627
Non-edible + Singular	3166.680	2001.498
Edible + Plural	3103.602	1971.953
Non-edible + Plural	3310.802	1963.070

Source: designed by the researchers.

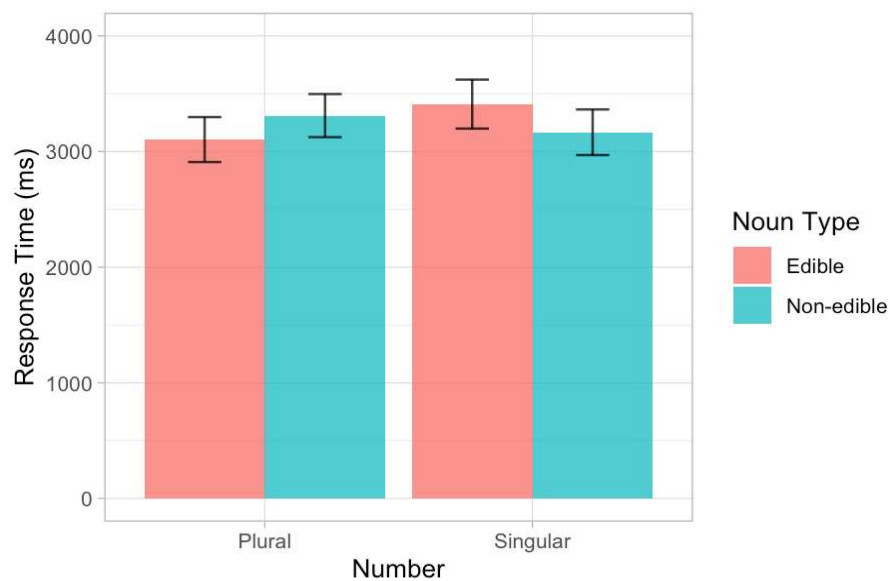
²⁶ The equation for the IQR is $Q3 + X*(Q3 - Q1)$

²⁷ Kolmogorov-Smirnov: $D = 0.041977$, $p\text{-value} = 0.07118$

²⁸ Kolmogorov-Smirnov: $D = 0.041487$, $p\text{-value} = 0.07795$

By checking the table above, we can observe that the means are quite stable across conditions, with the fastest being the Edible + Plural being 243.745 milliseconds faster than the Edible + Singular condition. In contrast, the Edible + Plural condition is 207.2 milliseconds faster than the Non-Edible + Plural condition. After that, we plotted the first graph in which the means and standard deviation of the response time are visualized. The graph is available below:

Graph 4.17 — Response Time means and standard deviation in milliseconds



Source: designed by the researchers on RStudio.

Based on the above graph, the response times are fairly similar across conditions, suggesting a small interaction. For plural nouns, responses were faster for edible than non-edibles. In contrast, for singular nouns, the pattern is reversed: non-edible nouns elicited faster responses than edible ones. This suggests that there is an interaction between noun and number in response times. We will check this potential influence in the Statistical Analysis subsection. Next, we move to the statistical analysis.

4.4.4.2 Statistical Analysis

The statistical analysis was conducted in RStudio, where we used a linear mixed model fit by maximum likelihood to account for both fixed and random effects across groups. Additionally, a t-test using Satterthwaite's method was applied to compare the means between two groups and determine if they were significantly different from each other. In addition, we

kept using the [S] singular as our reference value for the Number variable, [E] edible as our reference value for the Noun variable.

Using the logarithm of response time as a dependent variable, we fitted a mixed linear model with Noun, Number, and the interaction between these two factors as fixed effects, alongside random intercepts for each participant and item. The models used can be checked below:

```
model1 <- lmer (log ~ Number * Noun + (1|Participant) +
(1|Item), data = datart, REML = FALSE)
```

```
model2 <- lmer (log ~ Number + Noun + (1|Participant) +
(1|Item), data = datart, REML = FALSE)
```

```
model3 <- lmer (log ~ Number + (1|Participant) + (1|Item), data
= datart, REML = FALSE)
```

```
model4 <- lmer (log ~ Noun + (1|Participant) + (1|Item), data
= datart, REML = FALSE)
```

To assess whether the interaction between Noun and Number significantly improved model fit, we compared a model 1 with the interaction to model 2 with only the main effects using a likelihood ratio test. The comparison revealed that including the interaction did not significantly improve the model fit ($\chi^2 = 1.8213$, $p < 0.1772$).

Additional nested models with ANOVA were carried out. Removing the Noun variable as fixed effect and comparing it to the model without the interaction which also did not improve model fit ($\chi^2 = 0.0024$, $p < 0.9613$) and neither removing the Number variable did not show an improvement in fit ($\chi^2 = 0.0086$, $p < 0.9263$). In this way, to find the best fitting model we decided to check the model that showed the lower AIC and BIC values. Therefore, the best fitting model included only the Number as fixed effect (AIC = 740.15, BIC = 760.38). Next, we can check the models and the table with the model's results for response time:

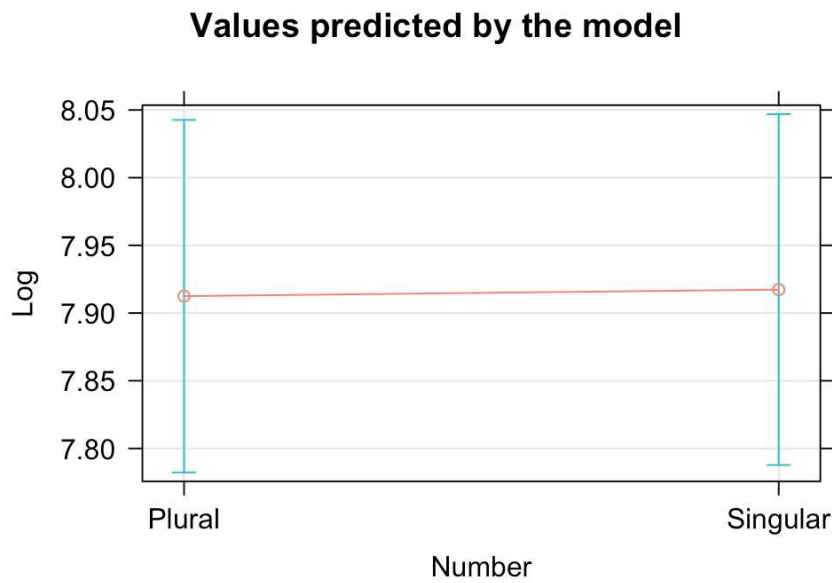
Table 4.31 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.91	7.78 – 8.04	<0.001
Number [P]	0.00	-0.10 – 0.11	0.927
Random Effects			
σ^2	0.29		
τ_{00} Participant	0.08		
τ_{00} Item	0.00		
ICC	0.23		
N Participant	29		
N Item	16		
Observations	423		
Marginal R^2 / Conditional R^2	0.000 / 0.225		

Source: designed by the researchers on RStudio.

The model's result on Noun type is not statistically significant, suggesting that the difference in response times between edible and non-edible was not statistically reliable. Below we can check the graph of the values predicted by the model.

Graph 4.18 — Values predicted by the model for the response time in log



Source: designed by the researchers on RStudio.

This graph visually displays the data from the model's results for Number in log-transformed values response times. While the model predicts slightly faster responses for plural nouns, the difference is minimal. Overall, although there's a small numerical decrease in predicted log RTs for plural nouns, therefore, not support a reliable effect of Number on response time. It is worth mentioning that there was not an effect for Noun on response times. Next, move forward for the summary of the key findings of this experiment along with general discussion of the results.

4.4.5 Summary of the Key Findings from Experiment 3

The table below provides an overview of the data collected for Experiment 3.

Table 4.32 — Summary of key findings from experiment 3 (Bilinguals)

Number	Noun	Mean Rate	Percentage	Probability	Response Time
Bare Singular	Edible	3	45.7%	Less probability between Edibles	=
	Non-Edible	2.7	42.2%	Less probability between Non-Edibles	=
Bare Plural	Edible	4.1	79.3%	More probability between Edibles	=
	Non-Edible	4.3	85.3%	More probability between Plurals	=

Source: designed by the researchers.

- There is an interaction between Noun and Number in the acceptability patterns of bilinguals;
- Overall, bare plural nouns are accepted by bilinguals, just like it is by BrP and English;
- Bare singular nouns tend to be accepted — even though the acceptability and rejection percentages are almost balanced between these two;
- Post hoc analysis revealed an effect for Number, indicating that the acceptability rating tends to decrease when the noun comes in the singular form;
- There were no effects encountered in the statistical analysis for response times;

4.4.6 General Discussion

The results of this experiment need our special attention regarding the acceptability of bare singular nouns in English by bilinguals. The percentages indicate that edible bare singular nouns were judged acceptable by 45.7% of participants, while 39.7% did not consider the structure acceptable. These suggest a trend toward acceptability of edible bare singulars in English among bilinguals.

As for non-edible bare singulars, 18.1% of participants judged them as *totally speakable* and 24.1% as *speakable*, resulting in an overall acceptability rate of 42.2%. In contrast, 51.8% of bilingual participants rejected the structure. Although this rejection rate suggests that non-edible bare singulars are not fully acceptable for bilinguals, their acceptability remains higher than that of native speakers, 80% of whom rejected the same structure.

These findings suggest that bilinguals are, to some extent, influenced by the grammatical representations of their L1 — BrP — when judging the acceptability of bare singular nouns in English. This interpretation aligns with Slabakova's Bottleneck Hypothesis (BH), which posits that the acquisition of functional morphology is a central challenge in second language learning. In this context, the interpretation of bare singulars indicates that the absence of functional morphology carries semantic features that are available in BrP but not in English. This provides further evidence that bilinguals are drawing on their L1 grammar when making acceptability judgments in English.

Therefore, we have sufficient evidence to reject the null hypothesis and support our working hypothesis. Based on the BH proposed by Slabakova (2016), bilinguals are expected to transfer L1 knowledge to their L2, particularly in contexts of cross-linguistic mismatch. Accordingly, we predicted that bilinguals would not show significant differences in acceptability judgments between their L1 and L2 when faced with parallel structures. In other words, we expected them to treat bare singular nouns as acceptable in English — which is a result that we have obtained.

Overall, bare singular nouns were generally accepted by bilingual participants. More specifically, non-edible bare singulars had an acceptability rate of 42.2% among bilinguals, 52.2% in BrP, and only 5.8% in English, suggesting that this condition may be the main driver of transfer effects. We also observed a difference in acceptability between bare singular and bare plural nouns, although response times did not vary significantly across conditions.

Despite some subtle differences, all types of bare nouns were treated as acceptable by bilinguals to some extent — a pattern that was also observed in the native speakers of BrP judging bare nouns. Although the evidence for transfer was not as strong as initially expected, it was still present and noticeable in the data. Group Comparison 2 is expected to provide further statistical support for this trend.

Finally, by previewing our comparison using raw percentages, we observe that in the edible bare singular condition, 45.7% of bilinguals accepted the structure, compared to 77.1% in BrP and 35.8% in English. This suggests that bilinguals adopt a pattern that lies between the two language systems. We now return to our RQs and address them in light of these findings.

RQ1. Are bare singular nouns accepted by bilinguals? *Generally, yes.*

RQ2. Is there a difference in acceptability of edible and non-edible nouns in English by bilinguals? *No, there is not. Although the statistical analysis did not reveal a statistical significance, we could observe a tendency that edible nouns are more accepted than non-edible noun by bilinguals.*

RQ3. Is there a difference in acceptability between plural and singular edible nouns by bilinguals? *Yes, there is. Number is a key factor influencing the acceptability of the nouns. Pluralized nouns are always accepted, while nouns in its singular form have their acceptability hindered.*

RQ4. Are response times longer for edibles or non-edibles for bilinguals? *There was not an effect for response times regarding edibility.*

RQ5. Are response times longer for bare singulars or bare plurals for bilinguals? *There was not an effect for response times regarding number.*

To conclude, we retake our predictions' table, contrasting with our results.

Table 4.33 — Predictions vs results for acceptability and response time for each condition

Condition	Speakability	Speakability	Response Time	Response Time
	<i>Prediction</i>	<i>Results</i>	<i>Prediction</i>	<i>Results</i>
Edible + Singular	4	3.0	Slow	No difference
Non-edible + Singular	3	2.7	Slowest	No difference
Edible + Plural	4	4.1	Fast	No difference
Non-edible + Plural	4	4.3	Fast	No difference

Source: designed by the researchers.

4.4.7 Conclusion

The findings from this experiment provide valuable insights into how bilingual speakers judge bare noun constructions in English. First, bare singular nouns were generally accepted by bilinguals, suggesting some degree of transfer from their L1, BrP. Second, although no statistically significant difference was found between edible and non-edible nouns, there was a tendency for edible nouns to be judged more acceptable, which aligns with patterns observed in native BrP speakers. Third, number emerged as a factor in bilinguals' acceptability judgments: plural nouns were consistently accepted, whereas bare singulars had reduced acceptability, indicating that pluralization facilitates acceptance — something that we have observed in Experiments 1 and 2. However, response times did not reveal significant effects for either edibility or number, suggesting that while acceptability judgments are sensitive to morphosyntactic features, response times are not similarly affected. Taken together, these results support the idea that L1 influence plays a role in L2 grammatical judgments, particularly in contexts where morphosyntactic mismatches between the two languages arise.

4.5 GROUP COMPARISON 2 — INVESTIGATING TRANSFER FROM BRAZILIAN PORTUGUESE L1 TO ENGLISH L2

4.5.1 Introduction

The rationale that supports this group comparison is more aligned with more grammatical trend from Slabakova which brings up the Bottleneck Hypothesis (BH), a fine-grained claim that the functional morphology of a second language acts like a *bottleneck*, meaning that certain aspects of the second language are more challenging to acquire than others. Looking specifically at our phenomenon investigated, the bare singular is a semantic phenomenon marked by the absence of functional morphology and determiners. This absence of morphological instruction highlights a morphosemantic mismatch between BrP and English that has acceptability consequences. Therefore, the BH posits that in order to the learner fully acquire the grammar of the second language, s/he has to overcome this functional morphology mismatch that is permeated by transfer.

Across the three experiments, results revealed clear cross-linguistic differences in the acceptability of bare nouns. In BrP, all conditions were generally acceptable, with the highest acceptability for edible plurals and the lowest for non-edible singulars. In contrast, English showed low acceptability for bare singulars — especially non-edible ones — while bare plurals were widely accepted. Bilinguals demonstrated a pattern closer to BrP than to English, particularly in the higher acceptance of bare singular nouns, suggesting potential L1 transfer effects. Notably, the non-edible singular condition had the lowest acceptability across all groups. Unlike Ionin et al. (2014), who found no evidence of transfer from BrP in acceptability judgments of bare nouns in English, the present study explores this possibility further. Group Comparison 1 confirmed a statistically significant mismatch between BrP and English, likely stemming from semantic differences related to bare nouns. The current analysis investigates whether bilinguals statistically differ from native English speakers in both acceptability and response times, offering additional evidence of L1 influence. Now, we turn our attention to our specific RQs that feeds this second group comparison:

4.5.1.1 Specific Research Questions

RQ1. Is there a transfer from BrP L1 to English L2 in bilinguals?

RQ2. Is language acceptability for the bilingual somewhat similar to the language acceptability pattern of BrP, of English pattern, or of neither?

RQ3. Are response times patterns from the linguistic system of the bilingual similar to the response times patterns of BrP, English, or neither?

4.5.1.2 Hypothesis (H) and Predictions (P) for Bare Singular Nouns Acceptability

H0. There should be no differences in the acceptability of bare singular nouns among native speakers of BrP, native speakers of English, and Bilinguals. Similarly, no differences should be reflected in response times among these languages. This lack of difference would suggest that these three groups behave similarly under the investigated conditions, showing no acceptability distinction in bare singular nouns.

P0. With the above proposition being true, we should not observe any statistical difference between the acceptability of bare singular nouns among groups, and neither a reflection in response times patterns of both languages.

H1. Assuming the Bottleneck Hypothesis (BH) from Slabakova (2016), bilinguals transfer their L1 knowledge to their L2 where there are mismatches between languages. Therefore, we should expect that bilinguals would not display no major differences in the acceptability patterns from their L1 when their encounter the same structure in the L2. In other words, bilinguals would consider that bare singular nouns would be accepted in English. We should observe a difference in acceptability between edible and non-edible nouns in bare singulars, since edible nouns are more easily accepted over non-edible bare singulars (PIRES DE OLIVEIRA; SILVA; BRESSANE, 2010; BRAGA; SENA; MARIANO; PIRES DE OLIVEIRA, 2010). Additionally, this might interfere in response times in which non-edible bare singulars might take more time to have the acceptability assigned than edible bare plurals. Although we would have such subtle differences, all bare nouns would be considered acceptable.

PI. If this is true, we predict that there will not be a statistically significant difference between the native speakers of BrP and the bilingual group.

In summary, we can already observe differences in the acceptability of bare nouns among the investigated groups. We now turn to the question of whether these differences are statistically significant across two domains: acceptability and response times. Since Experiments 1, 2, and 3 were identical — differing only in language and participant group — this design enables direct comparisons across groups to assess potential statistical differences. For this analysis, we adopt Hypothesis 1 as our working hypothesis. Furthermore, this group comparison allows us to statistically assess whether there is evidence of transfer from BrP L1 to English L2, by comparing the BrP L1 group, the English L1 group, and the bilingual group.

All materials used in this group comparison, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub.²⁹

4.5.2 Method

4.5.2.1 Participants

A total of 119 participants' data were analysed in the three groups comparison, comprising 89 voluntary participants from UFSC taking part on the study online and 30 paid participants from the University of Toronto also taking part in the study online. The mean age of these 119 participants was 28.7 years old (SD = 10.4).

4.5.2.2 Instruments

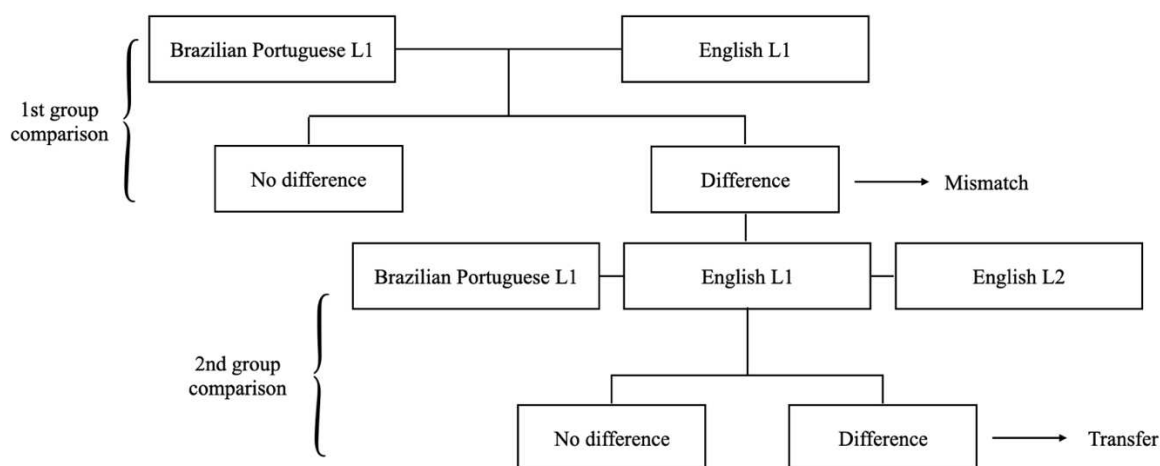
The instruments used in the study are the same as the ones reported in Experiment 1, 2, and 3. Therefore, this is just a group comparison with the data of the participants from these 3 experiments.

²⁹ Data analysis materials and raw results are available at <https://github.com/deardiones/AJT-Group-Comparison.git>

4.5.2.3 Procedures

The path adopted to conduct this second group comparison can be summarized by the flowchart below:

Flowchart 4.5 — Summary of the group comparison flowchart



Source: designed by the researchers.

The flowchart in 4.5 helps to illustrate the procedures adopted to conduct the groups comparison. The first part of the group comparison was carried out in the first group comparison in which we investigated the mismatches between BrP and English. In the second group comparison, we will then compare BrP L1, English L1, and BrPL1/EnglishL2 (three group comparison — bilingual group) which will also be as our independent variable. If there is no difference between these three groups, then we do not have evidence of transfer from languages. However, if there are differences between native speakers of English and bilingual groups, then we have evidence of transfer.

4.5.2.4 Data Analysis

Data processing was conducted in RStudio. For the group comparison, we gathered all the final sets that received data analysis on a single file directly as a new CSV file. A new column was added for each CSV file naming each group: the native speakers of BrP was named [BRPL1], the native speakers of English were named as [ENGL1], and the Bilingual group was named [ENGL2].

Since in the other two group comparisons we decided to use English as our reference value group, we decided to keep the pattern. Additionally, we can clearly observe a difference in the acceptability of bare nouns across groups, while in BrP the acceptability patterns are not so evident. Therefore, in the statistical analysis, we decided to include the [ENGL1] as our reference value for the variable Speaker since the literature is more categorical regarding the representation of the nouns in English, therefore, allowing us to compare it against the native speakers of Brazilian Portuguese [BRPL1] and Bilinguals [ENGL2]. Additionally, we kept using the singular [S] as our reference value for the variable Number and edible [E] as our reference value for the variable Noun.

4.5.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. For the BrP L1, English L1, and the bilingual group, we assumed a Cohen's *d* of 0.5 for medium groups. After adjusting the alpha level to 0.05 and using a sample size of 119, the resulting power was 0.9700213. Thus, we interpret this result as indicating that 97.0% of the outcomes are expected to represent the phenomenon investigated in the three groups comparison.

4.5.4 Acceptability Judgment Task

The AJT was our main instrument for investigating language acceptability. In the next subsection, we present how the treat data was analyzed in this last group comparison, along with the statistical analysis. This comparison directly challenges our working hypothesis regarding the acceptability pattern of this structure across languages, prompting us to re-evaluate it in relation to other groups. The data was unaltered from the data filtering reported for Experiments 4, 5, and 6. Next, we will focus on the data preparation and analysis for the AJT. It worths highlighting that in all groups we got a statistically significant interaction between the conditions investigated.

4.5.4.1 Data Preparation

We gathered the dataset named *ajtl2* of the two groups and tabled all the data in a single CSV file. After adding the new column for group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1904 observations, nested within 119 participants and 16 items.

4.5.4.2 Statistical Analysis

A Cumulative Link Mixed Model (CLMM) was fitted using the Laplace approximation to examine the effect of Noun, Number, and Speaker on judgment value. The model included random intercepts for Participants and Items. The models used in the comparison can be seen below:

```
model1 <- lmer (Value ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = s5, REML = FALSE)

model2 <- lmer (Value ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = s5, REML = FALSE)
```

The likelihood ratio test comparing the two models indicated a highly significant improvement in model fit ($\chi^2 = 163.55, p < 0.0001$). This suggests that the interactions among Noun, Number, and Speaker significantly contribute to explaining the variability in responses.

Table 4.34 — Model's results

<i>Predictors</i>	Value		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Noun [U]	0.13	0.08 – 0.22	<0.001
Number [P]	15.97	9.29 – 27.44	<0.001
Speaker [BRPL1]	10.30	5.25 – 20.20	<0.001
Speaker [ENGL2]	1.65	0.77 – 3.55	0.200
Noun [U] × Number [P]	5.01	2.36 – 10.61	<0.001
Noun [U] × Speaker [BRPL1]	1.70	0.92 – 3.17	0.093
Noun [U] × Speaker [ENGL2]	3.92	1.92 – 7.97	<0.001
Number [P] × Speaker [BRPL1]	0.10	0.05 – 0.19	<0.001
Number [P] × Speaker [ENGL2]	0.39	0.19 – 0.83	0.014
(Noun [U] × Number [P]) × Speaker [BRPL1]	0.95	0.38 – 2.37	0.905
(Noun [U] × Number [P]) × Speaker [ENGL2]	0.54	0.19 – 1.54	0.248
Random Effects			
σ^2	3.29		
τ_{00} Participant	1.32		
τ_{00} Item	0.67		
ICC	0.38		
$N_{\text{Participant}}$	119		
N_{Item}	16		
Observations	1904		
Marginal R^2 / Conditional R^2	0.273 / 0.547		

Source: designed by the researchers on RStudio.

The generalized linear mixed-effects model revealed significant main effects of Noun, Number, and Speaker. Compared to edible nouns, non-edible nouns significantly reduced the probabilities of getting higher values of acceptability ($p < 0.001$), while plural nouns greatly increased the probability when compared to singular ones ($p < 0.001$).

Native speakers of BrP were significantly more likely than native speakers of English to give higher ratings in the acceptability scale ($p < 0.001$) providing an effect for group, as we already seen in Group Comparison 3. The difference between native speakers of English and bilinguals was not statistically significant ($p = 0.200$) which indicates that they were similar.

The effect of non-edible nouns was moderated by number, such that non-edible plurals were associated with higher probabilities of getting higher acceptability values when compared to edible singular ($p < 0.001$). Additionally, bilinguals assigned higher acceptability for non-edible nouns than native speakers of English ($p < 0.001$) which might indicate a possible transfer effect, since non-edible nouns are more accepted in BrP, but rejected in English. Native speakers of BrP were less sensitive to plural inflection than native speakers of English ($p < 0.001$), while bilinguals showed a similar pattern ($p < 0.014$), also reinforcing our transfer effect. Although the three-way interaction was not significant, it was retained since it better explains the data.

A Bonferroni Correction was applied in the post-hoc analysis to account for multiple comparisons. The relevant comparisons here should be the Edible + Singular (E+S) and Non-Edible + Singular (U+S) among the three groups, specially where we would possibly observe a transfer from BrP L1 to English L2. Below, we present the pairwise comparison:

contrast	estimate	SE	df	z.ratio	p.value
E S ENGL1 - U S ENGL1	2.01016	0.263	Inf	7.647	<.0001
E S ENGL1 - E P ENGL1	-2.77067	0.276	Inf	-10.032	<.0001
E S ENGL1 - U P ENGL1	-2.37172	0.267	Inf	-8.869	<.0001
E S ENGL1 - E S BRPL1	-2.33180	0.344	Inf	-6.781	<.0001
E S ENGL1 - U S BRPL1	-0.85440	0.335	Inf	-2.547	0.7176
E S ENGL1 - E P BRPL1	-2.77612	0.349	Inf	-7.951	<.0001
E S ENGL1 - U P BRPL1	-2.85409	0.350	Inf	-8.156	<.0001
E S ENGL1 - E S ENGL2	-0.50060	0.391	Inf	-1.281	1.0000
E S ENGL1 - U S ENGL2	0.14455	0.391	Inf	0.370	1.0000
E S ENGL1 - E P ENGL2	-2.33470	0.405	Inf	-5.762	<.0001
E S ENGL1 - U P ENGL2	-2.67586	0.409	Inf	-6.548	<.0001
U S ENGL1 - E P ENGL1	-4.78083	0.301	Inf	-15.892	<.0001
U S ENGL1 - U P ENGL1	-4.38188	0.292	Inf	-15.018	<.0001
U S ENGL1 - E S BRPL1	-4.34196	0.361	Inf	-12.017	<.0001
U S ENGL1 - U S BRPL1	-2.86456	0.349	Inf	-8.202	<.0001
U S ENGL1 - E P BRPL1	-4.78629	0.367	Inf	-13.044	<.0001
U S ENGL1 - U P BRPL1	-4.86425	0.368	Inf	-13.221	<.0001
U S ENGL1 - E S ENGL2	-2.51076	0.402	Inf	-6.240	<.0001

U S ENGL1 - U S ENGL2	-1.86562	0.400	Inf	-4.662	0.0002
U S ENGL1 - E P ENGL2	-4.34486	0.420	Inf	-10.346	<.0001
U S ENGL1 - U P ENGL2	-4.68602	0.424	Inf	-11.065	<.0001
E P ENGL1 - U P ENGL1	0.39895	0.280	Inf	1.427	1.0000
E P ENGL1 - E S BRPL1	0.43887	0.356	Inf	1.232	1.0000
E P ENGL1 - U S BRPL1	1.91627	0.353	Inf	5.427	<.0001
E P ENGL1 - E P BRPL1	-0.00545	0.360	Inf	-0.015	1.0000
E P ENGL1 - U P BRPL1	-0.08342	0.360	Inf	-0.232	1.0000
E P ENGL1 - E S ENGL2	2.27008	0.407	Inf	5.577	<.0001
E P ENGL1 - U S ENGL2	2.91522	0.409	Inf	7.134	<.0001
E P ENGL1 - E P ENGL2	0.43597	0.415	Inf	1.051	1.0000
E P ENGL1 - U P ENGL2	0.09481	0.418	Inf	0.227	1.0000
U P ENGL1 - E S BRPL1	0.03992	0.350	Inf	0.114	1.0000
U P ENGL1 - U S BRPL1	1.51732	0.347	Inf	4.376	0.0008
U P ENGL1 - E P BRPL1	-0.40441	0.354	Inf	-1.142	1.0000
U P ENGL1 - U P BRPL1	-0.48237	0.354	Inf	-1.361	1.0000
U P ENGL1 - E S ENGL2	1.87112	0.401	Inf	4.663	0.0002
U P ENGL1 - U S ENGL2	2.51627	0.403	Inf	6.247	<.0001
U P ENGL1 - E P ENGL2	0.03702	0.410	Inf	0.090	1.0000
U P ENGL1 - U P ENGL2	-0.30414	0.413	Inf	-0.736	1.0000
E S BRPL1 - U S BRPL1	1.47740	0.185	Inf	7.975	<.0001
E S BRPL1 - E P BRPL1	-0.44433	0.197	Inf	-2.256	1.0000
E S BRPL1 - U P BRPL1	-0.52229	0.197	Inf	-2.650	0.5308
E S BRPL1 - E S ENGL2	1.83120	0.346	Inf	5.291	<.0001
E S BRPL1 - U S ENGL2	2.47634	0.348	Inf	7.112	<.0001
E S BRPL1 - E P ENGL2	-0.00290	0.357	Inf	-0.008	1.0000
E S BRPL1 - U P ENGL2	-0.34406	0.360	Inf	-0.956	1.0000
U S BRPL1 - E P BRPL1	-1.92173	0.194	Inf	-9.928	<.0001
U S BRPL1 - U P BRPL1	-1.99970	0.195	Inf	-10.236	<.0001
U S BRPL1 - E S ENGL2	0.35380	0.339	Inf	1.043	1.0000
U S BRPL1 - U S ENGL2	0.99894	0.339	Inf	2.942	0.2149
U S BRPL1 - E P ENGL2	-1.48030	0.353	Inf	-4.188	0.0019
U S BRPL1 - U P ENGL2	-1.82146	0.358	Inf	-5.094	<.0001
E P BRPL1 - U P BRPL1	-0.07797	0.204	Inf	-0.383	1.0000
E P BRPL1 - E S ENGL2	2.27553	0.352	Inf	6.471	<.0001
E P BRPL1 - U S ENGL2	2.92067	0.353	Inf	8.269	<.0001
E P BRPL1 - E P ENGL2	0.44143	0.360	Inf	1.226	1.0000
E P BRPL1 - U P ENGL2	0.10026	0.364	Inf	0.276	1.0000
U P BRPL1 - E S ENGL2	2.35350	0.352	Inf	6.685	<.0001
U P BRPL1 - U S ENGL2	2.99864	0.354	Inf	8.460	<.0001
U P BRPL1 - E P ENGL2	0.51939	0.361	Inf	1.439	1.0000

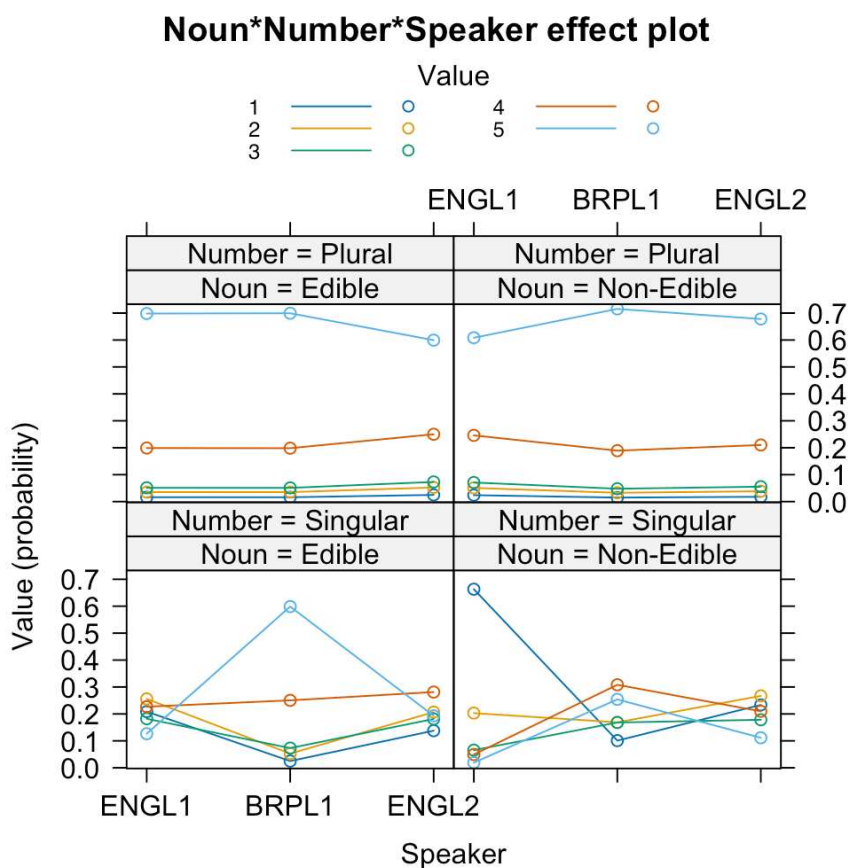
U P BRPL1 - U P ENGL2	0.17823	0.364	Inf	0.490	1.0000
E S ENGL2 - U S ENGL2	0.64514	0.253	Inf	2.549	0.7121
E S ENGL2 - E P ENGL2	-1.83411	0.273	Inf	-6.715	<.0001
E S ENGL2 - U P ENGL2	-2.17527	0.278	Inf	-7.834	<.0001
U S ENGL2 - E P ENGL2	-2.47925	0.276	Inf	-8.990	<.0001
U S ENGL2 - U P ENGL2	-2.82041	0.282	Inf	-10.005	<.0001
E P ENGL2 - U P ENGL2	-0.34116	0.288	Inf	-1.187	1.0000

All post hoc p-values were Bonferroni-corrected for 66 comparisons. The pairwise comparison between the groups highlights differences within the groups. Specifically, the comparison that is worth mentioning is the contrast in Non-Edible + Singular condition with ENGL1 against ENGL2 ($\beta = -1.86562$, $SE = 0.400$, $t = -4.662$, $p < 0.0002$) and BRPL1 Against ENGL2 ($\beta = 0.99894$, $SE = 0.339$, $t = 2.942$, $p = 0.2149$). The effect encountered in this comparison is interpreted as suggesting a transfer from the acceptability of non-edible singular nouns from BrP L1 to English L2.

Other comparisons that seem to be important to highlight, includes the Edible + Singular between ENGL1 and ENGL2 ($\beta = 0.50060$, $SE = 0.391$, $t = -1.281$, $p = 1.000$) which did not reach statistically significant difference between these two groups, but shown a difference between BRPL1 and ENGL2 ($\beta = 1.83120$, $SE = 0.346$, $t = 5.291$, $p < 0.0001$). Although this could suggest a lack of effect — indicating that bilinguals behave like native English speakers and showing no evidence of transfer — it might instead reflect differences in how edible nouns are treated across groups, since the variation in edible singular nouns is less pronounced than that observed with non-edible singular nouns.

All other comparisons were not relevant discussing since they do not highlight transfer effects across language groups. Below, we present the values predicted by the model:

Graph 4.19 — Values predicted by the model for the acceptability

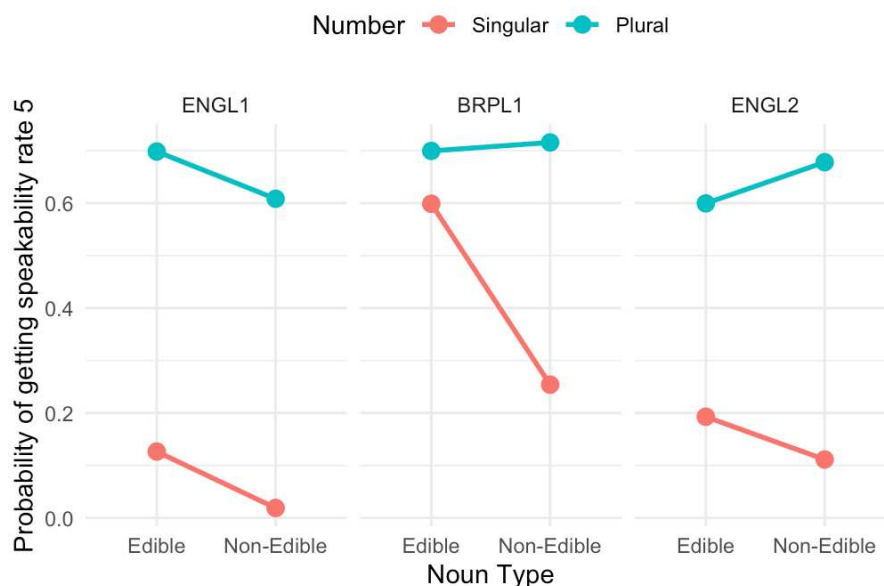


Source: designed by the researchers on RStudio.

The three-way interaction between Noun, Number, and Speaker revealed clear interpretive patterns. In the plural condition, all groups favored value 5, indicating higher probabilities of accepting the pluralized forms of the nouns tested in the experiment, regardless of noun type. However, in the singular condition, particularly with edible nouns, native speakers of BrP speakers showed a sharp increase in value 5 responses and greater variability across other values for non-edibles.

Since the interaction among groups is not clear cut, we plotted an additional graph isolating the probability of participants rate 5 the conditions tested in the experiments. The graph can be checked below:

Graph 4.20 — Values predicted by the model of assigning rate 5



Source: designed by the researchers on RStudio.

As can be observed by the plot above, plural nouns consistently received high ratings across all groups and noun types, indicating plural-marked noun phrases are more chosen since it is grammatical. However, singular nouns revealed stronger between-group differences. All groups assigned higher judgment values for edible singular nouns than non-edible ones. This indicates that the mismatch encountered in Group Comparison 1, disappear when we account for the bilinguals for edible bare singular nouns. However, non-edible bare singulars showed an effect which is taken as evidence of transfer for bilinguals. Additionally, native speakers of BrP speakers showed a sharp drop in ratings for non-edible singular nouns. This pattern reinforces that native speakers of BrP participants are particularly sensitive to the lexical semantics of the noun when determining the acceptability of singular noun phrases.

4.5.4 Response Time

Response time in the AJT provides insight into language processing, as it reflects the time participants took to decide whether a sentence was acceptable in each condition. This measure may enhance our understanding of how bare singular nouns are represented in BrP, English, and Bilinguals. It is worth noting that the response time effect was only marginally significant for BrP, while it was not significant for English or the bilingual group.

4.5.4.1 Data Treatment

For the response time, we gathered the data set *ajtrtl2* in log of the two groups and tabled all the data in a single CSV file, all of which were already in log. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1761 observations, nested within 119 participants and 16 items.

4.5.4.2 Statistical Analysis

In the response time, we used the logarithm of response times as the dependent variable and fitted a linear mixed-effects model using the maximum likelihood, with t-tests computed via Satterthwaite's method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both participants and items. The models used in the comparison can be seen below:

```
modell1 <- lmer (log ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)

modell2 <- lmer (log ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)
```

A comparison of nested models with ANOVA revealed that the best-fitting model that better explains the data included the three-way interaction between the quantifier, the noun, and the speaker which was on the limit of significance ($\chi^2 = 15.918$, $p < 0.025$). The model's result can be checked below:

Table 4.35 — Model's result

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.78	7.66 – 7.91	<0.001
Noun [U]	-0.12	-0.25 – 0.01	0.072
Number [P]	-0.03	-0.16 – 0.10	0.654
Speaker [BRPL1]	0.03	-0.13 – 0.19	0.686
Speaker [ENGL2]	0.17	-0.02 – 0.35	0.080
Noun [U] × Number [P]	0.10	-0.08 – 0.28	0.290
Noun [U] × Speaker [BRPL1]	0.26	0.10 – 0.42	0.001
Noun [U] × Speaker [ENGL2]	0.04	-0.14 – 0.23	0.649
Number [P] × Speaker [BRPL1]	0.02	-0.14 – 0.18	0.794
Number [P] × Speaker [ENGL2]	-0.04	-0.23 – 0.15	0.677
(Noun [U] × Number [P]) × Speaker [BRPL1]	-0.20	-0.42 – 0.03	0.083
(Noun [U] × Number [P]) × Speaker [ENGL2]	0.05	-0.22 – 0.31	0.738
Random Effects			
σ^2	0.24		
τ_{00} Participant	0.07		
τ_{00} Item	0.00		
$N_{\text{Participant}}$	119		
N_{Item}	16		
Observations	1761		
Marginal R^2 / Conditional R^2	0.027 / NA		

Source: designed by the researchers on RStudio.

The model above revealed a significant interaction between Noun Type and Speaker Group: BRPL1 speakers showed a significantly different pattern of response times for nouns compared to the reference group, which is native speakers of English ($p < 0.001$). This suggests that BRPL1 participants are more likely to take longer to respond to edible and non-edible nouns, which was already explored in Group Comparison 1, therefore, there is no need for further discussing this comparison.

No other main effects or interactions reached significance. However, the bilingual group was marginally non-significant ($p < 0.080$), indicating that bilinguals are marginally slower in deciding which point in the scale they would select, reflecting in response times. There was also a marginal effect for Noun type ($p < 0.07$) which indicates that non-edible nouns receive marginal faster response times than edible nouns.

A Bonferroni correction was applied in the post-hoc analysis to account for multiple comparisons. The relevant comparisons here should be the Edible + Singular (E+S) and Non-Edible + Singular (U+S) among the three groups, specially where we would possibly observe a transfer from BrP L1 to English L2. Below, we present the pairwise comparison:

contrast	estimate	SE	df	t.ratio	p.value
E S ENGL1 - U S ENGL1	0.118912	0.0663	1643	1.792	1.0000
E S ENGL1 - E P ENGL1	0.029351	0.0657	1642	0.447	1.0000
E S ENGL1 - U P ENGL1	0.049060	0.0664	1644	0.739	1.0000
E S ENGL1 - E S BRPL1	-0.032634	0.0815	297	-0.401	1.0000
E S ENGL1 - U S BRPL1	-0.171576	0.0814	297	-2.107	1.0000
E S ENGL1 - E P BRPL1	-0.024343	0.0816	298	-0.298	1.0000
E S ENGL1 - U P BRPL1	-0.063166	0.0815	297	-0.775	1.0000
E S ENGL1 - E S ENGL2	-0.165093	0.0952	301	-1.733	1.0000
E S ENGL1 - U S ENGL2	-0.089593	0.0957	306	-0.936	1.0000
E S ENGL1 - E P ENGL2	-0.096202	0.0956	306	-1.006	1.0000
E S ENGL1 - U P ENGL2	-0.164941	0.0947	295	-1.742	1.0000
U S ENGL1 - E P ENGL1	-0.089561	0.0667	1642	-1.344	1.0000
U S ENGL1 - U P ENGL1	-0.069852	0.0672	1643	-1.039	1.0000
U S ENGL1 - E S BRPL1	-0.151546	0.0823	308	-1.842	1.0000
U S ENGL1 - U S BRPL1	-0.290488	0.0822	307	-3.533	0.0313
U S ENGL1 - E P BRPL1	-0.143255	0.0823	309	-1.740	1.0000
U S ENGL1 - U P BRPL1	-0.182077	0.0823	308	-2.213	1.0000
U S ENGL1 - E S ENGL2	-0.284004	0.0959	309	-2.961	0.2182
U S ENGL1 - U S ENGL2	-0.208504	0.0964	314	-2.163	1.0000
U S ENGL1 - E P ENGL2	-0.215114	0.0963	314	-2.234	1.0000
U S ENGL1 - U P ENGL2	-0.283853	0.0954	302	-2.977	0.2079

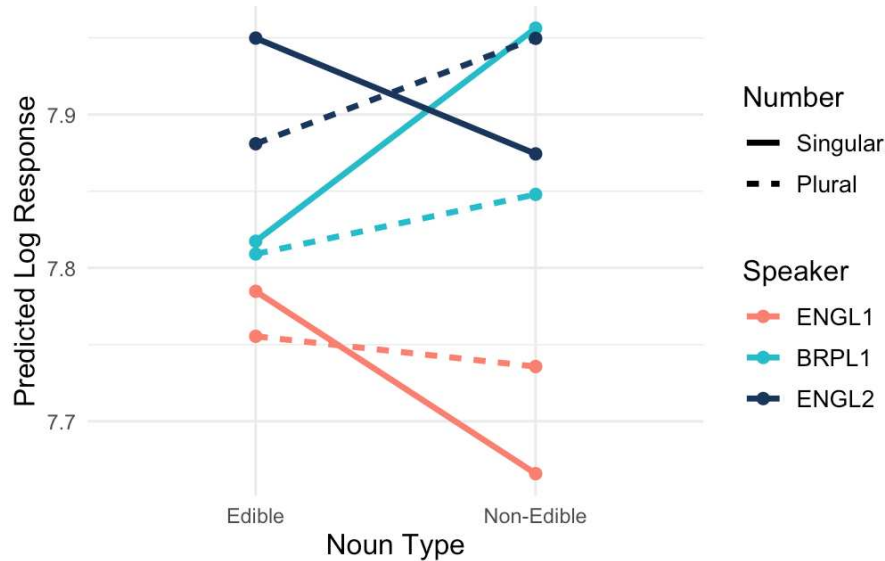
E P ENGL1 - U P ENGL1	0.019709	0.0667	1643	0.296	1.0000
E P ENGL1 - E S BRPL1	-0.061985	0.0817	301	-0.758	1.0000
E P ENGL1 - U S BRPL1	-0.200928	0.0817	300	-2.460	0.9541
E P ENGL1 - E P BRPL1	-0.053694	0.0818	302	-0.656	1.0000
E P ENGL1 - U P BRPL1	-0.092517	0.0817	301	-1.132	1.0000
E P ENGL1 - E S ENGL2	-0.194444	0.0955	304	-2.037	1.0000
E P ENGL1 - U S ENGL2	-0.118944	0.0959	309	-1.240	1.0000
E P ENGL1 - E P ENGL2	-0.125553	0.0958	308	-1.310	1.0000
E P ENGL1 - U P ENGL2	-0.194292	0.0949	297	-2.047	1.0000
U P ENGL1 - E S BRPL1	-0.081694	0.0823	308	-0.993	1.0000
U P ENGL1 - U S BRPL1	-0.220637	0.0822	307	-2.683	0.5073
U P ENGL1 - E P BRPL1	-0.073403	0.0823	309	-0.891	1.0000
U P ENGL1 - U P BRPL1	-0.112226	0.0823	308	-1.364	1.0000
U P ENGL1 - E S ENGL2	-0.214153	0.0959	309	-2.233	1.0000
U P ENGL1 - U S ENGL2	-0.138653	0.0964	314	-1.438	1.0000
U P ENGL1 - E P ENGL2	-0.145262	0.0963	314	-1.508	1.0000
U P ENGL1 - U P ENGL2	-0.214001	0.0954	302	-2.244	1.0000
E S BRPL1 - U S BRPL1	-0.138942	0.0469	1647	-2.962	0.2049
E S BRPL1 - E P BRPL1	0.008291	0.0471	1648	0.176	1.0000
E S BRPL1 - U P BRPL1	-0.030531	0.0470	1647	-0.649	1.0000
E S BRPL1 - E S ENGL2	-0.132458	0.0831	306	-1.594	1.0000
E S BRPL1 - U S ENGL2	-0.056958	0.0837	313	-0.681	1.0000
E S BRPL1 - E P ENGL2	-0.063568	0.0836	312	-0.761	1.0000
E S BRPL1 - U P ENGL2	-0.132307	0.0825	298	-1.605	1.0000
U S BRPL1 - E P BRPL1	0.147233	0.0470	1649	3.130	0.1173
U S BRPL1 - U P BRPL1	0.108411	0.0469	1653	2.310	1.0000
U S BRPL1 - E S ENGL2	0.006484	0.0831	306	0.078	1.0000
U S BRPL1 - U S ENGL2	0.081984	0.0836	312	0.981	1.0000
U S BRPL1 - E P ENGL2	0.075374	0.0835	312	0.903	1.0000
U S BRPL1 - U P ENGL2	0.006635	0.0824	297	0.081	1.0000
E P BRPL1 - U P BRPL1	-0.038823	0.0471	1646	-0.824	1.0000
E P BRPL1 - E S ENGL2	-0.140750	0.0832	307	-1.692	1.0000
E P BRPL1 - U S ENGL2	-0.065249	0.0837	314	-0.779	1.0000
E P BRPL1 - E P ENGL2	-0.071859	0.0836	313	-0.860	1.0000
E P BRPL1 - U P ENGL2	-0.140598	0.0825	298	-1.704	1.0000
U P BRPL1 - E S ENGL2	-0.101927	0.0831	307	-1.226	1.0000
U P BRPL1 - U S ENGL2	-0.026427	0.0837	313	-0.316	1.0000
U P BRPL1 - E P ENGL2	-0.033036	0.0836	312	-0.395	1.0000
U P BRPL1 - U P ENGL2	-0.101775	0.0824	298	-1.234	1.0000
E S ENGL2 - U S ENGL2	0.075500	0.0688	1653	1.097	1.0000
E S ENGL2 - E P ENGL2	0.068891	0.0687	1652	1.002	1.0000

E S ENGL2 - U P ENGL2	0.000152	0.0674	1644	0.002	1.0000
U S ENGL2 - E P ENGL2	-0.006609	0.0693	1653	-0.095	1.0000
U S ENGL2 - U P ENGL2	-0.075349	0.0681	1659	-1.106	1.0000
E P ENGL2 - U P ENGL2	-0.068739	0.0679	1648	-1.012	1.0000

Post hoc pairwise comparisons were conducted using the Kenward-Roger method for estimating degrees of freedom. *P*-values were adjusted using the Bonferroni correction to account for multiple comparisons (66 tests in total). The only comparison that reached significance was the pairwise for Non-Edible + Singular (U+S) between BrP and English ($\beta = -0.290488$, $SE = 0.0822$, $t = -3.533$, $p < 0.0313$) which highlights the mismatch between these two languages. However, no other comparison reached significance. Therefore, it was not possible to find in response times data any suggestion of transfer from BrP and English in Bilinguals in terms of response times. Next, we take a look at the values predicted by the model.

Graph 4.21 — Values predicted by the model for the response time in log

Three-Way Interaction: Noun, Number, Speaker



Source: designed by the researchers on RStudio.

Graph 4.21 illustrates the three-way interaction between Noun Type (Edible vs. Non-Edible), Number (Singular vs. Plural), and Speaker (ENGL1, BRPL1, and ENGL2) on predicted log-transformed response values. While the model did not find the three-way interaction to be statistically significant, the visual pattern reveals important group-level differences.

For native speakers of English, log responses were lower for non-edible nouns compared to edible ones, especially in the singular form, suggesting sensitivity to semantic distinctions in bare singulars. In contrast, native speakers of BrP showed the opposite pattern: they responded slower to non-edible nouns, regardless of number.

Interestingly, bilinguals exhibited a crossover pattern — non-edible nouns yielded lower log responses in the singular but higher in the plural, indicating greater variability or possibly sensitivity to both semantic and morphosyntactic cues, reflecting possible access to conscious knowledge about the English grammar. However, this effect was not found in the bilingual group alone. This crossover pattern was also observed for native speakers of English, this tendency shown in the graph was more even.

These results support the earlier finding that BRPL1 speakers differ significantly from the reference group, which is English, in their response to edible or non-edible nouns, particularly in singular contexts. Next, we retake the key findings from this group comparison:

4.5.5 Summary of the Key Findings from Group Comparison 4

The table below provides an overview of the statistical analysis results for Group Comparison 2.

Table 4.36 — Summary of key findings from group comparison 2 (Bilinguals)

Number	Noun	Probability	Response Time
Bare Singular	Edible	=	=
	Non-Edible	Higher probability of being accepted by Bilinguals than English L1	=
Bare Plural	Edible	=	=
	Non-Edible	=	=

Source: designed by the researchers.

- An effect was observed for non-edible bare singular nouns between native English speakers and bilinguals. This effect is interpreted as evidence of L1-to-L2 transfer in

the nominal system, as non-edible bare singular nouns receive low acceptability judgments in English but higher acceptability judgments in BrP. Therefore, bilinguals exhibit an acceptability pattern more closely aligned with BrP L1 than with English L1;

- Response times were not statistically significantly different among groups;
- These results should be interpreted with caution, as the same mismatch appeared in two conditions — the edible bare singular and the non-edible bare singular — between BrP L1 and English L1. However, evidence of transfer emerged only in the non-edible bare singular condition.

4.5.6 General Discussion

The main objective of this group comparison was to investigate whether there would be a transfer effect in the nominal system from BrP L1 to English L2. In Group Comparison 1, we found that the mismatch in bare singular nouns was statistically significant; thus, both edible and non-edible nouns represent a point of divergence between the two grammars. As observed in the current group comparison, we did find a transfer effect for non-edible bare singular nouns — a structure that is acceptable in BrP but rejected in English. When asked to provide acceptability judgments on these nouns, bilinguals rated them significantly more highly than native English speakers, thereby exhibiting a pattern more closely aligned with BrP.

Although we indeed found this effect, it was puzzling why the same did not occur with edible bare singular nouns, which was not statistically significant for bilinguals in comparison to native speakers of English, but it was statistically significant different when we compared the native speaker of BrP to the bilingual. This effect might be interpreted in three possible ways: The first is that the bilingual is behaving more similarly to the native speakers of English; the second, is that the effect encountered between these two groups might reflect differences in how edible nouns are treated across groups, since the variation in edible singular nouns is less pronounced than that observed with non-edible singular nouns; the third it has to do with the language since bilinguals were judging the edible bare singular nouns in English.

Another aspect that is puzzling is the absence of response time correlation in bilinguals, therefore resembling more the response time of native speakers of English. In fact, if we look to Graph 4.21 related to Response Times, we observe a crossover pattern in which

the bilingual displays a behavior of both native speakers of BrP and English, which might indicate a behaviour in between the two groups. This might reinforce that the bilingual does not resemble either the native speaker of BrP nor the native speaker of English, highlighting that the bilingual might possess a unique linguistic system that does not resemble both languages, but this linguistic system consists of a third grammar that is formed by the two systems, as proposed by Grosjean (1982, 2008), or it is still in the process of adapting both grammars to be fully able to juggle with divergent grammatical instructions.

In summary, the results of our study provide different results from the findings of Ionin et al., who did not find evidence of transfer from BrP L1 to English L2 in the acceptability of bare nouns. In contrast, we found a transfer effect in our study for non-edible bare singular nouns, providing evidence that native speakers of BrP, when reading and judging these nouns in English, assessed their acceptability based on patterns from their native language — thus demonstrating evidence of transfer.

As a result, we have sufficient evidence to reject our null hypothesis while maintaining support for Hypothesis 1, which assumes Slabakova's (2016) BH. According to this hypothesis, bilinguals transfer knowledge from their L1 to their L2 — a pattern we indeed observed with non-edible bare singulars. Although bilinguals largely behaved in line with their native language (BrP), they also showed a pattern closer to native English speakers in the case of edible bare singulars. The effect of transfer from the L1 to the L2, is evidence that our bilinguals were at an intermediate stage of a grammar formed by the two linguistic systems that are interacting with each other.

While response times were not statistically significant in this group comparison, we observed a tendency toward a crossover pattern: bilinguals' response times for edible and non-edible bare singulars were more closely aligned with English than with BrP, whereas for number, their response times were more consistent with BrP patterns.

As a result of these later findings, the BH offers a plausible account of the phenomenon we investigated, as the observed effect appears to be isolated or context-specific. However, our results have broader implications for bilingual cognition, suggesting that transfer effects may emerge selectively depending on linguistic context. We will return to this discussion on bilingual cognition in Chapter VI. Next, we retake our RQs in regard to this group comparison:

RQ1. Is there a transfer from BrP L1 to English L2 in bilinguals? *Yes, there is. The only transfer effect that we have found in this group comparison is related to non-edible bare singular noun, that are accepted in BrP, but they*

are not in English. The bilingual groups showed a transfer in this acceptability pattern, being statistically different from English, indicating a behaviour that is closely related to BrP L1 than English L2.

RQ2. Is language acceptability for the bilingual somewhat similar to the language acceptability pattern of BrP, of English pattern, or of neither? *Our results support the view that bilinguals transfer knowledge from their L1 in contexts where there is a mismatch between BrP and English, as exemplified by the case of non-edible bare singular nouns. This suggests that their acceptability patterns become more apparent in areas of structural divergence, providing evidence that these patterns are more closely aligned with their L1 when such mismatches occur.*

RQ3. Are response time patterns from the linguistic system of the bilingual similar to the response times patterns of BrP, English, or neither? *There is not an effect on response times when comparing bilinguals to BrP L1 and English L1 groups.*

4.5.7 Conclusion

This group comparison provides evidence of L1 transfer effects in bilinguals, specifically in the context of non-edible bare singular nouns, which are acceptable in BrP but ungrammatical in English. The bilingual group showed an acceptability pattern that was statistically different from native English speakers and more closely aligned with BrP, supporting the conclusion that transfer from the L1 occurs when there is a clear grammatical mismatch between the two languages. These findings also support the view that bilingual language representation is influenced by structural contrasts: bilinguals tend to rely on their L1 representations in contexts of divergence, as seen in the non-edible bare singular condition. However, with respect to response times, no significant differences were observed between bilinguals and either monolingual group, suggesting that while acceptability judgments reflect L1 influence, response times speed does not mirror this pattern. In other words, the trends observed individually in each experiment is not statistically significant when we contrast among groups. Together, these results highlight the complexity of bilingual cognition, where transfer may surface depending on the linguistic domain under investigation.

5 CHAPTER V — EXPERIMENTS REGARDING THE PROCESSING AND REPRESENTATION OF QUANTIFIER PHRASES

This chapter presents and discusses three Self-Paced Reading (SPR) experiments combined with an Interpretation Task (IT) designed to investigate the processing and representation of quantity quantifier phrases across three different linguistic groups: native speakers of Brazilian Portuguese (BrP), native speakers of English, and BrP speakers learning English as a second language. In addition to these three core studies, the chapter includes two group comparisons that explore cross-linguistic and bilingual differences more deeply.

As in the previous chapter, each experiment is presented as an independent study, with its own rationale, Research Questions (RQ), hypotheses, methods, data analysis, and discussion. However, it is important to emphasize that the overall methodological framework remains consistent across all three experiments. This consistency ensures that differences in the results can be more confidently attributed to language and participant group, rather than to procedural variations.

A key adaptation in these experiments — applied uniformly throughout — is the restriction for only non-edible noun and inclusion of both count and mass nouns in combination with quantity quantifiers, differing from the experiments in the previous chapter. Additionally, since this is a processing study, specific controls were applied to the critical regions of the sentences. That is, all nouns in the critical region — as well as in the post-critical and final regions — were matched for syllable count across BrP and English, ensuring that differences in processing could not be attributed to prosodic variation. Language-specific adaptations or considerations are detailed in the respective Methods sections of each study.

By maintaining a uniform methodological approach while varying the language context and participant profiles, this chapter aims to provide a comprehensive view of how quantity quantifier phrases are processed and represented by both native speakers and bilinguals. The following sections present each experiment in detail, followed by comparative analyses that highlight the cross-linguistic patterns and bilingual processing effects observed.

5.1 EXPERIMENT 4 — ASSESSING THE PROCESSING AND REPRESENTATION OF QUANTIFIER PHRASES IN BRAZILIAN PORTUGUESE

5.1.1 Introduction

The rationale that supports this experiment is based on two studies. The first is Frisson and Frazier (2005), a study that investigates the processing of an incongruity between the syntactic structure that projects a mass noun, but combined with a count noun, and a syntactic structure that projects a count noun, but combined with a mass noun in English. The second is Lima (2019), which is also inspired by Frisson and Frazier’s study focusing on investigating the processing and representation of this incongruity in BrP. These two studies have been discussed in depth in Chapter II — *Theoretical Background*.

We specifically examine quantifier singular phrases — ‘muita’ + count/mass noun — as our experimental conditions and quantifier plural phrases as control conditions — ‘muitas’ + count/mass plural nouns —, with the goal of assessing the status of quantity quantifier phrases in BrP in terms of both processing and representation. As proposed by Pires de Oliveira (2022), bare singular nouns in BrP are subject to underspecification. However, this underspecification is not limited to bare singular nouns; rather, it appears to permeate the system, becoming evident in the interpretation of quantity quantifier phrases as well. The RQs that guide this specific experiment are:

5.1.1.1 Specific Research Questions

RQ1. Is there additional processing, if any, in the quantifier singular phrases in BrP?

RQ2. Is there additional processing, if any, in the quantifiers in BrP?

RQ3. Are singular nouns interpreted as count, mass or are underspecified?

RQ4. Does the noun type affect interpretation?

RQ5. Do singular quantifiers influence the interpretation of the following singular count nouns in BrP?

5.1.1.2 Hypothesis (H) and Predictions (P) for the Processing and Representation of Quantifier Singular Phrases in BrP

H0. The true polysemy proposal suggests that a polysemous noun can refer to multiple related meanings—for example, *bank*, which may denote both a physical entity and the abstract conceptualization of a financial institution (FRAZIER; RAYNER, 1990; LAKOFF, 1987). This type of polysemy is assigned immediately and does not incur additional processing costs, making it a purely semantic phenomenon independent of syntax. If quantifier singular phrases in BrP are polysemous in this way, no differences between the experimental conditions are expected.

P0. Accordingly, we predict that acceptability judgments and response times for quantifier singular phrases in BrP will not differ across conditions, reflecting immediate interpretation without additional processing cost.

H1. The underspecification hypothesis (PIRES DE OLIVEIRA, 2022) suggests that the interpretation of a noun is open. That is, it lacks a specific interpretation in terms of atomicity and does not provide sufficient information for the processor to determine whether a bare singular noun should be interpreted by volume or cardinality. This may be resolved by the determiner, making this type of polysemy primarily a morphosyntactic phenomenon. The hypothesis further predicts that underspecification permeates BrP grammar, meaning that some quantifiers may also be underspecified, providing no morphosyntactic clue as to whether the noun should be interpreted as count or mass.

P1. Based on H1, we predict that acceptability judgments and response times for quantifier singular phrases in BrP will reflect underspecification. Specifically, no clear advantage or disadvantage is expected when interpreting count versus mass nouns, as the determiner does not provide explicit morphosyntactic information.

H2. Assuming Frisson and Frazier (2005) to predict BrP processing and representation patterns, this hypothesis proposes that BrP behaves in line with English. If quantifier singular phrases in BrP are specified, mass nouns should have a primitive meaning for volume or weight — compatible with a mass structure — and count nouns should have a primitive meaning related to cardinality — compatible with a cardinal structure.

P2. Based on H2, we predict that additional processing time will occur when quantifier type conflicts with noun type. Specifically, a singular quantifier combined with a count noun should increase response times, and similarly, a plural quantifier combined with a mass noun should increase processing time. Furthermore, quantifiers such as ‘muita’ are expected to be interpreted with mass nouns (corresponding to ‘much’), while ‘muitas’ should be interpreted with count nouns (corresponding to ‘many’), producing measurable effects in acceptability and response times.

In summary, the current research helps investigate BrP language processing, alongside adding to the literature of quantifier singular phrases representation in this language. So far, only Lima (2019) has done a tentative work in this reasoning. In addition, we developed a new instrument to assess language representation, which is the Interpretation Task (IT), discussed in the Method section. The results of the IT might help us to better understand the status of bare noun allowing us to access language representation. It is important to highlight that this experiment is considered a control group for our main study. Even though it contributes to the specific literature on the processing and representation of BrP, it directly supports our main bilingual study. In the next subsection, we present the specific method used in this experiment.

Additionally, we are dealing with quantifier singular phrases and quantifier plural phrases — that is, combinations of a quantifier with a noun. The noun in this position may be analyzed as a bare singular or a bare plural, depending on the literature. Here, we consider them quantifier phrases since the bare noun is headed by a quantifier. As discussed in Pires de Oliveira and Rothstein (2011) and Chierchia (1998), the interpretation of quantifier phrases in BrP may involve bare nouns, whose number marking and semantics vary depending on the quantifier and context.

All materials used in this experiment, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub³⁰.

5.1.2 Method

5.1.2.1 Participants

A total of 53 voluntary native speakers of BrP took part in this experiment, with a mean age of 27.7 years (SD = 12.7). Of these participants, 11 reported having previously studied linguistics, while 44 had not. Additionally, 48 participants reported having English as their second languages while 5 have reported not knowing English. All participants attended the study in the Computer Lab at the *Universidade Federal de Santa Catarina*. Additionally, two participants indicated in the Demographic Questionnaire that BrP was not their first language, though they considered themselves Brazilian. We decided to remove these two participants from the data analysis, resulting in a final total of 51 participants.

5.1.2.2 Instruments

The main instrument in this study was a Self-Paced Reading (SPR) task, combined with the IT, both programmed in Penn Controller Ibex Farm (PCIbex), as discussed in the Method section. This experiment followed a 2x2 factorial design, in which we manipulated the following independent variables: quantifier (singular/plural) and noun type (count/mass). The set of experimental conditions for this study is presented below and the bold segments represent the critical and post-critical segments:

32. Singular quantifier + singular count noun (S+C)
 - a) + / O / homem / vendeu / **muita** / **pena** / **em** / Madrid.
- Singular quantifier + singular mass noun (S+M)
 - b) + / O / homem / vendeu / **muita** / **prata** / **em** / Madrid.
- Plural quantifier + plural count noun (P+C)
 - c) + / O / homem / vendeu / **muitas** / **penas** / **em** / Madrid.

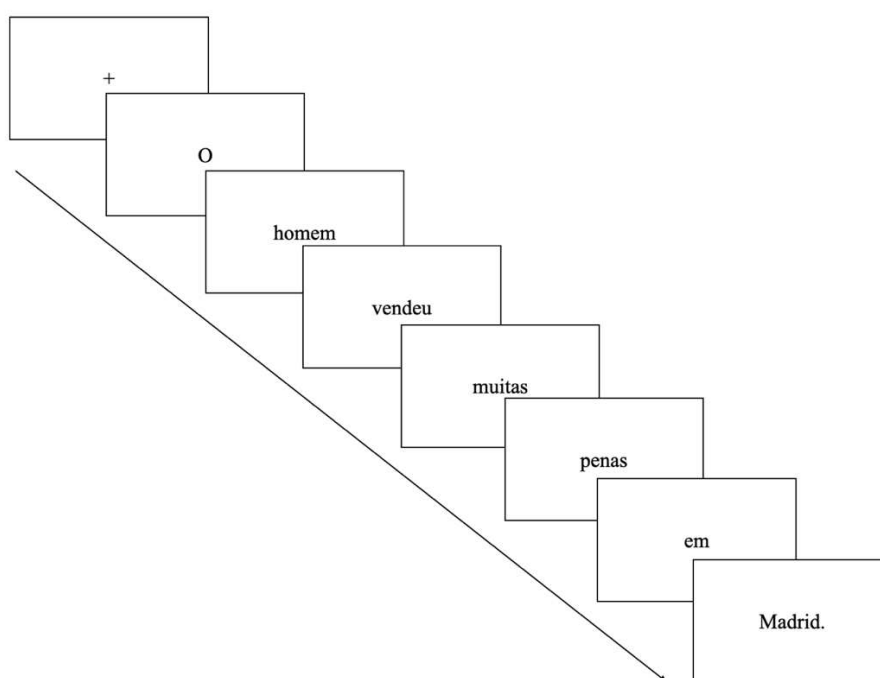
³⁰ Data analysis materials and raw results are available at https://github.com/deardiones/SPR_BRPL1_Data_Analysis.git

Plural quantifier + plural count noun (P+M)

d) + / O / homem / vendeu / **muitas** / **pratas** / **em** / Madrid.

The dependent variables were Reading Time (in milliseconds), Response Time (in milliseconds), and Answer Type (interpretation). This resulted in a total of 4 lists with 16 target sentences in BrP, randomized with 32 distractor items in a within-subject design. Each sentence was segmented word-by-word and presented using a non-cumulative, non-linear method on the platform, starting by the display of a fixation cross in the center of the screen. In order to read each segment, the participant had to press the space bar to read the following segment. The sentences were presented in the platform as it follows in Figure 5.1:

Figure 5.1 — Example of the experiment on PCIBex Farm



Source: designed by the researchers.

Each sentence was followed by the IT and 24 sentences were followed by Figure 5.2 while 24 were followed by a distractor image, as already pointed out in the method section. After reading the sentence, participants were presented with the IT, which included the question: “Qual figura melhor representa a interpretação da sentença que você leu?” Two images were then shown, as illustrated in Figure 5.2 below:

Figure 5.2 — Interpretation Task

Qual figura melhor representa a interpretação da sentença que você leu?



Continuar

Source: designed by the researchers and extracted from the experiment at PCIBex Farm platform.

If the participant selected the single large ball, their interpretation would be based on volume, indicating that they interpreted the noun as mass. However, if the participant selected the smaller balls in greater quantity, their interpretation was based on cardinality, meaning they interpreted the noun as count. Next, we move to the predictions of this experiment.

5.1.2.3 Predictions

Following Pires de Oliveira (2019, 2021, 2022), we present Table 5.1 below, which summarizes the predictions for processing for the critical segment of the noun, the interpretation attributed to sentence, and response times in each condition of this experiment.

Table 5.1 — Predictions for processing for the noun segment and interpretation for each condition

Condition	Processing	Interpretation	Response Time
Singular Quantifier + Count Noun	No additional processing	Oscillate	No additional time
Singular Quantifier + Mass Noun	No additional processing	Volume	No additional time
Plural Quantifier + Count Noun	No additional processing	Cardinal	No additional time
Plural Quantifier + Mass Noun	Additional processing	Cardinal	No additional time

Source: designed by the researchers.

Assuming the working hypothesis as the hypothesis 1, we do not expect differences in terms of processing between conditions (35.a), a condition with singular quantifier and a singular count noun, *versus* (35.c), a condition with a plural quantifier and a plural count noun, since (35.a) would be underspecified for atomicity according to Pires de Oliveira (2022) while the condition (35.c), would already carry the morphosyntactic information for atomicity. Therefore, the morphological instruction in both the quantifier and noun, we expected to dictate the interpretation of the noun. Since the interpretation is expected to be attributed during the course of derivation, only the plural condition would be interpreted as count, while the singular condition would oscillate in the interpretation.

In the conditions (35.b), a condition with a singular quantifier combined with a mass noun, *versus* (35.d), a condition with a plural quantifier with plural mass noun, we do expect differences between these two conditions. For the condition (35.d), the grammatical instruction is expected to force the interpretation of the mass noun to be interpreted as a cardinal, undertaking a packaging process as proposed by Frisson and Frazier (2005). This might happen because the plural inflection may force the participant to interpret a mass noun as cardinal. However, the condition (35.b), would not incur additional processing and would be interpreted solely as volume.

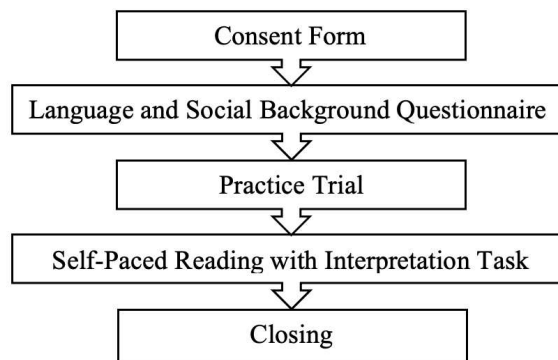
5.1.2.4 Procedures

Each participant voluntarily went to the Computer Lab at the *Universidade Federal de Santa Catarina* (UFSC), at the *Centro de Compreensão em Expressão* (CCE), located on the fourth floor, room 516B. Upon arrival, participants were seated in front of a laptop³¹ and asked if they knew English. If they answered negatively, they skipped the leveling task. If they answered positively, they were invited to take a leveling test from the Cambridge website. After completing the leveling test, the principal investigator checked the participant's level. If the level was between A1, A2, C1, or C2, the participant took the test in BrP. If the level was between B1 and B2, the participant was invited to take the task in English. The English task with bilinguals from level B1 and B2 will be reported in Experiment 3 section.

After the leveling task, participants were presented with the screen on the PCIBex website, which included the following presentation order:

³¹ The experiment was run on multiple Dell laptops, each equipped with an Intel Core i3-10100T processor, 16 GB RAM, and a 256 GB SSD, running Windows 10. Each laptop featured a 15.6-inch Full HD (1920 × 1080) display with a 60 Hz refresh rate. PCIBex was accessed via Google Chrome version 116.0.5845.

Flowchart 5.1 — Presentation order



Source: designed by the researchers.

The first prompt on the laptop screen was the Consent Form in their native language (Appendix C). After that, a brief instruction screen prepared participants for the upcoming Language and Social Background Questionnaire (Appendix E). As participants selected options on the questionnaire, the next question appeared automatically. After completing the nine questions, participants were presented with the task instructions.

The first eight trials served as practice trials (Appendix Q), allowing participants to become familiar with the SPR experiment combined with the IT. After the practice phase, the final instructions were given, followed by 16 experimental trials (Appendix M) and 32 filler items (Appendix O).

Upon completing the task, which took about 30 to 40 minutes, participants saw a thank-you screen, which also provided final instructions on how to save their data. Additionally, participants were shown their participant number, which had been randomly generated by the platform at the beginning of their session.

5.1.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. We assumed a Cohen's *d* of 0.8 for small groups where a large effect is expected. After adjusting the alpha level to 0.05 and using a sample size of 51, the resulting power was 0.9793621. Thus, we interpret this result as indicating that 97.21% of the results represent the phenomenon investigated.

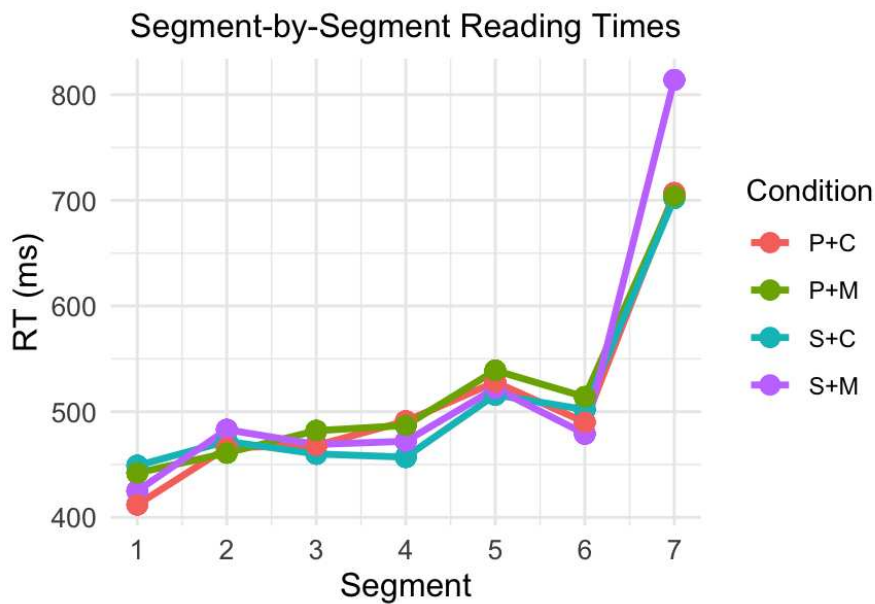
5.1.3 Self-Paced Reading

The SPR is our main instrument for investigating language processing in real time as we have already discussed in the previous method chapter. In the next subsection, we present how the data was processed for each segment, along with the statistical analysis.

5.1.3.1 Data Filtering

We begin by presenting the processing of the entire sentence with raw means for each segment as an overview of the results gathered in this study. In Graph 5.1 below, the raw mean times for each segment are displayed for the experimental conditions:

Graph 5.1 — Raw reading times means in milliseconds for each segment in the experimental conditions



Source: designed by the researchers on RStudio.

By observing the raw data, we can identify the processing pattern of the experimental sentences for BrP. The graph shows an increase in processing in the noun region (segment 5) and wrap-up processing at the end of the sentence. Notably, the Plural Quantifier + Mass Condition (P+M) shows a slight additional processing in the noun region. Interestingly, there seems to be a significant wrap-up effect (segment 7) in the Singular Quantifier + Mass Noun

(S+M) condition, standing out compared to all other conditions. The table below presents the raw means for both the quantifier region (segment 4) and the noun region (segment 5):

Table 5.2 — Raw means in reading time in milliseconds for the quantifier region

Quantifier	Mean
Singular	515.7525
Plural	513.6131

Source: designed by the researchers.

Table 5.3 — Raw means in reading time in milliseconds for the noun region

Noun	Mean
Count	508.4968
Mass	520.8687

Source: designed by the researchers.

All these results are examined in detail in the next subsections, with specific data treatment applied to each segment. We removed outliers from the samples for each segment based on data distribution and normality checks to ensure more homogeneous data. We removed outliers from all samples across all studies to make the data more consistent. Next, we will focus on the data treatment and analysis for the noun region.

5.1.3.2 Noun Region

We start by the analysis of the noun region, corresponding to segment 5, since it is the most important segment of the SPR, as it provides direct insights into whether BrP quantifier singular phrases undergo any additional processing. This region is critical for testing our working hypotheses regarding the processing pattern of this structure, allowing us to compare it with other groups. Below, we highlight the data treatment applied to this segment.

5.1.3.3 Data Analysis

By visual inspection on the graphs in the noun region, we checked the raw data to check for distribution and normality. Since the raw data did not meet both criteria above for normality and distribution, we applied the first treatment with the interquartile range with a

more conservative range 3, resulting in an upper limit of 1383. This means that all reading times that were above 1383 milliseconds were cut from the sample. After checking the distribution and the normality test, the data was still not well distributed and neither normal, in this way, we proceeded for the less conservative range 1.5, resulting in an upper limit of 993. After checking once again the graphs to check the distribution and the normality test, the data was still not well distributed and neither normal.³²

We then performed a logarithmic transformation as our last resource to better distribute the data. After the log transformation, dataset 3 did not achieve normality (Shapiro-Wilk: $W = 0.99319$, $p\text{-value} = 0.001534$)³³, and there were still three outliers visible at the bottom of the boxplot. The residuals were also not normal (Shapiro-Wilk: $W = 0.99344$, $p\text{-value} = 0.002062$)³⁴. However, both the dataset and residuals followed a normal distribution, as confirmed by visual inspection of the graphs. Therefore, dataset 3, with the logarithmic transformation, was used for the statistical analysis and was saved separately for the group comparison.

Removing the outliers from the sample reduced the number of observations from 816 to 761, resulting in the loss of 55 observations, representing 6,74% of the sample. Additionally, the condition with the highest data loss was P+C, with 16 data points lost, followed by S+M, which lost 14 data points. The conditions that preserved the most data were S+C, with a loss of 12 data points, and P+M, with a loss of 13 data points. The treated means and standard deviations for the noun region under each condition are shown in Table 5.4 below:

Table 5.4 Treated means and standard deviation for each experimental condition in the noun region

Condition	Mean	Standard Deviation
S+C	515.5392	249.7951
S+M	522.1324	415.8039
P+C	528.2647	340.6505
P+M	539.4314	287.2195

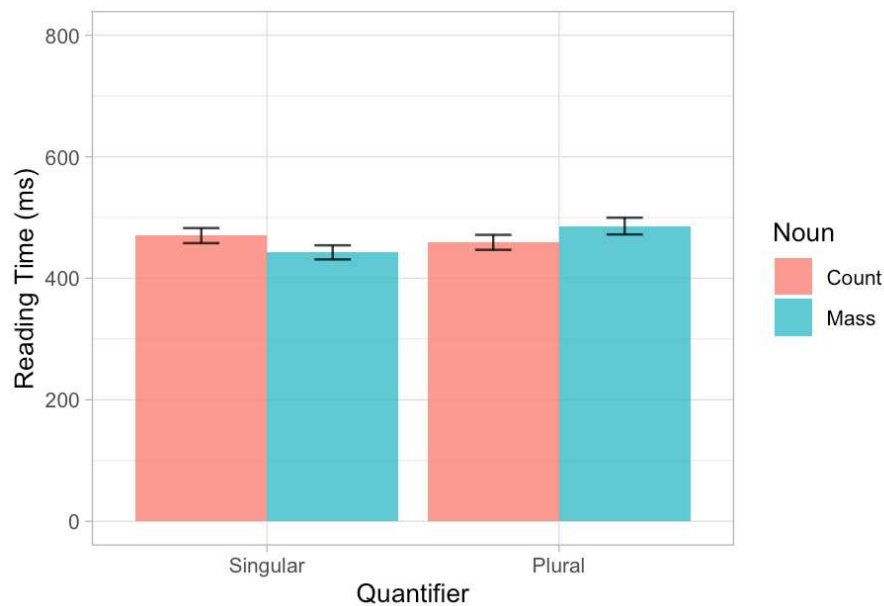
Source: designed by the researchers.

³³ Kolmogorov-Smirnov: $D = 0.042609$, $p\text{-value} = 0.002308$

³⁴ Kolmogorov-Smirnov: $D = 0.042041$, $p\text{-value} = 0.002838$

From the table above, we can see that the S+C condition is processed 6.593 milliseconds faster, having the lowest mean and the lowest standard deviation, compared to the S+M condition, which is slightly more time demanding. The P+C condition is 11.166 milliseconds faster compared to the P+M condition, which, in fact, stands out as the slowest among all the conditions. Below, the graph with the means are presented:

Graph 5.2 — Treated means and standard deviation for each experimental condition in the noun region



Source: designed by the researchers on RStudio.

The graph shows a comparison of reading times in milliseconds across different quantifiers and nouns. There does not seem to be a large difference in reading time between singular and plural quantifiers, but singular mass nouns are faster than the plural ones. The error bars are small and similar across all categories, which indicates that the averages are stable and there's not much variability within the groups. The statistical analysis might enlighten this visual tendency. Next, we can observe the means for each variable taking the segment 5 as the reference:

Table 5.5 — Means in reading time in milliseconds for the noun

Noun	Mean
Count	464.7605
Mass	464.3123

Source: designed by the researchers.

Table 5.6 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	456.5052
Plural	472.6306

Source: designed by the researchers.

In the table above, we can see that the means for the nouns are close to each other. However, the means for the quantifiers are more distant. The comparative analysis of the processing times for the mass noun and the count noun reveals that the mass noun is processed at a faster rate, with a difference of 0.448 milliseconds. Additionally, the plural quantifier is processed 16.125 milliseconds slower than the singular quantifier. Next, we will move on to the statistical analysis to determine whether these means and standard deviations yield any significant results regarding processing in the noun region.

5.1.3.4 Statistical Analysis

In the noun region, we used the logarithm of reading times as the dependent variable and fitted a linear model with Quantifier, Noun, and the interaction between these two factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be checked below:

```
model1 <- lmer (log.tempo ~ Quantificador * Nome +
  (1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model2 <- lmer (log.tempo ~ Quantificador + Nome +
  (1|Participant) + (1|Item), data = dataon3, REML = FALSE)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included a two-way interaction between the quantifier and the noun, which was statistically significant ($\chi^2 = 5.5101$, $p < 0.018$). The model's results can be seen below:

Table 5.7 — Model's results

<i>Predictors</i>	log.tempo		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	6.10	6.03 – 6.18	<0.001
Quantifier [P]	-0.02	-0.07 – 0.04	0.494
Noun [M]	-0.06	-0.11 – -0.00	0.037
Quantifier [P] × Noun [M]	0.10	0.02 – 0.18	0.013
Random Effects			
σ^2	0.07		
τ_{00} Participant	0.06		
τ_{00} Item	0.00		
ICC	0.44		
N Participant	51		
N Item	16		
Observations	761		
Marginal R^2 / Conditional R^2	0.006 / 0.444		

Source: designed by the researchers on RStudio.

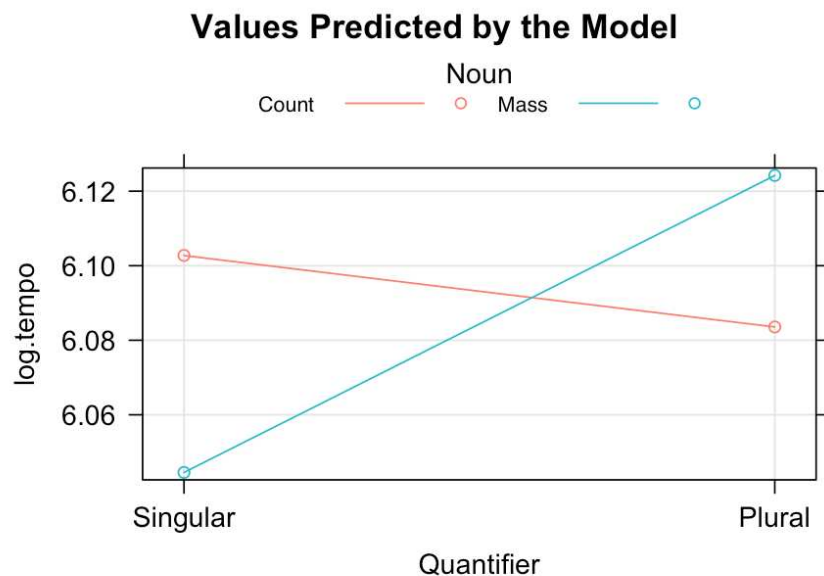
Based on the model's results, there was an effect for Noun, especially for mass nouns which significantly reduce reading times when compared to count nouns. Thus, there is a significant interaction between Quantifier and Noun, where reading times are reduced only when the noun is mass. Participant variability plays a large role in explaining reading times, as reflected by the high Intraclass Correlation Coefficient (ICC) and conditional R^2 .

A Bonferroni Correction was applied in the post-hoc analysis, revealing that the type of quantifier affects reading times for the noun only when the noun is mass. Specifically, the P+M condition is significantly slower compared to the S+M condition. Below, we present the pairwise comparison:

contrast	estimate	SE	df	t.ratio	p.value
S C - P C	0.0192	0.0281	701	0.683	1.0000
S C - S M	0.0582	0.0280	699	2.081	0.2269
S C - P M	-0.0215	0.0280	702	-0.767	1.0000
P C - S M	0.0390	0.0282	702	1.386	0.9973
P C - P M	-0.0406	0.0281	701	-1.444	0.8950
S M - P M	-0.0797	0.0280	701	-2.843	0.0276

The pairwise comparison highlights that the only condition with significant additional processing was P+M compared to S+M ($\beta = -0.0797$, $SE = 0.0280$, $t = -2.843$, $p < 0.0276$). This indicates that the effect of the quantifier is evident only when the noun is mass. Specifically, the plural quantifier combined with the mass noun is significantly slower, taking about 539 milliseconds to process, while the singular quantifier combined with the mass noun is faster, taking about 522 milliseconds. Below, we present the values predicted by the model (in log):

Graph 5.3 — Values predicted by the model for the noun region



Source: designed by the researchers on RStudio.

Graph 5.3 illustrates the interaction between singular and plural quantifiers and count and mass noun types in terms of predicted reading times on a log scale. The results reveal that mass nouns exhibit a sharp increase in reading times with plural quantifiers, whereas count nouns show a slight decrease with the same quantifier. This interaction suggests that processing of plural the quantifier combined with pluralized mass nouns may be more cognitively demanding compared to count nouns, which demonstrate more stable reading times across

quantifiers. As observed, the lines go in opposite direction for the mass noun, as the statistical analysis results. These results will be explored in greater depth in the general discussion. In the following subsection we explore the quantifier region.

5.1.3.5 Quantifier Region

The quantifier region, corresponding to segment 4, could also be informative in terms of BrP processing and question the working hypothesis of this dissertation. It is important to take a closer look at this region, as it can provide preliminary cues for the following noun. In English, the quantifier ‘many’ indicates in advance that the noun encountered next in the derivation will be a count noun, while ‘much’ grammatically signals that the following noun will be a mass noun. In BrP, we predict that the behavior might differ, and examining the processing of this region could shed light on the processing patterns of this structure.

5.1.3.6 Data Analysis

A new data treatment was applied using the original BrP dataset, extracted directly from the PCIBex platform. Three treatments were performed on segment 4, focusing on cleaning up outliers, primarily to visually distribute the data, while also applying normality tests. We began with a visual inspection of the graphs of the raw data and normality test, which were both not well distributed and neither normal. The first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 1166. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 858.5. After two upper limit cuts the data was visually well distributed. However, outliers remained in the sample, and the normality test still indicated non-normality (Shapiro-Wilk: $W = 0.97512$, $p\text{-value} = 2.875e-10$)³⁵. We also checked the residuals, which followed the same distribution pattern as the main data, but the normality test again indicated non-normality (Shapiro-Wilk: $W = 0.97538$, $p\text{-value} = 3.381e-10$)³⁶.

We then proceeded with a logarithmic transformation; however, this did not visually improve the distribution, and neither the normality. Consequently, we chose to retain dataset 3,

³⁵ Kolmogorov-Smirnov: $D = 0.069748$, $p\text{-value} = 1.263e-09$

³⁶ Kolmogorov-Smirnov: $D = 0.06599$, $p\text{-value} = 1.454e-08$

from before the logarithmic transformation, as we considered the log transformation a last resort for improving mainly the distribution of the data. Since the log transformation failed to enhance distribution, dataset 3, with the less conservative outlier cut, was saved for statistical analysis and comparison with other groups.

Removing outliers from the sample resulted in 781 observations out of the original 816, resulting in less 35 observations, representing 4.28% of data loss. The condition that lost the most data was P+M, with 10 observations removed, followed by P+C, with 9 observations removed. The conditions that retained the most data were S+C, which lost 7 observations, and S+M, which lost 9. The treated means and standard deviations for the quantifier region in each condition are presented in Table 5.8 below:

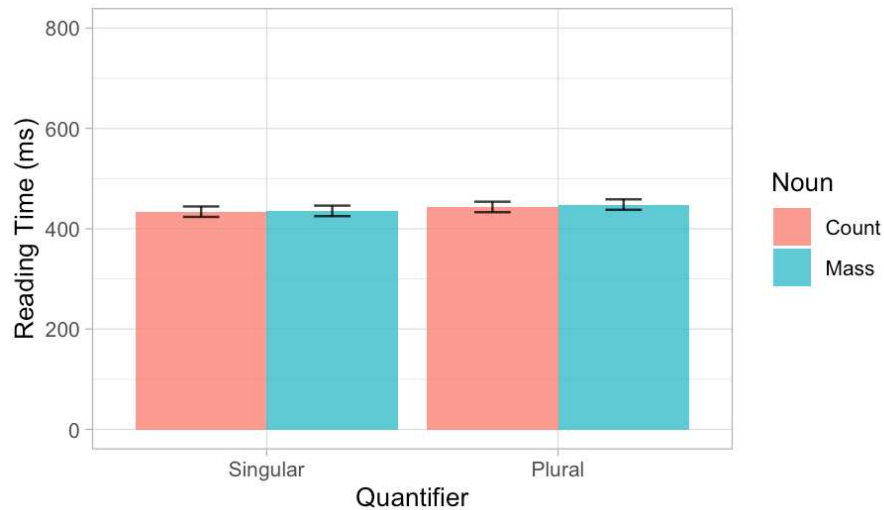
Table 5.8 — Treated means and standard deviation in milliseconds for each experimental condition in the quantifier region

Condition	Mean	Standard Deviation
S+C	433.9645	146.1265
S+M	435.5436	146.9186
P+C	443.4256	146.1208
P+M	448.1546	144.3003

Source: designed by the researchers.

By examining the table above, we can observe that the condition with the highest mean, indicating greater processing effort, is the P+M condition with 4.729 milliseconds slower than the P+C condition. The condition processed the fastest is the S+C condition being 1.579 milliseconds faster than the S+M condition, which aligns with the processing observed for the noun region. Additionally, we can already see in the treated means that the plural conditions are slower compared to the singular conditions, although the differences are minimal.

Graph 5.4 — Treated means and standard deviation for each experimental condition in the quantifier region



Source: designed by the researchers on RStudio.

The graph suggests that neither the quantifier nor the noun had a strong effect on reading times. Both quantifier and noun conditions seem to result in similar processing times, as indicated by the nearly identical bar heights across conditions. Thus, the small error bars suggest that the variability within each condition is low, meaning the results are relatively consistent across participants or trials. Below, we present the means for each variable accounting the segment 4 as reference:

Table 5.9 — Means in Reading Time in milliseconds for the quantifier

Quantifier	Mean
Singular	434.7500
Plural	445.7841

Source: designed by the researchers.

Table 5.10 — Means in Reading Time in milliseconds for the noun

Noun	Mean
Count	438.6709
Mass	441.8329

Source: designed by the researchers.

The tables above show that the plural quantifier is processed slower in comparison to the singular quantifier which is processed 10,034 milliseconds faster, and the mass noun is processed 3.162 milliseconds slower than the count noun. Next, we move to the statistical analysis to check whether these means and standard deviations result in any significance regarding processing of the quantifier region.

5.1.3.7 Statistical Analysis

In the quantifier region, using reading times as the dependent variable, we fitted a linear model with Quantifier, Noun, and their interaction as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be seen below:

```
model1 <- lmer (Reading.time ~ Quantifier * Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model2 <- lmer (Reading.time ~ Quantifier + Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model3 <- lmer (Reading.time ~ Quantifier + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)

model4 <- lmer (Reading.time ~ Noun + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)
```

A comparison of nested models using ANOVA revealed that neither the two-way interaction nor the model without the interaction ($\chi^2 = 0.0818$, $p = 0.774$) showed an improvement in fit. Similarly, additional nested models with ANOVA comparing the model without the interaction to the model with Quantifier as a predictor did not show an improvement in fit ($\chi^2 = 0.1287$, $p = 0.719$) and neither testing the effect of only the Noun as a predictor also did not result in an improvement in model fit ($\chi^2 = 2.3411$, $p = 0.126$).

Considering the AIC and BIC values of the model without the Quantifier variable had slightly lower values (AIC = 9736.5, BIC = 9759.8). Therefore, the best-fitting model included only the Noun as a fixed effect. The model's results are presented below:

Table 5.11 — Model's results

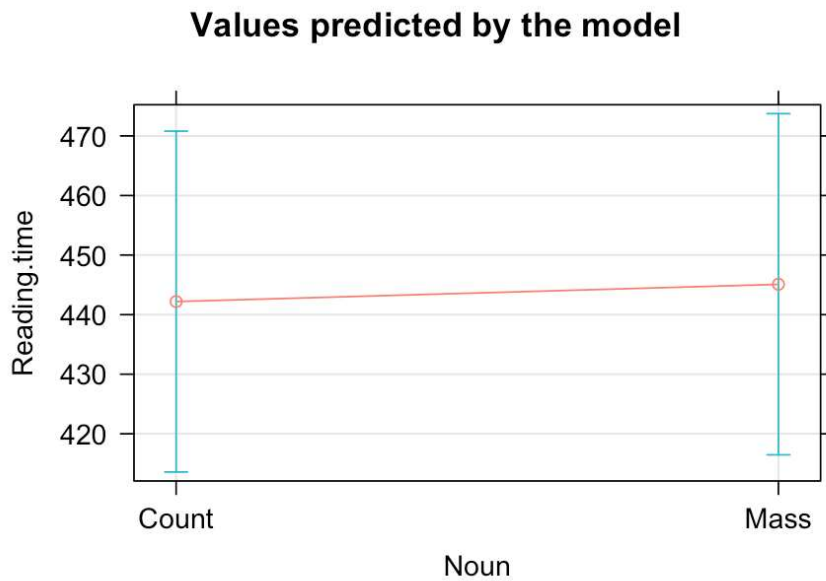
<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	442.19	413.58 – 470.81	<0.001
Noun [M]	2.91	-12.93 – 18.74	0.719
Random Effects			
σ^2	12676.00		
τ_{00} Participant	8668.78		
τ_{00} Item	161.55		
ICC	0.41		
N _{Participant}	51		
N _{Item}	16		
Observations	781		
Marginal R ² / Conditional R ²	0.000 / 0.411		

Source: designed by the researchers on RStudio.

The models suggests that there is no effect for noun, as indicated by the p value of ($p = 0.719$), therefore, not affecting reading times. This suggests that there is no evidence to support a strong effect of mass nouns on reading times compared to count nouns when using segment 4 as the baseline. Participant differences account for a substantial portion of the variability in reading times, as reflected by the high intraclass correlation coefficient and the variance components. This indicates that individual differences among participants play a major role in explaining the observed variability.

In the graph 5.5 below, the predicted reading times from the model are displayed, providing a visual representation of the relationship between noun type and reading time.

Graph 5.5 — Values predicted by the model for the quantifier region



Source: designed by the researchers on RStudio.

The graph above shows the predicted reading times for count and mass nouns. The lines vertical represents the noun type, while the horizontal lines represent the reading time in milliseconds. Each point on the graph corresponds to the predicted mean reading time for the respective noun type, with error bars indicating the confidence intervals. The predicted reading times are nearly identical for both noun types, with a slight increase for mass nouns. However, the wide and overlapping error bars suggest that this difference is not statistically significant, which is consistent with the model's findings.

5.1.3.8 Post-Critical Region

The final region to be analyzed is the post-critical region, corresponding to segment 6, which, due to the nature of the SPR task, might provide insight into spill-over effects in the processing of quantifier phrases. Since we did not find significant effects in the processing of quantifier singular phrases in either the noun region or the quantifier region, any additional processing difficulty may surface in this region for BrP.

5.1.3.9 Data Analysis

A new data treatment was performed using the original BrP dataset, extracted directly from the PCibex platform. The raw data was not normally distributed neither well distributed. The first treatment was done with the more conservative interquartile range of 3, resulting in an upper limit of 1098. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 827.25. In the more conservative outlier cut, the data was visually well distributed, though the normality test still indicated non-normality (Shapiro-Wilk: $W = 0.97736$, $p = 1.575e-09^{37}$).

We checked the residuals, which followed the same pattern as the main data. While the residuals were visually well distributed, the normality test remained non-normal (Shapiro-Wilk: $W = 0.9773$, $p = 1.508e-09^{38}$). We proceeded with a logarithmic transformation; however, this did not improve the distribution, and neither the normality test pointed that the data was normal. Therefore, we chose to retain dataset 3, from before the logarithmic transformation, as the final dataset for statistical analysis and comparison with other groups.

After removing outliers, the sample was reduced to 768 observations from the original 816, which comprised less 48 observations, representing 5.88% of the sample. The condition that lost the most data points was P+M, with 18 data points removed, followed by S+C, with 12 removed. The conditions that preserved the most data were S+M and P+C, each losing 9 data points. The treated means and standard deviations for the post-critical region can be seen in Table 5.12 below.

Table 5.12 — Treated means and standard deviation for each experimental condition in the post critical region in milliseconds

Condition	Mean	Standard Deviation
S+C	454.8073	126.0197
S+M	450.9949	130.5995
P+C	462.9949	123.4254
P+M	458.2903	127.3249

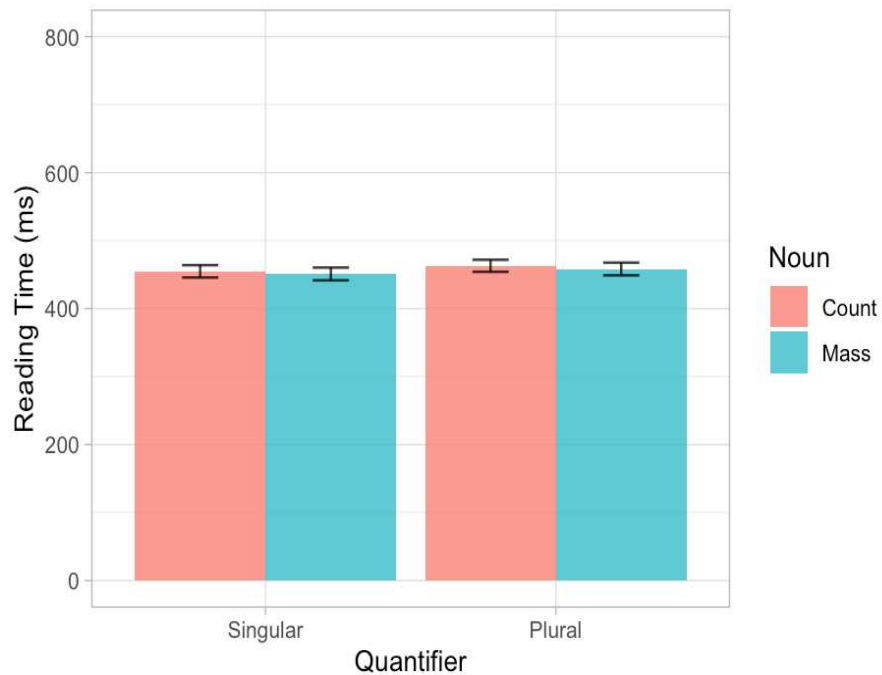
Source: designed by the researchers.

³⁷ Kolmogorov-Smirnov: $D = 0.060988$, $p = 3.95e-07$

³⁸ Kolmogorov-Smirnov: $D = 0.059172$, $p = 1.084e-06$

By examining the table above, we can see that the condition that is processed faster is the S+M condition being 3.812 milliseconds faster than S+C condition, contrasting with the previous quantifier and noun regions. The condition with the highest mean, indicating greater processing effort, is the P+C condition with 4.704 milliseconds slower than P+M condition. This differs from the patterns observed in both the quantifier and noun regions. Although the difference between plural and singular conditions is slight, we observe a trend in which plural conditions tend to be processed more slowly. Below, we can observe the graph of reading time means for the post-critical region:

Graph 5.6 — Treated means and standard deviation for each experimental condition in the post critical region



Source: designed by the researchers on RStudio.

The graph suggests that neither the quantifier nor the noun had a strong effect on reading times. Both quantifier and noun conditions seem to result in similar processing times, as indicated by the nearly identical bar heights across conditions. Thus, the small error bars also suggest that the variability within each condition is low, meaning the results are relatively consistent across participants. Below, we present the means for each variable taking the segment 6, as the baseline:

Table 5.13 — Means for reading time in milliseconds for the noun

Noun	Mean
Count	458.9328
Mass	454.5564

Source: designed by the researchers.

Table 5.14 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	452.8863
Plural	460.6982

Source: designed by the researchers.

The tables above indicate that the mass noun is processed 4.376 milliseconds faster than the count noun. Additionally, the plural quantifier is processed more slowly compared to the singular quantifier, which is processed 7,811 milliseconds faster. Next, we will conduct a statistical analysis to determine whether these means and standard deviations indicate any significant differences in processing within the post-critical region.

5.1.3.10 Statistical Analysis

In the post-critical region, using reading times as the dependent variable, we fitted a linear model with Quantifier, Noun, and the interaction between these two factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be checked below:

```
model1 <- lmer (Reading.time ~ Quantifier * Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model2 <- lmer (Reading.time ~ Quantifier + Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model3 <- lmer (Reading.time ~ Quantifier + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)

model4 <- lmer (Reading.time ~ Noun + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)
```

A comparison of nested models with ANOVA revealed that neither the two-way interaction nor the model without interaction ($\chi^2 = 0.0041$, $p = 0.948$) showed an improvement fit. Additional nested models with ANOVA, including the Quantifier as a predictor with a model without the interaction, did not indicate any improvement in model fit ($\chi^2 = 0.1408$, $p = 0.707$) and neither comparing the model with the Noun as a predictor with the model without the interaction also did not show any improvement in fit ($\chi^2 = 1.3275$, $p = 0.249$).

In this way, we considered the lower AIC and BIC values to identify the model with the best fit. The model without the Quantifier as the sole predictor showed a better balance between fit and simplicity (AIC = 9449.5, BIC = 9472.7). Thus, the best-fitting model included only the Noun as a fixed effect. Below, we present the models' results:

Table 5.15 — Model's results

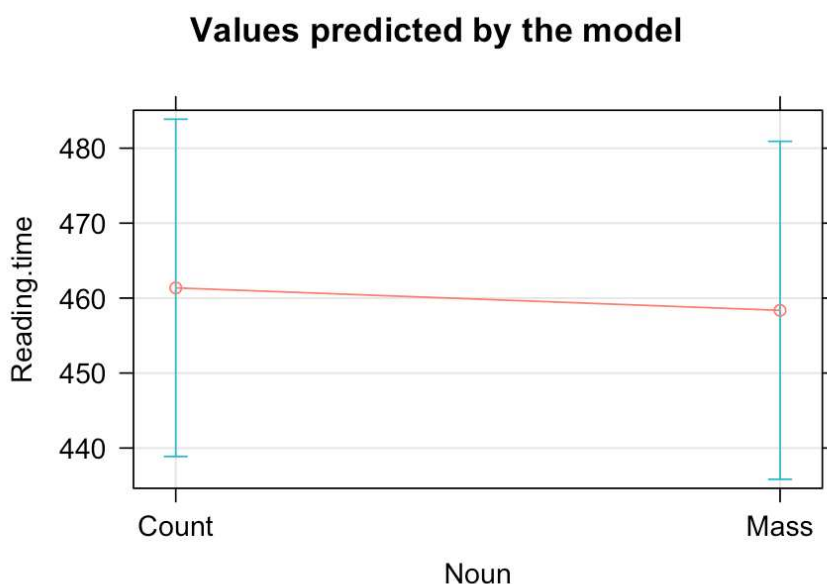
<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	461.37	438.87 – 483.86	<0.001
Noun [M]	-3.00	-17.92 – 11.93	0.693
Random Effects			
σ^2	11066.52		
τ_{00} Participant	5023.48		
τ_{00} Item	65.92		
ICC	0.32		
$N_{\text{Participant}}$	51		
N_{Item}	16		
Observations	768		
Marginal R^2 / Conditional R^2	0.000 / 0.315		

Source: designed by the researchers on RStudio.

The predictor Noun does not have a significant effect on reading times, as indicated by the non-significant estimate and confidence interval. Participant-level differences account for a substantial portion of the variability in reading times and the fixed effects for noun do not

contribute meaningfully to explaining the variance. In graph 5.7 below, we can observe the values predicted by the model in terms of reading times:

Graph 5.7 — Values predicted by the model for the post critical region



Source: designed by the researchers on RStudio.

The graph presents the predicted reading times for the count and mass nouns. While the model predicts a small increase in reading time for count compared to mass, the overlapping error bars indicate a high level of uncertainty. This suggests that the difference in predicted reading times between the two noun types is minimal and likely not statistically significant. This trend is confirmed through the statistical tests. Next, we move to the IT.

5.1.4 Interpretation Task

Now we present the instrument designed to capture the interpretation of BrP quantifier phrases. Additionally, this instrument enabled us to collect an offline measurement of language processing: Response Time, which is the data we will examine in the next subsection.

5.1.4.1 Response Time

The response time in the IT allows us to infer aspects of language processing, as it indicates the time taken by participants to determine whether their interpretation of the sentence they had just read referred to a volume or cardinal interpretation. This data may enhance our understanding of BrP language processing and representation.

5.1.4.2 Data Analysis

The data treatment was divided into two parts. In the first phase, we adjusted the coding for repeated participants and removed two non-native speakers of BrP. Next, we isolated the necessary information from the raw table extracted from PCIBex. This information included the target sentences, their selections concerning the two figures, and the time in milliseconds from when the IT appeared on the screen until the participant clicked the “Next” button.

In the second phase, we filtered the raw data to check for normality and distribution. However, the data did not meet the criteria for both. Therefore, the first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 6417. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 4414.5. After reviewing the graphs and conducting normality tests, we concluded that the data still did not follow a normal distribution, nor was it normal according to the tests. We then proceeded with a logarithmic transformation. Following the transformation, the data distribution improved, but the data was still not normal (Shapiro-Wilk: $W = 0.98988$, $p\text{-value} = 5.62e-05$)³⁹. In this way, we decided to keep with the log transformed data, prioritizing the distribution.

Removing the outliers from the sample resulted in 740 observations from the original 816, a reduction of 76 observations, representing 9.31% of the sample. The condition that lost the most data was S+M, with 27 data points lost, followed by P+M, which lost 21 data points. The conditions that preserved more data were P+C, losing 10 data points, and S+C, losing 18 data points. After this treatment, we plotted the table with the means and standard deviations in milliseconds, which can be reviewed below for each condition:

³⁹ Kolmogorov-Smirnov: $D = 0.031326$, $p\text{-value} = 0.08212$

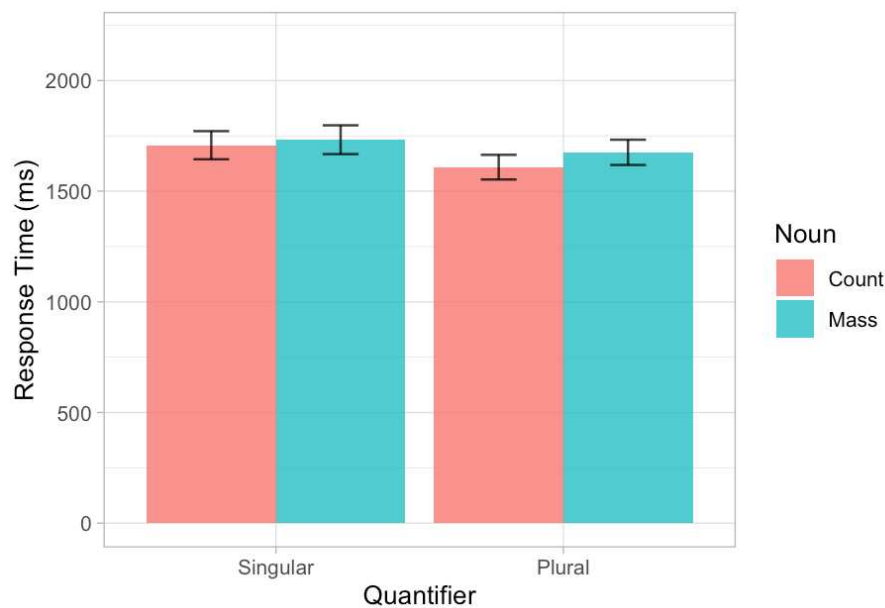
Table 5.16 — Treated means and standard deviation for each experimental condition in the response time in milliseconds

Condition	Mean	Standard Deviation
S+C	1707.952	866.2673
S+M	1732.740	865.3843
P+C	1608.603	776.4376
P+M	1675.661	772.0674

Source: designed by the researchers.

By checking the table above, we can observe that the response time for the S+M condition is 24.788 milliseconds slower than the S+C condition, while the P+C condition is 67.058 milliseconds faster than the P+M condition, also being the fastest comparison between noun types. The means and standard deviation of the response time can be visualized below:

Graph 5.8 — Response time means and standard deviation in milliseconds



Source: designed by the researchers on RStudio.

The bar graph presented above indicates that both singular and plural quantifiers, as well as count and mass noun types, do not result in visual variations in response times. The minimal differences observed indicate that response times are slightly affected by singular nouns. However, this visual trend is likely to be non-statistically significant due to the overlap in error bars. We will check that in the next subsection.

5.1.4.3 *Statistical Analysis*

For response times, using the logarithm of response time as a dependent variable, we fitted a mixed linear model with Quantifier, Noun, and the interaction between these two factors as fixed effects, alongside random intercepts for each Participant and Item. The models used in this statistical analysis can all be seen below:

```
model1 <- lmer (log ~ Quantifier * Noun + (1|Participant) +
(1|Item), data = dataoff3, REML = FALSE)
```

```
model2 <- lmer (log ~ Quantifier + Noun + (1|Participant) +
(1|Item), data = dataoff3, REML = FALSE)
```

```
model3 <- lmer (log ~ Quantifier + (1|Participant) + (1|Item),
data = dataoff3, REML = FALSE)
```

```
model4 <- lmer (log ~ Noun + (1|Participant) + (1|Item), data
= dataoff3, REML = FALSE)
```

A comparison of nested models with ANOVA indicated that the two-way interaction and the model without the interaction did not improve model fit ($\chi^2 = 0.4245$, $p = 0.514$). Therefore, further nested models were performed with ANOVA comparing the model without the interaction with the model that included the Quantifier alone showed a marginal non-significant fit ($\chi^2 = 2.8015$, $p < 0.094$). Comparing the model without the two-way interaction with the model with Noun alone also did not show an improvement in model fit ($\chi^2 = 2.0999$, $p = 0.147$).

Given the lack of differences between models, we considered the lower AIC and BIC values to identify the model with the best fit. The model with only the Noun as fixed effect showed a better balance between fit and simplicity (AIC = 843.46, BIC = 866.49), confirming the best fit even though it was marginally non-significant. Next, we can check the models alongside the table with the model's results for response time:

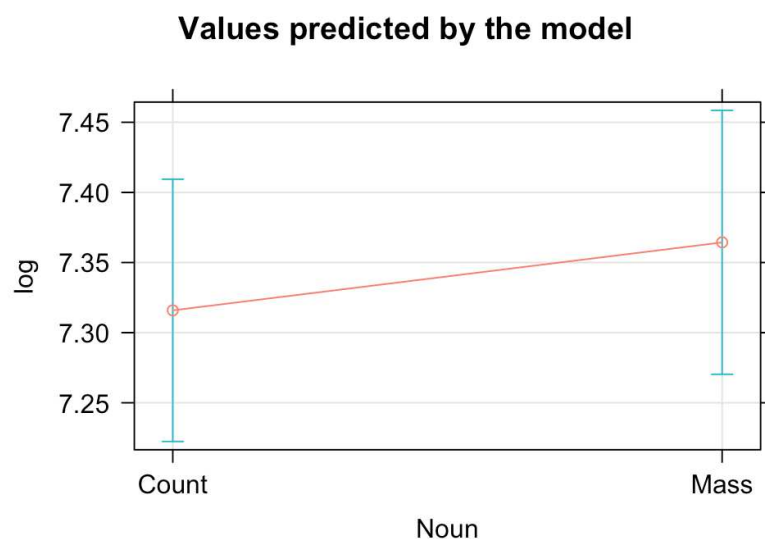
Table 5.17 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.32	7.22 – 7.41	<0.001
Noun [M]	0.05	-0.01 – 0.11	0.094
Random Effects			
σ^2	0.15		
τ_{00} Participant	0.08		
τ_{00} Item	0.00		
ICC	0.35		
$N_{\text{Participant}}$	50		
N_{Item}	16		
Observations	740		
Marginal R^2 / Conditional R^2	0.002 / 0.355		

Source: designed by the researchers on RStudio.

The analysis revealed that noun type has only a marginal non-significant effect for response time, not having a strong effect on the time that participants took to respond whether their interpretations of the sentence was cardinal or by volume with quantifiers not influencing the interpretations. Below we can check the values predicted by the model:

Graph 5.9 — Values predicted by the model for the response time in log



Source: designed by the researchers on RStudio.

This graph shows log-transformed values for noun type. Mass nouns have higher log values, indicating that the response time of these nouns are slower when we compare it to count nouns, even though this difference was only marginally non-significant. Additionally, based on the ANOVAs we may conclude that quantifiers do not affect response time, not having an effect on the interpretation. Next, we look at our final dependent variable in the answer type subsection.

5.1.4.4 Answer Type

Finally, the answer type will give specific information whether the nouns in BrP are interpreted as cardinal or volume, being mainly an offline measurement of language representation and interpretation.

5.1.4.5 Data Analysis

Following the data filtering of the response time, we continued working on the data filtering for the answer type, immediately after plotting the response time graph. The volume and cardinal responses that can be checked are presented in the table below in percentages:

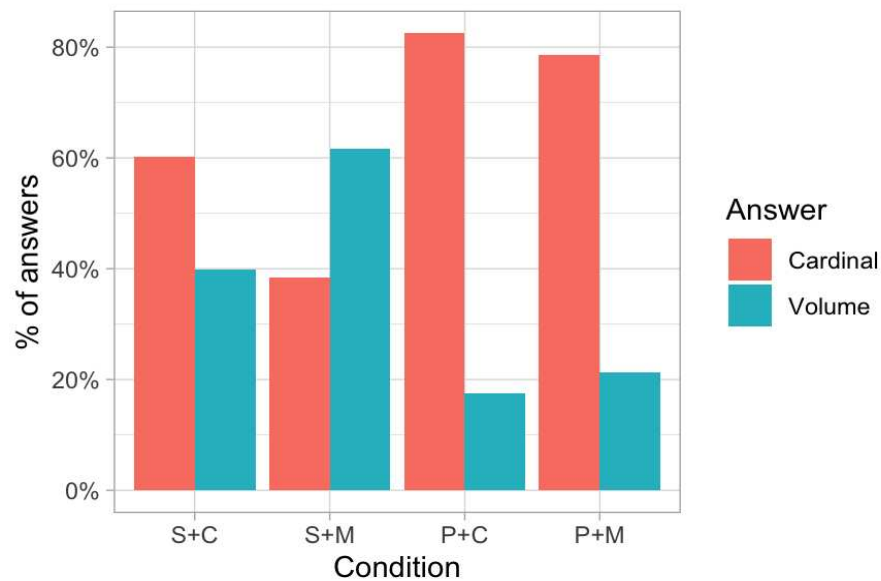
Table 5.18 — Percentage of cardinal and volume responses in the answer type

Condition	Cardinal	Volume
S+C	60,2%	39,8%
S+M	38,4%	61,6%
P+C	82,5%	17,5%
P+M	78,7%	21,3%

Source: designed by the researchers.

As we can observe from the table above, there was a slight preference for cardinal in condition S+C and for volume in condition S+M, however, the answer type oscillates in these two conditions. This behaviour is not observed for the plural + noun conditions, which appears to be more categorical in terms of cardinality. Next, we can observe the graph which illustrate these results:

Graph 5.10 — Answer type



Source: designed by the researchers on RStudio.

The graph above visually explores the table percentages. After plotting this graph, we checked that the residuals were not normal, but they followed a normal distribution. Next, we move for the statistical analysis of the answer type.

5.1.4.6 Statistical Analysis

For the answer type, using answer as the dependent variable, we fitted a Mixed Linear Generalized Model that included Quantifier, Noun, and the interaction between these two factors as fixed effects, along with random intercepts for each Participant and Item. The models used in this analysis can be checked below:

```
modell1 = glmer (Answer ~ Quantifier * Noun + (1|Participant) +
  (1|Item), data = dataoff3, family = binomial)

modell2 <- glmer (Answer ~ Quantifier + Noun + (1|Participant)
  + (1|Item), data = dataoff3, family = binomial)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included the two-way interaction between Quantifier and Noun, which was statistically significant ($\chi^2 = 4.8569$, $p < 0.027$). The model's results can be checked below:

Table 5.19 — Model's results

<i>Predictors</i>	Answer		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
(Intercept)	0.52	0.24 – 1.15	0.105
Quantifier [P]	0.15	0.07 – 0.29	<0.001
Noun [M]	4.36	2.44 – 7.81	<0.001
Quantifier [P] × Noun [M]	0.37	0.15 – 0.90	0.028
Random Effects			
σ^2	3.29		
τ_{00} Participant	4.48		
τ_{00} Item	0.38		
ICC	0.60		
N Participant	50		
N Item	16		
Observations	740		
Marginal R^2 / Conditional R^2	0.177 / 0.668		

Source: designed by the researchers on RStudio.

Based on the table above, the plural quantifier significantly decreases the probability of getting a volume response while the mass noun significantly increases this probability. The interaction between quantifier and noun has a statistically significant effect. The high ICC suggests that participant-level variability is a dominant factor in this model. Thus, the model explains a substantial portion of the variance.

Post-hoc Bonferroni Correction analysis indicated that the only non-significant comparison was between P+C and P+M. The interaction highlighted by the model, suggests that mass nouns increase the probability of volume responses only when the quantifier is singular. The pairwise comparison conducted can be found below:

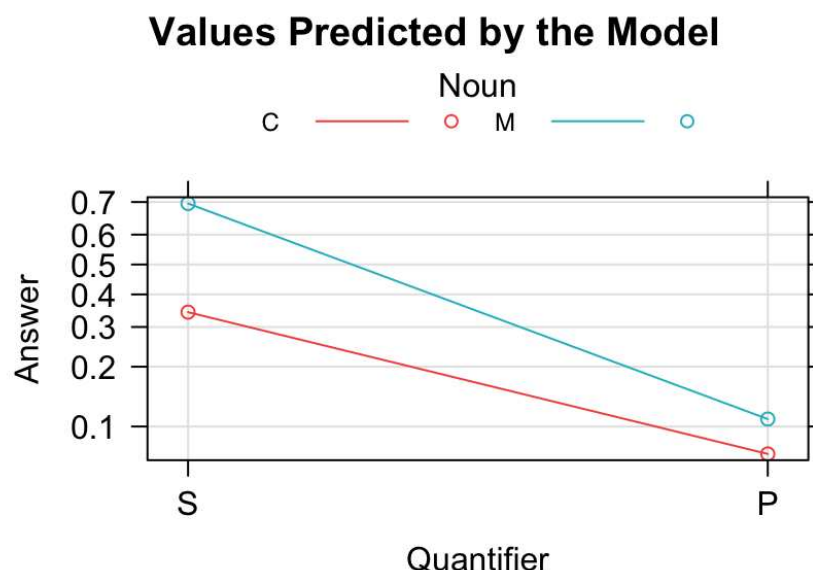
contrast	estimate	SE	df	z.ratio	p.value
S C - P C	1.923	0.342	Inf	5.627	<.0001
S C - S M	-1.473	0.297	Inf	-4.955	<.0001

S C - P M	1.450	0.323	Inf	4.494	<.0001
P C - S M	-3.396	0.375	Inf	-9.068	<.0001
P C - P M	-0.473	0.350	Inf	-1.351	1.0000
S M - P M	2.923	0.352	Inf	8.315	<.0001

The pairwise Bonferroni correction highlights that the only condition that did not had a significant difference was the P+C condition compared to P+M ($\beta = -0.473$, $SE = 0.350$, $t = -1.351$, $p = 1.0000$), while all the other conditions were significant ($p < 0.0001$). The comparisons that are worth highlighting are S+C and P+C ($\beta = 1.923$, $SE = 0.342$, $t = 5.627$, $p < .0001$), indicating that the quantifier type affects the interpretation of the count noun, showing a clear difference between ‘muita’ and ‘muitas’; the conditions S+C and S+M ($\beta = -1.473$, $SE = 0.297$, $t = -4.955$, $p < .0001$), indicating a difference in the interpretation between singular quantifier with mass nouns and singular quantifier with count nouns; and S+M and P+M ($\beta = 2.923$, $SE = 0.352$, $t = 8.315$, $p < .0001$), indicating that the interpretation of the mass noun is affected by the quantifier type.

This means that when quantifier is plural, the answer type is mainly cardinal, not being affected by the noun type, but when the quantifier is singular there is oscillation between cardinal and volume interpretations. Below, we can check the values predicted by the model:

Graph 5.11 — Values predicted by the model for the answer type in log



Source: designed by the researchers on RStudio.

As we observed by the graph above, both quantifier and noun influence the predicted variable answer type. Overall, when the quantifier is singular, the mass nouns have higher probabilities of getting a volume response than count nouns, while this trend changes to lower probabilities with plural quantifiers. In other words, there is more variation when the quantifier is singular while plural quantifiers are more categorical in terms of answer type. That is, there is a difference between count and mass noun only when the quantifier is singular. In the next subsection we take a look at the Intra-variable Analysis.

5.1.5 Intra-Variable Analysis

A chi-squared for given proportions test was performed to examine the frequency distribution of the categorical variable Answer, which has two levels: cardinal and volume. We conducted four chi-squared tests with give proportions as it follows:

Table 5.20 — Given proportions for each level for the variable answer

Condition	Cardinal	Volume
S+C	0.6	0.4
S+M	0.2	0.8
P+C	0.8	0.2
P+M	0.8	0.2

Source: designed by the researchers.

The proportions given are an approximation based on the predictions proposed by this experiment based on the literature discussed for this study. That is, we expect for BrP in the S+C condition more cardinal interpretations than volume, providing an oscillation in the answer with a preference for cardinal (about 2/3 for cardinal and 1/3 for volume) while for the S+M we expected much more volume interpretations, almost being categorical. For the P+C and P+M, we expected higher interpretations for cardinal than volume, close to categorical. In the following table we can check the results:

Table 5.21 — Chi-squared results for each condition

Condition	Chi-Squared	P-Value
S+C	$\chi^2 (1) = 0.0035842$	$p = 0.9523$
S+M	$\chi^2 (1) = 37.527$	$p < 0.0001$
P+C	$\chi^2 (1) = 0.74227$	$p = 0.3889$
P+M	$\chi^2 (1) = 0.19672$	$p = 0.6574$

Source: designed by the researchers.

The results of all comparison shows that the proportion expected based on our prediction, and the values got in the results of the experiments. For the conditions S+C, P+C, and P+M, our analysis failed to reject the null hypothesis of this test. In other words, the results are aligned with the predictions based on the literature. However, the S+M contradicted our prediction since the p-value is below 0.05, rejecting the null hypothesis.

Assuming the answer type of the IT, we could observe that we may have had oscillation also in the S+M condition. In order to further investigate this possible oscillation, we conducted an additional test adjusting the proportions for this condition to 0.6 for volume and 0.4 for cardinal (expecting 1/3 for cardinal interpretations and 2/3 volume) and the test failed to reject the null hypothesis ($\chi^2 = 0.18456$, $p = 0.6675$). In other word, this analysis on the S+M condition adjusting the values for a possible oscillation provides evidence that we had oscillation in the singular quantifier with mass nouns as well, contradicting the literature. This will be further explored in the General Discussion section.

5.1.6 Additional Analysis

We proceeded investigating whether the log values of response time would be affected by the answer type. For that, using log as the dependent variable, we fitted a linear model with Quantifier, Noun, Answer, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this additional analysis can be seen below:

```
modell1 <- lmer (log ~ Quantifier * Noun * Answer + (1 |  
Participant) + (1 | Item), data = dataoff3)
```



```

model2 <- lmer (log ~ Quantifier + Noun + Answer + (1 |
Participant) + (1 | Item), data = dataoff3)

model3 <- lmer (log ~ Quantifier + Answer + (1 | Participant)
+ (1 | Item), data = dataoff3)

model4 <- lmer (log ~ Noun + Answer + (1 | Participant) + (1 |
Item), data = dataoff3)

model5 <- lmer (log ~ Answer + (1 | Participant) + (1 | Item),
data = dataoff3)

```

A comparison of nested models with ANOVA revealed that neither the three-way interaction comparing it with the model without the interaction showed an improvement in fit ($\chi^2 = 4.8601$, $p = 0.302$). Additional nested models with ANOVA were performed comparing the model without the three-way interaction with the model that included the Quantifier and Answer as a predictor without the interaction between these two factors and it also did not indicate any improvement in model fit ($\chi^2 = 1.305$, $p = 0.253$). Comparing the three-way interaction with the model with Noun and Answer without the interaction between these two factors also did not show an improvement in fit ($\chi^2 = 0.034$, $p = 0.846$), neither including only the answer ($\chi^2 = 1.3189$, $p = 0.517$).

Considering the AIC and BIC values, the model without the Quantifier and Noun variables had slightly lower values (AIC = 833.86, BIC = 856.90). Therefore, the best-fitting model included only the Answer as a fixed effect. The models used and the model's results are presented below:

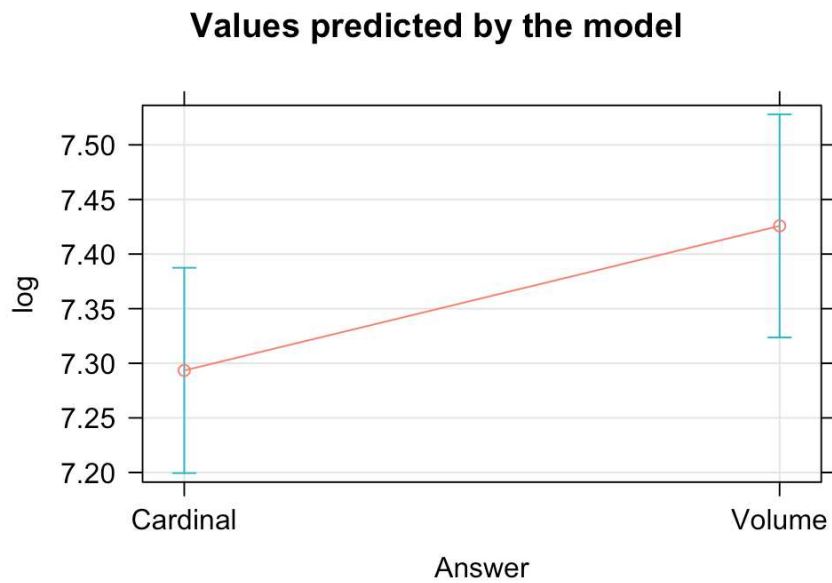
Table 5.22 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.29	7.20 – 7.39	<0.001
Answer [Volume]	0.13	0.06 – 0.20	<0.001
Random Effects			
σ^2	0.15		
τ_{00} Participant	0.09		
τ_{00} Item	0.00		
ICC	0.37		
N Participant	50		
N Item	16		
Observations	740		
Marginal R^2 / Conditional R^2	0.016 / 0.381		

Source. designed by the researchers on RStudio.

As we can observe by the model's result, there was a statistically significant effect for volume, which indicates that volume responses have higher log values than the baseline value which is cardinal responses. Next, we can observe the values predicted by the model:

Graph 5.12 — Values predicted by the model for the answer type in log



Source: designed by the researchers on RStudio.

The graph above shows the values predicted by the model in which we observe a tendency for higher log values for volume, while lower log values are observed for cardinal. In other words, the log values represent response times which is higher for volume. The answers given by participants took more time for volume responses than when it was cardinal responses, indicating that volume interpretation is more costly in terms of processing.

5.1.6.1.1 Summary of Key Findings from Experiment 4

The table below provides an overview of the data collected for Experiment 4.

Table 5.23 — Summary of key findings from experiment 4 (BrPL1)

<i>Region</i>						
Quantifier Type	Noun Type	Quantifier	Noun	Post-Critical	Response Time	Answer Type
Singular	Count	=	=	=	=	Oscillate +Cardinal
	Mass	=	=	=	=	Oscillate +Volume
Plural	Count	=	=	=	=	Cardinal
	Mass	=	+	=	=	Cardinal

Source: designed by the researchers

Observations: The meaning of the symbols are: (=) we did not find statistical effect; (+) we found statistically significant effect indicating additional processing time (-) we found statistically significant effect indicating less processing time; and (.) we found a marginal effect. Response Time were generally marginally non-significant for Noun ($p < 0.09$).

- In terms of processing, we do not observe any additional processing time for the quantifier, noun, and neither spill-over regions for quantity quantifier phrases;
- There is additional processing time for the noun region only when the quantifier is plural and it is combined with a pluralized mass noun;
- Neither the nouns nor the quantifiers affect response times;
- Volume responses suggest an additional response time;

- There is oscillation between cardinal and volume interpretation in bare singular nouns;
- Plural quantifier combined with pluralized nouns results in more categorical interpretations, favoring cardinality;
- There is a clear difference between singular and plural quantifiers.

5.1.7 General Discussion

We begin the discussion by specifically examining the processing patterns of BrP, which inform us whether the quantifier singular phrases require additional processing time. The supporting evidence includes the means, which show less than a millisecond of difference between mass and count nouns, and the statistical analysis, which highlights that the comparison between mass and count nouns is not statistically significant in the singular conditions. Additionally, neither the quantifier nor the post-critical regions show additional processing time for the quantifier phrases.

In a nutshell, bare singular nouns headed by a quantity quantifier do not require additional processing in any of the singular conditions tested in this experiment, as statistical tests failed to find significant effects in these conditions for the quantifier, noun, and post-critical regions. In other words, reading is unimpaired when a native speaker of BrP encounters sentences like ‘O homem vendeu muita pena em Madrid’ (The man sold a lot of feathers in Madrid) or ‘O homem vendeu muita prata em Madrid’ (The man sold a lot of silver in Madrid), both of which contain bare singular nouns as internal arguments. These results are consistent with previous findings from Lima (2019), which also failed to find statistical differences in conditions which contained bare singular nouns.

However, our study found differences in processing bare plurals with mass nouns. Specifically, comparing the processing of ‘O homem vendeu muita prata em Madrid’ (The man sold a lot of silver) and ‘O homem vendeu muitas pratas em Madrid’ (The man sold many silvers) showed a statistically significant difference in reading times, with the plural condition taking longer. A possible explanation that may account for the additional processing observed in this condition is that combining a plural quantifier with a mass plural noun is ungrammatical in BrP, resulting in this additional processing, therefore resulting in a process called packaging. In English, when a mass noun is pluralized, native speakers often undergo to a coercion process called packaging, in which the mass noun is interpreted as a count noun.

This coercion requires additional time, as observed in the study by Frisson and Frazier (2005). In BrP, the plural inflection might drive a similar process. This may occur because plural inflection grammatically instructs the native speaker of BrP to count nouns like ‘*pratas*,’ (silvers) interpreting it as pieces of silver. This process is similar to coercion in English, where a mass noun typically should not be pluralized; if pluralized, coercion affects the noun’s interpretation, requiring it to be understood as discrete items rather than a collective mass, thus initiating a packaging process (FRISSON; FRAZIER, 2005). Consequently, all plural conditions were interpreted as cardinal. This finding for quantifier plural phrases with mass nouns is different from Lima (2019), which did not identify any additional processing in bare plural conditions. The additional processing for the plural condition with a mass noun indicates that the processing of bare singular nouns is a morphosemantic phenomenon. In other words, we can signal to the speaker in advance whether a noun should be interpreted as cardinal based on its morphological information. In our experiment, the cardinal interpretation was triggered by the plural inflection but may also be dictated if determiners are present before the noun. When morphological cues are absent — for both the quantifier and noun — the interpretations remain open, allowing for oscillation between the two meanings in BrP.

Additionally, when examining the absence of significant processing effects for quantifiers, the singular quantifier ‘*muita*’ appears to be underspecified, as predicted by Pires de Oliveira (2022), meaning that its presence in the derivation does not provide any grammatical cue for the speaker about whether to interpret the following noun as a countable or a volume-based entity, which differs from English. No additional processing was observed in the quantifier’s own region neither in the noun region, where spillover effects could occur. This suggests that underspecification is not only a characteristic of processing and representation for mass and count nouns but also extends to BrP grammar, emerging in other linguistic phenomena, such as quantifiers, as predicted by Pires de Oliveira (2022). The plural quantifier ‘*muitas*’ grammatically instructs to convey a cardinal interpretation, driven by its plural inflection.

Moving forward to the response times, although the results were marginally non-significant, they shed light on the nature of the semantics of bare singular nouns. Specifically, mass nouns create uncertainty for speakers regarding whether to interpret the structure as denoting cardinality or indivisible units. This is a novel finding compared to previous studies on Quantity Judgment Tasks (QJT) conducted in BrP, such as those by Beviláqua and Pires de Oliveira (2014, 2017), as mass nouns in singular form were typically interpreted solely as mass. Our study is the first to demonstrate this oscillation in interpretation of mass nouns. Therefore,

there is no significant difference in response time between mass and count nouns, but there is a marginal non-significant difference between bare singular nouns and bare plural nouns, an effect that we have observed throughout the experiment. Based on this reasoning, quantifier singular phrases do not require additional processing time as reflected in response times.

Finally, the answer types provide insight into the interpretation of these nouns in sentences. There is oscillation in the interpretation of quantifier singular phrases. For instance, nouns like ‘pena’ (feather) and ‘prata’ (silver) can be interpreted as either cardinal or volume-based. There is, however, a slight preference for a cardinal interpretation for nouns like ‘pena’ and a slight preference for volume interpretation for nouns like ‘prata,’ and indicates that bare singular count nouns and bare singular mass nouns are different. This oscillation in interpretation for each noun type has psycholinguistic correlates, not indicating any additional processing time, and is predicted by the underspecification hypothesis (PIRES DE OLIVEIRA, 2022), suggesting that the noun has an open interpretation; therefore, its meaning can be filled by either cardinal or volume interpretations. Since the interpretation remains open, no additional processing times is observed. This indicates that these nouns do not have a primitive meaning, differing from English, as we have observed in Frisson and Frazier’s study.

An intra-condition analysis suggested an alignment with the literature for count noun in quantifier singular phrases, reinforcing that there is oscillation in the interpretation of count noun, with higher cardinal interpretations than volume ones. However, we also got oscillation in mass noun in bare singulars constructions, as discussed. Further investigation provided us with statistical evidence that we also have oscillation in for mass nouns, but with more volume interpretations than cardinal. Taken together, quantifier singular phrases conditions highlight a distinction between cardinal and volume interpretations in the investigated conditions, providing statistical support for the oscillation observed for the singular conditions. Additionally, the quantifier plural phrases behaved as expected by our predictions and literature, receiving much more cardinal interpretation than volume. Although some volume interpretations were observed in both plural conditions in the graphs, we believe this may be related to a floor effect. In this case, the restricted lower values for volume interpretations likely constrained variability and rendered these interpretations to no statistically significant. This pattern suggests a potential bias toward cardinal interpretations in which we adjusted with the proportion for the chi-squared test in order to reduce this effect.

Additional analysis accounting response time as dependent variable and answer as an independent variable did not highlight a dependency between the answer type to response times.

However, it showed that volume responses took more time for participants to decide their interpretation, when compared to cardinal interpretations. This might help to enlighten the nature of mass nouns.

Thus, adding to previous literature, the oscillation in the interpretation of bare singular noun headed by a quantifier in BrP is consistent with similar results found in previous QJT studies conducted by Beviláqua and Pires de Oliveira (2017) and Pires de Oliveira and Beviláqua (2020) with bare nominals. In addition, this result contributes to the literature, as our newly developed instrument, based on the QJT devised by Bale and Snedeker (2005), were able to replicate previous results from traditional quantity judgments. However, our experiment revealed a novel finding — the oscillation of bare singular mass nouns — which differs from previous studies. This result might be related to the mitigation of pragmatic information that could be gathered from the figures, as the main source guiding participants' interpretation was linguistic cues. Since there was no specification for atomicity in the morphosyntactic cues, speakers oscillated just as they did for count nouns.

Considering the results from both online and offline measurements, we have presented compelling evidence that singular quantifier phrases in BrP are underspecified for atomicity. This finding allows us to reject the null hypothesis while not refuting our working Hypothesis 1, aligning with the hypothesis proposed by Pires de Oliveira (2022), which claims that bare singular nouns are underspecified for atomicity. That is, bare singular nouns can be interpreted either by volume or cardinality, as observed in our quantifier singular phrases since the singular quantifier 'muita' does not provide a measure unit for the following noun. This underspecification is related to a morphosemantic phenomenon, but it has psycholinguistic correlates; that is, singular quantity quantifier phrases do not require additional processing time in BrP, not even when headed by a quantifier. We support this hypothesis for the several reasons highlighted so far in this discussion. Next, we revisit our specific RQs in light of our results to answer them.

RQ1. Is there additional processing, if any, in the quantifier singular phrases in BrP? *No, there is not an additional processing time in the quantifier singular phrases in BrP. They are underspecified for count and mass.*

RQ2. Is there additional processing, if any, in the quantifiers in BrP? *No, there is not an additional processing time in the singular quantifier 'muita' in BrP. The quantifier 'muita' is also underspecified for count and mass.*

However, the plural quantifier ‘muitas’ are specified, and they should be interpreted by cardinality.

RQ3. Are singular nouns are interpreted as count, mass or are underspecified?

During the course of derivation, singular nouns are underspecified. That is, they allow both, volume and cardinal interpretation, but this assignment of meaning comes later in the derivation. The singular noun itself does not provide any cue to meaning.

RQ4. Does the noun type affect interpretation? *Yes, it does. Especially when the noun type (count/mass) comes pluralized. That is, the functional morphology ‘-s’ grammatically instructs the BrP speaker to interpret the noun as cardinal, even if it is a mass noun. Additionally, there is a difference between cardinal and count nouns singular nouns.*

RQ5. Do singular quantifiers influence the interpretation of singular count nouns in BrP? *No, they do not. The quantifier only influences the interpretation of a noun if both, quantifier and noun, come pluralized. That is, the singular quantifier ‘muita’ is also underspecified.*

To conclude, we retake our predictions' table, contrasting with our results.

Table 5.24 — Predictions *vs* results for processing for the noun and interpretation for each condition

Condition	Processing		Interpretation		Response Time	
	<i>Prediction</i>	<i>Result</i>	<i>Prediction</i>	<i>Result</i>	<i>Prediction</i>	<i>Result</i>
Singular Quantifier + Count Noun	No additional processing	No additional processing	Oscillate	Oscillate	No additional time	No additional time
Singular Quantifier + Mass Noun	No additional processing	No additional processing	Volume	Oscillate	No additional time	No additional time
Plural Quantifier + Count Noun	No additional processing	No additional processing	Cardinal	Cardinal	No additional time	No additional time
Plural Quantifier + Mass Noun	Additional processing	Additional processing	Cardinal	Cardinal	No additional time	No additional time

Source: designed by the researchers.

5.1.8 Conclusion

In conclusion, the results from this study provide a detailed account of how quantity quantifier phrases and noun types are processed and interpreted in BrP. There is no evidence of additional processing cost for singular quantifier phrases or for the quantifier 'muita', supporting the view that both are underspecified for count and mass. In contrast, the plural quantifier 'muitas' is semantically specified and guides interpretation based on cardinality. Similarly, singular nouns in BrP are underspecified during the course of derivation, allowing for both volume and cardinal readings, with interpretation being contextually assigned at a later stage. However, noun type does affect interpretation, particularly when pluralized: the presence

of functional morphology ‘-s’ triggers a cardinal interpretation, even in the case of mass nouns. Finally, singular quantifiers do not influence the interpretation of singular count nouns; only when both quantifier and noun are pluralized does the quantifier contribute to meaning. Together, these findings reinforce the claim that underspecification is a central feature of the BrP nominal system, shaping both the processing dynamics and the interpretive flexibility observed in native speakers.

5.2 EXPERIMENT 5 — ASSESSING THE PROCESSING AND REPRESENTATION OF QUANTIFIER PHRASES IN ENGLISH

5.2.1 Introduction

The rationale that supports this experiment is based on Frisson and Frazier (2005) study, in which the researchers investigated the processing of mass and count edible nouns in structures that violate the match between the noun type and syntactic structure for English. Their aim was to investigate if the processing of these structures involved polysemy, therefore not resulting in any additional processing cost, or if the nouns were specified, that is, they would have a primitive meaning, that would incur an additional processing in these mismatches between syntactic information and semantic instruction. Though an eye-tracking experiment, they found evidence that the nouns in English have a primitive meaning. This primitive meaning was revealed by an additional processing cost when there was a mismatch between the syntactic structure and noun type since the shift in meaning from a count noun to be interpreted as a mass noun, and vice-versa, took additional processing time. Our aim with this experiment, is to investigate a structure where there is an incongruency between the quantifier type and the noun type. In this way, we expect to obtain similar results as obtained by Frisson and Frazier (2005) as quantity quantifiers would provide similar cues before the noun. The RQs that guide this specific experiment are:

5.2.1.1 Specific Research Questions

RQ1. Is there additional processing, if any, in the quantifier singular phrases in English?

RQ2. Is there additional processing, if any, in the quantifiers in English?

RQ3. Are singular nouns interpreted as count, mass or are underspecified in English?

RQ4. Does the noun type affect answer type in English?

RQ5. Do singular quantifiers influence the interpretation of singular count nouns in English?

5.2.1.2 Hypotheses (H) and Predictions (P) for the Processing and Representation of Quantifier Singular Phrases in English

H0. The true polysemy proposal suggests that a polysemous noun can refer to multiple related meanings—for example, *bank*, which may denote both a physical entity and the abstract conceptualization of a financial institution (FRAZIER; RAYNER, 1990; LAKOFF, 1987). This type of polysemy is assigned immediately and does not incur additional processing costs, making it a purely semantic phenomenon independent of syntax. If quantifier singular phrases in BrP are polysemous in this way, no differences between the experimental conditions are expected.

P0. Accordingly, we predict that acceptability judgments and response times for quantifier singular phrases in BrP will not differ across conditions, reflecting immediate interpretation without additional processing cost.

H1. Based on Frisson and Frazier (2005), we hypothesize that BrP processing and representation patterns are specified for both count and mass nouns, even for non-edible nouns. Mass nouns are expected to have a primitive meaning related to volume or weight, while count nouns are expected to have a primitive meaning related to cardinality. Quantifiers are also predicted to be specified, with ‘much’ combining with mass nouns and ‘many’ combining with count nouns.

P1. Accordingly, we predict increased processing times when quantifier type conflicts with noun type. Specifically, a singular quantifier with a count noun or a plural quantifier with a mass noun should produce longer response times. Acceptability judgments are also expected to reflect quantifier specification, favoring ‘much’ with mass nouns and ‘many’ with count nouns.

It worth highlighting that this study is a control condition dealing with negative data for English. That is, we are juggling with two conditions that are grammatical in English which are our control conditions, and two conditions that are ungrammatical, our experimental ones.

There are three main reasons to work with this type of ungrammatical sentences: (1) Frisson and Frazier (2005) also worked with ungrammatical conditions to investigate the nouns in order to shed light in the processing of sentences that were supposedly grammatical in English as the ones with edible nouns and enlightened the nature of mass and count nouns in English; (2) the negative data helps to shed light in the grammatical and semantic mismatch between English and BrP, being essential for group comparisons; and (3) through the mismatch, we will be able to access language processing and representation in bilinguals. This will be clearer as we compare the monolingual groups with the bilingual groups.

In summary, this experiment helps us to better understand the nature of nouns and quantifiers in English. In addition, we used our new instrument to assess language representation, the IT, already discussed in this dissertation. The results of the IT might help us establish this new instrument for assessing language representation as we can compare with QJT previously done for English. Even though the current experiment contributes to the specific literature on the processing and representation of English, it indirectly supports our main study. In the next subsection, we present the specific method used to run this experiment.

All materials used in this experiment, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub⁴⁰.

5.2.2 Method

5.2.2.1 Participants

A total of 31 paid native speakers of English took part in this experiment, with a mean age of 22.6 years ($SD = 5.8$). Of these participants, 15 reported having previously studied linguistics, while 16 had not. All participants attended the study at Sidney Smith, 6th floor in room 6027F at University of Toronto, St. George Campus. Participants from the Participants' pool received course credit for their participation, while participants outside the pool received \$10 Canadian Dollar (CAD) in cash. Additionally, two participants indicated in the questionnaire that English were not their first language, though they considered themselves Canadians. We decided to remove these two participants from the data analysis since English was not their first language. While treating the data, one participant stood out as a clear outlier

⁴⁰ Data analysis materials and raw results are available at https://github.com/deardiones/SPR_ENGL1_Data_Analysis-.git

in our study. The graphs and the means when this participant were present in the analysis in the raw data was extremely different after removing the participant manually. Through the participant's number, we could identify this participant on the data collection diaries in which the principal investigator took notes of any unusual behaviour from participants, taking notes of date, time, and other relevant personal information that was treated orally only. After checking the diary, we found out that this participant had done the SPR out loud. Clearly, this explained why the results of this participant was so different from the others. In this way, we also removed this participant since s/he did not do the SPR task as it should be done. This resulted in a loss of 3 participants, resulting a final sample of 28 participants.

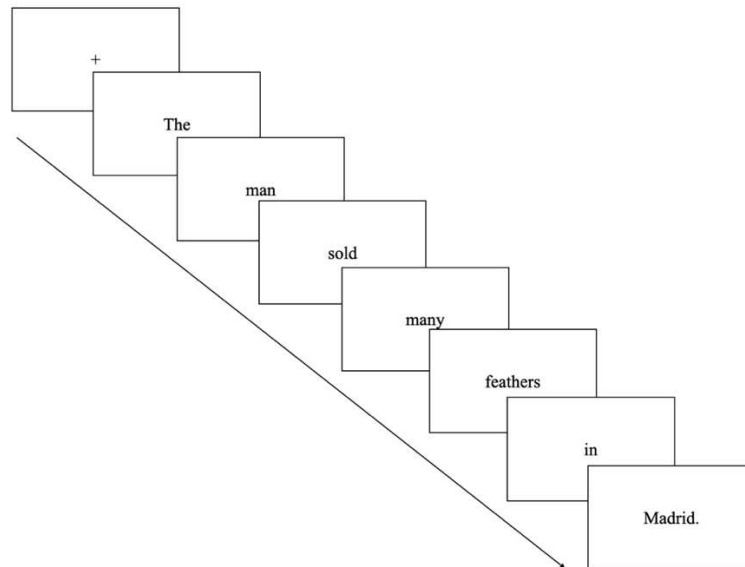
5.2.2.2 Instruments

The main instrument in this study was a SPR task, combined with the IT, both programmed in PCIBex, as discussed in the Method section. This experiment followed a 2x2 factorial design, in which we manipulated the following independent variables: quantifier type (singular/plural) and noun type (count/mass). The set of experimental conditions for this study is presented below and the bold segments represent the critical and post-critical segments:

33. Singular quantifier + singular count noun (S+C)
a) + / The / man / sold / **much** / **feather** / **in** / Madrid.
- Singular quantifier + singular mass noun (S+M)
b) + / The / man / sold / **much** / **silver** / **in** / Madrid.
- Plural quantifier + plural count noun (P+C)
c) + / The / man / sold / **many** / **feathers** / **in** / Madrid.
- Plural quantifier + plural count noun (P+M)
d) + / The / man / sold / **many** / **silvers** / **in** / Madrid.

The dependent variables were reading time (in milliseconds), response time (in milliseconds), and answer type (interpretation). This resulted in a total of 4 lists with 16 target sentences in English, randomized with 32 distractor items in a within-subject design. Each sentence was segmented word-by-word and presented using a non-cumulative, non-linear method on the platform, starting by the display of a fixation cross in the center of the screen. In order to read each segment, the participant had to press the space bar to read the following segment. The sentences were presented in the platform as it follows in Figure 5.3:

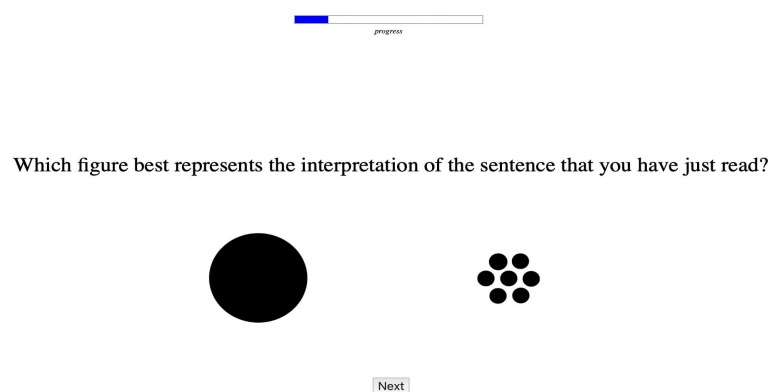
Figure 5.3 — Example of the experiment on PCIBex Farm



Source: designed by the researchers.

Each sentence was followed by the IT and 24 sentences were followed by Figure 5.4 while 24 were followed by a distractor image, as already pointed out in the method section. After reading the sentence, participants were presented with the IT, which included the question: “Which figure best represents the interpretation of the sentence that you have just read?” Two images were then shown, as illustrated in Figure 5.4 below:

Figure 5.4 — Interpretation Task



Source: designed by the researchers and extracted from the experiment at PCIBex farm platform.

As previously discussed, if the participant selected the single large ball, their interpretation would be based on volume, indicating that they interpreted the noun as mass. However, if the participant selected the smaller balls in greater quantity, their interpretation was

based on cardinality, meaning they interpreted the noun as count. Next, we move to the predictions of this experiment.

5.2.2.3 Predictions

Following Frisson and Frazier (2005), we present Table 5.25 below, which summarizes the predictions for processing of the noun segment, interpretation, and reaction times in each condition of this experiment.

Table 5.25 — Predictions for processing of the noun region and interpretation for each condition

Condition	Processing	Interpretation	Response Time
Singular Quantifier + Count Noun	Additional processing	Volume	Additional time
Singular Quantifier + Mass Noun	No additional processing	Volume	No additional time
Plural Quantifier + Count Noun	No additional processing	Cardinal	No additional time
Plural Quantifier + Mass Noun	Additional processing	Cardinal	Additional time

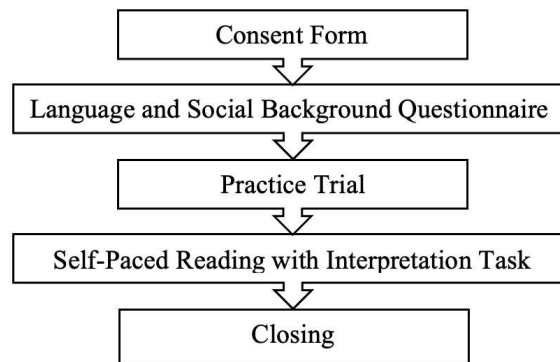
Source: designed by the researchers.

In cases where there is a match between the quantifier type and the noun type — such as with a singular quantifier paired with a mass noun or a plural quantifier paired with a count noun — we do not expect additional processing time or delays in response times. In the opposite direction, in cases where there is a mismatch between the quantifier type and the noun type — a singular quantifier with a count noun or a plural quantifier with a mass noun — we expect additional processing due to a coercion process. In this process, the grammatical structure influences the interpretation of the noun, leading to a mass noun being interpreted as cardinal and a count noun being interpreted as volume. This mismatch may also impose a cognitive load, potentially causing delays in response times for these mismatched conditions.

5.2.2.4 Procedures

Each participant had to previously set an appointment with the principal investigator and attend the session in person at the room 6027F at Sidney Smith Hall. Upon arrival, participants were seated in front of a laptop⁴¹ and given preliminary instructions, making them aware of what was going to appear on the screen. The following flowchart helps to illustrate the data collection order on PCIBex:

Flowchart 5.2 — Presentation order



Source: designed by the researchers.

The first prompt on the laptop screen was the Consent Form in their native language (Appendix D). After that, a brief instruction screen prepared participants for the upcoming Language and Social Background Questionnaire (Appendix F). As participants selected options on the questionnaire, the next question appeared automatically. After completing the nine questions, participants were presented with the task instructions.

The first eight trials served as practice trials (Appendix R), allowing participants to become familiar with the SPR experiment combined with the IT. After the practice phase, the final instructions were given, followed by 16 experimental trials (Appendix N) and 32 distractor items (Appendix P).

Upon completing the task, which took about 15 to 20 minutes, participants saw a thank-you screen, which also provided final instructions on how to save their data. Additionally, participants were shown their participant number, which had been randomly generated by the platform at the beginning of their session. The principal investigator collecting data double-checked whether participant's have saved their data or not, after they left the room. Some participant's happened to close the laptop tab before finishing the study, losing data by mistake

⁴¹ The experiment was conducted using a MacBook Pro running macOS Sonoma, equipped with an Apple M1 chip and 8 GB of RAM. The display was a built-in 13.1-inch Retina screen with a resolution of 2560 × 1600 pixels and a refresh rate of 60 Hz. The PCIBex experiment was run in Safari version 17.

or they gave up participating in the study. By checking the diaries, we found out that this type of data loss happened three times and were not accounted for in the initial sample of 31 participants.

5.2.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. We assumed a Cohen's d of 0.8 for small groups where a large effect is expected. After adjusting the alpha level to 0.05 and using a sample size of 28, the resulting power was 0.8363906. Thus, we interpret this result as indicating that 83.6% of the results represent the phenomenon investigated.

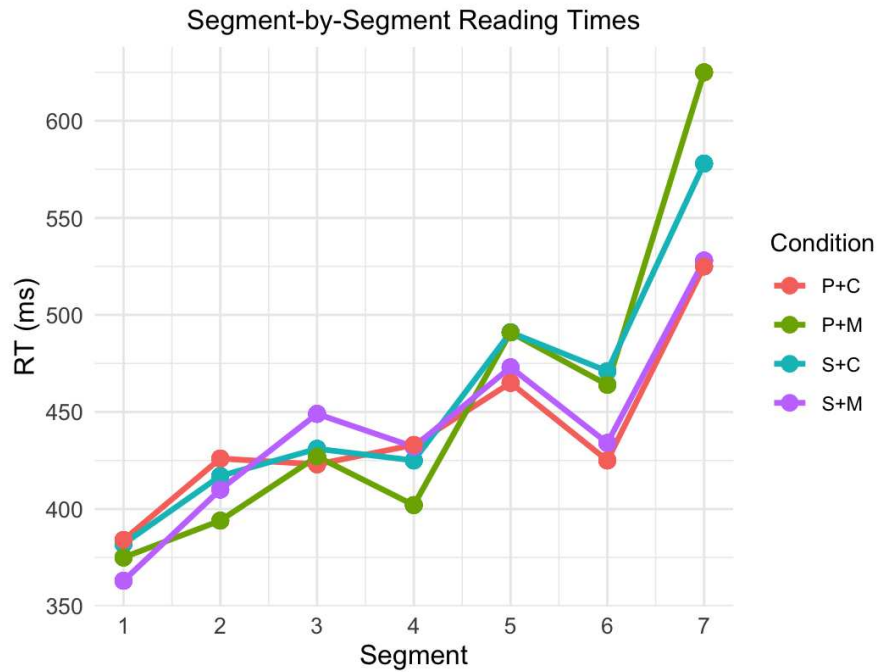
5.2.3 Self-Paced Reading

The SPR is our main instrument for investigating language processing in real time as we have already discussed in the previous method chapter. In the next subsection, we present how the data was processed for each segment, along with the statistical analysis.

5.2.3.1 Data Filtering

We begin by presenting the processing of the entire sentence with raw means for each segment as an overview of the results gathered in this study. In Graph 5.13 below, the raw RT mean for each segment are displayed for the experimental conditions:

Graph 5.13 — Raw RT means in milliseconds for each segment in the experimental conditions



Source: designed by the researchers on RStudio.

By observing the raw data, we can identify the processing pattern of the experimental sentences for English. The graph shows an increase in processing in the noun region (segment 5) and wrap-up processing at the end of the sentence for all conditions. Notably, the Plural Quantifier + Mass Condition (P+M) shows additional processing in segment 5, along with Singular Quantifier + Count Noun (S+C) condition. Interestingly, there is a visual wrap-up effect in these both conditions while the Plural Quantifier + Mass Noun (P+M) stands out compared to all other conditions. The table below presents the raw means for both the quantifier region (segment 4) and the noun region (segment 5):

Table 5.26 — Raw means in reading time in milliseconds for the quantifier region

Quantifier	Mean
Singular	448.8929
Plural	446.9751

Source: designed by the researchers.

Table 5.27 — Raw means in reading time in milliseconds for the noun region

Noun	Mean
Count	448.3029
Mass	447.5651

Source: designed by the researchers.

All these results are examined in detail in the next subsections, with specific data treatment applied to each segment. We removed outliers from the samples for each segment based on data distribution and normality checks to ensure more homogeneous data. Next, we will focus on the data treatment and analysis for the noun region.

5.2.3.2 Noun Region

The analysis of the noun region, corresponding to segment 5, is the most important part of the SPR, as it provides direct insight into whether singular nouns undergo additional processing in English when combined with pluralized quantifiers. This region is critical for testing our working hypothesis regarding the processing pattern of this structure, allowing us to compare it with other groups. Below, we highlight the data treatment applied to this segment.

5.2.3.3 Data Analysis

By visual inspection on the graphs in the noun region, we identified the visual outlier discussed in the Participants' subsection. We then proceeded to further investigate and then removed this participant and checked again the raw data. After inspecting the new raw data, the data was not normally distributed, and neither was normal. The first treatment was done with the interquartile range with a more conservative range 3 resulting in an upper limit of 1348.5. This means that all reading times that were above 1348 milliseconds were cut from the sample. After checking the distribution and the normality test, the histogram and boxplot were still not

well distributed and the tests were still not normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 960. After checking once again the graphs to check the distribution and the normality test (Shapiro-Wilk: $W = 0.96949$, $p\text{-value} = 1.017e-07$)⁴², the data was still not well distributed and neither normal.

We then performed a logarithmic transformation (log) as our last resource to improve the distribution of the data. After log transformation, dataset 3 did not achieved normality. The analysis indicated that the distribution did not become better after the logarithmic transformation, even though there are more outliers' cuts, with a single visual outlier. The residuals were not normal as well (Shapiro-Wilk: $W = 0.9694$, $p\text{-value} = 9.797e-08$)⁴³ and were not well distributed as well. Taking into account that the *dataon3* presented a better visual distribution compared with the log, we preserved some outliers, prioritizing a better distribution of the histogram. In this way, we keep working with *dataon3* before the logarithmic transformation, saving the data set for further statistical analysis and group comparison.

Removing the outliers from the sample reduced the number of observations from 448 to 423, resulting in the loss of 25 observations, representing 5,58% of the sample. Additionally, the condition with the highest data loss was S+C, with 9 data points lost, followed by P+M, which lost 8 data points. The conditions that preserved the most data were S+M and P+C with a loss of 4 data points. The treated means and standard deviations for the noun region under each condition are shown in Table 5.28 below:

Table 5.28 — Treated means and standard deviation for each experimental condition in the noun region

Condition	Mean	Standard Deviation
S+C	425.6990	167.2753
S+M	443.7222	179.5515
P+C	434.6667	170.5914
P+M	426.6154	181.9941

Source: designed by the researchers.

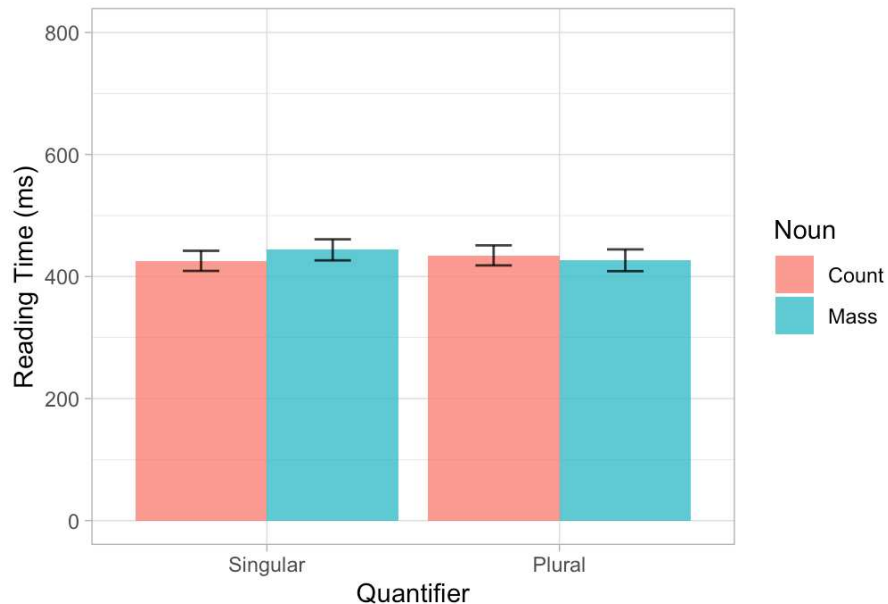
From the table above, we can see that the S+M condition is processed 18,023 milliseconds slower, having the highest mean, while the S+C condition is less time demanding.

⁴² Kolmogorov-Smirnov: $D = 0.065909$, $p\text{-value} = 0.0001482$.

⁴³ Kolmogorov-Smirnov: $D = 0.066959$, $p\text{-value} = 0.0001046$.

The P+C condition is 8,051 milliseconds slower compared to the P+M condition. Below, the graph with the mean is presented:

Graph 5.14 — Treated means and standard deviation for each experimental condition in the noun region



Source: designed by the researchers on RStudio.

In the graph above, we can observe a comparison of reading time in milliseconds across different quantifier and noun types. The mass noun seems to take slightly longer to process than the count noun in the singular conditions, while the opposite is observed for the plural conditions. There does not seem to be a large difference in reading time between singular and plural quantifiers. The error bars are small and similar across all categories, which indicates that the averages are stable and there's not much variability within the groups. The statistical analysis might enlighten this trend. Next, we have the means for each variable:

Table 5.29 — Means in reading time in milliseconds for the noun

Noun	Mean
Count	430.2891
Mass	435.3302

Source: designed by the researchers.

Table 5.30 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	434.9242
Plural	430.7170

Source: designed by the researchers.

In the table above, we can see that the means for the nouns are close to each other. The tables show that the mass noun is processed slower compared to the count noun, which is processed 5.041 milliseconds faster. Additionally, the plural quantifier is processed 4.207 milliseconds faster than the singular quantifier. Next, we will move on to the statistical analysis to determine whether these means and standard deviations yield any significant results regarding processing in the noun region.

5.2.3.4 Statistical Analysis

In the noun region, we used Reading Time as the dependent variable and fitted a linear model with Quantifier, Noun, and the interaction between these two factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be seen below:

```

model1 <- lmer (Reading.time ~ Quantifier * Noun +
  (1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model2 <- lmer (Reading.time ~ Quantifier + Noun +
  (1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model3 <- lmer (Reading.time ~ Quantifier + (1|Participant) +
  (1|Item), data = dataon3, REML = FALSE)

model4 <- lmer (Reading.time ~ Noun + (1|Participant) +
  (1|Item), data = dataon3, REML = FALSE)

```

A comparison of nested models with ANOVA revealed that neither the two-way interaction nor the model without the interaction ($\chi^2 = 0.493$, $p = 0.482$) had an improvement in fit. Additionally, comparing the model without the interaction and having only the Noun as

fixed effect also did not show an improvement in fit ($\chi^2 = 0.289$, $p = 0.5909$) nor the Quantifier alone showed a better fit ($\chi^2 = 0.0213$, $p = 0.884$).

Considering the AIC and BIC values, the model without the Noun variable had slightly lower values (AIC = 5284.6, BIC = 5304.8). Therefore, the best-fitting model included only Quantifier as a fixed effect. The model's results are presented below:

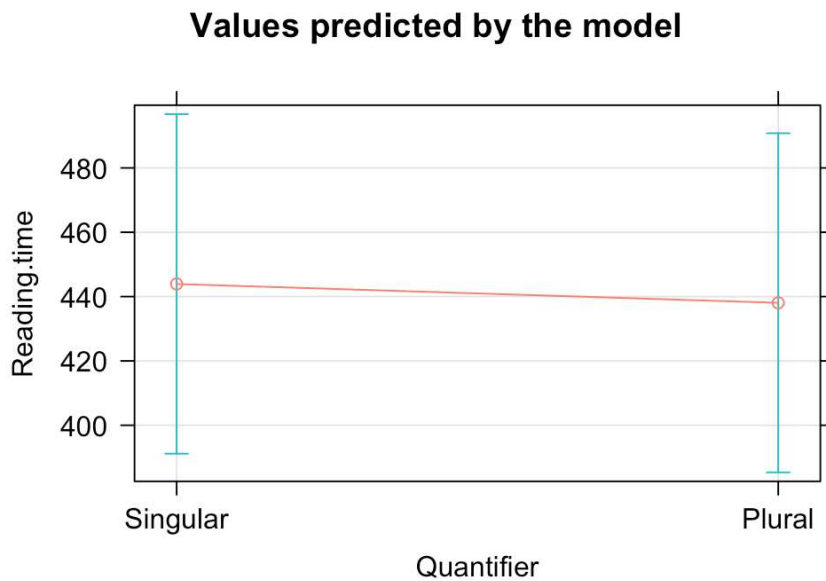
Table 5.31 — Model's results

<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	443.94	391.16 – 496.72	<0.001
Quantifier [P]	-5.88	-27.21 – 15.45	0.588
Random Effects			
σ^2	12372.18		
τ_{00} Participant	18490.93		
τ_{00} Item	0.00		
ICC	0.60		
N Participant	28		
N Item	16		
Observations	423		
Marginal R^2 / Conditional R^2	0.000 / 0.599		

Source: designed by the researchers on RStudio.

The table above highlights that the quantifier alone as fixed effect does not significantly influence reading time and nearly all variance is explained by individual differences among the random intercept participant, and not differences between item or quantifier. Below, we present a graph with the values predicted by the model:

Graph 5.15 — Values predicted by the model for the noun region



Source: designed by the researchers on RStudio.

Graph 5.15 supports that the quantifier does not have a meaningful impact on reading time, as the predicted values are very close for both levels, and the wide confidence intervals indicate variability not explained by quantifier. We could only observe a slight tendency for plural quantifier be processed faster than the singular one. Next, we take a look at the quantifier region.

5.2.3.5 Quantifier Region

The quantifier region, corresponding to segment 4, could also be informative in terms of English processing and question the working hypothesis of this dissertation. It is important to take a closer look at this region, as it can provide preliminary cues for the following noun. In English, the quantifier ‘many’ grammatically indicates in advance that the noun encountered next in the derivation will be a count noun, while ‘much’ grammatically signals that the following noun will be a mass noun.

5.2.3.6 Data Analysis

A new data treatment was applied using the original English group dataset, extracted directly from the PCIBex platform. Before exploring the raw data, we removed the three

participants already discussed and three treatments were performed on segment 4, focusing on cleaning up outliers, to improve the visual distribution of the data, while also applying normality test. We began with a visual inspection of the graphs of the raw data and normality test which were both not well distributed and neither normal. The first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 1095.5. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 802.25. After two upper limit cuts the data improved visually the distribution. However, outliers remained in the sample, and the normality test still indicated non-normality (Shapiro-Wilk: $W = 0.98231$, $p\text{-value} = 3.48e-05$)⁴⁴. We also checked the residuals, which followed the same distribution pattern as the main data, but the normality test again indicated non-normality (Shapiro-Wilk: $W = 0.98373$, $p\text{-value} = 7.909e-05$)⁴⁵.

We then proceeded with a logarithmic transformation; however, this did not visually improve the distribution, and neither normality. Consequently, we chose to retain *dataset3*, from before the logarithmic transformation. Since the log transformation failed to enhance distribution, *dataset3*, with the less conservative outlier cut was saved for statistical analysis and comparison with other groups.

Removing outliers from the sample resulted in 438 observations out of the original 448, resulting in less 10 observations, representing 2.23% of data loss. Additionally, the condition that lost the most data was S+M, with 5 observations removed, followed by P+C, with 3 observations removed. The conditions that retained the most data were S+C and P+M, both of which lost a single observation. The treated means and standard deviations for the quantifier region in each condition are presented in Table 5.32 as it follows.

⁴⁴ Kolmogorov-Smirnov: $D = 0.047378$, $p\text{-value} = 0.01984$

⁴⁵ Kolmogorov-Smirnov: $D = 0.041964$, $p\text{-value} = 0.06223$

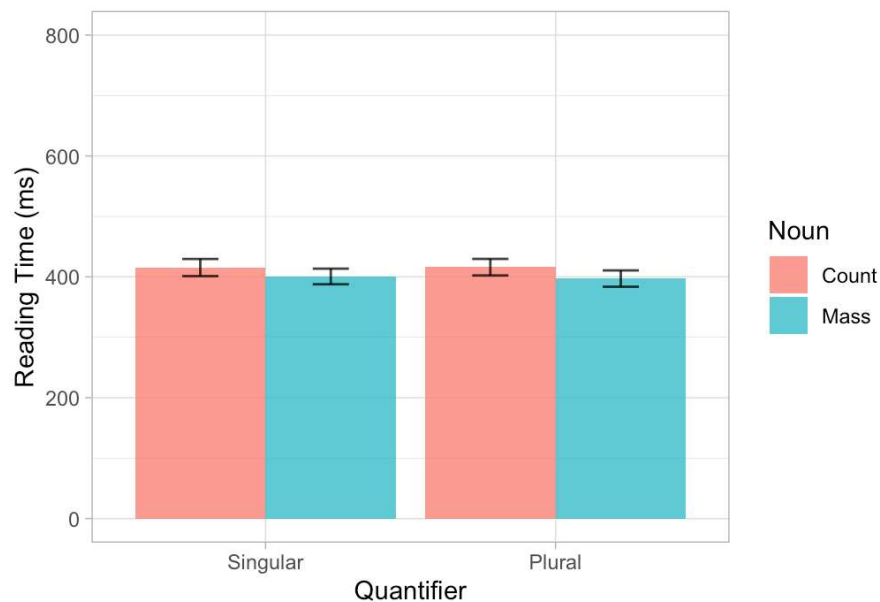
Table 5.32 — Treated means and standard deviation in milliseconds for each experimental condition in the noun region

Condition	Mean	Standard Deviation
S+C	415.3694	149.4429
S+M	400.6168	133.4103
P+C	415.9725	142.8864
P+M	397.0991	142.3408

Source: designed by the researchers.

By examining the table above, we can observe that the S+C condition is 14.752 milliseconds slower than the S+M condition. The condition P+C is 18.873 milliseconds slower than the P+M condition. Below, we can observe the graph that visually presents the treated means for reading time in bar heights and the standard deviation in the error bars for the quantifier region.

Graph 5.16 — Treated means and standard deviation for each experimental condition in the quantifier region



Source: designed by the researchers on RStudio.

The graph suggests that neither the quantifier nor the noun seems to affect reading times. Both quantifiers and noun types seem to result in similar processing times, as indicated

by the nearly identical bar heights across conditions. Thus, the small error bars suggest that the variability within each condition is low, meaning the results are relatively consistent across participants or trials. Below, we present the means for each variable:

Table 5.33 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	408.1284
Plural	406.4500

Source: designed by the researchers.

Table 5.34 — Means in reading time in milliseconds for the noun

Noun	Mean
Count	415.6682
Mass	398.8257

Source: designed by the researchers.

The means for the quantifier seems to be close, compared with the nouns that have a clear difference between count and mass. The tables above show that the plural quantifier is processed faster, in comparison to the singular quantifier which is processed 1.678 milliseconds slower. The mass noun is processed 16.842 milliseconds faster than the count noun. Next, we move to the statistical analysis to check whether these means result in any significance regarding processing on the quantifier region.

5.2.3.7 Statistical Analysis

In the quantifier region, using reading times as the dependent variable, we fitted a linear model with Quantifier, Noun, and their interaction as fixed effects, along with random intercepts for both Participants and Items. The models used in this statistical analysis can be seen below:

```
model1 <- lmer (Reading.time ~ Quantifier * Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model2 <- lmer (Reading.time ~ Quantifier + Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)
```

```

model3 <- lmer (Reading.time ~ Quantifier + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)

model4 <- lmer (Reading.time ~ Noun + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)

```

A comparison between nested models with ANOVA revealed that neither the two-way interaction nor fitting the model without the interaction resulted in improvement in fit ($\chi^2 = 0.2677$, $p = 0.604$). Additional nested models with ANOVA were performed, comparing a model without the Noun as a predictor that showed a marginal improvement in fit ($\chi^2 = 3.1372$, $p < 0.076$) and a model with Noun as a predictor ($\chi^2 = 0.0095$, $p = 0.922$). Therefore, the best-fitting model included only Noun as a fixed effect. The models used and the model's result can all be seen below:

Table 5.35 — Model's results

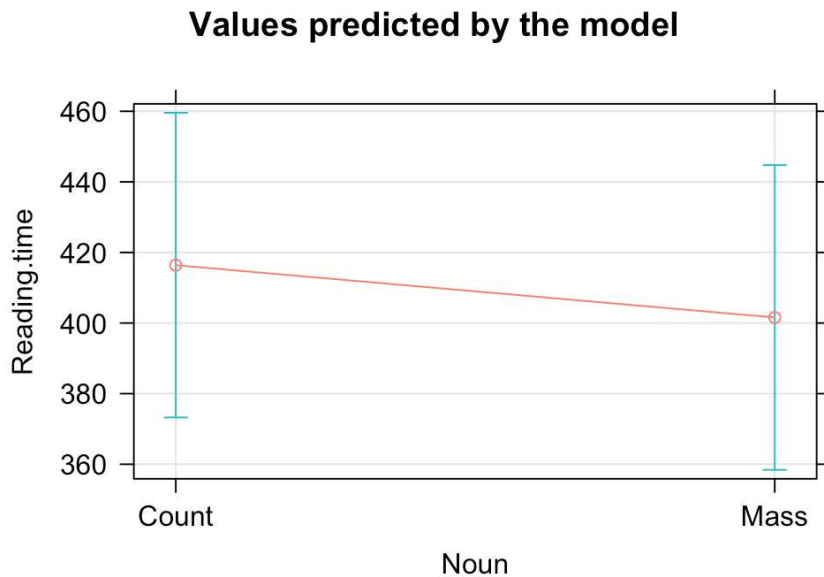
<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	416.42	373.25 – 459.58	<0.001
Noun [M]	-14.84	-31.21 – 1.54	0.076
Random Effects			
σ^2	7532.04		
τ_{00} Participant	12311.66		
τ_{00} Item	130.19		
ICC	0.62		
$N_{\text{Participant}}$	28		
N_{Item}	16		
Observations	438		
Marginal R^2 / Conditional R^2	0.003 / 0.624		

Source: designed by the researchers on RStudio.

As shown by the table above, there is a marginal effect for mass nouns, suggesting that they are read at a slightly faster pace compared to count nouns. Participant variations

significantly contribute to the observed variability in reading times, as evidenced by the substantial ICC and the variance components. The graph below illustrates the predicted reading times based on the model.

Graph 5.17 — Values predicted by the model for the quantifier region



Source: designed by the researchers on RStudio.

Graph 5.17 shows the predicted reading times for count and mass nouns. The predicted mean reading time for the count noun is slightly higher than that for the mass noun. However, the confidence intervals suggest that this difference is marginal, as indicated by the statistical analysis. In the next subsection, we verify the results for the post-critical region.

5.2.3.8 Post-Critical Region

The final region to be analyzed is the post-critical region, corresponding to segment 6, which, due to the nature of the SPR task, might provide insight into spill-over effects in the processing of quantifier phrases. Since we did not find significant effects in the processing of quantifier singular phrases in either the noun region or the quantifier region, any additional processing difficulty may surface in this region for English.

5.2.3.9 Data Analysis

A new data treatment was performed using the original dataset, extracted from the PCibex platform. We started removing once again the three participants and resulted that the raw data was not normal and neither well distributed. The first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 1032.8. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 774.5. In the more conservative outlier cut, resulted that the data was visually well distributed with a single outlier in the sample, even though the normality test did not indicate normality (Shapiro-Wilk: $W = 0.99153$, $p\text{-value} = 0.01434$)⁴⁶.

We checked the residuals, which followed the same distribution pattern as the main data. While the data was visually well distributed, and with the test not showing normality (Shapiro-Wilk: $W = 0.99159$, $p\text{-value} = 0.01499$)⁴⁷. Since the data was already well distributed for both data and residuals, we decided not to explore the logarithmic transformation, therefore retaining the *dataset3* for further statistical analysis.

After removing outliers, the sample was reduced to 432 observations from the original 448, which comprised less 16 observations, representing 3.57% of the sample. The condition that lost the most data points was S+C, with 7 data points removed, followed by P+M, with 6 removed. The conditions that preserved the most data were S+M, with a single data point loss and P+C with 2 data points lost. The treated means and standard deviations for the post-critical region can be seen in Table 5.36 in the following.

Table 5.36 — Treated means and standard deviation for each experimental condition in the post critical region in milliseconds

Condition	Mean	Standard Deviation
S+C	427.3524	135.0822
S+M	417.5766	127.0124
P+C	414.1364	115.5098
P+M	428.0660	128.7209

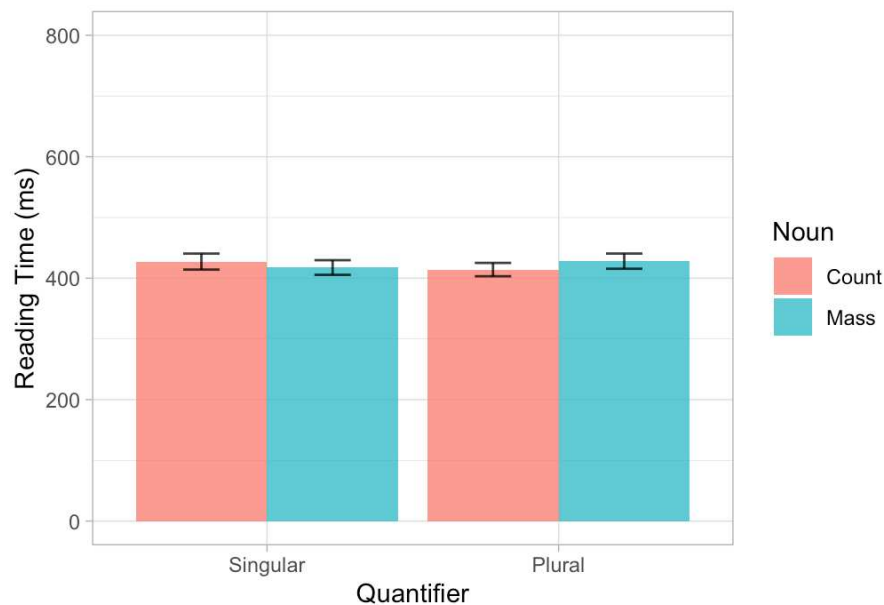
Source: designed by the researchers.

⁴⁶ Kolmogorov-Smirnov: $D = 0.030675$, $p\text{-value} = 0.4157$

⁴⁷ Kolmogorov-Smirnov: $D = 0.030616$, $p\text{-value} = 0.4188$

By examining the table above, we can see that the condition with the highest mean, indicating greater processing effort, is the P+M condition with 13.929 milliseconds slower than P+C condition. The condition S+M condition is 9.775 milliseconds faster than S+C condition. Based on this number, we already can see a possible effect between the mismatch between the quantifier and the noun type, as evidenced by the ungrammatical conditions being slower than the grammatical ones, being noticeable only in the post critical region. Below, we can observe the graph of reading times means for the post-critical region:

Graph 5.18 — Treated means and standard deviation for each experimental condition in the post-critical region



Source: designed by the researchers on RStudio.

The graph indicates that we might have an interaction between conditions, with singular quantifier with mass noun and a plural quantifier with count noun, being processed faster than the conditions in which we have a singular quantifier with a count noun and a plural quantifier with a mass noun. Additionally, the error bars also suggest that the variability within each condition is low, meaning the results are relatively consistent across participants. Below, we present the means for each variable:

Table 5.37 — Means in reading time in milliseconds for the noun

Noun	Mean
Count	420.5907
Mass	422.7005

Source: designed by the researchers.

Table 5.38 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	422.3287
Plural	420.9722

Source: designed by the researchers.

The tables 5.37 and 5.38 above indicate that the plural quantifier is processed faster compared to the singular quantifier, which is processed 1.356 milliseconds slower. Additionally, the mass noun is processed 2.109 milliseconds slower than the count noun. Next, we will conduct a statistical analysis to determine whether these means and standard deviations yield any significant differences in processing within the post-critical region.

5.2.3.10 Statistical Analysis

In the post-critical region, using reading times as the dependent variable, we fitted a linear model with Quantifier, Noun, and the interaction between these two factors as fixed effects, along with random intercepts for both Participants and Items. The models run in this statistical analysis can be checked below:

```
model1 <- lmer (Reading.time ~ Quantifier * Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model2 <- lmer (Reading.time ~ Quantifier + Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included the two-way interaction between the Quantifier and the Noun, and this interaction is statistically significant ($\chi^2 = 5.4458$ $p < 0.019$). The models' results can be seen next:

Table 5.39 — Model's results

<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	431.26	390.37 – 472.15	<0.001
Quantifier [P]	-17.04	-36.50 – 2.43	0.086
Noun [M]	-12.96	-32.42 – 6.49	0.191
Quantifier [P] × Noun [M]	32.68	5.25 – 60.11	0.020
Random Effects			
σ^2	5231.71		
τ_{00} Participant	10492.41		
τ_{00} Item	118.31		
ICC	0.67		
N Participant	28		
N Item	16		
Observations	432		
Marginal R^2 / Conditional R^2	0.004 / 0.671		

Source: designed by the researchers on RStudio.

The model highlights an interaction between the quantifier and the noun, and this interaction is statistically significant, suggesting that the combination of these predictors influence reading time. Most variability in reading time can be attributed to individual differences among participants, as indicated by the high ICC and the large variance associated with the random intercept for participants.

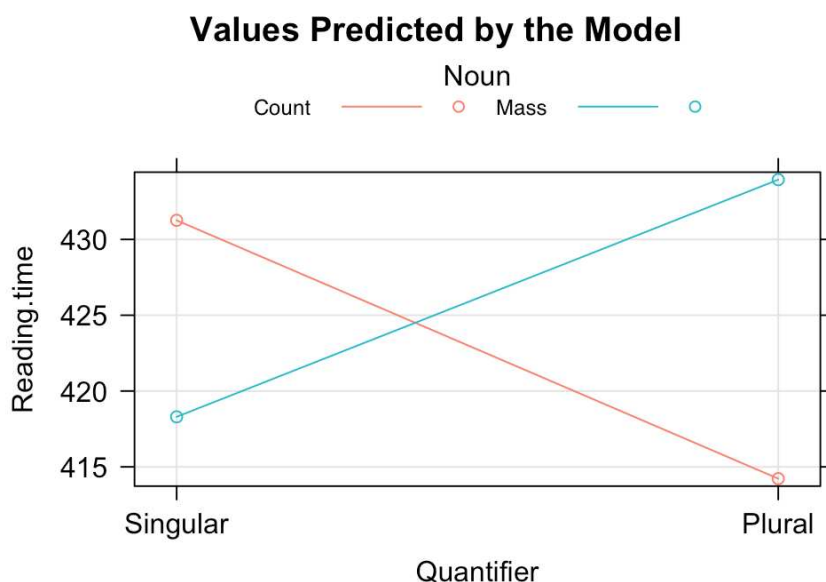
A Bonferroni Correction⁴⁸ was applied in the post-hoc analysis to further explore this interaction, which can be checked below:

contrast	estimate	SE	df	t.ratio	p.value
S C – P C	17.04	9.95	396	1.713	0.5254
S C – S M	12.96	9.95	400	1.302	1.0000
S C – P M	-2.68	10.09	403	-0.266	1.0000
P C – S M	-4.08	9.83	401	-0.415	1.0000
P C – P M	-19.72	9.93	398	-1.986	0.2861
S M – P M	-15.64	9.90	397	-1.580	0.6891

⁴⁸ Tukey Correction also did not show any relevant comparison in the pairwise.

The pairwise comparison did not reveal any significant effect in any condition compared. Below, we present the values predicted by the model:

Graph 5.19 — Values predicted by the model for the post critical region



Source: designed by the researchers on RStudio.

This plot shows the model's predicted reading times for combinations of singular and plural quantifiers and count and mass nouns. As the line cross, it becomes clear the interaction between quantifier and noun. In other words, the effect of the quantifier on reading time depends on the noun type. The count noun is read faster when the quantifier is plural than when it is singular while the mass noun is read slower with the plural quantifier than with singular quantifier.

5.2.4 Interpretation Task

Now we present the instrument designed to capture the interpretation of English quantifier phrases. Additionally, this instrument enabled us to collect an offline measurement of language processing: response time, which is the data we will examine in the next subsection.

5.2.4.1 Response Time

The response time in the IT allows us to infer aspects of language processing, as it indicates the time taken by participants to determine whether their interpretation of the sentence they had just read referred to a volume or cardinal interpretation. This data may add to our understanding of English language processing and representation.

5.2.4.2 Data Analysis

The data treatment was divided into two parts. In the first part, we removed the three participants. Next, we isolated the necessary information from the raw table extracted from PCIBex Farm. This information included the target sentences, their selections concerning the two figures, and the time in milliseconds from when the IT onset, selecting the image, and up to the point in which the participant clicked the “Next” button. The selection was mandatory and the “Next” button only appeared on the screen after participants selected their interpretation.

In the second phase, we filtered the raw data to check for normality and distribution. However, the data did not meet the criteria for both. Therefore, the first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 4999. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 3455.5. After reviewing the graphs and conducting normality test, we concluded that the data still did not follow a normal distribution, nor was it normal according to the test. We then proceeded with a logarithmic transformation. Following the transformation, the data distribution improved, but the data was still not normal (Shapiro-Wilk: $W = 0.98988$, $p\text{-value} = 5.62e-05$)⁴⁹. In this way, we decided to keep with the log transformed data, prioritizing the distribution.

Removing the outliers from the sample resulted in 403 observations from the original 448, a reduction of 45 observations, representing 10.04% of the sample. The condition that lost the most data was S+C, with 20 data points lost, followed by S+M and P+M, which both lost 12 data points. The condition that preserved more data was P+C, losing a single data point.

⁴⁹ Kolmogorov-Smirnov: $D = 0.0673$, $p\text{-value} = 0.0001576$

After this treatment, we plotted the table with the means and standard deviations in milliseconds, which can be reviewed above for each condition:

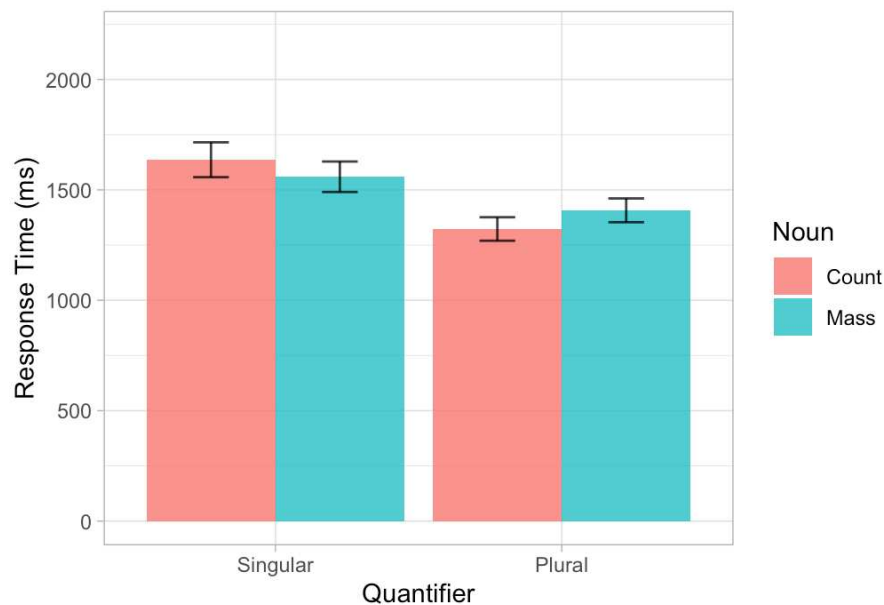
Table 5.40 — Treated means and standard deviation for each experimental condition in the response time in milliseconds

Condition	Mean	Standard Deviation
S+C	1636.304	756.5569
S+M	1559.280	689.4465
P+C	1322.856	561.0245
P+M	1407.290	539.3269

Source: designed by the researchers.

By checking the table above, we can observe that the S+M is faster than the S+C condition, being 77.024 millisecond faster, while the P+C is 84.434 milliseconds faster than the P+M condition. After that, we plotted the first graph in which the means and standard deviation of the response time is visualized. The graph is available below:

Graph 5.20 — Response time means and standard deviation in milliseconds



Source: designed by the researchers on RStudio.

The graph above suggests an interaction between quantifier and noun, in which the plural quantifier reduces response time, especially for count noun, while the count noun

displays an increase compared with the mass noun in the singular conditions, pointing towards the opposite direction. This supports the previous finding of quantifier and noun interaction effect on reading time, highlighting that certain combinations of quantifiers and nouns lead to faster processing.

5.2.4.3 Statistical Analysis

In the response times, using the logarithm of response time as a dependent variable, we fitted a mixed linear model with Quantifier, Noun, and the interaction between these two factors as fixed effects, alongside random intercepts for each Participant and Item. The models run in this statistical analysis can be seen below:

```
model1 <- lmer (log.tempo ~ Quantifier * Noun + (1|Participant)
+ (1|Item), data = dataoff3, REML = FALSE)
```

```
model2 <- lmer (log.tempo ~ Quantifier + Noun + (1|Participant)
+ (1|Item), data = dataoff3, REML = FALSE)
```

A comparison of nested models with ANOVA adjusted with the Quantifier, Noun and the interaction between these two factors and a model with Quantifier and Noun without the interaction shown a marginal effect. In this way, the best-fitting model included the interaction between the Quantifier and the Noun ($\chi^2 = 2.9189$, $p < 0.087$). Next, we can check the model's results for response time:

Table 5.41 — Model's results

<i>Predictors</i>	log.tempo		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	7.31	7.22 – 7.40	<0.001
Quantifier [P]	-0.19	-0.29 – -0.09	<0.001
Noun [M]	-0.04	-0.14 – 0.06	0.427
Quantifier [P] × Noun [M]	0.12	-0.02 – 0.26	0.087
Random Effects			
σ^2	0.13		
τ_{00} Participant	0.02		
τ_{00} Item	0.00		
N Participant	28		
N Item	16		
Observations	403		
Marginal R^2 / Conditional R^2	0.042 / NA		

Source: designed by the researchers on RStudio.

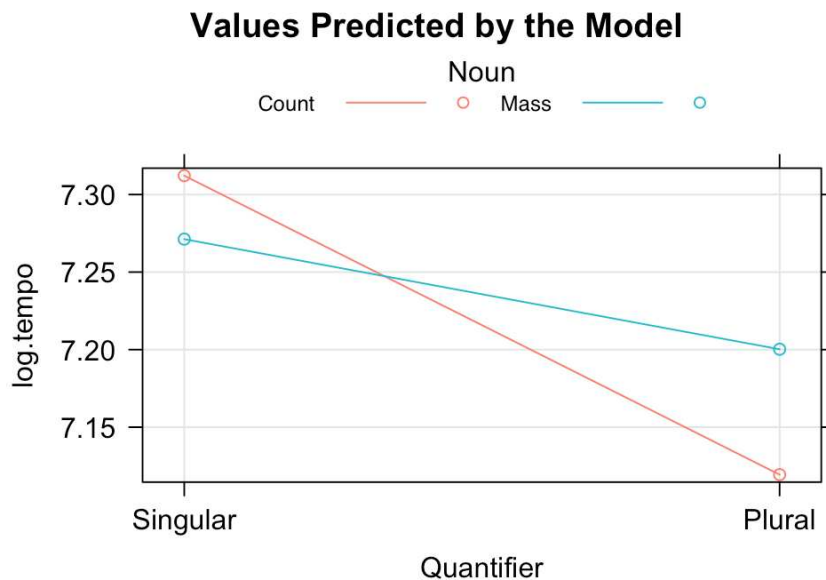
Based on the table, the quantifier predictor significantly affects log-transformed response time, with plural quantifier leading to a shorter time of decision, and a marginal effect for the interaction between quantifier and noun. Participants show some variability in response times, but items do not contribute much additional variance.

A post-hoc Bonferroni Correction was performed to further explore this interaction and can be checked below:

contrast	estimate	SE	df	t.ratio	p.value
S C – P C	0.1928	0.0505	373	3.819	0.0009
S C – S M	0.0409	0.0518	373	0.791	1.0000
S C – P M	0.1119	0.0518	377	2.160	0.1886
P C – S M	-0.1518	0.0493	377	-3.078	0.0134
P C – P M	-0.0809	0.0492	371	-1.642	0.6089
S M – P M	0.0710	0.0506	376	1.402	0.9711

The pairwise comparison highlighted that the only significant interaction was between the singular quantifier combined with a count noun and the plural quantifier combined with a count noun ($\beta = 0.1928$, $SE = 0.0505$, $t = 3.819$, $p < 0.0009$) indicating an effect for quantifier in which when the quantifier is singular and the noun is count, it generates increased response times, while when the quantifier is singular and the noun is mass, then the opposite happens, decreasing response times. The other comparisons did not show a statistically significant difference, or their comparison did not reveal any relevant result. Below, we can check the values predicted by the model:

Graph 5.21 — Values predicted by the model for the response time in log



Source: designed by the researchers on RStudio.

This graph suggests that mass and count nouns are processed differently depending on the type of the quantifier, especially for plural quantifier in which the graphs show a sharp decrease for both noun types, but more for the count noun. This indicates that the values in log show a dependency for count noun combined with plural quantifiers, suggesting a decrease in response time, leading to faster decision while the singular quantifier combined with count noun leads to slower decision making. Next, we look at our final dependent variable in the answer type subsection.

5.2.4.4 Answer Type

Finally, the answer type will give specific information whether the nouns in English are interpreted as cardinal or volume, being mainly an offline access of language representation.

5.2.4.5 Data Analysis

Following the data filtering of the response time, we kept working on the data filtering for the answer type, right after plotting the response time graph. We tabled the volume and cardinal responses that can be checked below in percentages:

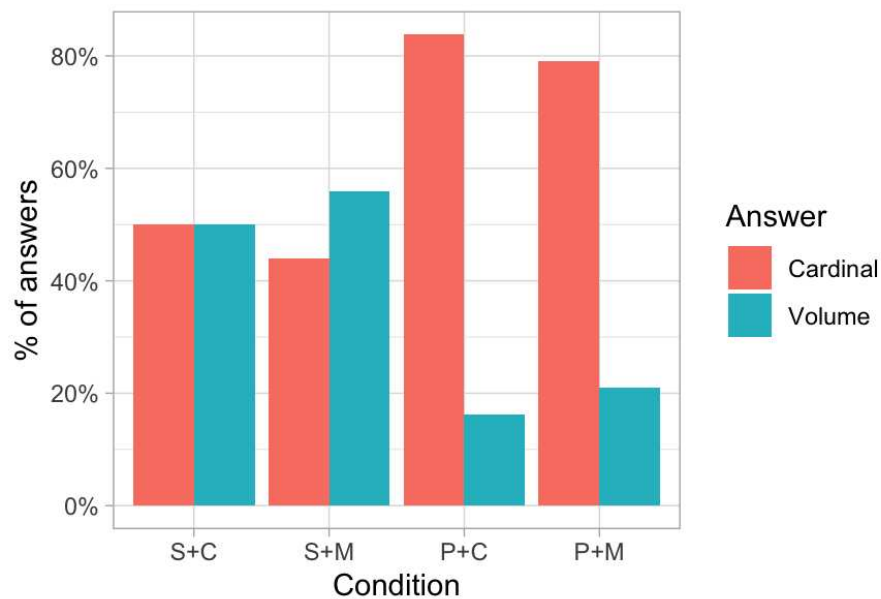
Table 5.42 — Percentage of cardinal and volume responses in the answer type

Condition	Cardinal	Volume
S+C	50%	50%
S+M	44%	56%
P+C	83%	16%
P+M	79%	21%

Source: designed by the researchers.

The table above is surprising: the S+C condition suggests random interpretation of the nouns. Although there is a slight preference for the volume interpretation, the S+M condition suggests an oscillation in interpretation, which is unexpected as well. The plural conditions are more categorical in which the P+C condition is mainly interpreted by cardinality as well as the P+M condition. Next, we can observe the graph which illustrate these results:

Graph 5.22 — Answer type



Source: designed by the researchers on RStudio.

The graph above illustrates the trend from the table. After plotting this graph, we checked that the residuals were not normal (Shapiro-Wilk: $W = 0.96573$, $p\text{-value} = 4.206e-08$)⁵⁰ and neither followed a normal distribution throughout checking the histograms and boxplots. Next, we move for the statistical analysis of the Answer Type.

5.2.4.6 Statistical Analysis

For the answer type, using answer as the dependent variable, we fitted a Mixed Linear Generalized Model that included Quantifier, Noun, and the interaction between these two factors as fixed effects, along with random intercepts for each Participant and Item. The models run can be seen below:

```
modell1 = glmer (Answer ~ Quantifier * Noun + (1|Participant) +
  (1|Item), data = dataoff3, family = binomial)

modell2 <- glmer (Answer ~ Quantifier + Noun + (1|Participant)
  + (1|Item), data = dataoff3, family = binomial)
```

⁵⁰ Kolmogorov-Smirnov: $D = 0.0688$, $p\text{-value} = 9.688e-05$

```

model3 <- glmer (Answer ~ Quantifier + (1|Participant) +
(1|Item), data = dataoff3, family = binomial)

model4 <- glmer (Answer ~ Noun + (1|Participant) + (1|Item),
data = dataoff3, family = binomial)

```

A comparison of nested models with ANOVA with a model without the interaction shown a marginal improvement in fit ($\chi^2 = 0.0084$, $p = 0.9268$). Additional nested models with ANOVA were performed comparing the model without the interaction and including only the Quantifier as fixed effect and it did not show an improvement in fit ($\chi^2 = 2.1873$, $p = 0.1392$), but removing the Quantifier shown a better fit ($\chi^2 = 62.701$, $p < 0.0001$). Therefore, the best fitting model includes only the Noun as a predictor. The table for the model's results can be seen below:

Table 5.43 — Model's results

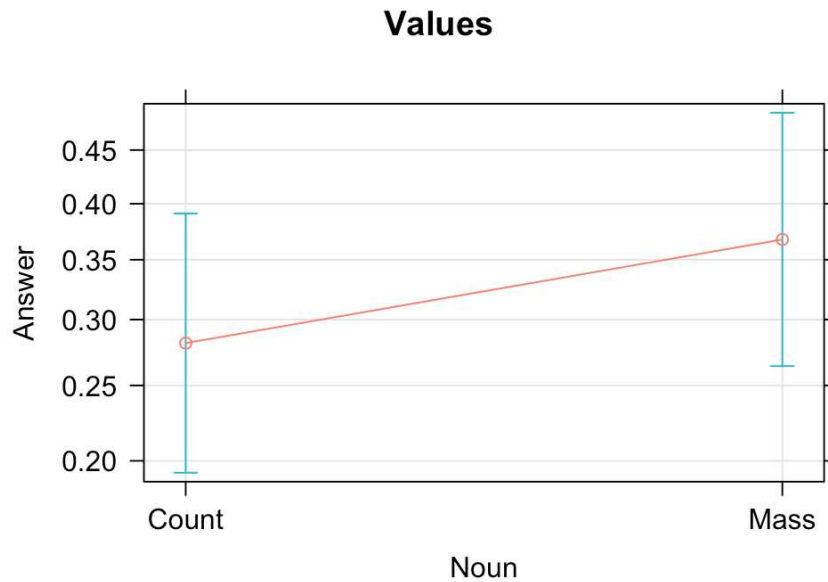
<i>Predictors</i>	Answer		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
(Intercept)	0.39	0.24 – 0.64	<0.001
Noun [M]	1.49	0.95 – 2.33	0.084
Random Effects			
σ^2	3.29		
τ_{00} Participant	0.89		
τ_{00} Item	0.05		
ICC	0.22		
$N_{\text{Participant}}$	28		
N_{Item}	16		
Observations	403		
Marginal R^2 / Conditional R^2	0.009 / 0.229		

Source: designed by the researchers on RStudio.

Based on the table above, the noun is a marginal predictor for interpretation. More specifically, the mass noun increases the probability of getting a volume response, while the count noun decreases this probability. The model explains a substantial amount of variability,

especially when accounting for random effects like participant differences. The ICC suggests participant-level differences play an important role. Below, the values predicted by the model:

Graph 5.23 — Values predicted by the model for the answer type in log



Source: designed by the researchers on RStudio.

As suggested by the graph above, mass nouns increase the probability of getting a volume response, while the count noun decreases this probability.

5.2.4.7 Intra-condition Analysis

A chi-squared for given probabilities test was performed to examine the frequency distribution of the categorical variable Answer, which has two levels: Cardinal and Volume. We conducted 4 chi-squared tests with give proportions as it follows:

Table 5.44 — Given proportions for each level for the variable Answer

Condition	Cardinal	Volume
S+C	0.2	0.8
S+M	0.2	0.8
P+C	0.8	0.2
P+M	0.8	0.2

Source: designed by the researchers.

The proportions given are an approximation based on the predictions supported by the literature discussed for this experiment. That is, we expect much higher values of volume interpretations for conditions S+C and S+M, than cardinal ones. In the same line, we expect much more values for cardinal interpretations for conditions P+C and P+M, than volume ones. In the following table we can check the results:

Table 5.45 — Chi-squared results for each condition

Condition	Chi-Squared	P-Value
S+C	$\chi^2 (1) = 51.75$	$p < 0.0001$
S+M	$\chi^2 (1) = 36$	$p < 0.0001$
P+C	$\chi^2 (1) = 0.99324$	$p = 0.319$
P+M	$\chi^2 (1) = 0.0625$	$p = 0.8026$

Source: designed by the researchers.

The results shows that the proportion expected based on our predictions for S+C and S+M do not support the null hypothesis of the test since the p-value is way below 0.05, indicating that what we expected is different from the results that we got. However, the values obtained by the chi-square for the conditions P+C and P+M were not significant, not rejecting the null hypothesis of the test, indicating that the results that we got are aligned with our expectations.

Further analysis was conducted in the S+C and S+M condition to further explore why did the chi-squared test rejected the null hypothesis. By observing the results from the answer type, it suggests a possible oscillation in these two conditions. Therefore, we adjusted the test for the S+C condition with the proportion of 0.4 for cardinal and 0.6 for volume and the result given was in the limit of significance to reject the null hypothesis ($\chi^2 = 3.8333$, $p < 0.050$). In this way, we take this result as evidence of randomness which will be further explored.

Additionally, in the S+M condition adjusting the proportion of 0.4 for cardinal and 0.6 for volume the output of the test indicated that we failed to reject the null hypothesis, confirming an oscillation in the S+M condition ($\chi^2 = 0.66667$, $p = 0.4142$). These two conditions which received further analysis contradicts the previous results from the literature and will be further explored in depth in the General Discussion section.

5.2.4.8 Additional Analysis

We proceeded investigating whether the log values of response time would be affected by the answer type. For that, in the additional analysis, taking time in log as a dependent variable, we fitted a linear mixed model with Quantifier, Noun, Answer, and the interaction between these three factors and random intercept for Participant and Items. The models run in this additional analysis can be seen below:

```
model11 <- lmer (log.tempo ~ Quantifier * Noun * Answer + (1 |
Participant) + (1 | Item), data = dataoff3)

model2 <- lmer (log.tempo ~ Quantifier + Noun + Answer + (1 |
Participant) + (1 | Item), data = dataoff3)

model3 <- lmer (log.tempo ~ Quantifier * Answer + (1 |
Participant) + (1 | Item), data = dataoff3)

model4 <- lmer (log.tempo ~ Quantifier + Answer + (1 |
Participant) + (1 | Item), data = dataoff3)

model5 <- lmer (log.tempo ~ Noun * Answer + (1 | Participant)
+ (1 | Item), data = dataoff3)

model6 <- lmer (log.tempo ~ Noun + Answer + (1 | Participant)
+ (1 | Item), data = dataoff3)

model7 <- lmer (log.tempo ~ Answer + (1 | Participant) + (1 |
Item), data = dataoff3)
```

A nested model comparison was carried out with ANOVA and it indicated that including the three factors without the interaction provided a best fit to the data since adding a three-way interaction did not show an improvement in fit ($\chi^2 = 5.427$, $p = 0.246$).

Additionally, simple models including only the Quantifier and Answer as fixed effects did not show an improvement in fit ($\chi^2 = 0.224$, $p = 0.636$). The model with only the Noun and the Answer as fixed effect outperformed the model without the three-way interaction ($\chi^2 = 6.3212$, $p < 0.011$), and the model only with Answer as a fixed effect also shown an improvement in fit compared to the three-way interaction model ($\chi^2 = 6.5847$, $p < 0.037$). In

this way, the model including only the Noun and Answer as fixed factors was selected since it shown a better fit. Next, the models used and the model's results:

Table 5.46 — Model's results

<i>Predictors</i>	log.tempo		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	7.16	7.09 – 7.24	<0.001
Noun [M]	0.02	-0.05 – 0.09	0.608
Answer [Volume]	0.14	0.06 – 0.22	<0.001
Random Effects			
σ^2	0.13		
τ_{00} Participant	0.02		
τ_{00} Item	0.00		
N Participant	28		
N Item	16		
Observations	403		
Marginal R^2 / Conditional R^2	0.037 / NA		

Source: designed by the researchers on RStudio.

By observing the model's result above, we can verify that the noun does not show a significant effect in affecting reading times in log. In other words, the noun alone does not predict faster response times regarding the interpretation of the variable answer. However, the answer type is significant and volume interpretations results are higher in log values. That is, volume interpretations take additional processing time compared to cardinal ones.

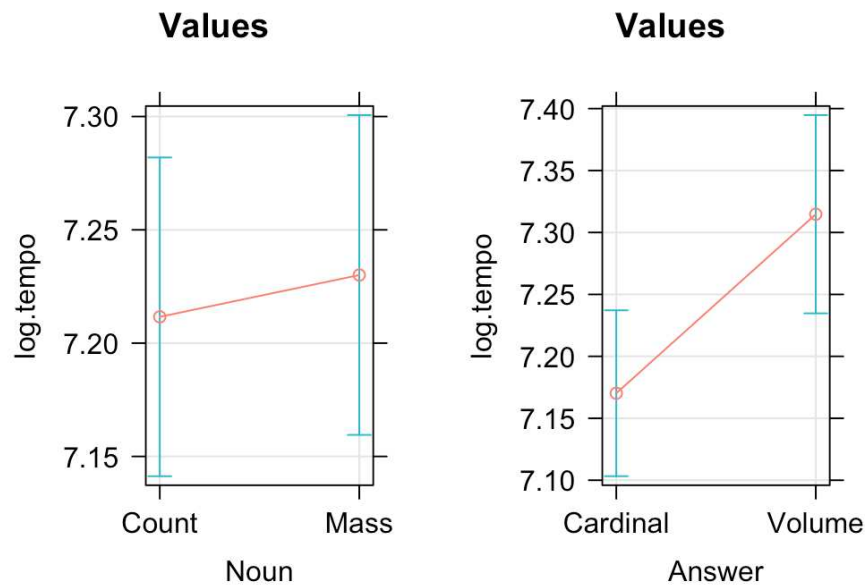
Although we did not get an interaction between noun and answer, a Bonferroni Correction was applied to further explore pairwise comparisons. The pairwise can be seen below:

contrast	estimate	SE	df	t.ratio	p.value
S C Cardinal - P C Cardinal	1.24e-01	0.0656	377	1.895	1.0000
S C Cardinal - S M Cardinal	-3.66e-02	0.0762	371	-0.481	1.0000
S C Cardinal - P M Cardinal	4.68e-02	0.0678	381	0.690	1.0000

S C Cardinal - S C Volume	-1.78e-01	0.0786	383	-2.271	0.6640
S C Cardinal - P C Volume	5.60e-07	0.1051	394	0.000	1.0000
S C Cardinal - S M Volume	-5.54e-02	0.0737	388	-0.751	1.0000
S C Cardinal - P M Volume	-6.10e-02	0.0974	388	-0.627	1.0000
P C Cardinal - S M Cardinal	-1.61e-01	0.0669	383	-2.407	0.4638
P C Cardinal - P M Cardinal	-7.76e-02	0.0546	361	-1.423	1.0000
P C Cardinal - S C Volume	-3.03e-01	0.0661	384	-4.579	0.0002
P C Cardinal - P C Volume	-1.24e-01	0.0993	391	-1.252	1.0000
P C Cardinal - S M Volume	-1.80e-01	0.0615	378	-2.922	0.1033
P C Cardinal - P M Volume	-1.85e-01	0.0906	391	-2.047	1.0000
S M Cardinal - P M Cardinal	8.34e-02	0.0688	383	1.213	1.0000
S M Cardinal - S C Volume	-1.42e-01	0.0786	389	-1.804	1.0000
S M Cardinal - P C Volume	3.66e-02	0.1052	394	0.348	1.0000
S M Cardinal - S M Volume	-1.88e-02	0.0758	359	-0.247	1.0000
S M Cardinal - P M Volume	-2.44e-02	0.0984	389	-0.248	1.0000
P M Cardinal - S C Volume	-2.25e-01	0.0681	384	-3.308	0.0288
P M Cardinal - P C Volume	-4.68e-02	0.1006	392	-0.465	1.0000
P M Cardinal - S M Volume	-1.02e-01	0.0637	381	-1.602	1.0000
P M Cardinal - P M Volume	-1.08e-01	0.0925	392	-1.166	1.0000
S C Volume - P C Volume	1.78e-01	0.1044	392	1.708	1.0000
S C Volume - S M Volume	1.23e-01	0.0724	367	1.700	1.0000
S C Volume - P M Volume	1.17e-01	0.0971	386	1.209	1.0000
P C Volume - S M Volume	-5.54e-02	0.1028	395	-0.539	1.0000
P C Volume - P M Volume	-6.10e-02	0.1163	375	-0.525	1.0000
S M Volume - P M Volume	-5.65e-03	0.0944	388	-0.060	1.0000

The important comparison that worth highlight here is P+C = Cardinal against S+C = Volume ($\beta = -3.03e-01$, SE = 0.0661, $t = -4.579$, $p < 0.0002$) and which reveals that when the quantifier is plural, the count noun will be interpreted by cardinality, but when the quantifier is singular, the count noun is interpreted by volume. Another important comparison is P+M = Cardinal against S+C = Volume ($\beta = -2.25e-01$, SE = 0.0681, $t = -3.308$, $p < 0.028$), which also shows the role of the quantifier in the interpretation of the nouns. This signals that the grammatical instruction forces the interpretation of the noun. Next, the graph with the values predicted by the model can be check below.

Graph 5.24 — Values predicted by the model for the answer type in log



Source: designed by the researchers on RStudio.

The graph above illustrates the model's results, visually displaying in the left graph that the noun alone does not seem to affect response times, as already seen through the statistical tests, but there is a trend for mass noun have higher log values. In the right graph, we observe that answer type is a predictor of response times, indicating that volume interpretations have higher log values, suggesting that this interpretation is more costly in terms of processing than cardinal ones. Next, we move for the summary of the general finding from this experiment and the General Discussion.

5.2.4.9 Summary of Key Findings from Experiment 5

The table below provides an overview of the data collected for Experiment 5.

Table 5.47 — Summary of key findings from experiment 5 (EngL1)

<i>Region</i>						
Quantifier Type	Noun Type	Quantifier	Noun	Post-Critical	Response Time	Answer Type
Singular	Count	.	=	+	. / +	Random
	Mass	=	=	-	. / -	Oscillate +Volume
Plural	Count	.	=	-	. / -	Cardinal
	Mass	=	=	+	. / +	Cardinal

Source: designed by the researchers.

Observations: The symbols mean: (=) we did not find statistical effect; (+) we found statistically significant effect indicating additional processing time (-) we found statistically significant effect less processing time; and (.) we found a marginal effect.

- No additional processing is observed in the quantifier and neither noun regions, only in the post critical region due to the nature of the SPR task;
- The post-critical region reveals that when there is a mismatch between the quantifier type and the noun type, there is additional processing;
- Noun type is a marginal predictor for interpretation, with mass nouns increasing the probability of getting volume responses;
- The conditions with the mismatch, leads to marginal increase in response times, being affected by the noun;

- Volume interpretations take more time than cardinal ones;
- The results for the answer type and further statistical tests indicated that we had oscillation in singular quantifier combined with mass noun condition while the results from singular quantifier with count noun condition answers were random. The plural conditions behaved accordingly the literature;
- The grammatical instruction influences the interpretation of the noun. That is, when the quantifier is plural, the noun mass noun will be interpreted as cardinal whereas when the quantifier is singular, the count noun will be interpreted as volume.

5.2.5 General Discussion

As we reach to the end of the description given to the data as well as the statistical analysis, we can look at specifically what these results tell us in light of the literature. In terms of processing, the absence of significance is quite surprising at first for the noun region. We expected additional processing in this region, especially where there was a mismatch between the quantifier type and the noun type, namely the singular quantifier with a count noun and with the plural quantifier and the mass noun since the quantifier in these contexts would trigger the expectation of a mass noun for the singular quantifier and an expectation of count noun for the plural quantifier. This expectation was in line with the literature on processing, but it did not occur at first.

Taking a close look at Frisson and Frazier's (2005) study, they found additional processing for conditions similar as our 'The man sold much feather in Madrid' that would be similar to their experimental sentence of 'Yesterday, John wanted just a small amount of imported pear after the rich main course. His girlfriend didn't want anything' in which the 'just a small amount'. In the case of our study, 'much' would give the grammatical cue for the mass noun, but what is encountered next is 'pear' and 'feather', count nouns. Although the lack of processing evidence may leave as puzzled⁵¹, the additional processing noticed by Frisson and

⁵¹ Additionally, we checked *dataon1* and *dataon2*, treating them and giving a statistical analysis for each of them, and we still could not find much difference in the results. However, the graphs started to display a similar behavior found for Frisson and Frazier only for the *dataon1* for the noun region, making us to believe that in their study they did not have any outliers cut. This was not mentioned in their study and neither in their treatment. The additional treatment and analysis are all available at GitHub.

Frazier's study was related to the second pass reading, a processing pattern that is captured by the nature of an Eye-Tracking study which is related to the instrument, something that a Self-Paced Reading does not allow us to observe since we prioritized the non-linear and non-cumulative method, not allowing the participant to make any type of regressions. As a result, the processing of this structure would be evidenced at the post critical region since we could encounter a spill-over effect.

Looking at the spill-over region, namely the post-critical, we found that the data aligns with the literature. That is, the behaviour expected for the noun region is encountered in the post critical region, as observed by statistical analysis. The conditions in which we have a match between the quantifier type and the noun type, such as 'The man sold much silver in Madrid' and 'The man sold many feathers in Madrid' are the sentences that are processed faster when compared to the sentences in which there is an incongruency between the quantifier type and the noun type such as 'The man sold much feather in Madrid' and 'The man sold many silvers in Madrid'. As a result, we did find the same processing pattern expected for our conditions as participants behaved similarly to the results found by Frisson and Frazier (2005). In other words, the additional processing found for Frisson and Frazier for their ungrammatical conditions aligned in a similar manner as found in our study also suggesting coercion for the nouns.

In the quantifier region, we were able to observe a difference between the count and mass nouns in the milliseconds with the statistical analysis evidencing that we have a marginal effect for noun type. Mass nouns are marginally faster to be processed when compared to count ones and this marginal effect is observed when accounting the quantifier region as a baseline for comparison. In fact, the quantifier itself does not seem to affect our critical regions since we could not find any effect in the quantifier region for the quantifier and neither in the noun region in which a spill-over effect of the quantifier could be observed. To put differently, it seems that in our sentences, the grammatical instruction at this level of the derivation does not affect processing patterns in this region. What happens in fact in terms of processing is when there is an incongruency between the grammatical instruction given by the quantifier and the noun type, a similar pattern observed for Frisson and Frazier (2005) emerged in our study.

In terms of representation, there was a marginal effect of noun type on response times: conditions in which a singular quantifier was combined with a count noun and a plural quantifier with a mass noun were marginally slower — these are the incongruent combinations of quantifier and noun — compared to singular quantifiers with mass nouns and plural quantifiers with count nouns, which represent congruent combinations.

Delving deeper into representation, we finally reach the answer type of our experimental sentences in which the linguistic cues in the sentences would be the main driver guiding participants to respond to our IT. However, the results are quite surprising since they contradicted our expectations based on previous QJTs (BALE; BARNER, 2009, 2018; BARNER; SNEDEKER, 2005, 2006). The plural conditions all had categorical interpretations based on cardinality, while the singular conditions did not meet our expectations. Some possible explanations are proposed:

Our first and least favorable explanation is that the test failed to access the representation of the nouns for English. However, we could observe additional processing time taken in the course of derivation, especially for the ones that we had a mismatch between the quantifier type and the noun type, indicating that the participants undertook the coercion process, even though this coercion was not reflected in their answers.

Our second and most likely possible explanation is that there is an interplay between the grammatical information and the noun type that is observed in the singular quantifier and count noun in which the language user is puzzled to decide whether s/he is going to obey grammatical information or semantic information. This would explain the variability for the singular quantifier and count noun since the quantifier is projecting a mass noun in the derivation, but the participant is encountering a count noun, hindering processing and forcing interpretation. Since there are two divergent grammatical instructions, participants behaved randomly as shown by our intra-condition analysis. In other words, the participant did not know what to do in this case, resulting in a perfectly balance between volume and cardinal interpretations.

However, the same pattern is not observed for the singular quantifier and mass noun in which the grammatical information predicts a mass noun in the derivation, which is met, but answers are not categorical as they should be. In this particular condition we had oscillation confirmed by the intra-condition analysis. This is puzzling since we had two congruent grammatical instructions in this condition. Given this result, the combination with the singular quantifier ‘much’ and suggest that this combination might be ungrammatical in English, even though it did not result in additional processing time. Participants just could not interpret the sentences. We observed additional processing time taken to process the sentences with the singular quantifier combined with count nouns, that is coercion, which was a way to interpret the sentence, even though participants behaved randomly. This suggests that this type of ungrammaticality does not incur additional processing.

The plural conditions resulted close to categorical interpretations based on cardinality. The plural quantifier combined with a pluralized count noun gives the instruction to count on the quantifier, the noun, and by the inflectional morphology for plurality which are all congruent. Additionally, in the plural quantifier combined with mass nouns, we have two instructions going against one. To clarify, we have the first information carried by the quantifier itself, providing grammatical cues that what is coming next is a count noun, we have the second information carried by the plural inflection on the noun which is the morphological instruction and the third information is foreshadow by these two, that is the primitive meaning of the noun given by the lexical item. If the noun is count, then no issues are found during processing. However, if the noun is mass, we have two grammatical information going against a semantic information, forcing a cardinal interpretation, therefore, coerced by the grammatical instruction. Therefore, this would explain the cardinal interpretations for the plural conditions and suggest that the IT in fact worked in our study.

Another possible explanation for these results is in a sense going in line with Scontras, Davidson, Deal, and Murray (2017) that provided a slightly modified version of this instrument. Instead of removing the image, they removed the nouns and participants would have only the figures to guide their interpretation. For these conditions, variability was observed for the nouns in which participants slightly oscillated between cardinality and volume interpretations. They did that as a way to reinforce that English carries the atomicity in the nouns. That is, nouns in English have a primitive meaning, as discussed by Frisson and Frazier. In a nutshell, count nouns conditions were interpreted as cardinal, mass nouns conditions were interpreted as volume, and the no-noun conditions participants oscillated between cardinal and volume. In the no-noun condition, participants had to rely on the figures to provide their interpretation of the noun, therefore there was a slight oscillation. In our study, the linguistic cues were the main source guiding participants' interpretation. What might have happened in our study was that we were on the edge of assessing cognition and the primitive meaning given by the noun alongside the grammar might have not been enough to lead to categorical answers regarding their interpretation in the singular conditions.

The oscillation in the S+M condition in English might be due to one possibility that is marked by the grammatical instruction, and the other is marked by the primitive meaning of the noun; however, since the combination does not provide any additional contextual clues to atomicity, they lead to oscillation, not having additional processing times as well since both the grammatical structure and noun type were congruent. One possible explanation is that the lack of rich contextual clues before our sentences hindered more categorical interpretation, as

observed in Frisson and Frazier's study, which could have contributed participants to undertake the coercion process, allowing volume interpretations and count structures and cardinal interpretation in cardinal structures in English.

Finally, our results support the argument that English nouns carry a primitive meaning that reflects their inherent semantic structure and our results point that the quantifier lexically encode whether they require a mass noun, that is, 'much' requires a mass noun as a cumulative predicate or they require an atomic predicate, as in 'many' requires a count noun. It is worth noting that there are two lexical entries in English for the quantifiers, one that requires a mass noun and the other that requires a count noun.

Following Chierchia, this difference is not only ontological, referring to the nature of things, but it is cognitively driven. For example, the entity "coffee" is typically a mass noun referring to a substance, but we can go to a coffee shop with a friend and order "two coffees, please" from the waiter. This reflects a packaging process, in which the substance partially loses its original characteristic of being a non-atomic entity and becomes two atomic portions of that same substance. Similarly, if we go to a family dinner and the host warns us that "there is apple in the salad,"⁵² we observe that the atomic entity 'apple' was cut into pieces, and once again, the original entity loses its atomic characteristic, becoming a substance. Both of these processes — packaging for substances and grinding for individualized items — were observed in Frisson and Frazier's study for edible nouns, which, even though they are easier to coerce, still reflect underlying cognitive processes. These processes were also observed in our study for non-edible nouns, demonstrating that the cognitive mechanisms involved in these changes in meaning are not limited to edible entities but extend to other domains, such as non-edible nouns, as well.

Taken into account this discussion, we reject our null Hypothesis since we did find differences between our conditions in terms of processing, therefore, partially not refuting our working Hypothesis 1 in which we claim that the processing and representation patterns of English are specified for both count and mass; therefore, the nouns in English have a primitive meaning while the quantifiers lexically encode whether they require a count or mass noun. Several reasons provide evidence for us to reinforce that our results aligns with Frisson and Frazier's study: (1) the incongruent constructions between noun type and the previous element in the sentence — which was the quantifier in our study — the condition behaved in a similar way in both studies, providing evidence that English nouns carry a primitive meaning whether a noun is interpreted by cardinality or volume, especially observing the plural conditions; (2)

⁵² This is a famous example from Link (1983)

when there is a mismatch between the quantifier type and noun type, there is additional processing cost, namely coercion, in which a mass noun is transformed into a count noun. We found evidence of coercion with a singular quantifier combined with count nouns; and (3) the plural quantifier ‘many’ is specified for atomicity. The singular quantifier ‘much’ seems to be specified as we have observed for processing, however, it seems that it does not allow to be combined with count nouns, as expected. Next, we retake our RQs and answer them considering our results.

RQ1. Is there additional processing, if any, in the quantifier singular phrases in English? *Yes, it does. But only when there is an incongruency between the quantifier type and the noun type. That is, the plural quantifier requires a count noun, but when there is a mass noun in the place, it takes additional processing time. The opposite is also true.*

RQ2. Is there additional processing, if any, in the quantifiers in English? *No, it does not. We did not find enough evidence for the quantifier region.*

RQ3. Are singular nouns interpreted as count, mass or are underspecified in English? *Singular nouns headed by singular quantifiers in English are not interpreted, providing additional evidence that they are ungrammatical.*

RQ4. Does the noun type affect answer type in English? *It marginally contributes to the answer type. If the noun type comes pluralized, the functional morphology ‘-s’ grammatically instructs the speaker to interpret the noun as cardinal. If the noun comes in singular form, it does not affect answer type.*

RQ5. Do singular quantifiers influence the interpretation of singular count nouns in English? *No, they do not. The quantifier only influences the interpretation of a noun if is a plural quantifier and the noun comes pluralized.*

To conclude, we retake our predictions’ table, contrasting with our results.

Table 5.48 — Predictions vs results for processing and interpretation for each condition

Condition	Processing		Interpretation		Response Time	
	<i>Prediction</i>	<i>Result</i>	<i>Prediction</i>	<i>Result</i>	<i>Prediction</i>	<i>Result</i>
Singular Quantifier + Count Noun	Additional processing	Additional processing	Volume via coercion (grinding)	Random	Additional time	Additional time (marginal)
Singular Quantifier + Mass Noun	No additional processing	No additional processing	Volume	Oscillation	No additional time	No additional time
Plural Quantifier + Count Noun	No additional processing	No additional processing	Cardinal	Cardinal	No additional time	No additional time
Plural Quantifier + Mass Noun	Additional processing	Additional processing	Cardinal via coercion (packaging)	Cardinal via coercion (packaging)	Additional time	Additional time (marginal)

Source: designed by the researchers.

5.2.6 Conclusion

In summary, our results indicate that processing costs in English arise primarily when there is an incongruency between quantifier and noun types — such as when a plural quantifier precedes a mass noun, or a singular quantifier precedes a count noun — confirming that congruency facilitates processing. This serves as evidence that both the quantifier and the noun lexically carry semantic information. However, we did not find significant evidence of additional processing associated with the quantifier region itself. With respect to interpretation, singular nouns headed by singular quantifiers are not interpreted, reinforcing the claim that such constructions are ungrammatical in English. As for answer patterns, noun type marginally affects interpretation: plural morphology ‘-s’ cues a cardinal reading, while singular nouns do not show a consistent influence on answer type. Finally, singular quantifiers do not guide the interpretation of singular count nouns, whereas plural quantifiers only affect

interpretation when paired with pluralized nouns. These findings highlight the strict alignment between morphology and meaning in English.

5.3 GROUP COMPARISON 3 — INVESTIGATING POSSIBLE MISMATCHES IN QUANTIFIER PHRASES BETWEEN BRAZILIAN PORTUGUESE AND ENGLISH L1 SPEAKERS

5.3.1 Introduction

As we observed in both Experiment 4 for BrP and Experiment 5 for English, the two languages exhibit a clear difference, particularly in the nominal domain. In BrP, the processing of singular nouns is unaffected by manipulations involving the singular quantifier or the noun type. Additionally, singular nouns that follow the singular quantifier vary in interpretation: count nouns show a preference for cardinal interpretations but can also receive volume readings, while mass nouns tend to be interpreted as volume but can also receive cardinal readings.

For English, processing is substantially different, as observed in Experiment 5. Singular count nouns exhibit an additional processing cost after the singular quantifier. When a mass noun is inserted before a plural quantifier, the processing of the noun is hindered; similarly, when a count noun appears after a singular quantifier, we observe the same effect. In terms of interpretation, singular count nouns are not interpreted reliably, as they receive random interpretations — showing an equal number of cardinal and volume readings.

Given these two studies conducted, there is some evidence of possible mismatches between these two languages as we have observed in both experiments. Based on that, we present our RQs that guide this specific group comparison:

5.3.1.1 Specific Research Questions

RQ1. Are there differences (or mismatches) in the processing patterns between BrP and English?

RQ2. Are there differences (or mismatches) in representation patterns between BrP and English?

5.3.1.2 Hypothesis (H) and Predictions (P) for Processing and Representation of Quantifier Singular Phrases Mismatches

H0. There are no differences between English and BrP. In terms of processing, no statistical differences are expected for quantifiers or nouns. In terms of representation, there should be no significant semantic differences in the interpretation of nominal expressions between the two languages, as both are assumed to rely on universal principles of reference and quantification (CHIERCHIA, 2021). Any lack of differences should also be reflected in response times.

P0. Based on H0, we predict that acceptability judgments will not differ between cardinal and volume interpretations of nouns, and that response times will not show significant differences across languages or conditions.

H1. Assuming a cross-linguistic mismatch, the meaning of singular count nouns headed by a quantifier varies between BrP and English. In BrP, singular nouns are underspecified for atomicity, allowing both cardinal (count) and volume (mass) interpretations (PIRES DE OLIVEIRA, 2020, 2021). In English, atomicity is grammatically encoded, with mass nouns interpreted in terms of volume/weight and count nouns defaulting to cardinality (CHIERCHIA, 1998, 2021). Consequently, manipulating syntactic structure in English may incur additional processing cost, whereas in BrP, where bare nouns remain underspecified, no such cost is expected (PIRES DE OLIVEIRA; BEVILÁQUA, 2020).

P1. Based on H1, we predict statistical differences in the interpretation of singular nouns headed by a quantifier between cardinal and volume readings, and corresponding differences in processing times across the two languages.

We assume the Hypothesis 1 as our working hypothesis. Additionally, this groups comparison allows us to statistically verify whether there are mismatches between BrP and English, by comparing BrP L1 and English L1 groups, two native speakers' groups.

All materials used in this group comparison, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub⁵³.

5.3.2 Method

5.3.2.1 Participants

A total of 84 participants' data was analysed in this group comparison, comprising 53 voluntary participants from UFSC attending the study at the Computer Lab and 31 paid participants from the University of Toronto attending the study at the Indigenous Room at Sidney Smith Hall. The mean age of these 84 participants was 25.7 years old (SD = 10.4).

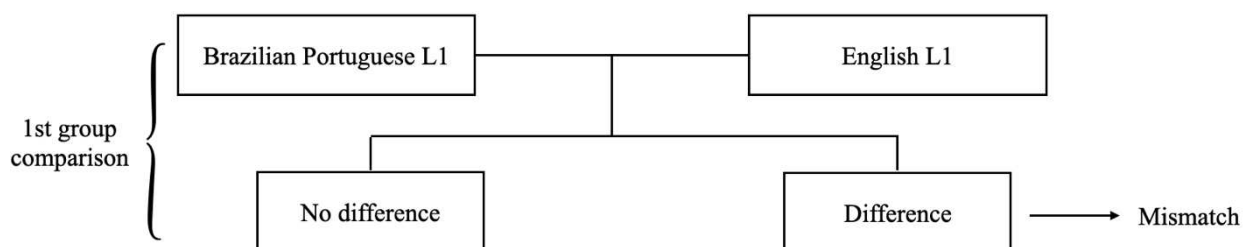
5.3.2.2 Instruments

The instruments used in the study are the same as the ones reported in Experiment 1 and 2. Therefore, this is just a group comparison with the data of the participants from the native speakers' groups to investigate the possible mismatches between BrP and English.

5.3.2.3 Procedures

The procedures adopted to conduct this group comparison can be summarized by the flowchart below:

Flowchart 5.3 — Group comparison flowchart



Source: designed by the researchers.

⁵³ Data analysis materials and raw results are available at <https://github.com/deardiones/SPR-Group-Comparisons.git>

The Flowchart 5.3 helps to illustrate the procedures adopted to conduct the group comparison, as it follows: This first group comparison aims to compare the groups of native speakers of BrP and native speakers English L1 (two groups comparison — native speakers) as independent variable. This analysis will be carried out for the quantifier, noun, and post critical regions, while also comparing response times and answer types (which corresponds to interpretation). If no difference is found between these two groups, we do not have evidence of a mismatch between these two languages, therefore no further analysis in the data is necessary. If there is a difference between these two groups, then we have evidence of a mismatch between these two languages, therefore the second group comparison will be carried out adding the bilingual group in the second group comparison.

5.3.2.4 Data Preparation

Data processing was conducted in RStudio. For the group comparison, we gathered all the treated *datasets3* of each region for the SPR and the IT and tabled the final treated data on a single file directly as a new Comma-Separated Values (CSV) file. A new column was added for each CSV file naming each group: the native speakers of BrP was named [BRPL1], the native speakers of English were named as [ENGL1].

In the statistical analysis, we decided to include the [ENGL1] as our reference value for the variable Speaker since the literature is more categorical regarding the processing and representation of the nouns in English, therefore, allowing us to compare it against the native speakers of Brazilian Portuguese [BRPL1]. Additionally, we kept using the plural [P] as our reference value for the variable Quantifier and count [C] as our reference value for the variable Noun.

5.3.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. For the BrP L1 and English L1 comparison, we assumed a Cohen's *d* of 0.5 for medium groups. After adjusting the alpha level to 0.5 and using a sample size of 79, the resulting power was 0.8776024. Thus, we interpret this result as indicating that 87,7% of the outcomes are expected to represent the phenomenon investigated in the native speakers group comparison. The sample

size is smaller than previously reported for the participants section since it refers to the total amount of participants after data treatment and outliers' cut.

5.3.3 Self-Paced Reading

The SPR is our main instrument for investigating language processing in real time. In the next subsection, we present how the treated data was statistically analyzed in this group comparison for each segment.

5.3.3.1 Noun Region

The analysis of the noun region, corresponding to segment 5, is the most important part of the SPR, as it provides direct insight into whether singular count nouns headed by a singular quantifier undergo additional processing in these two languages or not. This region is critical for testing our working hypotheses regarding the processing pattern of this structure, allowing us to compare it with other groups. The data filtering was unaltered from the data filtering reported for Experiments 1 and 2. Next, we will focus on the data preparation and analysis for the noun region.

It worths highlighting that in this segment we did not observe any significant additional reading time in the nouns for English, but for BrP we had additional processing time in the plural quantifier with mass noun condition and this additional processing was statistically significant.

5.3.3.2 Data Preparation

For the noun region, we gathered *dataset3* in log of the two groups and tabled all the data in a single CSV file. The final treated data from English were not in log. However, we performed the log transformation in order to be aligned with BrP data. The BRPL1 and ENGL2 final data sets were both in log in this group comparison. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1184 observations, nested within 79 participants and 16 items.

5.3.3.3 *Statistical Analysis*

In the noun region, we used Reading Times as the dependent variable and fitted a Linear Mixed-Effects Model using Maximum Likelihood, with t-tests computed via Satterthwaite's method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be checked below:

```
model1 <- lmer (Log ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = s5, REML = FALSE)

model2 <- lmer (Log ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = s5, REML = FALSE)
```

A comparison of nested models with ANOVA⁵⁴ revealed that including a three-way interaction show a statistically significant difference when compared to the model without interaction ($\chi^2 = 9.7997$, $p < 0.043$). The model's results can be seen below:

⁵⁴ Other models were also done in order to explore possible effects for noun alone and quantifier alone, but these can be checked on GitHub.

Table 5.49 — Model's results

<i>Predictors</i>	<i>Estimates</i>	Log	
		<i>CI</i>	<i>p</i>
(Intercept)	6.01	5.89 – 6.12	<0.001
Quantifier [S]	-0.01	-0.08 – 0.06	0.838
Noun [M]	-0.02	-0.10 – 0.05	0.500
Speaker [BRPL1]	0.08	-0.07 – 0.22	0.296
Quantifier [S] × Noun [M]	0.05	-0.05 – 0.15	0.332
Quantifier [S] × Speaker [BRPL1]	0.03	-0.06 – 0.12	0.556
Noun [M] × Speaker [BRPL1]	0.07	-0.02 – 0.16	0.150
(Quantifier [S] × Noun [M]) × Speaker [BRPL1]	-0.15	-0.28 – -0.02	0.021
Random Effects			
σ^2	0.07		
τ_{00} Participant	0.08		
τ_{00} Item	0.00		
N Participant	79		
N Item	16		
Observations	1184		
Marginal R^2 / Conditional R^2	0.032 / NA		

Source: designed by the researchers on RStudio.

The models' results highlight that there is a significant main effect observed for the native speakers of BrP group in comparison to the native speakers of English group. This significant main effect suggests that the interaction between Noun, Quantifier, and Speaker is significant, influencing our dependent variable reading time in log values. It suggests that quantifiers and nouns are processed slower in BrP when compared with our reference value group, English. This result suggests a potential mismatch between the processing of nouns between BrP and English in the noun region. Given by the negative estimate, mass nouns take more time than count noun to process in the noun region.

A Bonferroni Correction⁵⁵ was applied in the post-hoc analysis to account for multiple comparisons. The relevant comparisons here would be the S+C against S+C and P+M against P+M between ENGL1 and BRPL1, where we would possibly observe a mismatch between BrP and English. Below, we present the pairwise comparison:

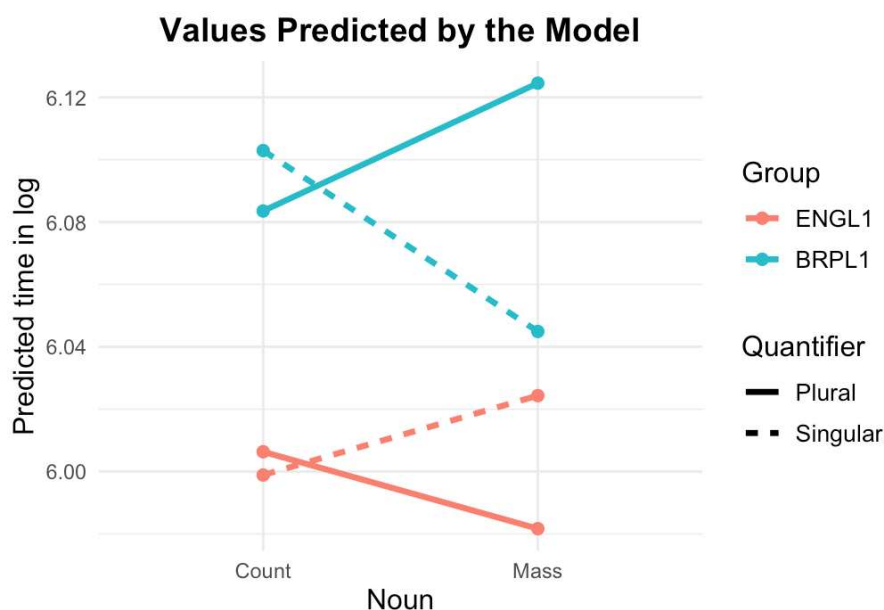
contrast	estimate	SE	df	t.ratio	p.value
P C ENGL1 - S C ENGL1	0.00746	0.0367	1106	0.203	1.0000
P C ENGL1 - P M ENGL1	0.02466	0.0366	1105	0.673	1.0000
P C ENGL1 - S M ENGL1	-0.01799	0.0363	1109	-0.496	1.0000
P C ENGL1 - P C BRPL1	-0.07719	0.0747	110	-1.034	1.0000
P C ENGL1 - S C BRPL1	-0.09657	0.0746	109	-1.294	1.0000
P C ENGL1 - P M BRPL1	-0.11818	0.0746	109	-1.583	1.0000
P C ENGL1 - S M BRPL1	-0.03856	0.0747	109	-0.517	1.0000
S C ENGL1 - P M ENGL1	0.01720	0.0372	1112	0.463	1.0000
S C ENGL1 - S M ENGL1	-0.02545	0.0367	1104	-0.694	1.0000
S C ENGL1 - P C BRPL1	-0.08466	0.0750	111	-1.129	1.0000
S C ENGL1 - S C BRPL1	-0.10404	0.0749	111	-1.389	1.0000
S C ENGL1 - P M BRPL1	-0.12565	0.0749	111	-1.677	1.0000
S C ENGL1 - S M BRPL1	-0.04603	0.0749	111	-0.614	1.0000
P M ENGL1 - S M ENGL1	-0.04266	0.0367	1107	-1.164	1.0000
P M ENGL1 - P C BRPL1	-0.10186	0.0749	111	-1.361	1.0000
P M ENGL1 - S C BRPL1	-0.12124	0.0748	110	-1.621	1.0000
P M ENGL1 - P M BRPL1	-0.14285	0.0748	110	-1.909	1.0000
P M ENGL1 - S M BRPL1	-0.06323	0.0748	110	-0.845	1.0000
S M ENGL1 - P C BRPL1	-0.05920	0.0747	110	-0.792	1.0000
S M ENGL1 - S C BRPL1	-0.07858	0.0747	109	-1.053	1.0000
S M ENGL1 - P M BRPL1	-0.10019	0.0747	109	-1.342	1.0000
S M ENGL1 - S M BRPL1	-0.02057	0.0747	109	-0.276	1.0000
P C BRPL1 - S C BRPL1	-0.01938	0.0274	1100	-0.708	1.0000
P C BRPL1 - P M BRPL1	-0.04099	0.0274	1100	-1.496	1.0000
P C BRPL1 - S M BRPL1	0.03863	0.0274	1101	1.409	1.0000
S C BRPL1 - P M BRPL1	-0.02161	0.0272	1101	-0.793	1.0000
S C BRPL1 - S M BRPL1	0.05801	0.0272	1098	2.129	0.9371
P M BRPL1 - S M BRPL1	0.07962	0.0273	1100	2.918	0.1006

The model revealed a significant three-way interaction between Quantifier, Noun, and Speaker ($\beta = -0.15$, $p = 0.021$), indicating that the combination of these variables influences

⁵⁵ We also did a Tukey correction which is less conservative, but we did not find any significant effect as well.

response times. However, the pairwise comparisons between specific conditions did not show significant differences, suggesting that the effect is distributed more globally and is not concentrated in any single pairwise comparison. Below, we present the values predicted by the model (in log values):

Graph 5.25 — Values predicted by the model for the noun region for both language groups



Source: designed by the researchers on RStudio.

Graph 5.25 above illustrates the values predicted by the model. In the vertical lines we have reading time in log values and in the horizontal lines we have the noun type. The blue color refers to native speakers of BrP while the salmon one refers to native speakers of English. The solid lines refer to plural while the dotted ones refer to singular quantifier.

The graph suggests that the mass nouns in English are processed faster when combined with plural quantifiers, while mass nouns combined with singular quantifiers take more time. The difference between count nouns and the two quantifiers are very small as shown by the graph. BrP goes in the opposite direction, with mass noun with plural quantifiers being slower when compared to singular quantifier. The count nouns also show little difference between the two quantifiers.

It worths highlighting that neither in Experiment 1, for BrP, nor in Experiment 2, for English, we found a significant effect in this region. Therefore, the significance interaction between these two is only found when comparing both languages groups, even though the pairwise comparison did not highlight any significant effect in the relevant condition between

the two languages, not adding substantial evidence regarding the possible mismatch between BrP and English.

5.3.3.4 *Quantifier Region*

The quantifier region, corresponding to segment 4, could also be informative in terms of differences in processing between linguistic experiences and it is also critical for the working hypothesis of this dissertation. It is important to take a closer look at this region, as it can provide preliminary clue for the following noun. In English, the quantifier ‘many’ grammatically indicates in advance that the noun encountered next in the derivation will be a count noun, while ‘much’ grammatically signals that the following noun will be a mass noun. For in BrP, ‘muita’ does not signal whether the following noun will be count or mass, but the quantifier ‘muitas’ signals that the following noun will be cardinal.

It worths highlighting that in this region we did not observe any significant additional reading time in the quantifier neither for English nor for BrP.

5.3.3.5 *Data Preparation*

For the quantifier region, we gathered *dataset3* of the three groups and tabled all the data in a single csv file. All three datasets in the less conservative outliers’ cut. After, adding the new column group, we checked whether all participants number were different and if all the data was correctly included. Data comprised 1219 observations, nested within 79 participants and 16 items.

5.3.3.6 *Statistical Analysis*

In the quantifier region, we used Reading Times as the dependent variable and fitted a Linear Mixed-Effects Model using Maximum Likelihood, with t-tests computed via Satterthwaite’s method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both participants and items. The models used in this analysis can be seen as it follows:

```
modell1 <- lmer (Reading.time ~ Quantifier * Noun * Speaker +
(1|Participant) + (1|Item), data = s4, REML = FALSE)
```

```

model2 <- lmer (Reading.time ~ Quantifier + Noun + Speaker +
(1|Participant) + (1|Item), data = s4, REML = FALSE)

model3 <- lmer(Reading.time ~ Quantifier * Speaker +
(1|Participant) + (1|Item), data = s4, REML = FALSE)

model4 <- lmer (Reading.time ~ Quantifier + Speaker +
(1|Participant) + (1|Item), data = s4, REML = FALSE)

model5 <- lmer(Reading.time ~ Noun * Speaker + (1|Participant)
+ (1|Item), data = s4, REML = FALSE)

model6 <- lmer(Reading.time ~ Noun + Speaker + (1|Participant)
+ (1|Item), data = s4, REML = FALSE)

```

A comparison of nested models with ANOVA⁵⁶ revealed that including a three-way interaction and without interaction did not show an improvement in fit ($\chi^2 = 3.914$, $p = 0.417$). Additional nested models with ANOVA with the model without the three-way interaction and including an interaction between the Quantifier and Speaker did not show an improvement in fit ($\chi^2 = 0.982$, $p = 1$), neither without the two-way interaction ($\chi^2 = 0.368$, $p = 0.544$). Thus, the nested models also did not show an improvement in fit when comparing the model without the three-way interaction, with a model with the interaction between the Noun and the Speaker ($\chi^2 = 0.828$, $p = 1$), neither without the two-way interaction ($\chi^2 = 1.4753$, $p = 0.224$).

In this way, considering the low AIC and BIC values, the best fitting model was the including the Quantifier and the Speaker as fixed effects without and interaction between these two factors (AIC = 15027, BIC = 15058). The model's results can be seen below:

⁵⁶ Other models were also done in order to explore possible effects for noun alone and quantifier alone, but these can be checked on GitHub.

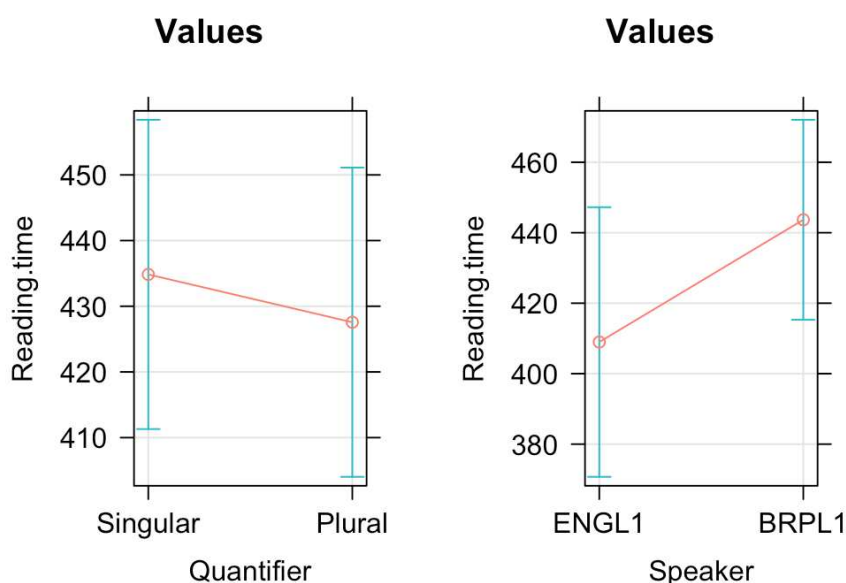
Table 5.50 — Model's results

<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	412.61	373.91 – 451.32	<0.001
Quantifier [S]	-7.28	-19.07 – 4.51	0.226
Speaker [BRPL1]	34.70	-12.93 – 82.33	0.153
Random Effects			
σ^2	10989.58		
τ_{00} Participant	9944.32		
τ_{00} Item	0.00		
N Participant	79		
N Item	16		
Observations	1219		
Marginal R^2 / Conditional R^2	0.026 / NA		

Source: designed by the researchers on RStudio.

The models' results do not show any significant effect comparing the native speakers of BrP group against the native speakers of English group. This lack of significance points that there are no processing differences between these two language groups in the quantifier region. Below, we present the values predicted by the model.

Graph 5.26 — Values predicted by the model for the quantifier region for both language groups



Source: designed by the researchers on RStudio.

Graph 5.26 shows the predicted reading times for Quantifiers and Speakers. In the right graph, we observe that singular quantifiers have higher reading times, while plural quantifiers have lower reading times. Additionally, the left graph shows that in English, reading times are faster when compared to BrP. These differences between quantifiers and speakers did not show a statistical difference, suggesting that there is no difference in processing times for the quantifiers between these two languages groups.⁵⁷

5.3.3.7 Post-Critical Region

The final region to be analyzed is the post-critical region, which, due to the nature of the SPR task, might provide insight into spill-over effects in processing of the noun region, as we have seen for native speakers of English.

It worths highlighting that in this region we did not observe any significant additional reading time in the spill over region for BrP, but for English, we had additional processing time in the plural quantifier with mass noun condition and for the singular quantifier combined with

⁵⁷ Even though we did not see any evidence with the best fitting model, we also conducted a Bonferroni and Tukey corrections with *model2* in R scripts to further investigate possible effects that could be missing, but we did not find any significant comparison in both pairwise.

count noun conditions and this additional processing for these conditions were statistically significant.

5.3.3.8 Data Preparation

For the post-critical region, we gathered *dataset3* of the three groups and tabled all the data in a single CSV file. All three datasets were in the less conservative outliers' cut. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. Data comprised 1200 observations, nested within 79 participants and 16 items. This file also contained the columns with the answer type that would further receive statistical analysis.

5.3.3.9 Statistical Analysis

In the post-critical region, we used Reading Times as the dependent variable and fitted a Linear Mixed-Effects Model using Maximum Likelihood, with t-tests computed via Satterthwaite's method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both participants and items. The models used in this statistical analysis can all be checked below:

```
model1 <- lmer (Reading.time ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = s6, REML = FALSE)
```

```
model2 <- lmer (Reading.time ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = s6, REML = FALSE)
```

```
model3 <- lmer (Reading.time ~ Quantifier * Speaker +
  (1|Participant) + (1|Item), data = s6, REML = FALSE)
```

```
model4 <- lmer (Reading.time ~ Quantifier + Speaker +
  (1|Participant) + (1|Item), data = s6, REML = FALSE)
```

```
model5 <- lmer (Reading.time ~ Noun * Speaker + (1|Participant)
  + (1|Item), data = s6, REML = FALSE)
```

```
model6 <- lmer (Reading.time ~ Noun + Speaker + (1|Participant)
+ (1|Item), data = s6, REML = FALSE)
```

A comparison of nested models with ANOVA⁵⁸ revealed that including a three-way interaction and without interaction did not show an improvement in fit ($\chi^2 = 4.1169$, $p < 0.390$). Additional nested models with ANOVA with the model without the three-way interaction and including an interaction between the quantifier and speaker did not show an improvement in fit ($\chi^2 = 0.6608$, $p = 1$), neither without the two-way interaction ($\chi^2 = 0.0177$, $p = 0.894$). Thus, the nested models also did not show an improvement in fit when comparing the model without the three-way interaction, with a model with the interaction between the noun and the speaker ($\chi^2 = 0$, $p = 1$), neither without the two-way interaction ($\chi^2 = 1.036$, $p = 0.308$).

In this way, considering the low AIC and BIC values, the best fitting model was the including the quantifier and the speaker as fixed effects without and interaction between these two factors (AIC = 14548, BIC = 14578). The model's results can be checked below:

⁵⁸ Other models were also done in order to explore possible effects for noun alone and quantifier alone, but these can be checked on GitHub.

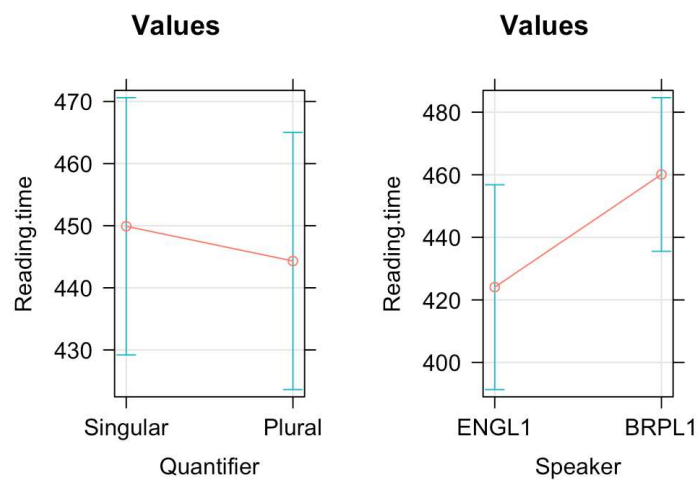
Table 5.51 — Model's results

<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	426.86	393.71 – 460.02	<0.001
Quantifier [S]	-5.59	-16.34 – 5.15	0.307
Speaker [BRPL1]	36.02	-4.12 – 76.16	0.079
Random Effects			
σ^2	8937.71		
τ_{00} Participant	6974.50		
τ_{00} Item	129.34		
ICC	0.44		
N Participant	79		
N Item	16		
Observations	1200		
Marginal R^2 / Conditional R^2	0.019 / 0.453		

Source: designed by the researchers on RStudio.

The table above shows the model's results indicating a marginal difference between BrP and English. Based on the estimate values, we can observe that the native speakers of BrP is slower in processing the post critical region in comparison to native speakers of English which processes the post critical region faster. Below, we present the values predicted by the model:

Graph 5.27 — Values predicted by the model for the post critical region for English and BrP



Source: designed by the researchers on RStudio.

The graphs illustrating the values predicted by the model above suggests that plural quantifiers are processed faster than singular ones when taking the post critical region as a baseline, indicating that plural quantifier facilitates the processing of the post critical region, even though this is not statistically significant. However, when observing the left graph, we can observe that BrP group is slower in processing the post critical region when compared to the English group and this difference is marginally significant, suggesting that there is a difference in the processing of this region. That is, the post critical region might be processed differently by these two language groups.⁵⁹

5.3.4 Interpretation Task

The IT was the instrument designed to capture the interpretation of nouns and the time that participants took to decide their interpretation based on two figures. In the next subsection, we take a closer look at the response time, contrasting the native speakers' English group with the native speakers of BrP group.

5.3.4.1 Response Time

The response time in the IT allows us to infer aspects of language processing, as it indicates the time taken by participants to determine whether their interpretation of the sentence participants had just read referred to a volume or cardinal interpretation. This data may enhance our understanding of language processing and representation between these English and BrP.

It worths highlighting that response time for English was only significant for the singular quantifier combined with count noun, indicating that this condition led to slower response times while for BrP there was a marginally non-significant effect for noun itself.

⁵⁹ Even though we did not see any evidence with the best fitting model, we also conducted a Bonferroni and Tukey corrections with *model2* in R scripts to further investigate possible effects that could be missing, but we did not find any significant comparison in both pairwise.

5.3.4.2 Data Preparation

For the response time, we gathered *dataset3* in log of the three groups and tabled all the data in a single CSV file, all of which were already in log. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1143 observations, nested within 78 participants and 16 items.

5.3.4.3 Statistical Analysis

In the response time, we used Reading Times as the dependent variable and fitted a Linear Mixed-Effects Model using Maximum Likelihood, with t-tests computed via Satterthwaite's method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models use in this analysis can be checked below:

```
model1 <- lmer (Log ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)

model2 <- lmer (Log ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)

model3 <- lmer (Log ~ Quantifier * Speaker + (1|Participant) +
  (1|Item), data = rtat, REML = FALSE)

model4 <- lmer (Log ~ Quantifier + Speaker + (1|Participant) +
  (1|Item), data = rtat, REML = FALSE)

model5 <- lmer (Log ~ Noun * Speaker + (1|Participant) +
  (1|Item), data = rtat, REML = FALSE)

model6 <- lmer (Log ~ Noun + Speaker + (1|Participant) +
  (1|Item), data = rtat, REML = FALSE)
```

A comparison of nested models with ANOVA⁶⁰ revealed that including a three-way interaction and without interaction did not show an improvement in fit ($\chi^2 = 6.9662$, $p < 0.137$). Additional nested models with ANOVA with the model without the three-way interaction and including an interaction between the quantifier and group did not show an improvement in fit ($\chi^2 = 0.4834$, $p = 1$), but without the two-way interaction there was a marginal difference between the models ($\chi^2 = 3.0881$, $p < 0.078$). Thus, the nested models also did not show an improvement in fit when comparing the model without the three-way interaction, with a model with the interaction between the noun and the speaker ($\chi^2 = 0$, $p = 1$), but it was statistically significant without the two-way interaction ($\chi^2 = 10.488$, $p < 0.001$). Therefore, the best fitting model was the one including the noun and the speaker as fixed effects without the two-way interaction between these two factors. The model's results can be seen in the following table:

Table 5.52 — Model's results

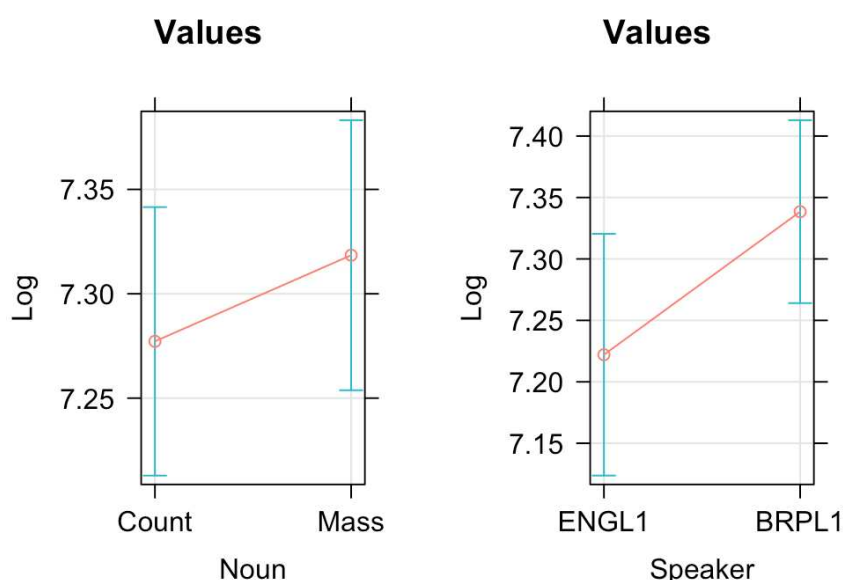
<i>Predictors</i>	<i>Estimates</i>	Log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.20	7.10 – 7.30	<0.001
Noun [M]	0.04	-0.00 – 0.09	0.071
Speaker [BRPL1]	0.12	-0.00 – 0.24	0.059
Random Effects			
σ^2	0.15		
τ_{00} Participant	0.06		
τ_{00} Item	0.00		
ICC	0.29		
$N_{\text{Participant}}$	78		
N_{Item}	16		
Observations	1143		
Marginal R^2 / Conditional R^2	0.017 / 0.298		

Source: designed by the researchers on RStudio.

⁶⁰ Other models were also done in order to explore possible effects for noun alone and quantifier alone, but these can be checked on GitHub.

The model above suggests a marginal effect for Noun indicating that mass nouns trigger slower response times than count ones. We have an effect for group in the limit of significance. The model points toward in the direction that there is a difference in the response times in the interpretation of the sentences from the experiment with mass nouns being slower and suggesting that there is a mismatch between these two languages as observed by the group difference that shows up in the response times. This mismatch might be lead the noun and reflected in response times, especially when comparing with BrP. Next, we take a look at the values predicted by the model.

Graph 5.28 — Values predicted by the model for the response time in log for English and BrP



Source: designed by the researchers on RStudio.

As we can observe by the left graph, the response times is affected by the noun, suggesting that mass nouns result in slower response times than count ones. In the right graph, we can observe that this effect also slows up in the group with native speakers of BrP taking more time to decide their interpretation of the nouns than native speakers of English. This suggests that response times are different between these two groups also being affected by the noun⁶¹. This might indicate that the response times are slower for BrP. Native speakers of this language may rely on extralinguistic information to determine the interpretation of nouns,

⁶¹ As we did for the regions, we also conducted a Bonferroni and Tukey corrections to double check if we have missed any relevant data in the comparison, especially for the S+M condition in *model2*. We did find some effects for both corrections, however they did not reveal any relevant comparison indicating a mismatch in the processing of the S+C.

whereas English speakers compute the necessary information through linguistic and grammatical means. Next, we look at answer type in the following subsection.

5.3.4.4 Answer Type

Finally, the answer type will give specific information whether the nouns are interpreted as cardinal or volume, being mainly an offline measurement of language representation. Therefore, we look at the answers given by the participants and see how they differ between language groups.

It worths highlighting that for answer type in English we had a marginal effect for noun with mass nouns increasing the probability of getting a volume response while for BrP we had an interaction between quantifier and noun, with singular quantifiers increasing the probabilities of getting volume responses, with higher probabilities for mass nouns. In BrP, plural quantifiers the following noun have lower probabilities of getting a volume response with the count nouns having an even lower probability.

5.3.4.5 Data Preparation

For the answer type, we gathered *dataset3* in log from the same file used in the response time in which the three groups were combined in the same csv file, therefore, assessing the statistics in the answer type column. The dataset comprised 1143 observations, nested within 78 participants and 16 items.

5.3.4.6 Statistical Analysis

In the answer type, we used answer as our dependent variable and fitted a Generalized Linear Mixed Model using the Maximum Likelihood, with Laplace Approximation method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this statical analysis can be checked as it follows:

```
modell = glmer (Answer ~ Quantifier * Noun * Speaker +
(1|Participant) + (1|Item), data = rtat, family = binomial)
```



```
model2 = glmer (Answer ~ Quantifier + Noun + Speaker +
(1|Participant) + (1|Item), data = rtat, family = binomial)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included an interaction between the quantifier, the noun, and the speaker, which was marginally non-significant ($\chi^2 = 8.0325$, $p = 0.090$). The model's results can be seen below.

Table 5.53 — Model's results

<i>Predictors</i>	Answer		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
(Intercept)	0.11	0.04 – 0.28	<0.001
Quantifier [S]	8.67	3.98 – 18.90	<0.001
Noun [M]	1.58	0.70 – 3.56	0.266
Speaker [BRPL1]	0.82	0.27 – 2.55	0.735
Quantifier [S] × Noun [M]	0.92	0.32 – 2.65	0.879
Quantifier [S] × Speaker [BRPL1]	0.69	0.25 – 1.87	0.465
Noun [M] × Speaker [BRPL1]	0.96	0.34 – 2.72	0.937
(Quantifier [S] × Noun [M]) × Speaker [BRPL1]	2.86	0.74 – 11.14	0.129
Random Effects			
σ^2	3.29		
τ_{00} Participant	3.04		
τ_{00} Item	0.19		
ICC	0.50		
$N_{\text{Participant}}$	78		
N_{Item}	16		
Observations	1143		
Marginal R^2 / Conditional R^2	0.179 / 0.586		

Source: designed by the researchers on RStudio.

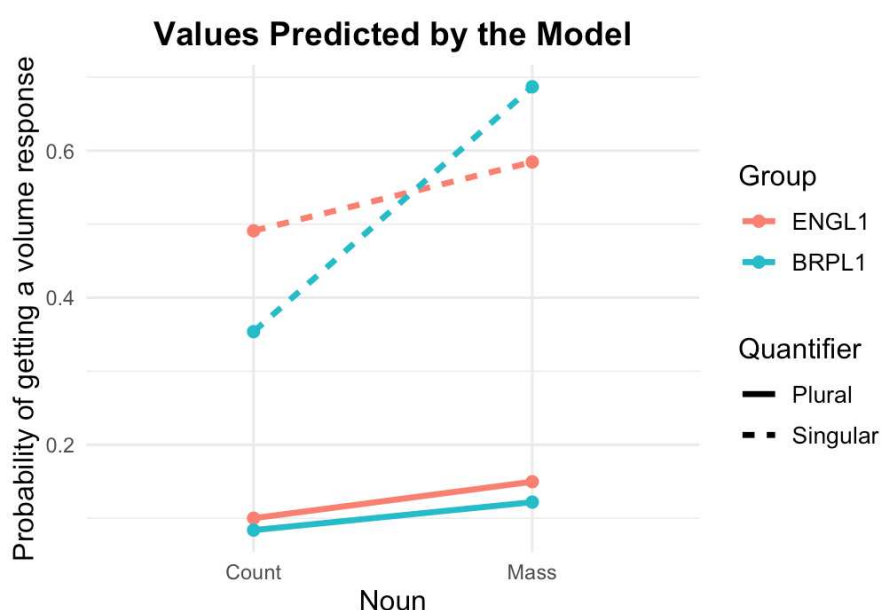
The model's results suggest an effect only for the Quantifier, with singular quantifier being highly significant between the two groups. It suggests that the singular quantifier triggers more volume responses than cardinal ones. An additional pairwise Bonferroni comparison was conducted to account for multiple comparisons. The pairwise can be found below:

contrast	estimate	SE	df	z.ratio	p.value
P C ENGL1 - S C ENGL1	-2.160	0.397	Inf	-5.435	<.0001
P C ENGL1 - P M ENGL1	-0.459	0.413	Inf	-1.111	1.0000
P C ENGL1 - S M ENGL1	-2.538	0.397	Inf	-6.388	<.0001
P C ENGL1 - P C BRPL1	0.195	0.577	Inf	0.338	1.0000
P C ENGL1 - S C BRPL1	-1.594	0.554	Inf	-2.880	0.1115
P C ENGL1 - P M BRPL1	-0.222	0.570	Inf	-0.390	1.0000
P C ENGL1 - S M BRPL1	-2.982	0.558	Inf	-5.340	<.0001
S C ENGL1 - P M ENGL1	1.701	0.384	Inf	4.431	0.0003
S C ENGL1 - S M ENGL1	-0.378	0.346	Inf	-1.091	1.0000
S C ENGL1 - P C BRPL1	2.355	0.553	Inf	4.260	0.0006
S C ENGL1 - S C BRPL1	0.566	0.524	Inf	1.080	1.0000
S C ENGL1 - P M BRPL1	1.938	0.544	Inf	3.559	0.0104
S C ENGL1 - S M BRPL1	-0.822	0.526	Inf	-1.563	1.0000
P M ENGL1 - S M ENGL1	-2.078	0.383	Inf	-5.428	<.0001
P M ENGL1 - P C BRPL1	0.654	0.570	Inf	1.148	1.0000
P M ENGL1 - S C BRPL1	-1.134	0.545	Inf	-2.081	1.0000
P M ENGL1 - P M BRPL1	0.237	0.562	Inf	0.422	1.0000
P M ENGL1 - S M BRPL1	-2.522	0.549	Inf	-4.595	0.0001
S M ENGL1 - P C BRPL1	2.733	0.549	Inf	4.975	<.0001
S M ENGL1 - S C BRPL1	0.944	0.520	Inf	1.816	1.0000
S M ENGL1 - P M BRPL1	2.315	0.541	Inf	4.279	0.0005
S M ENGL1 - S M BRPL1	-0.444	0.521	Inf	-0.853	1.0000
P C BRPL1 - S C BRPL1	-1.789	0.324	Inf	-5.520	<.0001
P C BRPL1 - P M BRPL1	-0.417	0.335	Inf	-1.244	1.0000
P C BRPL1 - S M BRPL1	-3.177	0.348	Inf	-9.125	<.0001
S C BRPL1 - P M BRPL1	1.371	0.309	Inf	4.433	0.0003
S C BRPL1 - S M BRPL1	-1.388	0.284	Inf	-4.883	<.0001
P M BRPL1 - S M BRPL1	-2.759	0.331	Inf	-8.337	<.0001

The pairwise show some significant comparisons. We observe some relevant comparisons such as S+C and S+M. For English in the conditions S+C ENGL1 — S+M ENGL1 ($\beta = -0.378$, $SE = 0.346$, $t = -1.091$, $p = 1.0000$) and for BrP group in the conditions S+C BRPL1 — S+M BRPL1 ($\beta = -1.388$, $SE = 0.284$, $t = -4.883$, $p < .0001$) we did observe that while there

is not a difference for English, for BrP it does. This indicates that there is a significant difference between S+C and S+M for BrP, indicating that in this condition we get lower probability of getting volume responses for the S+C when compared to S+M which gets higher probability of getting volume responses. For English, we do not see this effect and neither between the two groups. However, a mismatch is observed in the interpretations by looking at this condition⁶². Below, we can check the values predicted by the model.

Graph 5.29 — Values predicted by the model for the answer type in log for both language groups



Source: designed by the researchers on RStudio.

Graph 5.29 illustrates the values predicted by the model. In the vertical lines we have the probability of getting a volume response in log values and in the horizontal lines we have the noun type. The blue color refers to native speakers of BrP while the salmon one refers to native speakers of English. The solid lines refer to plural while the dotted ones refer to singular quantifier.

As we can observe in the graph, plural quantifiers trigger lower probabilities of getting a volume interpretation, with a tendency for mass nouns in both language groups. Next, we turn

⁶² The Tukey correction revealed that the comparison between S+C and P+M between the two groups was significant ($\beta = -0.660$, $SE = 0.447$, $t = -1.384$, $p < 0.04$), indicating that we get higher probability of getting volume responses for the S+C in English than for the P+M in BrP.

our attention to the additional analysis in which we investigate if answer type affects response time.

5.3.4.7 Additional Analysis

In the additional analysis of each group, we observed that for both of them volume responses were lower than cardinal ones and this difference were statistically significant. Therefore, we proceeded investigating whether the log values of response time would be affected by the answer type in a group comparison. For that, In the additional analysis, taking time in log as a dependent variable, we fitted a linear mixed model with Quantifier, Noun, Answer, Speaker, and the interaction between these four factors and random intercept for Participant and Item. The models used in this analysis can be checked below:

```
modell1 <- lmer (log ~ Quantifier * Noun * Answer * Speaker +  
(1 | Participant) + (1 | Item), data = rtat)
```

```
modell2 <- lmer (log ~ Quantifier + Noun + Answer + Speaker +  
(1 | Participant) + (1 | Item), data = rtat)
```

```
modell3 <- lmer (log ~ Quantifier * Answer * Speaker + (1 |  
Participant) + (1 | Item), data = rtat)
```

```
modell4 <- lmer (log ~ Quantifier + Answer + Speaker + (1 |  
Participant) + (1 | Item), data = rtat)
```

```
modell5 <- lmer (log ~ Noun * Answer * Speaker + (1 |  
Participant) + (1 | Item), data = rtat)
```

```
modell6 <- lmer (log ~ Noun + Answer + Speaker + (1 |  
Participant) + (1 | Item), data = rtat)
```

```
modell7 <- lmer (log ~ Answer * Speaker + (1 | Participant) +  
(1 | Item), data = rtat)
```

```
modell8 <- lmer (log ~ Answer + Speaker + (1 | Participant) +  
(1 | Item), data = rtat)
```

```
model9 <- lmer (log ~ Answer + (1 | Participant) + (1 | Item),
data = rtat)
```

A nested model comparison was carried out with ANOVA and it indicated that including the four-way interaction and without the interaction did not show an improvement in fit ($\chi^2 = 13.688$, $p = 0.250$). Simpler models including only the Quantifier, Answer, Speaker and the interaction between them as fixed effects did not show an improvement in fit ($\chi^2 = 2.4184$, $p = 0.490$) and neither including them without the interaction ($\chi^2 = 1.5299$, $p = 0.216$). The model with Noun, Answer, Speaker, and the three-way interaction between these factors did not show improved in fit ($\chi^2 = 2.4524$, $p = 0.484$) and neither the model without the three-way interaction ($\chi^2 = 2.4477$, $p = 0.117$). However, including only Answer, Speaker, and the interaction between these two factors, shown an improvement in fit in the limit of significance ($\chi^2 = 3.8372$, $p < 0.050$). Further ANOVA without the interaction between Answer and Speaker did not show an improvement in fit ($\chi^2 = 3.8411$, $p < 0.146$), but including only the Answer as fixed effect showed a marginal improvement in fit ($\chi^2 = 7.2006$, $p < 0.065$). In this way, the best fitting model was the one including Answer, Speakers and the two-way between these two factors. The model's results can be seen below:

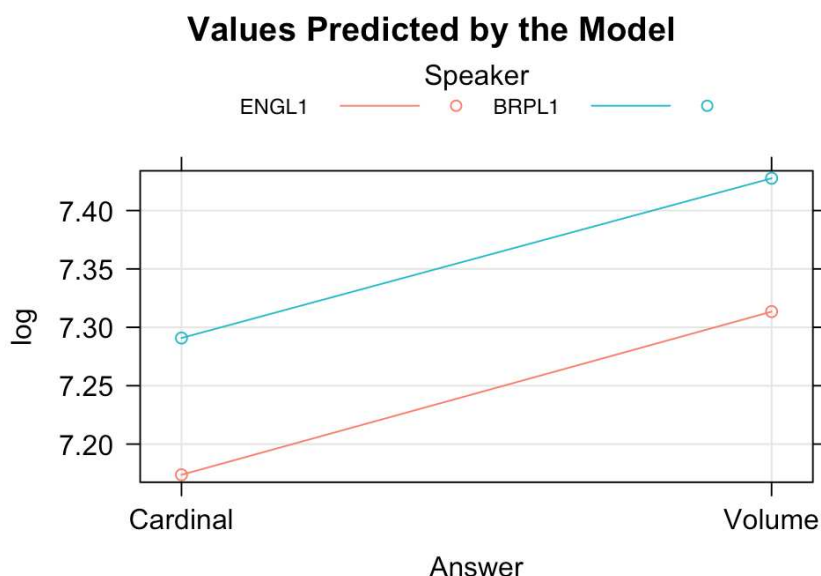
Table 5.54 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.17	7.07 – 7.28	<0.001
Answer [Volume]	0.14	0.05 – 0.23	0.001
Speaker [BRPL1]	0.12	-0.01 – 0.25	0.078
Answer [Volume] × Speaker [BRPL1]	-0.00	-0.11 – 0.11	0.959
Random Effects			
σ^2	0.14		
τ_{00} Participant	0.06		
τ_{00} Item	0.00		
ICC	0.30		
$N_{\text{Participant}}$	78		
N_{Item}	16		
Observations	1143		
Marginal R^2 / Conditional R^2	0.034 / 0.327		

Source: designed by the researchers on RStudio.

The model's result suggests that the variable Answer has a statistically significant effect for volume interpretations. Compared to the reference value cardinal and the positive estimate, it indicates that volume responses take more time than cardinal ones to be assigned. Additionally, there is a marginal difference between BrP and English in response times. Taken by the positive value on estimate, it suggests that BrP is marginally slower assigning volume interpretations, when compared to the reference value for speaker, which is English.

Graph 5.30 — Values predicted by the model for the answer type in log



Source: designed by the researchers on RStudio.

The graph 5.30 above visually display the values predicted by the model. The blue line refers to native speakers of BrP while the salmon line refers to the native speakers of English. The information in horizontal, from left to right, cardinal and volume interpretations and the vertical lines indicates the times taken to assign the interpretation in log values. The lines visually show that volume responses take more time than cardinal ones for both languages, with BrP being slightly slower in comparison to English. It suggests that volume interpretations are slower than cardinal ones while also signalling that BrP is slower in assigning this interpretation. Next, we retake the key findings in this group comparison and move forward discussing them in light of the literature on processing, representation and mismatch.

5.3.4.8 Summary of Key Findings from Group Comparison 3

The table below provides an overview of the Group Comparison 3.

Table 5.55 — Summary of key findings from group comparison 3 (Native Speakers)

<i>Region</i>						
Quantifier Type	Noun Type	Quantifier	Noun	Post-Critical	Response Time	Interpretation (Probability)
Singular	Count	=	+	.	.	Less probability of volume interpretations for BrP
	Mass	=	+	.	.	More probability of volume interpretations for BrP
Plural	Count	=	+	.	.	Less probability of volume interpretations for BrP
	Mass	=	+	.	.	Less probability of volume interpretations for BrP

Source: designed by the researchers.

Observations: The symbols mean: (=) we did not find statistical effect; (+) we found statistically significant effect indicating additional processing time and (.) we found a marginal effect. The reference value for comparison is English. The results for the noun region were a global effect for the three-way interaction, not showing up in the post-hoc ($p < 0.02$) and post-critical was marginally slower for BrP ($p < 0.07$). Response times were marginally slower for Noun ($p < 0.07$) and Speaker (0.07).

- Even though the pairwise comparison did not yield any relevant difference in the conditions, there is an interaction between quantifier, noun and group in the noun region, with BrP being slower than English in processing the noun region. We take that as evidence of a mismatch;

- There are no differences in the processing of quantifiers in the quantifier region;
- BrP is marginally slower in reading the post critical region in comparison to English;
- Mass nouns trigger slower response times and BrP is slower than English in assigning the volume interpretations;
- Response times are slower for BrP when comparing to English, indicating that extralinguistic information are required to assign the interpretation of the nouns;
- The singular quantifier triggers higher volume interpretations in answer type;
- Volume interpretations are significantly costly to assign than cardinal ones in both languages, with BrP being slightly slower than English;

5.3.5 General Discussion

We observed through statistical analysis comparing native speakers of BrP and native speakers of English that we have evidence to claim that there is a mismatch between these two languages in terms of processing and representation, which we now discuss.

At first, it seems that quantifiers are processed similarly in both languages, with no significant differences between them. It is worth highlighting that the quantifier is the first element encountered in the derivation, providing preliminary clues for the following noun. This is expected in terms of processing, as it is the first element that triggers the expectation for the noun to be read for English. For BrP, ‘muita’ does not signal what noun type should be expected next. Therefore, it does not have a direct effect on the noun itself. The effect for the quantifier region may appear later in the sentence.

Even though there is a statistically significant effect in the interaction between quantifier and noun, the post hoc did not highlighted any relevant pairwise comparison. However, it underlies the mismatch showing a statistical difference in this group comparison is the noun region, and it is attributed to an interaction between the noun and the quantifier. BrP and English differ in terms of processing, and the first evidence of this is found in the

manipulation of the quantifier and noun types. Therefore, manipulating the quantifier type and noun type does not result in any effect on the latter interpretation of these nouns for BrP. This manipulation does not incur an additional processing cost, as we have observed, and the nouns are underspecified for atomicity. In Experiment 4, we believed that we could manipulate the quantifiers to provide preliminary cues. However, as we have seen, the singular quantifier is also underspecified for atomicity, reflecting the lack of atomicity that spreads over BrP grammar as already predicted by Pires de Oliveira (2020).

For English, the scenario is different. The grammar marks atomicity, allowing us to manipulate the quantifier to coerce the interpretation of the noun, which is also marked for atomicity. That is, the singular quantifier and plural quantifier lexically dictate what to expect next in the derivation — whether it will be a mass noun or a count noun. The main reason supporting this argument is the observed additional processing cost when manipulating quantifiers and types nouns in sentences, as observed in Experiment 2. In this way, the mismatch between BrP and English is found in this series of studies is pronounced primarily in terms of processing observing each group separately. Together, the data provide some statistical evidence for this claim, although the effect observed is somewhat weak.

In the post-critical region, we observed a slight difference between groups, with BrP speakers being slower in reading the post-critical region than English speakers. However, this difference was not attributed to the quantifier itself or to the noun, making it less informative in this group comparison.

The additional analysis for response times showed a difference between the two groups in how long they take to process mass nouns and select the interpretation. The analysis suggested that, in general, mass nouns marginally trigger slower response times compared to count nouns for both groups. However, BrP speakers were also slower in triggering responses in general compared to English speakers. This is not consistent with previous literature as it suggests that mass nouns are more difficult to process. Since they lack discrete individualization, these preliminary results for response times suggest that this might indicate an additional processing effort to process these noun types in both languages. The assignment of cardinal interpretation being faster than volume ones might be attributed to the plural inflection, being an explicit instruction to count, indicating during the derivation that the noun must be counted. However, mass nouns do not have an explicit functional morphology to measure, therefore leaving room for further information, such as pragmatic, to sum to the possible volume interpretation

Looking at the answer type, our results for the group comparison, especially for the post-hoc, it informs us about the mismatch between languages: the singular quantifier combined with count nouns have lower probability of getting volume responses for BrP than for English, but only looking at the groups separately.

Even though the answer type does not seem to shed much light on the noun types, it does on the quantifiers themselves, as they were the only marginal effect found in this comparison. On the one hand, the singular quantifier for BrP, namely ‘*muita*,’ is underspecified for atomicity, therefore not indicating whether the following noun should be count or mass — it does not provide an instruction to count — but allows both noun types in the derivation. On the other hand, the singular quantifier ‘*much*’ grammatically projects that the following noun is not supposed to be count. That is, when we have the combination of the singular quantifier with a count noun, additional processing is observed, but when we have a mass noun following ‘*much*,’ we do not observe additional processing. However, we failed to access categorical interpretations for volume, with an oscillation in the interpretation.

The plural quantifiers for both languages led to categorical interpretations based on cardinality, but the singular ones allowed us to observe another source of mismatch between these two languages. While ‘*muita*’ is underspecified, ‘*much*’ is specified. However, ‘*much*’ does not parallel ‘*muita*,’ as it has different properties.

Finally, it is important to explore a key observation that shows up in our study that may leave us puzzled: BrP speakers demonstrated slower processing and response times compared to English speakers. A possible line of reasoning to account for these processing differences lies in the nature of the atomization process. We can interpret the marginal additional processing observed in our group comparison as a consequence of lexical underspecification for atomicity. While native speakers of English tend to specify atomicity immediately upon interpreting the noun, this specification may reduce the cognitive load at later stages of processing since it is given at the quantifiers and the nouns. In contrast, native speakers of BrP may leave the lexical entry underspecified, postponing the commitment to atomicity until further pragmatic or compositional information becomes available. This delayed specification likely incurs additional processing costs when such information is eventually integrated, which is reflected in the response times. This interpretation might suggest that underspecification, while initially flexible, can impose cognitive demands during later stages of interpretation since the processor has additional paths to follow.

Therefore, specifying atomicity early in the derivation may be cognitively less demanding than leaving the lexical entry open to later specification. This contrast becomes

evident when comparing languages that differ in how they grammatically encode atomization. Although this might appear counterintuitive, early specification in our studies facilitates the derivation, whereas underspecification can ease early processing but results in delayed costs. This explains why the additional processing time in English arises when there is incongruent grammatical information (e.g., a mismatch between the quantifier type and the noun type), while in BrP, such effects are less pronounced due to the absence of overt grammatical cues for singular quantifier phrases.

Taken together, we have found somewhat some evidence to refute our null hypothesis, as we found semantic differences between these two languages that are reflected in the nature of nouns and differences in processing, while not refuting our working Hypothesis 1 for several reasons, which we now revisit. As we have seen, there is a mismatch between these two languages that is observed in the nominal system. The meaning of singular count nouns headed by a quantifier is not fixed and varies between these two languages.

In BrP, quantifier singular phrases are underspecified for atomicity, allowing both cardinal interpretations for count nouns and volume interpretations for mass nouns (PIRES DE OLIVEIRA, 2020). Extralinguistic information is required in BrP, as reflected in response times in this group comparison. In contrast, English grammatically encodes atomicity, distinguishing count from mass nouns through morphosyntactic and lexical constraints also reflected in the quantifiers. This cross-linguistic difference led to differences in cognitive processing. In line with Chierchia (2021), our results points that English maintains a strong relationship between mass/count semantics and grammar. In BrP, by contrast, displays a weak syntax-semantics mapping for the mass/count distinction, permitting more flexible use of quantifiers. As a result, the interpretation of singular count nouns in BrP may rely more on extralinguistic cues than on grammatical computation (PIRES DE OLIVEIRA, 2020, 2021). Consequently, increased processing costs were not observed during semantic derivation in BrP. However, in English, atomicity is grammatically and lexically marked: mass nouns are interpreted in terms of volume/weight, while count nouns default to cardinality — and this distinction is reflected in syntactic structure (CHIERCHIA, 1998). Next, we revisit our RQs in the light of our results and discussion:

RQ1. Are there differences (or mismatches) in the processing patterns between BrP and English? *Yes, there are differences in the processing patterns between BrP and English, though they are subtle and not always strongly supported by statistical significance. The main contrast lies in how the two languages*

handle atomicity and the interaction between quantifiers and noun types. In English, additional processing costs emerge when there is a mismatch between the grammatical specification of quantifiers and nouns (e.g., ‘much’ combined with a count noun), suggesting that quantifiers in English grammatically constrain what kind of noun is expected and how it should be interpreted. In BrP, however, both singular quantifiers and nouns are underspecified for atomicity, leading to no significant processing cost, even in incongruent combinations. BrP speakers also exhibited slower response times overall, which may reflect the delayed specification of atomicity, requiring the integration of pragmatic or compositional cues later in the derivation. Therefore, while English relies on early grammatical cues to guide processing, BrP leaves more room for interpretive flexibility, potentially incurring costs at later stages of processing.

RQ2. *Are there differences (or mismatches) in representation patterns between BrP and English? Is so, what are these differences? Yes, there are mismatches in representation patterns between BrP and English, particularly in how each language encodes mass/count distinctions and atomicity. In English, atomicity is grammatically and lexically encoded, with singular and plural quantifiers as well as noun type playing a central role in determining interpretation (e.g., ‘much’ requires mass nouns while ‘many’ requires count nouns). This leads to a fixed representation pattern, where the semantic category of a noun (mass or count) is tightly mapped to syntactic structure. In BrP, by contrast, singular quantifiers (e.g., ‘muita’) and bare singular nouns are underspecified for atomicity, allowing them to combine with both count and mass nouns without committing to a specific interpretation. This weaker syntax-semantics mapping makes BrP more flexible but may rely more on extralinguistic or contextual information to resolve meaning. As a result, the representation of singular count nouns varies across languages: in English, they are strictly interpreted through grammatical cues, while in BrP, they allow for multiple interpretations depending on context.*

5.3.6 Conclusion

In conclusion, this study reveals both processing and representational mismatches between BrP and English in the treatment of quantifier–noun combinations, particularly regarding atomicity and mass/count interpretation. While English exhibits a tighter syntax–semantics mapping, where quantifiers and noun type strongly constrain interpretation, BrP operates under a more flexible system, in which both singular quantifiers and bare singular nouns are underspecified for atomicity. This distinction is reflected in processing patterns: English speakers show increased processing times in incongruent combinations, suggesting early grammatical conflict resolution, whereas BrP speakers show no such cost, possibly due to delayed specification that depends on compositional or pragmatic cues. Representationally, English adheres to a rigid grammatical encoding of mass and count, while BrP, although it also marks the mass/count distinction, allows for more interpretive flexibility.

5.4 EXPERIMENT 6 — ASSESSING THE PROCESSING AND REPRESENTATION OF QUANTIFIER PHRASES IN BILINGUALS

5.4.1 Introduction

The literature behind this experiment is supported by a series of studies, including Pires de Oliveira (2022), Frisson and Frazier (2005), but primarily by Slabakova (2016) and Grosjean (2008), which help explain the bilingual interface of the phenomenon under investigation. As observed in Experiment 1, related to BrP, and Experiment 2, related to English, these two languages exhibit processing and representation patterns that allowed us to identify a mismatch between the nominal system, reflecting differences in the grammatical structure of the quantifier phrases and the nouns, also reflecting differences in the semantic domain.

As we saw in Experiment 4, in BrP, quantifier singular phrases are underspecified for atomicity, allowing both cardinal and volume interpretations. This underspecification is reflected in processing: no additional effort is required when combining a singular quantifier with different noun types, since the singular quantifier itself does not encode atomicity either. In Experiment 5, we observed the opposite pattern. Although our IT task was not entirely successful in assessing the interpretation of nouns in English, it did show that combining a singular quantifier with a count noun and a plural quantifier with a mass noun is ungrammatical. Furthermore, noun processing varied depending on the quantifier, with longer processing times when the quantifier and noun types were incongruent.

Additionally, we could observe in the Group Comparison 3 that these differences are reflected statistically when comparing both native speakers' groups. That is, there are differences in the processing of the nouns reflected in the noun region and in the post-critical one. Thus, BrP is slower at all comparisons with English. Now, the aim of Experiment 3 is to verify the processing and representation of singular count nouns in English by native speakers of BrP.

Based on Slabakova's hypothesis, we expect that bilinguals will behave according to their L1 in respect to the grammar differences. According to the author, when mismatches between languages occur, L2 bilinguals will rely on their existing knowledge of their L1, effectively transferring it. It is worth mentioning that in the current experiment, we will only report the experiment with bilinguals. Therefore, we continue to investigate the interpretation

and processing of quantifier phrases. A comparison and further discussion will be reserved for the next analysis, where we will conduct a group comparison with the three groups investigated in this dissertation. The RQs guiding this specific experiment are presented as it follows.

5.4.1.1 Specific Research Questions

RQ1. Do bilinguals display an additional processing, if any, in nouns in English?

RQ2. Do bilinguals display an additional processing, if any, in the quantifiers in English?

RQ3. Are singular nouns interpreted as count, mass or are underspecified by bilinguals?

RQ4. Does the noun type affect interpretation for bilinguals?

RQ5. Do singular quantifiers influence the interpretation of singular count nouns for bilinguals?

5.4.1.2 Hypotheses (H) and Predictions (P) for the Processing and Representation of Quantifier Singular Phrases

H0. The true polysemy proposal suggests that a polysemous noun can refer to multiple related meanings—for example, *bank*, which may denote both a physical entity and the abstract conceptualization of a financial institution (FRAZIER; RAYNER, 1990; LAKOFF, 1987). This type of polysemy is assigned immediately and does not incur additional processing costs, making it a purely semantic phenomenon independent of syntax. If quantifier singular phrases in BrP are polysemous in this way, no differences between the experimental conditions are expected.

P0. Accordingly, we predict that acceptability judgments and response times for quantifier singular phrases in BrP will not differ across conditions, reflecting immediate interpretation without additional processing cost.

H1. Assuming the Bottleneck Hypothesis (BH) from Slabakova (2016), bilinguals transfer their L1 knowledge to their L2. Consequently, no additional processing is expected in the noun region, and representation patterns in the L2 should match those of the L1, reflecting underspecification. According to the underspecification hypothesis (PIRES DE OLIVEIRA, 2022), singular nouns lack a fixed interpretation in terms of atomicity, providing insufficient grammatical information to determine whether they should be interpreted by volume or cardinality. This morphosyntactic underspecification may be resolved by the determiner but does not inherently require additional processing.

P1. Based on H1, we predict that bilingual participants will show no differences in processing times or acceptability patterns for singular nouns in BrP and L2 contexts, consistent with the underspecified nature of these nouns.

H2. Assuming Frisson and Frazier's (2005) view, nouns in English are specified, having a primitive meaning. Mass nouns are interpreted in terms of volume or weight, and count nouns in terms of cardinality. This specification results in additional processing time when grammatical structures conflict with noun type, as coercion is required to reinterpret the noun according to the structure. If bilinguals' behavior aligns with their L2, similar processing and representation patterns are expected.

P2. Based on H2, we predict longer processing times when mass nouns appear in count structures or count nouns appear in mass structures, reflecting coercion. Acceptability judgments should also favor grammatically congruent noun-quantifier combinations, consistent with English specification patterns.

In summary, this is the most important experiment of the current research, being the experimental group as it helps to investigate the bilingual cognition; therefore, enabling us to infer whether there is a transfer in the nominal domain from the L1 to the L2. Needless to say, it is important to highlight that we are not comparing monolinguals to bilinguals, as criticized by Grosjean (2008) in the fractional view of bilingualism. In fact, we are comparing linguistic experiences that encompass the processing and representation patterns of two distinct languages. Therefore, we assume Grosjean as our background theory supporting the current study while specifically challenging Slabakova's view. In the next subsection, we present the specific method used to run this experiment.

All materials used in this experiment, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub⁶³.

5.4.2 Method

5.4.2.1 Participants

A total of 33 voluntary native speakers of BrP took part in this experiment, with a mean age of 24.5 years ($SD = 5.5$). Of these participants, 14 reported having previously studied linguistics, while 19 had not. All participants attended the study in the Computer Laboratory at *Centro de Comunicação e Expressão* in the UFSC and they were all Brazilians who had Brazilian Portuguese as their L1.

5.4.2.2 Instruments

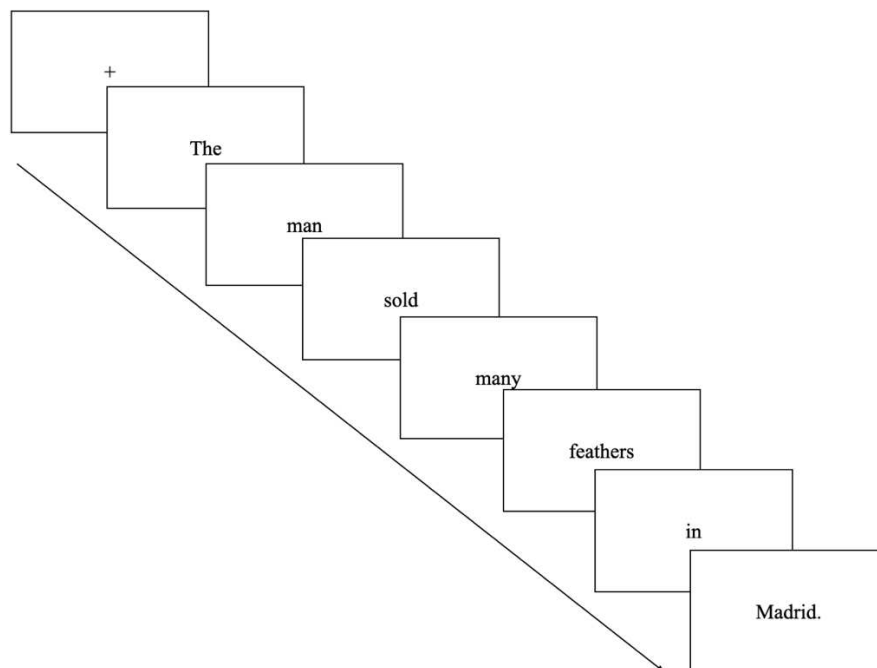
The main instrument in this study was a SPR task, combined with the IT, both programmed in PCIBex, as discussed in the Method section. This experiment followed a 2x2 factorial design, in which we manipulated the following independent variables: quantifier (singular/plural) and noun type (count/mass). The set of experimental conditions for this study is presented below and the bold segments represent the critical and post-critical segments:

⁶³ Data analysis materials and raw results are available at <https://github.com/deardiones/SPR-Bilinguals.git>

34. Singular quantifier + singular count noun (S+C)
 a) + / The / man / sold / **much** / **feather** / **in** / Madrid.
 Singular quantifier + singular mass noun (S+M)
 b) + / The / man / sold / **much** / **silver** / **in** / Madrid.
 Plural quantifier + plural count noun (P+C)
 c) + / The / man / sold / **many** / **feathers** / **in** / Madrid.
 Plural quantifier + plural count noun (P+M)
 d) + / The / man / sold / **many** / **silvers** / **in** / Madrid.

The dependent variables were Reading Time (in milliseconds), Response Time (in milliseconds), and Answer Type (interpretation). This resulted in a total of 4 lists with 16 target sentences in English, randomized with 32 distractor items in a within-subject design. Each sentence was segmented word-by-word and presented using a non-cumulative, non-linear method on the platform, starting by the display of a fixation cross in the center of the screen. In order to read each segment, the participant had to press the space bar to read the following segment. The sentences were presented in the platform as it follows in Figure 5.5:

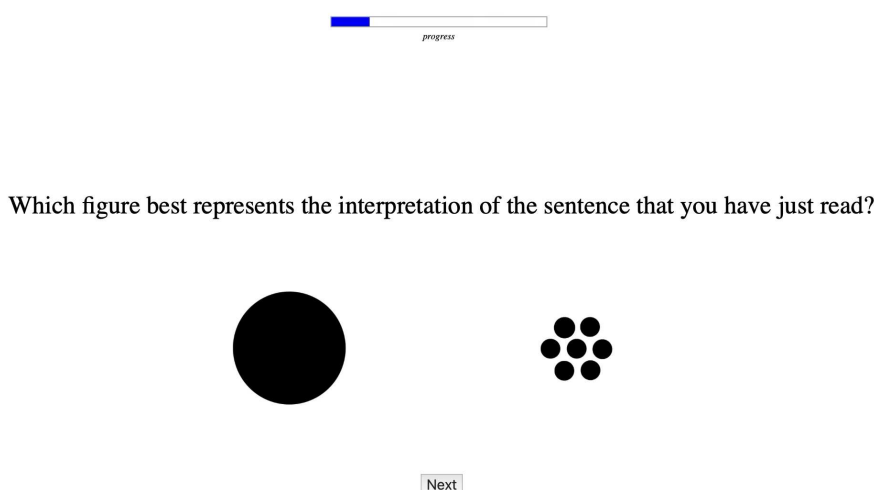
Figure 5.5 — Example of the experiment on PCIBex Farm



Source: designed by the researchers.

After reading the sentence, participants were presented with the IT, which included the question: “Which figure best represents the interpretation of the sentence that you have just read?” Two images were then shown, as illustrated in Figure 5.6 below:

Figure 5.6 — Interpretation Task



Source: designed by the researchers and extracted from the experiment at PCIBex farm platform.

As previously discussed, if the participant selected the single large ball, their interpretation would be based on volume, indicating that they interpreted the noun as mass. However, if the participant selected the smaller balls in greater quantity, their interpretation was based on cardinality, meaning they interpreted the noun as count. Next, we move to the predictions of this experiment.

5.4.2.3 Predictions

As our participants from this study were native speakers of BrP and were intermediate learners of English as their L1, and assuming the transfer hypothesis from Slabakova, we assume Hypothesis 1 as our working hypothesis. As a result, our predictions are based on the results obtained from Experiment 1. In the Table 5.56 below, we present our predictions for the processing for the noun region, the interpretation of these nouns, and the response time:

Table 5.56 — Predictions for processing and interpretation of the noun region for each condition

Condition	Processing	Interpretation	Response Time
Singular Quantifier + Count Noun	No additional processing	Oscillate	No additional time
Singular Quantifier + Mass Noun	No additional processing	Oscillate	No additional time
Plural Quantifier + Count Noun	No additional processing	Cardinal	No additional time
Plural Quantifier + Mass Noun	Additional processing	Cardinal	No additional time

Source: designed by the researchers.

Assuming Slabakova (2016), we do not expect differences from bilinguals to behave differently from their L1. Since the proficiency level of the bilingual group is intermediate, and according to the Bottleneck Hypothesis, at this level of language acquisition, the mismatches between syntax and semantics are not fully acquired. Therefore, their language processing patterns and representation may resemble the same processing patterns and representation of their first language.

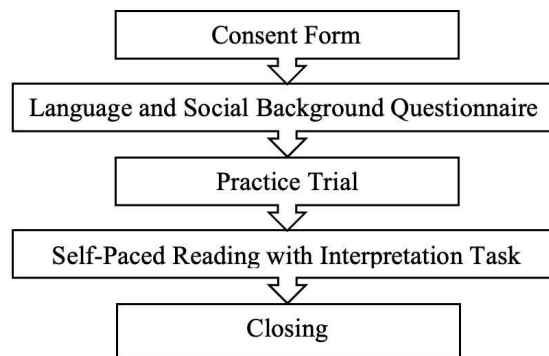
5.4.2.4 Procedures

Each participant voluntarily went to the Computer Lab from UFSC, at the CCE, located on the fourth floor, room 516B. Upon arrival, participants were seated in front of a laptop⁶⁴ and were asked if they knew English. If they answered negatively, they skipped the leveling task. If they answered positively, they were invited to take a leveling test from the Cambridge website. After completing the leveling test, the principal investigator checked the participant's level. If the level fell between A1, A2, C1, or C2, the participant took the test in BrP. If the level fell between B1 and B2, the participant was invited to take the task in English.

After the leveling task, participants were presented with the screen on the PCibex website, which included the following presentation order:

⁶⁴ The experiment was run on multiple Dell laptops, each equipped with an Intel Core i3-10100T processor, 16 GB RAM, and a 256 GB SSD, running Windows 10. Each laptop featured a 15.6-inch Full HD (1920 × 1080) display with a 60 Hz refresh rate. PCibex was accessed via Google Chrome version 116.0.5845.

Flowchart 5.4 — Presentation order



Source: designed by the researchers.

The first prompt on the laptop screen was the Consent Form in their native language (Appendix C). After that, a brief instruction screen prepared participants for the upcoming Language and Social Background Questionnaire (Appendix F). From this point onwards, all the information displayed in PCIBex was in English, including the instructions. As participants selected options on the questionnaire, the next question appeared automatically. After completing the nine questions, participants were presented with the task instructions.

The first eight trials served as practice trials (Appendix R), allowing participants to become familiar with the SPR experiment combined with the IT. After the practice phase, the final instructions were given, followed by 48 trials in which 16 were experimental (Appendix N) and 32 were distractors (Appendix P).

Upon completing the task, which took about 30 to 40 minutes, participants saw a thank-you screen, which also provided final instructions on how to save their data. Additionally, participants were shown their participant number, which had been randomly generated by the platform at the beginning of their session.

5.4.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. We assumed a Cohen's *d* of 0.8 for small groups in which a large effect is expected. After adjusting the alpha level to 0.05 and using a sample size of 33, the resulting power was 0.8926077. Thus, we interpret this result as indicating that 89.2% of the data represent the phenomenon investigated within the expected range.

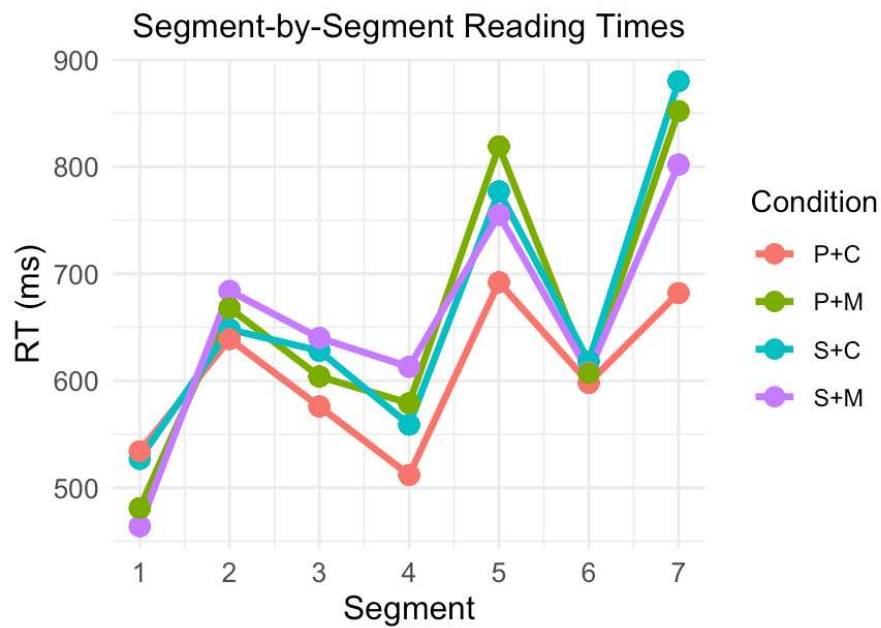
5.4.3 Self-Paced Reading

The SPR is our main instrument for investigating language processing in real time as we have already discussed in the previous method chapter. In the next subsection, we present how the data was processed for each segment, along with the statistical analysis.

5.4.3.1 Data Filtering

We begin by presenting the processing of the entire sentence with raw means for each segment as an overview of the results gathered in this study. Graph 5.31 below, the raw RT mean for each segment are displayed for the experimental conditions:

Graph 5.31 — Raw RT means in milliseconds for each segment in the experimental conditions



Source: designed by the researchers on RStudio.

By observing the raw data, we can identify the processing pattern of the experimental sentences for the bilingual group. The graph shows an increase in processing in the noun region (segment 5) and wrap-up processing at the end of the sentence (segment 7). Notably, the Plural Quantifier + Mass Condition (P+M) shows additional processing in the noun region, alongside with Singular Quantifier + Count Noun (S+C) condition. Interestingly, there is a significant

wrap-up effect in the Singular Quantifier + Count Noun (S+C) condition, standing out compared to all other conditions. Additionally, the Plural Quantifier + Count Noun (P+C) is the fastest condition among all others. The table below presents the raw means for both the quantifier region (segment 4) and the noun region (segment 5):

Table 5.57 — Raw means in reading time in milliseconds for the quantifier region

Quantifier	Mean
Singular	657.2635
Plural	631.6109

Source: designed by the researchers.

Table 5.58 — Raw means in reading time in milliseconds for the noun region

Noun	Mean
Count	633.4984
Mass	655.3761

Source: designed by the researchers.

For the quantifier region, we can observe that the plural quantifier is 25.652 milliseconds faster when compared to the singular quantifier. Thus, for the noun region, the mass noun is 21.877 slower than the count noun. All these results are examined in detail in the next subsections, with specific data treatment applied to each segment. We removed outliers from the samples for each segment based on data distribution and normality checks to ensure more homogeneous data as we have done for the previous control groups. Next, we will focus on the data treatment and analysis for the noun region.

5.4.3.2 Noun Region

We start by the analysis of the noun region, corresponding to segment 5, since it is the most important segment of the SPR, as it provides direct insights into whether BrP quantifier singular phrases undergo any additional processing. This region is critical for testing our working hypotheses regarding the processing pattern of this structure, allowing us to compare it with other groups. Below, we highlight the data treatment applied to this segment.

5.4.3.3 Data Analysis

For the noun region, we applied three data treatments, beginning with a visual inspection of the graphs of the raw data and normality test which were both not well distributed and neither normal. The first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 2148.2. This means that all reading times that were above 2148.2 milliseconds, were cut from the sample. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 1497.5. After checking once again the graphs to check the distribution and the normality test, the data was still not well distributed and neither normal.⁶⁵ Thus, the residuals were also not normal and neither well distributed.

We then performed a log transformation as our last resource to improve the distribution of the data. After the log transformation, *dataset3* still did not achieved normality (Shapiro-Wilk: $W = 0.98159$, $p\text{-value} = 8.653e-06$)⁶⁶, but it was well distributed in the histogram and without any outliers visible at the bottom of the boxplot graph. The residuals were also not normal (Shapiro-Wilk: $W = 0.98244$, $p\text{-value} = 1.438e-05$)⁶⁷ but they were visually well distributed. Therefore, *dataset3*, with the logarithmic transformation, was used for the statistical analysis and was saved separately for the group comparison.

Removing the outliers from the sample reduced the number of observations from 528 to 482, resulting in the loss of 46 observations, representing 8,6% of the sample. Additionally, the condition with the highest data loss was S+C, with 13 data points lost, followed by P+M, which lost 12 data points. The conditions that preserved the most data were P+C, with a loss of 10 data points, and S+M, with a loss of 11 data points. The table containing the treated means and standard deviations for the noun region under each condition are shown in Table 5.59 below:

⁶⁵ The normality tests and graphs can all be checked on GitHub.

⁶⁶ Kolmogorov-Smirnov: $D = 0.068405$, $p\text{-value} = 1.275e-05$

⁶⁷ Kolmogorov-Smirnov: $D = 0.074669$, $p\text{-value} = 9.414e-07$

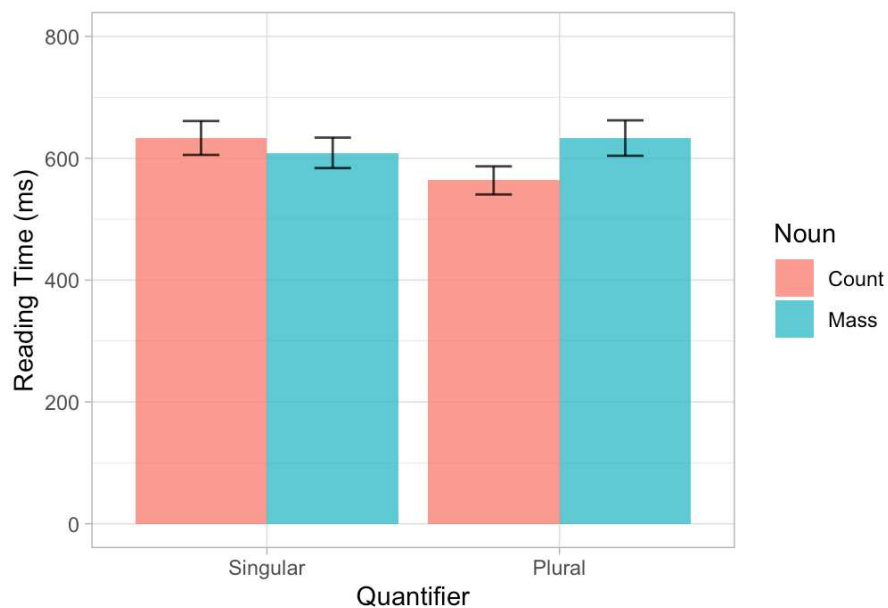
Table 5.59 — Treated means and standard deviation for each experimental condition in the noun region milliseconds

Condition	Mean	Standard Deviation
S+C	633.2605	303.7901
S+M	608.8760	274.7294
P+C	563.6230	255.1359
P+M	633.1333	318.5072

Source: designed by the researchers.

From the table above, we can see that the S+C condition is processed 24.384 milliseconds slower, having the highest mean, while the S+M condition is less time demanding. The P+C condition is 69.510 milliseconds faster compared to the P+M condition which is slower. Below, the graph with the mean is presented:

Graph 5.32 — Treated means and standard deviation for each experimental condition in the noun region milliseconds



Source: designed by the researchers on RStudio.

The graph shows a comparison of reading time in milliseconds across quantifiers and nouns. As we can observe, the condition in English that have incongruent syntactic structure with noun type takes a little more time to process, namely the conditions S+C and P+M, while the P+C is the fastest among all, followed by the S+M condition. The error bars are similar

across all categories, which indicates that the averages are not stable and there's variability within the participants. The statistical analysis will say more about these apparent differences. Next, we can observe the means for each variable:

Table 5.60 — Means in reading time in milliseconds for the noun

Noun	Mean
Count	598.0083
Mass	620.9544

Source: designed by the researchers.

Table 5.61 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	620.9667
Plural	598.0909

Source: designed by the researchers.

In the table above, we can observe that the mass noun is processed slower compared to the count noun, being 22.946 milliseconds slower. Additionally, the plural quantifier is processed 22.875 milliseconds faster than the singular quantifier. Next, we will move on to the statistical analysis to determine whether these means and standard deviations yield any significant results regarding processing in the noun region.

5.4.3.4 Statistical Analysis

In the noun region, we used the logarithm of reading times as our dependent variable and fitted a Linear Model with Quantifier, Noun, and the interaction between these two factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be seen below:

```
model1 <- lmer (log ~ Quantificador * Nome + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)
```

```
model2 <- lmer (log ~ Quantifier + Noun + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included an interaction between the Quantifier and the Noun, which was statistically significant ($\chi^2 = 5.5101$, $p < 0.018$). The model's results can be checked below:

Table 5.62 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	6.38	6.26 – 6.51	<0.001
Quantifier [P]	-0.11	-0.19 – -0.03	0.010
Noun [M]	-0.05	-0.13 – 0.04	0.275
Quantifier [P] × Noun [M]	0.14	0.02 – 0.25	0.019
Random Effects			
σ^2	0.10		
τ_{00} Participant	0.10		
τ_{00} Item	0.00		
ICC	0.51		
$N_{\text{Participant}}$	33		
N_{Item}	16		
Observations	482		
Marginal R^2 / Conditional R^2	0.008 / 0.513		

Source: designed by the researchers on RStudio.

The model shows a significant effect for plural quantifier and a significant interaction between the quantifier and noun type. However, there is a substantial participant-level variability, as indicated by the ICC and R^2 , which indicates that participant differences contribute significantly to the result.

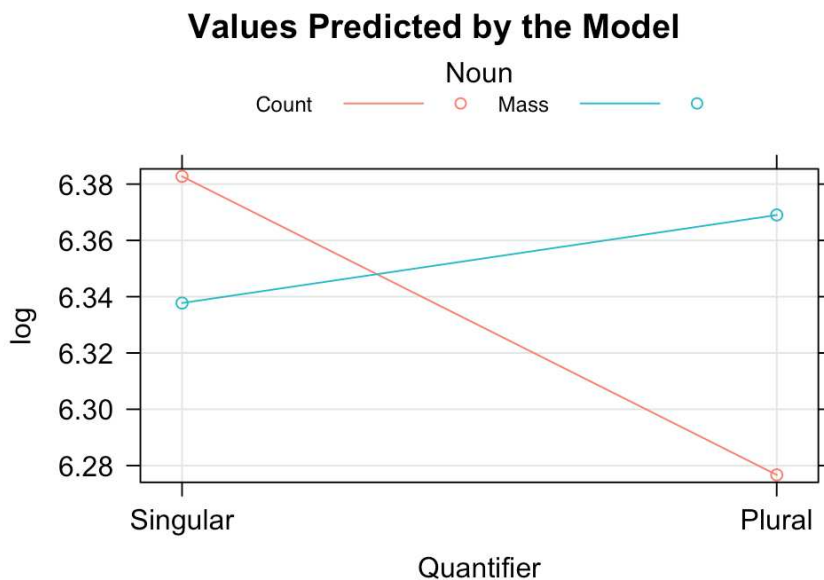
A post-hoc analysis with the Bonferroni⁶⁸ Correction was performed, revealing that the quantifier type affects reading times for the noun only when the noun is count. Specifically, the S+C condition is marginally slower compared to the P+C condition ($p < 0.06$). Below, we present the pairwise comparison:

⁶⁸ A Tukey post-hoc was also done and can be seen in the R scripts on GitHub.

contrast	estimate	SE	df	t.ratio	p.value
S C - P C	0.1061	0.0413	443	2.566	0.0637
S C - S M	0.0450	0.0414	443	1.088	1.0000
S C - P M	0.0137	0.0414	441	0.331	1.0000
P C - S M	-0.0611	0.0410	440	-1.489	0.8235
P C - P M	-0.0924	0.0412	443	-2.240	0.1534
S M - P M	-0.0313	0.0413	443	-0.758	1.0000

The pairwise comparison highlights that the only comparison that approached significance was S+C compared to P+C ($\beta = 0.1061$, $SE = 0.0413$, $t = 2.566$, $p < 0.0637$). This indicates that the effect of the quantifier is evident only when the noun is count. Specifically, the singular quantifier combined with the count noun is marginally slower, taking about 633 milliseconds to process, while the singular quantifier combined with the mass noun is faster, taking about 563 milliseconds. Below, we present a graph with the values predicted by the model (in log):

Graph 5.33 — Values predicted by the model for the noun region



Source: designed by the researchers on RStudio.

The observed plot above suggests that quantifiers have different effects on predicted values for nouns of type count and mass, highlighting a possible syntactic-semantic interaction between noun type and quantifier in our model's predictions. These results will be explored in

greater depth in the general discussion. In the following subsection we explore the quantifier region.

5.4.3.5 Quantifier Region

The quantifier region, corresponding to segment 4, could also be informative in terms of BrP processing and question the working hypothesis of this dissertation. It is important to take a closer look at this region, as it can provide preliminary cues for the following noun. In English, the quantifier ‘many’ indicates in advance that the noun encountered next in the derivation will be a count noun, while ‘much’ grammatically signals that the following noun will be a mass noun. In BrP, we predict that the behavior might differ, and examining the processing of this region could shed light on the processing patterns of this structure.

5.4.3.6 Data Analysis

A new data treatment was applied using the original bilingual data set, extracted directly from the PCIBex platform. Three treatments were performed on segment 4, focusing on cleaning up outliers, primarily to visually distribute the data, while also applying normality test. We began with a visual inspection of the graphs of the raw data and normality test which were both not well distributed and neither normal. The first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 1178.2. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 885.7. After two upper limit cuts the data was visually well distributed. However, outliers remained in the sample, and the normality test still indicated non-normality (Shapiro-Wilk: $W = 0.98524$, $p\text{-value} = 9.153e-05$)⁶⁹. We also checked the residuals, which followed the same distribution pattern as the main data, but the normality test again indicated non-normality (Shapiro-Wilk: $W = 0.98511$, $p\text{-value} = 8.381e-05$)⁷⁰.

We then proceeded with a logarithmic transformation; however, this the distribution becomes worse, and the test was still not normal. Consequently, we chose to retain *dataset3*, from before the logarithmic transformation, as we considered the log transformation a last resort for improving distribution. Since the log transformation failed to enhance distribution, *dataset3*,

⁶⁹ Kolmogorov-Smirnov: $D = 0.058344$, $p\text{-value} = 0.000531$

⁷⁰ Kolmogorov-Smirnov: $D = 0.055183$, $p\text{-value} = 0.001429$

with the less conservative outlier cut, was retained for statistical analysis and comparison with other groups. Graphs for each dataset can be viewed on GitHub.

Removing outliers from the sample resulted in 477 observations out of the original 528, resulting in less 51 observations, representing 9.65% of data loss. Additionally, the condition that lost the most data was S+M and P+M, with 15 data points removed each, followed by S+C, with 11 data points removed. The condition that retained the most data was P+C, which lost 10 data points. The treated means and standard deviations for the quantifier region in each condition are presented in Table 5.63.

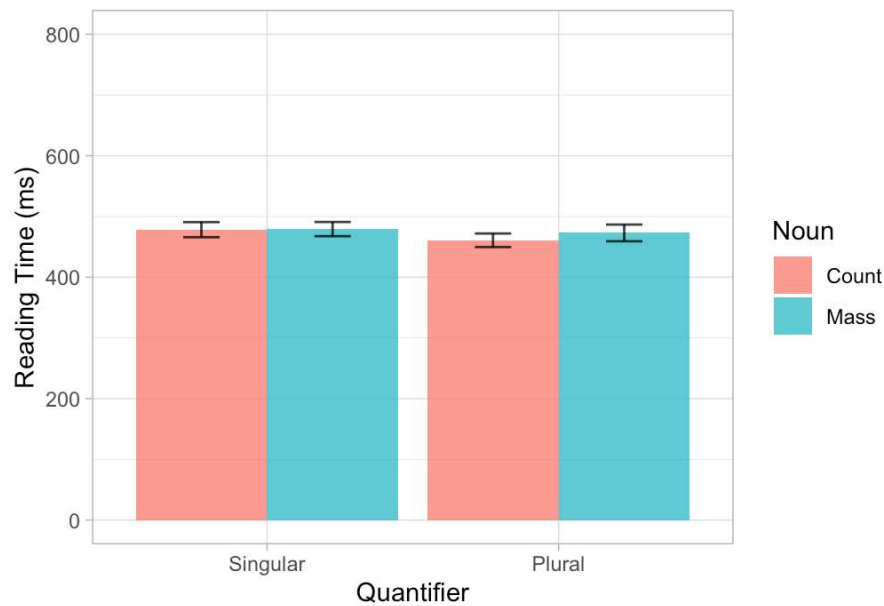
Table 5.63 — Treated means and standard deviation for each experimental condition in the quantifier region in milliseconds

Condition	Mean	Standard Deviation
S+C	478.2314	136.4874
S+M	479.1966	126.6076
P+C	460.7705	123.1837
P+M	472.8974	148.6583

Source: designed by the researchers.

By examining the table above, we can observe that the condition with the highest mean is the S+M condition being 0.965 milliseconds slower than the S+C condition. The condition processed the fastest is the P+C condition being 12.126 milliseconds faster than the P+M condition. Next, the graph containing the means and standard deviation for the quantifier region can be observed:

Graph 5.34 — Treated means and standard deviation for each experimental condition in the quantifier region



Source: designed by the researchers on RStudio.

The graph indicates that neither the quantifier nor the noun had a strong effect on reading times. Both quantifier and noun conditions seem to result in similar processing times, as indicated by the similar bar heights across conditions. Thus, the small error bars suggest that the variability within each condition is low, meaning the results are relatively consistent across participants or trials. Below, we present the means for each variable:

Table 5.64 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	478.7059
Plural	466.7071

Source: designed by the researchers.

Table 5.65 — Means in reading time in milliseconds for the noun

Noun	Mean
Count	469.465
Mass	476.047

Source: designed by the researchers.

The tables above show that the plural quantifier is processed faster, being 11.998 faster in comparison to the singular quantifier. The mass noun is processed 6.582 milliseconds slower than the count noun. Next, we move to the statistical analysis to check whether these means and standard derivation result in any significance regarding processing of the quantifier region.

5.4.3.7 Statistical Analysis

In the quantifier region, using reading times as the dependent variable, we fitted a Linear Model with Quantifier, Noun, and their interaction as fixed effects, along with random intercepts for both Participants and Items. The models used can be seen below:

```
model1 <- lmer (Reading.time ~ Quantifier * Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model2 <- lmer (Reading.time ~ Quantifier + Noun +
(1|Participant) + (1|Item), data = dataon3, REML = FALSE)

model3 <- lmer (Reading.time ~ Quantifier + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)

model4 <- lmer (Reading.time ~ Noun + (1|Participant) +
(1|Item), data = dataon3, REML = FALSE)
```

A comparison between nested models with ANOVA revealed that neither the two-way interaction nor fitting the model without the interaction resulted in a significant improvement in model fit ($\chi^2 = 0.1473$, $p = 0.701$). Additional ANOVA tests with the model without the interaction and a model only with the Noun as fixed did not show an improvement in fit ($\chi^2 = 2.2944$, $p = 0.129$), neither including only the Quantifier as a fixed effect showed an improvement in fit ($\chi^2 = 0.7224$, $p = 0.395$).

Considering the AIC and BIC values, the model without the Noun as fixed effect had slightly lower values (AIC = 5878.0, BIC = 5898.8). Therefore, the best-fitting model included only Quantifier as a fixed effect. The model's results are presented below:

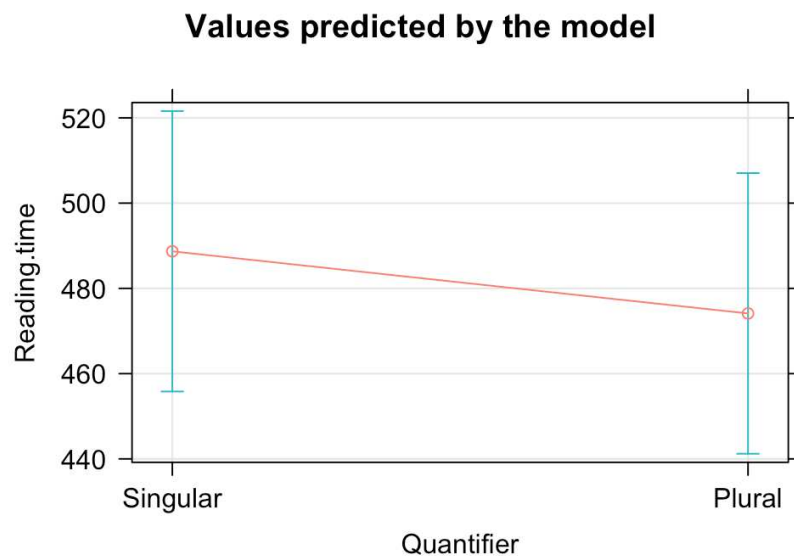
Table 5.66 — Model's results

<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	488.70	455.81 – 521.59	<0.001
Quantifier [P]	-14.57	-33.44 – 4.29	0.130
Random Effects			
σ^2	10917.97		
τ_{00} Participant	7544.41		
τ_{00} Item	30.49		
ICC	0.41		
N Participant	33		
N Item	16		
Observations	477		
Marginal R^2 / Conditional R^2	0.003 / 0.411		

Source: designed by the researchers on RStudio.

The model suggests that there is no significant effect for the quantifier on reading time, as indicated by the non-significant estimate for the reference value which is the plural quantifier. A large portion of the variance in reading time is explained by participant variation rather than the quantifier manipulation or the items. In the Graph 5.35 below, we can observe the graph with the values predicted by the model in terms of reading times.

Graph 5.35 — Values predicted by the model for the quantifier region



Source: designed by the researchers on RStudio.

Graph 5.35 shows the predicted reading times for singular and plural quantifiers. The plot visually suggests that the predicted reading times for the singular and plural quantifiers are similar, with minor advantage for the plural quantifier. This reinforces the interpretation that quantifier type alone likely has little to no effect on reading times in this context.

5.4.3.8 Post-Critical Region

The final region to be analyzed related to processing is the post-critical region, corresponding to segment 6, which might provide insights into spill-over effects in processing. Any additional processing may surface in this region, as it was observed for the English experiment.

5.4.3.9 Data Analysis

A new data treatment was performed using the original bilingual dataset, extracted directly from the PCibex platform. The raw data was not normally distributed neither well distributed. The first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 1183.6. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 899.8. In the more conservative outlier cut, resulted that the data was visually well distributed, though the normality test still indicated non-normality.

We checked the residuals, which followed the same pattern as the main data. While the data was visually well distributed, the normality test remained non-normal. We proceeded with a logarithmic transformation and the data kept a good distribution, the normality test did not show normality (Shapiro-Wilk: $W = 0.98599$, $p\text{-value} = 0.0001411$)⁷¹. The residuals also kept a good distribution but they were also not normal (Shapiro-Wilk: $W = 0.9871$, $p\text{-value} = 0.0002977$)⁷². Therefore, we decided to retain *dataset3* with the log-transformed data as the final dataset for statistical analysis and comparison with other groups.

After removing outliers, the sample was reduced to 480 observations from the original 528, which comprised less 48 observations, representing 9.09% of the sample. The condition that lost the more data points was S+C, with 14 data points removed, followed by P+C, with 13

⁷¹ Kolmogorov-Smirnov: $D = 0.049069$, $p\text{-value} = 0.007703$

⁷² Kolmogorov-Smirnov: $D = 0.053437$, $p\text{-value} = 0.002286$

data points removed. The conditions that preserved the most data were S+M, losing 10 data sets and P+M, losing 11 data points. The treated means and standard deviations for the post-critical region can be seen in Table 5.67.

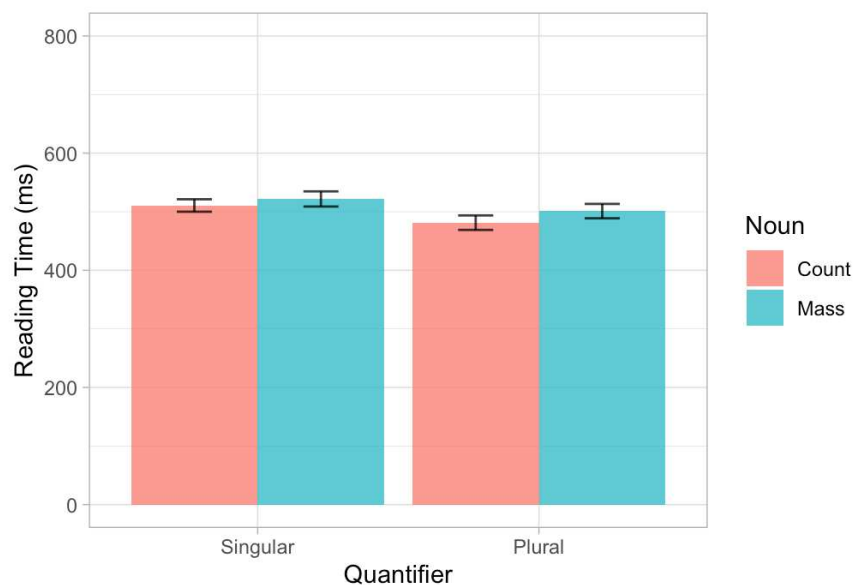
Table 5.67 — Treated means and standard deviation for each experimental condition in the post critical region in milliseconds

Condition	Mean	Standard Deviation
S+C	510.5847	115.4599
S+M	521.7459	142.7222
P+C	481.2353	134.9305
P+M	501.0248	134.8267

Source: designed by the researchers.

By examining the table above, we can see that the condition with the highest mean, indicating greater processing effort, is the S+M condition being 11.161 milliseconds slower than S+C condition. The condition that is processed the fastest is the P+C condition being 19.789 milliseconds faster than P+M condition. Below, we can observe the graph of reading times means for the post-critical region:

Graph 5.36 — Treated means and standard deviation for each experimental condition in the post-critical region



Source: designed by the researchers on RStudio.

The graph indicates that the noun does not have a strong effect on reading times. However, plural quantifier leads to slight faster processing, especially for count nouns. Below, we present the means for each variable:

Table 5.68 — Means in reading time in milliseconds for the noun

Noun	Mean
Count	495.8481
Mass	511.4280

Source: designed by the researchers.

Table 5.69 — Means in reading time in milliseconds for the quantifier

Quantifier	Mean
Singular	516.2583
Plural	491.2125

Source: designed by the researchers.

The tables above indicate that the mass noun is processed 15.579 milliseconds slower than the count noun. Additionally, the plural quantifier is processed 25.045 milliseconds faster than the singular quantifier. Next, we will conduct a statistical analysis to determine whether these means and standard deviations yell any significant differences in processing within the post-critical region.

5.4.3.10 Statistical Analysis

In the post-critical region, using log as the dependent variable, we fitted a Linear Mixed-Effects Model with Quantifier, Noun, and their interaction as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be seen below:

```
model1 <- lmer (log ~ Quantifier * Noun + (1|Participant) +
  (1|Item), data = dataon3, REML = FALSE)
```

```
model2 <- lmer (log ~ Quantifier + Noun + (1|Participant) +
  (1|Item), data = dataon3, REML = FALSE)
```

```

model3 <- lmer (log ~ Quantifier + (1|Participant) + (1|Item),
data = dataon3, REML = FALSE)

model4 <- lmer (log ~ Noun + (1|Participant) + (1|Item), data
= dataon3, REML = FALSE)

model5 <- lmer (log ~ (1|Participant) + (1|Item), data =
dataon3, REML = FALSE)

```

A comparison of nested models using ANOVA revealed that the two-way interaction did not suggest an improvement in model fit compared to the model without the interaction ($\chi^2 = 0.659$, $p = 0.417$). An additional ANOVA comparing the model without the two-way interaction to a model with only Quantifier as a fixed effect also did not show a significant improvement in fit ($\chi^2 = 1.4402$, $p = 0.230$). However, a comparison between the model with only Noun as a fixed effect with the model without the two-way interaction showed a significant improvement in fit ($\chi^2 = 8.211$, $p < 0.004$). In this way, the best-fitting model included Noun as the sole fixed effect, with random intercepts for participants and items. The models result can be checked below:

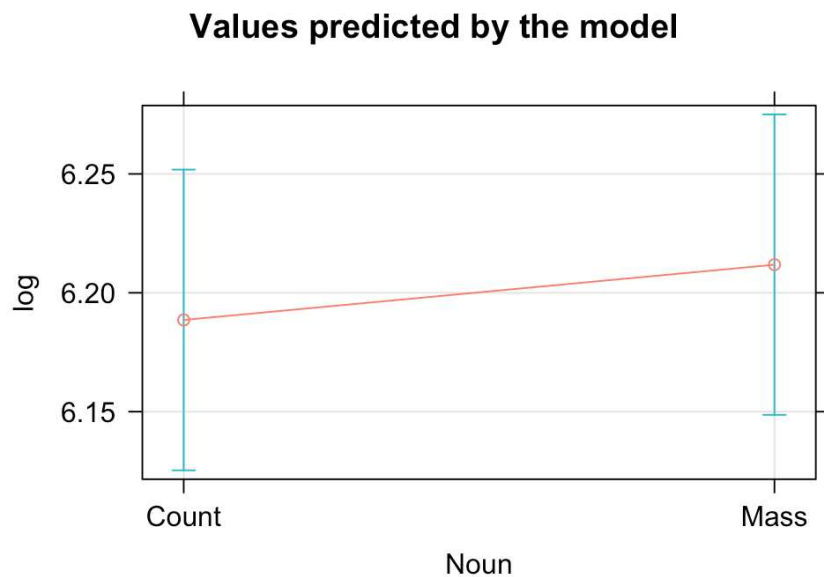
Table 5.70 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	6.19	6.13 – 6.25	<0.001
Noun [M]	0.02	-0.01 – 0.06	0.229
Random Effects			
σ^2	0.04		
τ_{00} Participant	0.03		
τ_{00} Item	0.00		
$N_{\text{Participant}}$	33		
N_{Item}	16		
Observations	480		
Marginal R^2 / Conditional R^2	0.003 / NA		

Source: designed by the researchers on RStudio.

The table above shows that the log-transformed reading times indicated that noun has no significant effect in the processing of the post critical region, therefore, the noun itself does not affect reading times in this region. Next, we can observe the graph with the values predicted by the model for the critical segment 6:

Graph 5.37 — Values predicted by the model for the post critical region



Source: designed by the researchers on RStudio.

The graph presents the predicted reading times in log for the noun. The model suggests an increase in reading times for mass nouns while a decrease for count nouns. Although we could observe this trend in the graph, statistical tests did not find significance in the reading times for the nouns in this region, not showing an effect for noun. Next, we move to the analysis of the IT.

5.4.1 Interpretation Task

Now we present the instrument designed to capture the interpretation of the nouns. Besides capturing the answer type, this instrument enabled us to collect an offline measurement of language processing: response time, which is the data we will examine in the next subsection.

5.4.2 Response Time

The response time in the IT allows us to infer aspects of language processing, as it indicates the time taken by participants to determine whether their interpretation of the sentence they had just read best fits the meaning of the sentence. This data may enhance our understanding of the bilingual language processing and representation.

5.4.2.1 Data Analysis

In the data treatment was divided into two parts. In the first phase, we isolated the necessary information from the raw table extracted from PCIBex. This information included the target sentences, their selections concerning the two figures, and the time in milliseconds from when the IT appeared on the screen until the participant clicked the “Next” button.

In the second phase, we filtered the raw data to check for normality and distribution. However, the data did not meet the criteria for both. Therefore, the first treatment was done with the interquartile range with the first treatment with a more conservative range 3 resulting in an upper limit of 5560. After checking the distribution and the normality test, the data was still not well distributed and neither normal, proceeding in this way for the less conservative range 1.5, resulting in an upper limit of 3917.5. After reviewing the graphs and conducting normality test, we concluded that the data still did not follow a normal distribution, nor was it normal according to the test. We then proceeded with a logarithmic transformation. Following the transformation, the data distribution improved but the data was still not normal (Shapiro-Wilk: $W = 0.98844$, $p\text{-value} = 0.0008864$)⁷³. In this way, we decided to keep with *dataoff3* with the log-transformed data.

Removing the outliers from the sample resulted in 471 observations from the original 528, a reduction of 57 observations, representing 10.79% of the sample. The condition that lost the most data was S+C, with 24 data points lost, followed by S+M, which lost 22 data points. The conditions that preserved more data were P+C, losing 4 data points, and P+M, losing 7 data points. After this treatment, we plotted the table with the means and standard deviations in milliseconds, which can be reviewed above for each condition:

⁷³ Kolmogorov-Smirnov: $D = 0.047541$, $p\text{-value} = 0.01277$

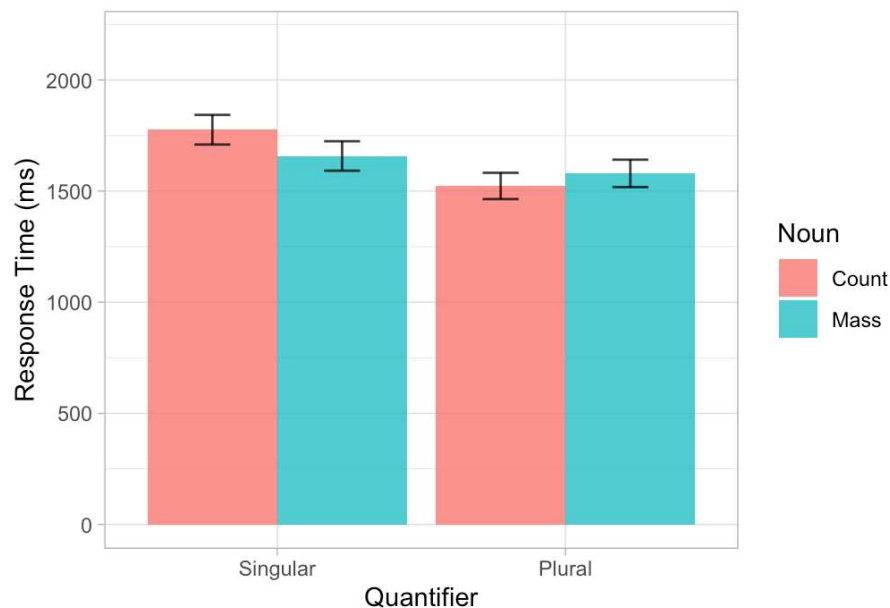
Table 5.71 — Treated means and standard deviation for each experimental condition in the response time in milliseconds

Condition	Mean	Standard Deviation
S+C	1776.139	693.2723
S+M	1657.964	694.8556
P+C	1523.117	668.8325
P+M	1579.648	690.9282

Source: designed by the researchers.

By checking the table above, we can observe that the S+M is 118.175 milliseconds faster than the S+C condition, while the P+C is 56.531 milliseconds faster than the P+M condition, also being the fastest comparison between noun types. After that, we plotted the first graph in which the means and standard deviation of the response time is visualized. The graph is available below:

Graph 5.38 — Response time means and standard deviation in milliseconds



Source: designed by the researchers on RStudio.

The bar graph suggests that the noun does not have a strong effect on response time. However, we might observe a possible effect for the quantifier type. The error bars show some variability in response times, suggesting that this variability might be statistically significant. We will check that in the statistical analysis in the next subsection.

5.4.2.2 Statistical Analysis

For the response time, using the logarithm of response time as a dependent variable, we fitted a Mixed Linear Model with Quantifier, Noun, and the interaction between these two factors as fixed effects, alongside random intercepts for each Participant and Item. The models used in this analysis can be seen below:

```
modell1 <- lmer (log ~ Quantifier * Noun + (1|Participant) +
(1|Item), data = dataoff3, REML = FALSE)

modell2 <- lmer (log ~ Quantifier + Noun + (1|Participant) +
(1|Item), data = dataoff3, REML = FALSE)
```

A comparison of nested models with ANOVA indicated that there was a significant interaction between quantifier and noun with the best-fitting model including the interaction as fixed effect ($\chi^2 = 3.9334$, $p < 0.04$). Below, the model's results for response time:

Table 5.72 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.42	7.31 – 7.53	<0.001
Quantifier [P]	-0.19	-0.28 – -0.09	<0.001
Noun [M]	-0.10	-0.20 – 0.00	0.052
Quantifier [P] × Noun [M]	0.14	0.00 – 0.27	0.047
Random Effects			
σ^2	0.13		
τ_{00} Participant	0.04		
τ_{00} Item	0.01		
ICC	0.27		
N Participant	33		
N Item	16		
Observations	471		
Marginal R^2 / Conditional R^2	0.025 / 0.286		

Source: designed by the researchers on RStudio.

Based on the table, we can observe an effect for quantifier, with the plural predicting faster response times than the singular one, an effect for noun in the limit of significance for mass, also triggering faster response times when compared to count ones, and an effect of interaction between the quantifier and noun, with the combination of plural quantifier with mass noun triggering lower response times.

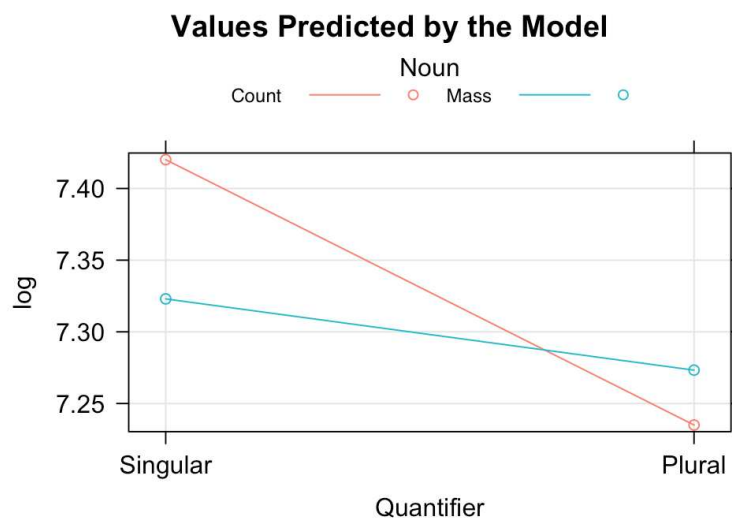
A Bonferroni⁷⁴ Correction was applied in the post-hoc analysis, revealed that the only comparison worth highlighting is the quantifier type which affects reading times for the noun only when the noun is count. Below, we present the pairwise comparison:

contrast	estimate	SE	df	t.ratio	p.value
S C - P C	0.1851	0.0483	429	3.831	0.0009
S C - S M	0.0971	0.0502	430	1.937	0.3206
S C - P M	0.1468	0.0487	431	3.016	0.0163
P C - S M	-0.0880	0.0480	429	-1.833	0.4054
P C - P M	-0.0383	0.0464	429	-0.824	1.0000
S M - P M	0.0497	0.0483	430	1.029	1.0000

Specifically, the S+C condition is significantly slower compared to the P+C condition ($\beta = 0.1851$, $SE = 0.0483$, $t = 3.831$, $p < 0.0009$) indicating an effect for quantifier in which when the quantifier is singular and the noun is count, it generates increased response times, while when the quantifier is singular and the noun is mass, then the opposite happens, decreasing response times. This same pattern was observed for native speakers of English. The other comparisons are not significant or relevant to the purpose of this study. Below we can check the graph in which the values predicted by the model are presented:

⁷⁴ A Tukey post-hoc was also done and can be seen in the R scripts on GitHub.

Graph 5.39 — Values predicted by the model for the response time in log



Source: designed by the researchers on RStudio.

This graph shows the log-transformed values suggests that the quantifier type influences the predicted log values in different manners, depending on the noun type. More specifically, count noun shows an increase in the log values of response times for singular quantifiers while plural quantifiers go in the opposite direction. This indicates that the quantifier affects response times is permeated by noun type. Next, we look at our final dependent variable in the answer type subsection.

5.4.2.3 Answer Type

Finally, the answer type will give specific information how bilinguals interpret nouns in English, being mainly an offline access of language representation.

5.4.2.4 Data Analysis

Following the data filtering of the response time, we kept working on the data filtering for the answer type, right after plotting the response time graph. We tabled the volume and cardinal responses that can be checked below in percentages:

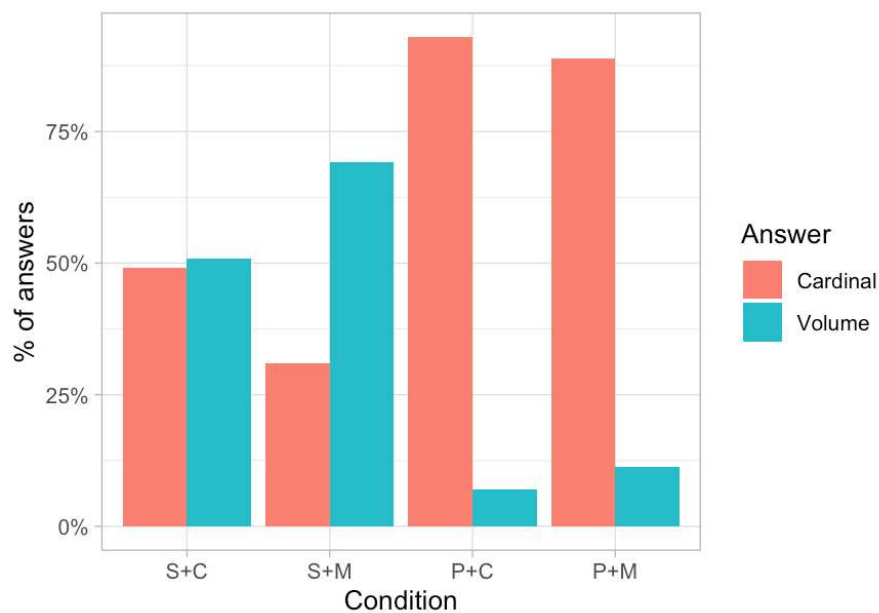
Table 5.73 — Percentage of cardinal and volume responses in the answer type

Condition	Cardinal	Volume
S+C	49.1%	50.9%
S+M	30.9%	69.1%
P+C	92.9%	7.1%
P+M	88.8%	11.2%

Source: designed by the researchers.

As we can observe from the table above, the answers seem to be random between cardinal and volume in the S+C condition, while in the S+M there is oscillation, with a preference for volume. Such behaviour is not observed in for the plural conditions, which appears to be more categorical for cardinal interpretations. Next, we can observe the graph which illustrate these results:

Graph 5.40 — Answer type



Source: designed by the researchers on RStudio.

The graph above seems to show the trend from the table. After plotting this graph, we checked the residuals and they were normal (Shapiro-Wilk: $W = 0.99017$, $p\text{-value} = 0.003086$)⁷⁵ and also followed a normal distribution. Next, we move for the statistical analysis of the answer type.

⁷⁵ Kolmogorov-Smirnov: $D = 0.045578$, $p\text{-value} = 0.02052$

5.4.2.5 Statistical Analysis

For the answer type, using answer as the dependent variable, we fitted a Linear Mixed-Effects Model with Quantifier, Noun, and their interaction as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be seen below:

```
model1 = glmer (Answer ~ Quantifier * Noun + (1|Participant) +
(1|Item), data = dataoff3, family = binomial)

model2 <- glmer (Answer ~ Quantifier + Noun + (1|Participant)
+ (1|Item), data = dataoff3, family = binomial)

model3 <- glmer (Answer ~ Quantifier + (1|Participant) +
(1|Item), data = dataoff3, family = binomial)

model4 <- glmer (Answer ~ Noun + (1|Participant) + (1|Item),
data = dataoff3, family = binomial)
```

A comparison of nested models using ANOVA revealed that the two-way interaction did not significantly improve the model fit compared to the model without the interaction ($\chi^2 = 0.6969$, $p = 0.403$). Additional model comparisons were conducted comparing the model without the two-way interaction and a model with only the quantifier as fixed effect and it revealed a significant improvement in fit ($\chi^2 = 10.449$, $p < 0.001$). Including only the noun as fixed effect and comparing it to the model without the two-way interaction also showed a significant improvement in fit ($\chi^2 = 170.45$, $p < 0.0001$). Therefore, the model with only the noun was selected as the best fitting model. Next, we can check the models used alongside the model's result.

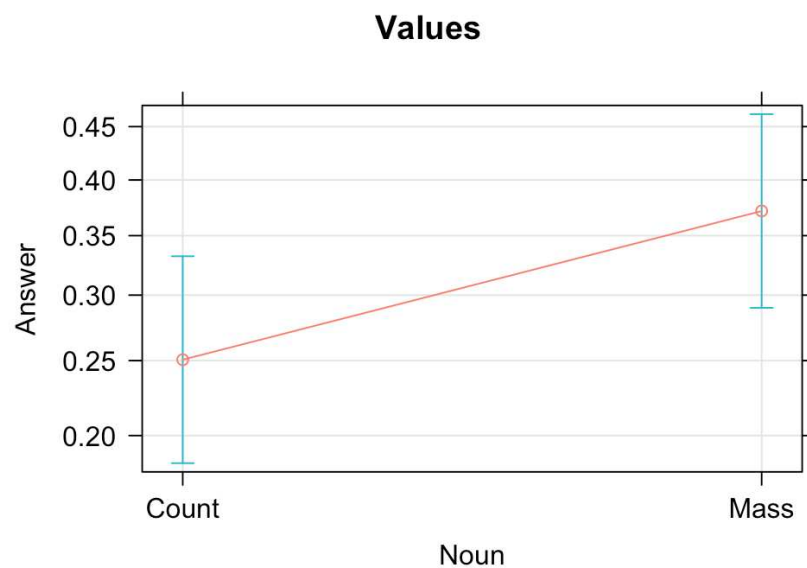
Table 5.74 — Model's results

<i>Predictors</i>	Answer		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
(Intercept)	0.33	0.22 – 0.50	<0.001
Noun [M]	1.77	1.17 – 2.66	0.006
Random Effects			
σ^2	3.29		
τ_{00} Participant	0.40		
τ_{00} Item	0.05		
ICC	0.12		
$N_{\text{Participant}}$	33		
N_{Item}	16		
Observations	471		
Marginal R^2 / Conditional R^2	0.021 / 0.141		

Source: designed by the researchers on RStudio.

The model's result highlights a significant effect for noun, with mass nouns triggering higher probabilities of getting a volume interpretation than cardinal ones. Below, we can check the values predicted by the model:

Graph 5.41 — Values predicted by the model for answer type in log



Source: designed by the researchers on RStudio.

As we observed by the graph above, it displays the tendency highlighted by the statistical analysis. Mass nouns show higher probabilities of getting a volume interpretation when compared to count nouns that show lower probabilities of getting a volume interpretation. In the next subsection we take a look in the Intra-condition Analysis.

5.4.3 Intra-Condition Analysis

A chi-squared for given proportions test was performed to examine the frequency distribution of the categorical variable Answer, which has two levels: cardinal and volume. We conducted four chi-squared tests with give proportions as it follows:

Table 5.75 — Given proportions for each level for the variable Answer

Condition	Cardinal	Volume
S+C	0.6	0.4
S+M	0.4	0.6
P+C	0.8	0.2
P+M	0.8	0.2

Source: designed by the researchers.

The proportions given are an approximation based on the two previous experiments conducted for the native speakers group as discussed for this study. That is, we expect that for the bilingual group to behave the same was the native speakers' groups. In the following table we can check the results:

Table 5.76 — Chi-squared results for each condition

Condition	Chi-Squared	P-Value
S+C	$\chi^2 (1) = 5.3719$	$p < 0.02046$
S+M	$\chi^2 (1) = 3.7879$	$p < 0.05163$
P+C	$\chi^2 (1) = 5.3719$	$p < 0.02046$
P+M	$\chi^2 (1) = 6.05$	$p < 0.01391$

Source: designed by the researchers.

The results of all comparison shows that the proportion expected based on our prediction, and the values got in the results of the experiments. All conditions refuted the null hypothesis, except the S+M condition which was in the limit of significance, indicating an oscillation in the interpretation of the mass nouns, as for English. We conducted an additional chi-square with new proportions, but with slightly lower values for all conditions.

Table 5.77 — Given proportions for each level for the variable Answer with new proportions

Condition	Cardinal	Volume
S+C	0.7	0.3
S+M	0.3	0.7
P+C	0.9	0.1
P+M	0.9	0.1

Source: designed by the researchers.

The results based on the new proportions can be seen below:

Table 5.78 — Chi-squared results for each condition

Condition	Chi-Squared	P-Value
S+C	$\chi^2 (1) = 22.52$	$p < 2.079\text{e-}06$
S+M	$\chi^2 (1) = 0.04329$	$p = 0.8352$
P+C	$\chi^2 (1) = 1.2535$	$p = 0.2629$
P+M	$\chi^2 (1) = 0.2$	$p = 0.6547$

Source: designed by the researchers.

Assuming the answer type of the IT, we could observe that we had an oscillation in the S+M condition as observed for English. In order to further investigate the S+C condition we conducted a third analysis in the condition with balanced proportion and we interpret the result given as random, just like we observed for English ($\chi^2 = 0.037037$, $p = 0.8474$). For the plural conditions, the lower proportions indicated that both conditions were categorically interpreted by cardinality. This will be further explored in the General Discussion section.

5.4.4 Additional Analyses

In the additional analysis, taking time in log as a dependent variable, we fitted a Linear Mixed Model with Quantifier, Noun, Answer, and the interaction between these three factors and random intercept for Participant. The models used can be seen below:

```
modell1 <- lmer (log ~ Quantifier * Noun * Answer + (1 |  
Participant) data = dataoff3)
```

```
modell2 <- lmer (log ~ Quantifier + Noun + Answer + (1 |  
Participant), data = dataoff3)
```

A nested model comparison was carried out with ANOVA and it indicated that including the three-way interaction, compared with the model without the interaction, showed a marginal significance, providing a better fit ($\chi^2 = 8.1971$, $p < 0.084$). Next, the models used and the model's results:

Table 5.79 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.45	7.32 – 7.58	<0.001
Quantifier [P]	-0.22	-0.35 – -0.10	<0.001
Noun [M]	-0.15	-0.32 – 0.01	0.070
Answer [Volume]	-0.06	-0.21 – 0.09	0.444
Quantifier [P] × Noun [M]	0.18	-0.01 – 0.37	0.069
Quantifier [P] × Answer [Volume]	0.25	-0.06 – 0.55	0.112
Noun [M] × Answer [Volume]	0.10	-0.11 – 0.31	0.358
(Quantifier [P] × Noun [M]) × Answer [Volume]	-0.10	-0.50 – 0.30	0.616
Random Effects			
σ^2	0.14		
τ_{00} Participant	0.05		
ICC	0.24		
N Participant	33		
Observations	471		
Marginal R^2 / Conditional R^2	0.034 / 0.270		

Source: designed by the researchers on RStudio.

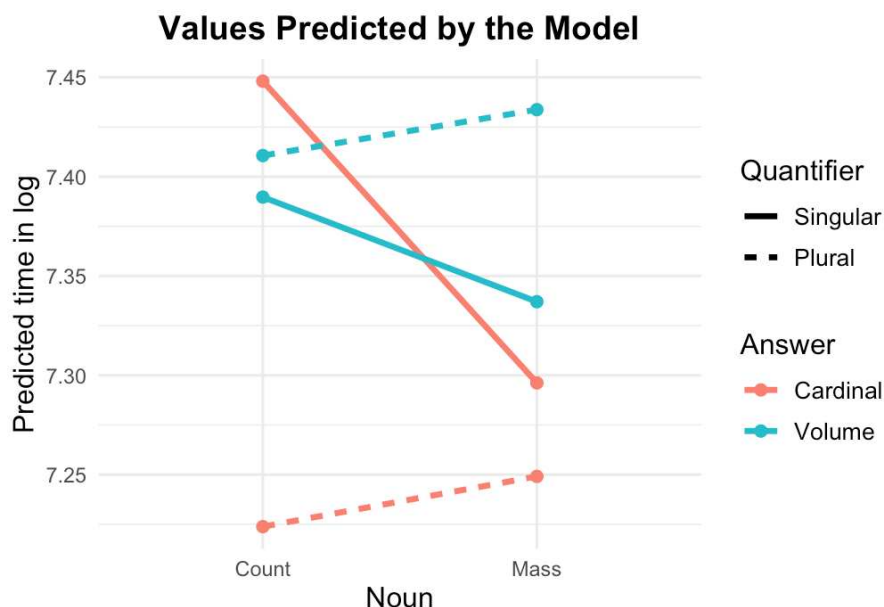
By observing the model's result above, we can verify that the plural quantifier predicts lower log values of response time when compared to the baseline quantifier type. Additionally, there is a marginal effect for noun, with mass noun showing lower log values compared to the baseline noun type. Thus, there is a marginal interaction between quantifier and noun affecting response times. A post-hoc Bonferroni correction was performed in order to further investigate the nature of the interaction and can be checked below:

contrast	estimate	SE	df	t.ratio	p.value
S C Cardinal - P C Cardinal	0.2243	0.0634	441	3.540	0.0124

S C Cardinal - S M Cardinal	0.1519	0.0836	437	1.817	1.0000
S C Cardinal - P M Cardinal	0.1990	0.0642	442	3.098	0.0580
S C Cardinal - S C Volume	0.0584	0.0763	450	0.765	1.0000
S C Cardinal - P C Volume	0.0375	0.1411	446	0.266	1.0000
S C Cardinal - S M Volume	0.1111	0.0700	447	1.586	1.0000
S C Cardinal - P M Volume	0.0144	0.1166	444	0.123	1.0000
P C Cardinal - S M Cardinal	-0.0724	0.0755	444	-0.959	1.0000
P C Cardinal - P M Cardinal	-0.0253	0.0496	433	-0.511	1.0000
P C Cardinal - S C Volume	-0.1660	0.0626	440	-2.653	0.2314
P C Cardinal - P C Volume	-0.1869	0.1354	446	-1.380	1.0000
P C Cardinal - S M Volume	-0.1133	0.0557	436	-2.034	1.0000
P C Cardinal - P M Volume	-0.2100	0.1096	444	-1.915	1.0000
S M Cardinal - P M Cardinal	0.0471	0.0763	445	0.617	1.0000
S M Cardinal - S C Volume	-0.0936	0.0864	450	-1.082	1.0000
S M Cardinal - P C Volume	-0.1144	0.1468	446	-0.780	1.0000
S M Cardinal - S M Volume	-0.0409	0.0820	451	-0.499	1.0000
S M Cardinal - P M Volume	-0.1376	0.1232	444	-1.117	1.0000
P M Cardinal - S C Volume	-0.1406	0.0632	440	-2.225	0.7440
P M Cardinal - P C Volume	-0.1615	0.1357	446	-1.191	1.0000
P M Cardinal - S M Volume	-0.0880	0.0564	436	-1.559	1.0000
P M Cardinal - P M Volume	-0.1847	0.1106	445	-1.669	1.0000
S C Volume - P C Volume	-0.0209	0.1393	443	-0.150	1.0000
S C Volume - S M Volume	0.0527	0.0671	436	0.785	1.0000
S C Volume - P M Volume	-0.0440	0.1157	442	-0.380	1.0000
P C Volume - S M Volume	0.0736	0.1370	444	0.537	1.0000
P C Volume - P M Volume	-0.0231	0.1631	438	-0.142	1.0000
S M Volume - P M Volume	-0.0967	0.1126	443	-0.858	1.0000

The pairwise comparison highlighted that the only significant effect is for quantifier in the comparisons between count noun and the cardinal interpretations ($\beta = 0.2243$, $SE = 0.0634$, $t = 3.540$, $p < 0.0124$). The other comparisons or did not show a statistically significant difference, or their comparison does not reveal any relevant result. Below, we can check the values predicted by the model:

Graph 5.42 — Values predicted by the model for the answer type in log



Source: designed by the researchers on RStudio.

The graph above illustrates the model's results, visually displaying that the predicted response times in log scale. The colors represent the interpretation given (answer) while the salmon color represents cardinal interpretation; the blue color represent the volume interpretation. Additionally, the dotted lines represent the plural quantifier while the solid lines represent the plural quantifier.

By observing the graph, we see an effect for quantifier with the singular leading to higher response times while the plural leads to faster cardinal responses. Additionally, we can observe that singular quantifiers are responsible for sharp decrease in response time for cardinal answers when shifting from count to mass while cardinal interpretations with plural quantifiers are consistent.

For nouns cardinal answers decrease from count to mass while volume answers response times also decrease but less steeply. Volume responses show a small decline from count to mass nouns in both singular and plural contexts.

Two important findings should be taken into account by looking at this graph: the first is the S+C=C (singular quantifier with count nouns that resulted in cardinal interpretations) shows that this was the slowest condition to be assigned the cardinal interpretation and the second is the P+M=V (plural quantifier combined with mass noun that resulted in volume interpretation), the second most demanding response to be assigned, show patterns of response times that are similar as observed in coercion for native speakers of English.

Overall, bilinguals have an advantage processing the plural quantifier with count nouns and are faster assigning cardinal interpretation for this condition, however volume responses are more consistent suggesting that the quantifier or the noun has little influence on the interpretation. Next, we move for the summary of the findings and then the General Discussion of this experiment.

5.4.5 Summary of Key Findings from Experiment 6

The following table summarizes the results from Experiment 6:

Table 5.80 — Summary of key findings from experiment 6 (Bilinguals)

Quantifier Type	Noun Type	<i>Region</i>		Post-Critical	Response Time	Interpretation
		Quantifier	Noun			
Singular	Count	=	+	=	+	Random
	Mass	=	-	=	=	Oscillate +Volume
Plural	Count	=	-	=	-	Cardinal
	Mass	=	+	=	=	Cardinal

Source: designed by the researchers.

Observations: The symbols mean: (=) we did not find statistical effect; (+) we found statistically significant effect indicating additional processing time; and (-) we found statistically significant effect less processing time.

- There was an interaction in the noun region depending on the quantifier type. Singular quantifiers trigger an additional processing in the noun region when the noun is count, while plural quantifier triggers faster reading times in the noun region when the noun is count;
- Neither in the quantifier region nor in the post critical region show significant additional processing;

- Overall, bilinguals displayed random answer for singular quantifier with count noun, and oscillation when combining singular quantifier and mass nouns;
- Volume responses take more time than cardinal ones.

5.4.6 General Discussion

Taking a look at the processing patterns of the bilinguals, we can observe that the noun region is somewhat different from by both L1 and also their L2. In BrP, we observed additional processing in the noun region only when the plural quantifier was combined with a mass noun. However, for the bilingual group, we had an effect for the plural quantifier with plural mass noun and singular quantifier with singular count noun, both of which were processed more slowly in the noun region. This pattern is similar to the behaviour of native speakers of English reported in Experiment 5 in the post-critical region. This may indicate that bilinguals undertook to grinding and portioning processes of coercion, just like found for native speakers of English. However, this was found in the noun region for bilinguals, instead of the post-critical region found for native speakers of English. This might signal that, bilinguals seem to assign more immediate interpretations to the quantifier phrases when compared to native speakers of English.

A possible explanation for the difference in processing sentences like ‘The man sold much feather in Madrid’ being slower than ‘The man sold many feathers in Madrid’ might be related to grammar. On the one hand, ‘many’ grammatically signals that the following noun is cardinal, as seen in ‘feathers,’ with the plural inflection also indicating countability, thus facilitating processing. On the other hand, ‘much’ instructs the bilingual to not expect a count noun, which does not align with the noun ‘feather’, affecting processing. Although this result was unexpected, it might suggest that the bilinguals in this study had, to some extent, formal instruction on when to use ‘much’ and ‘many’ or they were already operating in the English grammar. This would allow them to detect ungrammaticality, even as intermediate learners of English. This signals in a sense that the bilinguals in our study had grammatical knowledge about how to use the quantifiers and possibly some knowledge about the noun type and their combination with quantifiers. Therefore, it indicates that although the sentences would be grammatical in their native language, it was not in their second language, suggesting that they had acquired the grammar of English that is different from their L1 knowledge, displaying processing patterns more aligned to the L2.

Another possible explanation has to do with the atomicity feature built into English, whereas BrP is underspecified for atomicity. In other words, the bilinguals in our study had acquired, to some extent, the semantic feature from English grammar. Since atomicity is grammatically encoded in English, the bilinguals operated within this system. Our proposal is that it should be easier to operate in a language where atomicity is encoded in the grammar than in one where it is underspecified. This proposal is in line with Slabakova (2008, 2016), who argues that semantic features such as quantification are acquired differently depending on the L1—L2 pairing. Although bilinguals may transfer features from the L1, they also acquire L2-specific features when these are grammatically encoded — as is the case with atomicity in English.

In the quantifier region, no differences were found across conditions for the bilingual group, mirroring the pattern observed in BrP and English. This happens since it is the first input of the experimental conditions, which might give preliminary clues of whether the following nouns encountered in the derivation are count or mass. The effect of the quantifier is possibly observed in the following parts of the sentence. Additionally, we did not observe any effect in the post critical region, indicating that all the processing load was only carried out in the noun region.

In terms of representation, the response time — the time taken by the bilinguals to decide whether their interpretation was based on cardinality or volume — was significant only when comparing the singular quantifier with a count noun to the plural quantifier with a count noun. Additionally, we found a significant effect for quantifier and in the limit of significance for noun. This indicated a substantial difference between singular and plural quantifiers, suggesting that this distinction had already been internalized in the bilinguals' grammatical knowledge. In other words, they had the grammatical awareness that 'much' should not be used with count nouns and 'many' should be used with count nouns. This behaviour was consistent with the finding for English in which the S+C and P+M which triggered marginally slower response times, which was also observed by the bilinguals in the same conditions but with a significant effect, indicating that bilinguals were more affected by the incongruency than native speakers of English.

In relation to answer type, the results remained largely the same as in the English experiment, where responses for the singular quantifier and count noun were random. That is, the bilinguals were unsure whether their interpretation should be based on volume or cardinality. For the singular quantifier and mass nouns, there was oscillation, with a preference for volume. For the plural quantifier with count nouns and plural quantifiers with mass nouns,

both conditions had categorical interpretations, all related to cardinality. These results were nearly identical to those from the English experiment, while are different from the BrP experiment, providing support for our view that atomicity is encoded in the English grammar and such feature is acquired with the language.

Once again, the plural inflection might have led to faster processing in comparison with conditions that did not have this explicit clue such as the singular conditions. This result is similar to the pattern observed in English processing, where we found a statistical difference not only for the singular quantifier with count noun condition but also for the plural quantifier with a mass noun. However, this differs from their L1, where no additional processing time was observed in the singular count condition, but only for the plural quantifier with mass nouns condition.

The lack of difference regarding nouns in English, helps us to better understand the nature of nouns in English and also the acquisition process that the bilingual undertakes where there is a mismatch between languages. Since the bilinguals behaved in a more similar way as native speakers of English did, the bilinguals in our study had already acquired the cumulative feature for mass nouns and the cardinality feature for count nouns, allowing them to detect that the combination of the singular quantifier with a count noun is not possible since count nouns in English would carry the atomicity feature, not allowing its use with the singular quantifier. The same was observed by the behaviour for the combination of plural quantifier with mass nouns. This provides additional evidence that nouns and the quantifiers in English lexically encode atomicity, as already discussed for Experiment 5, aligned with Chierchia (1998), and even bilinguals are able to acquire such distinction by restructuring their knowledge from the L1 to comport the distinct features from the L2 in line with Slabakova (2016), since as discussed in Experiment 4, the nouns in BrP are underspecified, not carrying the atomicity feature. As mentioned, atomicity is built into English grammar and it is acquired together with the language.

This leads us to believe that, in some sense, the grammatical knowledge for English was already acquired by the intermediate learners. The processing patterns reflect grammatical representations that are only present in English. This brings us back to Slabakova's bottleneck hypothesis, which claims that some aspects of functional morphology might not be acquired in the early stages of second language acquisition. However, in our study, the bilinguals had already acquired specific knowledge about quantifiers and nouns, which accounts for the difference in our results. This suggests that since bilinguals behaved more likely to native speakers of English, we have very low probabilities of detecting a possible transfer from the L1

to the L2 in the context of this research since they already posed the knowledge of the distinct features between these two languages.

Interestingly, the L2 does seem to significantly alter processing patterns of the bilingual since the English grammar seems to influence language representation. In other words, the grammatical knowledge appears to guide whether ‘much’ or ‘many’ should be used with count or mass nouns, and this knowledge seems to be possessed by the bilinguals. This was observed in the condition where the combination of ‘much’ with ‘feather’ caused additional response times. This could reflect the atomicity built into English language, negatively affecting response times while positively affecting response times for the opposite condition with ‘many’ and ‘feathers.’ Atomicity also helps to explain why we did not get additional time for ‘many’ and ‘silvers’ since the presence of a plural inflection facilitates processing in this case, just like it happened for the results from native speakers of English.

Based on these results, we have evidence to refute the null Hypothesis and refute our working hypothesis while not refuting our alternative Hypothesis 2. We have observed that the combination of the singular quantifier with count noun leads to an increase in reading times in the noun region, which is similar as observed for native speakers of English in the post critical region. This increase of additional process is regarded to the incongruency of the grammatical information and the noun type; therefore, the bilinguals also undertake to a coercion process when there is a mismatch between the syntactic structure and the noun type. In addition, the results of the interpretation were consistently with the native speakers of English. As an alternative to explain the data, we resorted on the Restructuring Hypothesis (RH) from Slabakova (2016), which appears to best accommodate our findings since it helps us to understand the processing patterns of the bilinguals and enlighten the nature of nouns in English and the bilingual cognition.

According to the RH proposed by Slabakova (2016), not all linguistic features are directly transferred from the L1 to the L2. Instead, learners restructure their grammatical representations based on exposure to L2 input. Unlike the Bottleneck Hypothesis, which focuses on the challenges of acquiring functional morphology as a *bottleneck* in L2 acquisition, the RH emphasizes the central role of input in driving the restructuring process. Specifically, the RH posits that acquiring L2-specific features requires extensive input to trigger restructuring. Rather than assuming that L1 features are directly transferred, the RH suggests that bilinguals gradually adjust their grammatical representations to align with the L2, particularly for features that are absent or differ significantly from their L1. Additionally, this restructuring process would incur additional processing cost since the restructuring of features

is highly cognitively demanding and was noticeable throughout the conditions in the noun region.

In a nutshell, the bilingual seems to operate within the English grammar, which lexically encodes atomicity. Since atomicity is built-in in the English grammar, the bilingual acquires this semantic feature from the very beginning of language acquisition. Therefore, when operating in the English grammar, the bilingual will assign interpretations as soon as the input becomes available — such as cardinal and volume interpretations — thus avoiding the underspecification of lexical entries, as is commonly observed among native speakers of BrP. Next, we revisit our RQs and answer them in the light of our findings:

RQ1. Do bilinguals display an additional processing, if any, in the singular nouns in English? *Yes, they do. We observed an additional processing for count nouns headed by a singular quantifier in the noun region.*

RQ2. Do bilinguals display an additional processing, if any, in the quantifiers in English? *No, they do not.*

RQ3. Are singular nouns interpreted as count, mass or are underspecified by bilinguals? *Bilinguals display a behavior similar to native speakers of English, showing that the nouns in the bilingual grammar are specified for atomicity. Therefore, bilinguals did not interpret singular count nouns when headed by a singular quantifier.*

RQ4. Does the noun type affect interpretation for bilinguals? *Yes, they do. English is specified for atomicity and our bilinguals had already internalized this feature for their second language, which seems to be learned within the English grammar.*

RQ5. Do singular quantifiers influence the interpretation of singular count nouns for bilinguals? *Yes, they do. There is a clear distinction between singular and plural quantifiers for bilinguals and this could be observed in the additional processing when combining the singular quantifier with count noun, resulting in coercion.*

To conclude, we retake our predictions' table, contrasting with our results.

Table 5.81 — Predictions *vs* results for processing for the noun region and interpretation for each condition

Condition	Processing		Interpretation		Response Time	
	<i>Prediction</i>	<i>Result</i>	<i>Prediction</i>	<i>Result</i>	<i>Prediction</i>	<i>Result</i>
Singular Quantifier + Count Noun	No additional processing	Additional processing	Oscillate	Random	No additional time	Additional time
Singular Quantifier + Mass Noun	No additional processing	No additional processing	Oscillate	Oscillation with a preference for Volume	No additional time	No additional time
Plural Quantifier + Count Noun	No additional processing	No additional processing	Cardinal	Cardinal	No additional time	No additional time
Plural Quantifier + Mass Noun	Additional processing	No additional processing	Cardinal	Cardinal	No additional time	No additional time

Source: designed by the researchers.

5.4.7 Conclusion

In summary, bilingual speakers demonstrated processing and interpretive patterns closely aligned with native English speakers, indicating that they had internalized key grammatical properties of their second language. Specifically, bilinguals showed additional processing in the noun region when singular count nouns were combined with singular quantifiers — evidence of grammatical coercion due to incongruent information to atomicity. No such effect was observed in the quantifier region, suggesting that the processing cost arises later, at the noun itself. Importantly, bilinguals did not interpret singular count nouns in these

constructions, reflecting their sensitivity to the ungrammaticality of such combinations in English. This supports the conclusion that bilinguals treat English singular nouns as specified for atomicity. The noun type affected interpretation, showing that bilinguals had refined to a more rigid distinction between mass and count nouns and the grammatical constraints associated with quantifier type. Altogether, these findings suggest that bilinguals possess a target-like representation of English quantifier–noun combinations, including the morphosyntactic and semantic features that govern mass/count distinctions.

5.5 GROUP COMPARISON 4 — INVESTIGATING POSSIBLE TRANSFER IN THE QUANTIFIED PHRASES IN BILINGUALS

5.5.1 Introduction

The rationale that supports this group comparison is based on Grosjean (2008) and Slabakova (2016). In a more cognitive approach, Grosjean claims that the bilingual mind is composed of a linguistic system that embraces two or more languages, adapting itself to accommodate the additional ones. This adaptation leads to language competition that, in fact, is the constant activation of the languages that a speaker knows, and the bilingual has to suppress one language against the other, thereby improving cognitive control. This language competition makes adaptations to neural wiring, making bilinguals better in some cognitive skills such as executive functions, cognitive flexibility, memory, cognitive decline delay, among others, while some cognitive functions are hindered in a trade-off such as response times, language interference, attrition, among others (BIALYSTOK, 2001; BIALYSTOK, CRAIK, LUK, 2012; BIALYSTOK, FENG, 2009; KROLL, BIALYSTOK, 2013, among others). Bialystok's research extensively delves into the bilingualism, further exploring the bilingual mind.

In a more grammatical trend, Slabakova brings up the bottleneck hypothesis, a fine-grained claim that some aspects of a second language might be more difficult to acquire, such as the functional morphology that acts like a *bottleneck*, meaning that there are certain aspects of the second language are more challenging to acquire than others. Looking specifically at the phenomenon we investigated, the use of singular count nouns headed by singular quantifiers is a morphosemantic phenomenon that may trigger a transfer effect in bilinguals. This highlights a grammatical mismatch between BrP and English, which, as we have seen in Experiments 4 and 5, also leads to semantic and processing implications. These implications result from the absence of atomicity cues in both the grammatical structure and the lexical properties of nouns in BrP, whereas English provides such cues both grammatically and lexically. Therefore, the BH posits that in order for the learner to fully acquire the grammar of the second language, s/he has to overcome this functional morphology mismatch.

As we have observed in the Group Comparison 3, there are differences in processing of BrP and English that allowed us to infer that these differences in processing are related to semantic differences nurtured by the nature of the nouns between these two languages, as discussed. Therefore, we further investigate bilinguals to verify whether how bilinguals would

behave in terms of processing and representation when facing this mismatch. Now, we turn our attention to our specific RQs that feeds this second group comparison:

5.5.1.1 Specific Research Questions

RQ1. Is there a transfer from BrP L1 to English L2 in bilinguals?

RQ2. Is the processing pattern from the bilingual's linguistic system similar to the processing pattern of BrP, to that of English, or to neither?

RQ3. Is language representation for the bilingual somewhat similar to the language representation pattern of BrP, from the English pattern, or neither?

5.5.1.2 Hypothesis (H) and Predictions (P) for Transfer in the Processing and Representation of Quantifier Singular Phrases

H0. There are no differences between English and BrP. In terms of processing, no statistical differences are expected for quantifiers or nouns. In terms of representation, there should be no significant semantic differences in the interpretation of nominal expressions between the two languages, as both are assumed to rely on universal principles of reference and quantification (CHIERCHIA, 2021). Any lack of differences should also be reflected in response times.

P0. Based on H0, we predict that acceptability judgments will not differ between cardinal and volume interpretations of nouns, and that response times will not show significant differences across languages or conditions.

H1. According to the Bottleneck Hypothesis (Slabakova, 2016) and the underspecification hypothesis (PIRES DE OLIVEIRA, 2022), bilinguals transfer their L1 knowledge to their L2. Singular nouns in BrP are underspecified for atomicity, leaving interpretation (volume vs. cardinality) open and not requiring additional processing. Representation patterns in L2 are expected to mirror those of the L1.

PI. If H1 is correct, we predict no significant differences in processing or acceptability between native speakers of BrP and bilingual participants.

In summary, we assume Hypothesis 1 as our working hypothesis. Additionally, this groups comparison allows us to statistically verify whether the mismatches highlighted in Group Comparison 1 between BrP and English, results in a transfer from the L1 to the L2.

All materials used in this group comparison, including the data analysis scripts, graphs plotted, and additional Tukey corrections are all available on GitHub.⁷⁶

5.5.2 Method

5.5.2.1 Participants

A total of 112 participants' data were analysed in the three groups comparison, comprising 84 voluntary participants from UFSC attending the study at the Computer Lab and 28 paid participants from the University of Toronto attending the study at the Indigenous Room. The mean age of these 112 participants was 25.3 years old (SD = 9.3).

5.5.2.2 Instruments

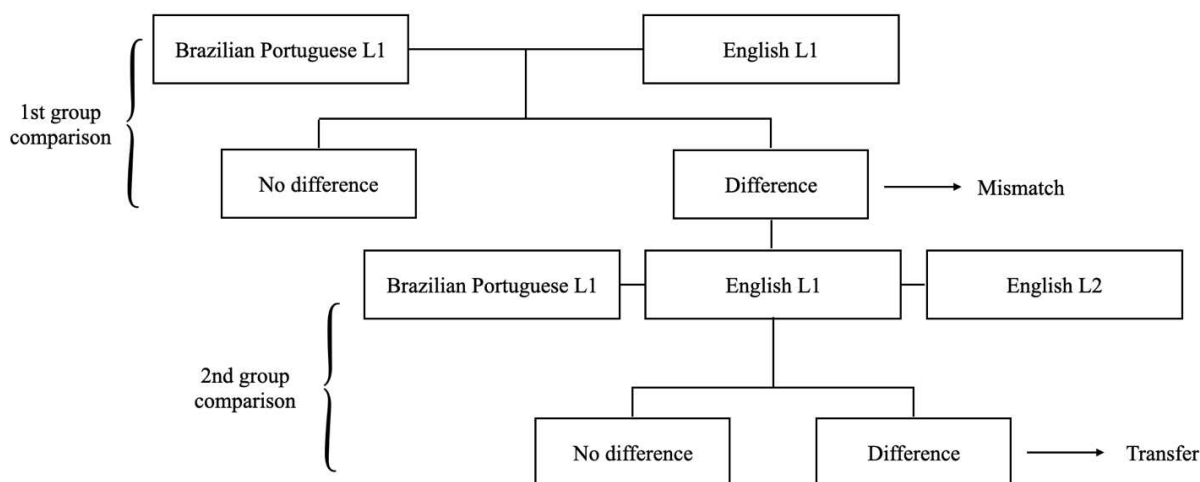
The instruments used in the study are the same as the ones reported in Experiment 1, 2, and 3. Therefore, this is just a group comparison with the data of the participants from these 3 experiments.

5.5.2.3 Procedures

The procedures adopted to conduct this second group comparison can be summarized by the flowchart that follows:

⁷⁶ Data analysis materials and raw results are available at <https://github.com/deardiones/SPR-Group-Comparisons.git>

Flowchart 5.5 — Summary of the group comparison



Source: designed by the researchers.

The flowchart in 5.5 helps to illustrate the procedures adopted to conduct the groups comparison. The first part of the group comparison was carried out in the first group comparison in which we investigated the mismatches between BrP and English. In the second group comparison, we will then compare BrP L1, English L1, and BrPL1/EnglishL2 (three group comparison — bilingual group) which will also be as our independent variable. If there is no difference between these three groups, then we do not have evidence of transfer from languages. However, if there are differences between these three groups, then we have evidence of transfer.

5.5.2.4 Data Analysis

Data processing was conducted in RStudio. For the group comparison, we gathered all the treated *datasets3* of each region for the SPR and the IT and tabled the final treated data on a single file directly as a new CSV file. A new column was added for each CSV file naming each group: the native speakers of BrP was named [BRPL1], the native speakers of English were named as [ENGL1], and the bilingual group was named [ENGL2].

In the statistical analysis, we decided to include the [ENGL1] as our reference value for the variable Speaker since the literature is more categorical regarding the processing and representation of the nouns in English, therefore, allowing us to compare it against the bilingual group [ENGL2] since both experiments were in English and also comparing it to the native speakers of Brazilian Portuguese [BRPL1]. Additionally, we kept using the plural [P] as our

reference value for the variable Quantifier and count [C] as our reference value for the variable Noun.

5.5.2.5 Power Analysis

A power analysis was conducted in RStudio using the *pwr* package to determine whether the number of participants was sufficient to capture the investigated phenomenon. For the BrP L1, English L1, and the bilingual group, we assumed a Cohen's *d* of 0.5 for medium groups. After adjusting the alpha level to 0.05 and using a sample size of 112, the resulting power was 0.9612566. Thus, we interpret this result as indicating that 96.1% of the outcomes are expected to represent the phenomenon investigated in the three groups comparison.

5.5.3 Self-Paced Reading

The SPR is our main instrument for investigating language processing in real time. In the next subsection, we present how the data was processed for each segment, along with the statistical analysis and preliminary discussion.

5.5.3.1 Data Filtering

The data filtering was unaltered from the data filtering reported for experiments 1, 2, and 3. Next, we will focus on the data treatment and analysis for the noun region.

5.5.3.2 Noun Region

As we have observed for the first group comparison, there was a mismatch evidence by the statistical analysis carried out for the noun region. Therefore, the analysis of the noun region, corresponding to segment 5, is the most important part of the SPR, as it provides direct insight into whether singular count nouns differences in processing between these two will result in any difference in processing from the L1 to the L2, which might also be taken as evidence of transfer. If singular nouns undergo any additional processing by bilinguals, then they are behaving as the native speakers of English. If the singular nouns are no subject of

additional processing, then the bilingual group is behaving as their BrP L1. Below, we highlight the additional data treatment applied to this segment.

It worths highlighting that in this segment we did not observe any significant additional reading time in the nouns for English, but for BrP we had additional processing time in the plural quantifier with mass pluralized noun condition and this additional processing was statistically significant. For bilinguals, we observed an interaction between quantifier and noun and the post hoc revealed that only comparing the singular quantifier with count noun against the plural quantifier with count noun, highlighting that the noun is marginally slower to process when the quantifier is singular.

5.5.3.3 Data Analysis

For the noun region, we gathered dataset3 in log of the three groups and tabled all the data in a single CSV file. While the BrPL1 and ENGL2 final data sets were in log, the ENGL1 group was not in log. In this way, we decided to apply the logarithmic transformation in the final data set from the English group, so that all groups had the same scale for this current comparison. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1666 observations, nested within 112 participants and 16 items.

5.5.3.4 Statistical Analysis

In the noun region, we used the logarithm of reading times as the dependent variable and fitted a Linear Mixed-Effects Model using Maximum Likelihood, with t-tests computed via Satterthwaite's method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be checked below:

```
modell1 <- lmer (log ~ Quantifier * Noun * Speaker +
(1|Participant) + (1|Item), data = s5, REML = FALSE)

modell2 <- lmer (log ~ Quantifier + Noun + Speaker +
(1|Participant) + (1|Item), data = s5, REML = FALSE)
```

A comparison of nested models with ANOVA⁷⁷ revealed that the best-fitting model included an interaction between Quantifier, Noun, and Speaker, which was statistically significant ($\chi^2 = 19.179$, $p < 0.007$). The model's results can be checked below:

Table 5.82 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	6.01	5.88 – 6.13	<0.001
Quantifier [S]	-0.01	-0.08 – 0.07	0.868
Noun [M]	-0.02	-0.10 – 0.05	0.529
Speaker [BRPL1]	0.08	-0.07 – 0.23	0.314
Speaker [ENGL2]	0.27	0.11 – 0.44	0.001
Quantifier [S] × Noun [M]	0.05	-0.06 – 0.16	0.364
Quantifier [S] × Speaker [BRPL1]	0.03	-0.07 – 0.12	0.593
Quantifier [S] × Speaker [ENGL2]	0.11	0.01 – 0.22	0.032
Noun [M] × Speaker [BRPL1]	0.07	-0.03 – 0.16	0.178
Noun [M] × Speaker [ENGL2]	0.11	0.01 – 0.22	0.033
(Quantifier [S] × Noun [M]) × Speaker [BRPL1]	-0.15	-0.28 – -0.01	0.030
(Quantifier [S] × Noun [M]) × Speaker [ENGL2]	-0.19	-0.33 – -0.04	0.014
Random Effects			
σ^2	0.08		
τ_{00} Participant	0.09		
τ_{00} Item	0.00		
ICC	0.52		
$N_{\text{Participant}}$	112		
N_{Item}	16		
Observations	1666		
Marginal R^2 / Conditional R^2	0.101 / 0.569		

Source: designed by the researchers on RStudio.

⁷⁷ Other models were also done in order to explore possible effects for noun alone and quantifier alone, but these can be checked on GitHub.

The models' results highlight that there is a significant main effect observed for the ENGL2 group in comparison to the ENGL1 group. This significant main effect suggests that the interaction between Noun, Quantifier, and Speaker is significant, influencing our dependent variable reading time in log, pointing towards a difference among groups, with the bilingual group being slower compared to native speakers of English.

The model highlights that the predictor Speaker was also significant, and based on the positive estimate, it suggests that the bilingual speakers were slower in general than the native speakers of English. Additionally, there was also an interaction between Quantifier and Speaker for bilinguals, and for the interaction between Noun and Speaker, suggesting that this comparison also showed additional processing since in both condition bilinguals were slower.

The predictors Quantifier, Noun, and the interaction between the Quantifier and the Noun for native speakers of BrP were also statistically significant when compared to the native speakers of English groups. This indicates that the log values of reading time are higher for the BrP, highlighting that the reading times of this group is slower in comparison to native speakers of English. Since in the first group comparison we compared native speakers of English and native speakers of BrP, we will leave aside this comparison and further effects between native speakers of BrP and English, focusing only with the effects for the bilinguals.

An additional pairwise Bonferroni Correction was carried out to account for multiple comparisons. The relevant comparisons here would be the S+C and P+M between ENGL1 and ENGL2, where we could observe if the mismatch between BrP and English would result in a transfer for the bilingual. The pairwise can be found below:

contrast	estimate	SE	df	t.ratio	p.value
P C ENGL1 - S C ENGL1	0.00649	0.0391	1557	0.166	1.0000
P C ENGL1 - P M ENGL1	0.02451	0.0391	1556	0.627	1.0000
P C ENGL1 - S M ENGL1	-0.01895	0.0387	1560	-0.490	1.0000
P C ENGL1 - P C BRPL1	-0.07768	0.0781	157	-0.995	1.0000
P C ENGL1 - S C BRPL1	-0.09722	0.0780	157	-1.246	1.0000
P C ENGL1 - P M BRPL1	-0.11872	0.0780	157	-1.521	1.0000
P C ENGL1 - S M BRPL1	-0.03941	0.0781	157	-0.505	1.0000
P C ENGL1 - P C ENGL2	-0.27232	0.0855	158	-3.186	0.1147
P C ENGL1 - S C ENGL2	-0.38028	0.0855	158	-4.447	0.0011
P C ENGL1 - P M ENGL2	-0.36140	0.0855	158	-4.227	0.0026
P C ENGL1 - S M ENGL2	-0.33412	0.0855	158	-3.908	0.0091
S C ENGL1 - P M ENGL1	0.01802	0.0396	1563	0.455	1.0000
S C ENGL1 - S M ENGL1	-0.02544	0.0391	1555	-0.650	1.0000

S C ENGL1 - P C BRPL1	-0.08418	0.0784	160	-1.074	1.0000
S C ENGL1 - S C BRPL1	-0.10371	0.0783	159	-1.324	1.0000
S C ENGL1 - P M BRPL1	-0.12521	0.0784	159	-1.598	1.0000
S C ENGL1 - S M BRPL1	-0.04590	0.0784	159	-0.586	1.0000
S C ENGL1 - P C ENGL2	-0.27881	0.0858	160	-3.251	0.0925
S C ENGL1 - S C ENGL2	-0.38677	0.0858	161	-4.507	0.0008
S C ENGL1 - P M ENGL2	-0.36790	0.0858	160	-4.289	0.0020
S C ENGL1 - S M ENGL2	-0.34061	0.0858	160	-3.970	0.0071
P M ENGL1 - S M ENGL1	-0.04346	0.0391	1558	-1.112	1.0000
P M ENGL1 - P C BRPL1	-0.10220	0.0783	159	-1.306	1.0000
P M ENGL1 - S C BRPL1	-0.12173	0.0782	158	-1.556	1.0000
P M ENGL1 - P M BRPL1	-0.14323	0.0782	158	-1.831	1.0000
P M ENGL1 - S M BRPL1	-0.06392	0.0782	158	-0.817	1.0000
P M ENGL1 - P C ENGL2	-0.29683	0.0856	159	-3.466	0.0448
P M ENGL1 - S C ENGL2	-0.40479	0.0857	160	-4.724	0.0003
P M ENGL1 - P M ENGL2	-0.38592	0.0857	159	-4.506	0.0008
P M ENGL1 - S M ENGL2	-0.35863	0.0857	159	-4.187	0.0031
S M ENGL1 - P C BRPL1	-0.05873	0.0781	157	-0.752	1.0000
S M ENGL1 - S C BRPL1	-0.07827	0.0781	157	-1.003	1.0000
S M ENGL1 - P M BRPL1	-0.09977	0.0781	157	-1.278	1.0000
S M ENGL1 - S M BRPL1	-0.02046	0.0781	157	-0.262	1.0000
S M ENGL1 - P C ENGL2	-0.25337	0.0855	158	-2.964	0.2317
S M ENGL1 - S C ENGL2	-0.36133	0.0856	159	-4.223	0.0027
S M ENGL1 - P M ENGL2	-0.34245	0.0855	158	-4.005	0.0063
S M ENGL1 - S M ENGL2	-0.31517	0.0855	158	-3.685	0.0207
P C BRPL1 - S C BRPL1	-0.01954	0.0292	1552	-0.670	1.0000
P C BRPL1 - P M BRPL1	-0.04104	0.0292	1552	-1.404	1.0000
P C BRPL1 - S M BRPL1	0.03828	0.0292	1553	1.310	1.0000
P C BRPL1 - P C ENGL2	-0.19464	0.0745	160	-2.611	0.6518
P C BRPL1 - S C ENGL2	-0.30259	0.0746	160	-4.057	0.0051
P C BRPL1 - P M ENGL2	-0.28372	0.0745	160	-3.806	0.0133
P C BRPL1 - S M ENGL2	-0.25643	0.0746	160	-3.439	0.0491
S C BRPL1 - P M BRPL1	-0.02150	0.0290	1553	-0.740	1.0000
S C BRPL1 - S M BRPL1	0.05781	0.0290	1550	1.990	1.0000
S C BRPL1 - P C ENGL2	-0.17510	0.0745	159	-2.351	1.0000
S C BRPL1 - S C ENGL2	-0.28306	0.0745	160	-3.798	0.0137
S C BRPL1 - P M ENGL2	-0.26418	0.0745	159	-3.547	0.0338
S C BRPL1 - S M ENGL2	-0.23690	0.0745	159	-3.180	0.1169
P M BRPL1 - S M BRPL1	0.07931	0.0291	1552	2.727	0.4272
P M BRPL1 - P C ENGL2	-0.15360	0.0745	159	-2.062	1.0000
P M BRPL1 - S C ENGL2	-0.26156	0.0745	160	-3.509	0.0386

P M BRPL1 - P M ENGL2	-0.24268	0.0745	160	-3.258	0.0906
P M BRPL1 - S M ENGL2	-0.21540	0.0745	159	-2.891	0.2890
S M BRPL1 - P C ENGL2	-0.23291	0.0745	159	-3.127	0.1387
S M BRPL1 - S C ENGL2	-0.34087	0.0746	160	-4.572	0.0006
S M BRPL1 - P M ENGL2	-0.32200	0.0745	160	-4.322	0.0018
S M BRPL1 - S M ENGL2	-0.29471	0.0745	160	-3.955	0.0076
P C ENGL2 - S C ENGL2	-0.10796	0.0367	1559	-2.943	0.2174
P C ENGL2 - P M ENGL2	-0.08908	0.0366	1558	-2.435	0.9896
P C ENGL2 - S M ENGL2	-0.06180	0.0364	1553	-1.696	1.0000
S C ENGL2 - P M ENGL2	0.01887	0.0367	1555	0.514	1.0000
S C ENGL2 - S M ENGL2	0.04616	0.0367	1558	1.257	1.0000
P M ENGL2 - S M ENGL2	0.02729	0.0367	1558	0.744	1.0000

The table below summarizes each condition with the bare singular (S+C) alone, against the P+M and P+C conditions. The symbol + represent that the S+C had additional processing time in the noun region when compared to the other conditions and groups.

Table 5.83 — Bonferroni⁷⁸ summary highlighting relevant comparisons

Comparison	S+C against P+C	S+C against P+M	S+C
EngL1	=	=	
EngL1 against BrPL1	=	=	=
EngL1 against EngL2	+	+	+
BrPL1	=	=	
BrPL1 against EngL2	+	+	+
EngL2	=	=	

Source: designed by the researchers.

The pairwise comparison between the groups highlights differences within the groups. Specifically, the comparisons that are worth mentioning are the contrast in S+C condition with ENGL1 against ENGL2 ($\beta = -0.38677$, $SE = 0.0858$, $t = -4.507$, $p < 0.0008$), the P+M condition with ENGL1 against ENGL2 ($\beta = -0.38592$, $SE = 0.0857$, $t = -4.506$, $p < 0.0008$), and the S+M condition with ENGL1 against ENGL2 ($\beta = -0.31517$, $SE = 0.0855$, $t = -3.685$, $p < 0.0207$). This result indicates that the bilingual group (ENGL2) took more time than our reference group

⁷⁸ The same tendency was observed for the Tukey correction.

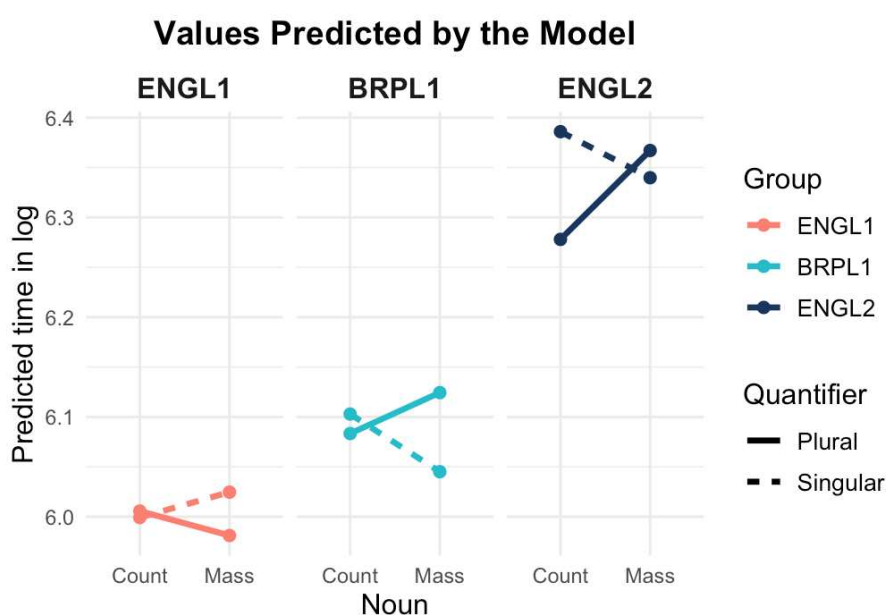
that was the native speakers of English (ENGL1) based on the negative estimate, and this difference was statistically significant.

It worth highlighting that the bilingual group also displayed significant lower log values when compared to BRL1, namely the conditions S+C ($\beta = -0.28306$, $SE = 0.0745$, $t = -3.798$, $p < 0.013$), S+M ($\beta = -0.29471$, $SE = 0.0745$, $t = -3.955$, $p < 0.007$), and a marginal non-significant effect for P+M ($\beta = -0.24268$, $SE = 0.0745$, $t = -3.258$, $p < 0.090$). This indicates that bilinguals were also slower when compared to their native language group. This suggests that there is a possible difficulty in processing these structures in their L2.

The only comparison that was not significant was the P+C across the three groups, which indicates that the combination of the plural quantifier with a count noun pluralized do not hinder processing.

It worth noticing that the S+C condition, namely the singular quantifier with count singular noun stands out as a clear difficulty in processing for the bilingual group, when compared to English and BrP. This indicates that this condition is a source of difficulty in processing the noun in English by bilinguals and it is possibly related to the mismatch observed between BrP and English, as discussed in the other texts. Below, we present the values predicted by the model (in log):

Graph 5.43 — Values predicted by the model for the noun region



Source: designed by the researchers on RStudio.

The graph above visually displays the values predicted by the model. In salmon color we have the native speakers of English, in light blue the native speakers of BrP, and in dark blue the bilingual group. While the dotted lines represent singular quantifiers, the solid ones represent the plural ones. At the bottom of the graph, we have the noun type, while in the vertical line we have the predicted reading times values in log.

The general trend of the graph suggests that plural quantifiers result in faster reading times for count nouns across all groups, while singular ones are slower for native speakers of BrP and bilinguals. Singular quantifiers deliver consistent response times for mass nouns, but are slower for count nouns in BrP and bilingual groups.

For the noun region, native speakers of English show the smallest variation between count and mass noun. As we have already seen, the effects for count and mass nouns only shows up in the spill-over region due to the nature of the task. BrP and bilinguals show stronger effects for noun type and quantifiers, with BrP showing a reversal trend for mass nouns.

In summary, plural quantifiers generally facilitates the response times for count nouns while hindering mass nouns for bilinguals. The pairwise suggests that that there are differences between conditions, and across the groups. However, the bilinguals are always slower than both, the native speakers of English and BrP. For the noun region, there is evidence showing that bilinguals are slower than both native speakers' groups highlighting a source of difficulty in processing singular quantifier with count nouns. This difficulty might be attributed to the mismatch as we have been discussing so far. The graphs suggests that native speakers of BrP and bilinguals takes more time in processing the combination of the plural quantifier with a mass noun, while this effect is not observed in the graph for the native speakers of English.

5.5.3.5 *Quantifier Region*

The quantifier region, corresponding to segment 4, did not show a statistical difference between the BRPL1 group and ENGL1 group in the native speakers' comparison. We acknowledge this result as no evidence of a mismatch in this region since reading times for the quantifier were not different between these two groups. Therefore, since there is no mismatch, no difference will be expected between the processing times when comparing BRPL1 and

ENGL1 to the bilingual group, which also did not have an effect. In this way, there is no reason to present a group comparison between these three language groups.⁷⁹

5.5.3.6 *Post-Critical Region*

The final region to be analyzed is the post-critical region, which, due to the nature of the SPR task, might provide insight into spill-over effects in processing, as we have seen for native speakers of English.

It worths highlighting that in this region we did not observe any significant additional reading time in the spill over region for BrP and neither for bilinguals, but for English, we had additional processing time in the plural quantifier with plural mass noun condition and for the singular quantifier combined with singular count noun conditions and this additional processing for these conditions were statistically significant.

5.5.3.7 *Data Analysis*

For the post-critical region, we gathered *dataset3* of the three groups and tabled all the data in a single CSV file. All three datasets were in the less conservative outliers' cut. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. Data comprised 1614 observations, nested within 112 participants and 16 items. This file also contained the columns with the answer type that would further receive statistical analysis.

5.5.3.8 *Statistical Analysis*

In the post-critical region, we used Reading Time as the dependent variable and fitted a Linear Mixed-Effects Model using the Maximum Likelihood, with t-tests computed via Satterthwaite's method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be checked below:

⁷⁹ The analysis was carried out and can be checked on GitHub. However, it did not yell any relevant effects in terms of processing that could add the discussion.

```
modell1 <- lmer (Reading.time ~ Quantifier * Noun * Speaker +  
  (1|Participant) + (1|Item), data = s6, REML = FALSE)  
  
modell2 <- lmer (Reading.time ~ Quantifier + Noun + Speaker +  
  (1|Participant) + (1|Item), data = s6, REML = FALSE)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included an interaction between the quantifier, the noun, and the speaker, which marginally shows an improvement in fit ($\chi^2 = 13.483$, $p < 0.061$). The model's results can be seen in the following:

Table 5.84 — Model's results

<i>Predictors</i>	Reading.time		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	414.38	378.88 – 449.87	<0.001
Quantifier [S]	17.02	-9.67 – 43.72	0.211
Noun [M]	18.82	-7.80 – 45.43	0.166
Speaker [BRL1]	51.16	7.15 – 95.16	0.023
Speaker [ENL2]	74.88	26.44 – 123.32	0.002
Quantifier [S] × Noun [M]	-32.20	-69.86 – 5.45	0.094
Quantifier [S] × Speaker [BRL1]	-25.20	-58.49 – 8.10	0.138
Quantifier [S] × Speaker [ENL2]	11.84	-25.03 – 48.72	0.529
Noun [M] × Speaker [BRL1]	-21.08	-54.40 – 12.24	0.215
Noun [M] × Speaker [ENL2]	-0.12	-36.79 – 36.55	0.995
(Quantifier [S] × Noun [M]) × Speaker [BRL1]	31.16	-15.92 – 78.23	0.194
(Quantifier [S] × Noun [M]) × Speaker [ENL2]	23.53	-28.36 – 75.42	0.374
Random Effects			
σ^2	9911.14		
τ_{00} Participant	6544.29		
τ_{00} Item	55.13		
ICC	0.40		
$N_{\text{Participant}}$	112		
N_{Item}	16		
Observations	1680		
Marginal R^2 / Conditional R^2	0.064 / 0.438		

Source: designed by the researchers on RStudio.

The model's results above represent the output of the analysis of reading times, with predictors being Quantifier, Nouns, Speaker, and their interactions. Bilinguals and BrP L1 are

significantly slower to process the post-critical region compared to our reference value, the native speakers of English. Additionally, we found marginally non-significant two-ways interactions in the singular quantifier and mass noun, indicating that reading times might decrease slightly when compared to plural quantifier and count noun, which is our reference value.

A Bonferroni⁸⁰ Correction was applied in the post-hoc analysis in order to further explore this marginally non-significant interaction between the noun and quantifier. Below, we present the pairwise comparison:

contrast	estimate	SE	df	t.ratio	p.value
P C ENGL1 - S C ENGL1	-17.02	13.7	1568	-1.247	1.0000
P C ENGL1 - P M ENGL1	-18.82	13.6	1569	-1.382	1.0000
P C ENGL1 - S M ENGL1	-3.64	13.5	1571	-0.270	1.0000
P C ENGL1 - P C BRL1	-51.16	22.7	181	-2.254	1.0000
P C ENGL1 - S C BRL1	-42.98	22.7	182	-1.892	1.0000
P C ENGL1 - P M BRL1	-48.89	22.8	183	-2.149	1.0000
P C ENGL1 - S M BRL1	-39.67	22.7	181	-1.748	1.0000
P C ENGL1 - P C ENL2	-74.88	25.0	185	-2.998	0.2043
P C ENGL1 - S C ENL2	-103.75	25.0	185	-4.157	0.0032
P C ENGL1 - P M ENL2	-93.58	25.0	184	-3.750	0.0156
P C ENGL1 - S M ENL2	-113.78	24.9	184	-4.563	0.0006
S C ENGL1 - P M ENGL1	-1.79	13.8	1574	-0.130	1.0000
S C ENGL1 - S M ENGL1	13.39	13.6	1572	0.982	1.0000
S C ENGL1 - P C BRL1	-34.13	22.8	185	-1.496	1.0000
S C ENGL1 - S C BRL1	-25.96	22.8	185	-1.137	1.0000
S C ENGL1 - P M BRL1	-31.87	22.9	187	-1.394	1.0000
S C ENGL1 - S M BRL1	-22.65	22.8	185	-0.993	1.0000
S C ENGL1 - P C ENL2	-57.86	25.1	188	-2.307	1.0000
S C ENGL1 - S C ENL2	-86.73	25.1	188	-3.460	0.0440
S C ENGL1 - P M ENL2	-76.56	25.1	187	-3.056	0.1700
S C ENGL1 - S M ENL2	-96.75	25.0	187	-3.864	0.0102
P M ENGL1 - S M ENGL1	15.18	13.6	1568	1.118	1.0000
P M ENGL1 - P C BRL1	-32.34	22.8	184	-1.420	1.0000
P M ENGL1 - S C BRL1	-24.17	22.8	185	-1.060	1.0000
P M ENGL1 - P M BRL1	-30.08	22.8	186	-1.317	1.0000
P M ENGL1 - S M BRL1	-20.86	22.8	184	-0.916	1.0000
P M ENGL1 - P C ENL2	-56.07	25.1	187	-2.237	1.0000

⁸⁰ A Tukey post-hoc was also done and can be seen in the R scripts on GitHub.

P M ENGL1 - S C ENL2	-84.94	25.0	187	-3.393	0.0557
P M ENGL1 - P M ENL2	-74.76	25.0	186	-2.988	0.2106
P M ENGL1 - S M ENL2	-94.96	25.0	186	-3.797	0.0131
S M ENGL1 - P C BRL1	-47.52	22.7	181	-2.095	1.0000
S M ENGL1 - S C BRL1	-39.35	22.7	181	-1.734	1.0000
S M ENGL1 - P M BRL1	-45.26	22.7	183	-1.990	1.0000
S M ENGL1 - S M BRL1	-36.04	22.7	181	-1.589	1.0000
S M ENGL1 - P C ENL2	-71.25	25.0	184	-2.854	0.3176
S M ENGL1 - S C ENL2	-100.11	24.9	185	-4.013	0.0057
S M ENGL1 - P M ENL2	-89.94	24.9	183	-3.608	0.0263
S M ENGL1 - S M ENL2	-110.14	24.9	183	-4.420	0.0011
P C BRL1 - S C BRL1	8.17	10.2	1567	0.803	1.0000
P C BRL1 - P M BRL1	2.26	10.3	1565	0.221	1.0000
P C BRL1 - S M BRL1	11.48	10.1	1566	1.134	1.0000
P C BRL1 - P C ENL2	-23.73	21.8	187	-1.088	1.0000
P C BRL1 - S C ENL2	-52.60	21.8	188	-2.414	1.0000
P C BRL1 - P M ENL2	-42.42	21.8	186	-1.948	1.0000
P C BRL1 - S M ENL2	-62.62	21.8	186	-2.878	0.2956
S C BRL1 - P M BRL1	-5.91	10.3	1566	-0.574	1.0000
S C BRL1 - S M BRL1	3.31	10.2	1564	0.325	1.0000
S C BRL1 - P C ENL2	-31.90	21.8	188	-1.461	1.0000
S C BRL1 - S C ENL2	-60.77	21.8	189	-2.786	0.3885
S C BRL1 - P M ENL2	-50.60	21.8	187	-2.321	1.0000
S C BRL1 - S M ENL2	-70.79	21.8	186	-3.250	0.0905
P M BRL1 - S M BRL1	9.22	10.3	1566	0.899	1.0000
P M BRL1 - P C ENL2	-25.99	21.9	190	-1.188	1.0000
P M BRL1 - S C ENL2	-54.86	21.9	190	-2.510	0.8515
P M BRL1 - P M ENL2	-44.69	21.8	188	-2.046	1.0000
P M BRL1 - S M ENL2	-64.88	21.8	188	-2.973	0.2202
S M BRL1 - P C ENL2	-35.21	21.8	187	-1.614	1.0000
S M BRL1 - S C ENL2	-64.08	21.8	188	-2.940	0.2436
S M BRL1 - P M ENL2	-53.91	21.8	186	-2.475	0.9382
S M BRL1 - S M ENL2	-74.10	21.8	186	-3.405	0.0535
P C ENL2 - S C ENL2	-28.87	13.0	1573	-2.219	1.0000
P C ENL2 - P M ENL2	-18.70	12.9	1568	-1.448	1.0000
P C ENL2 - S M ENL2	-38.89	12.9	1567	-3.015	0.1721
S C ENL2 - P M ENL2	10.17	13.0	1572	0.785	1.0000
S C ENL2 - S M ENL2	-10.02	12.9	1573	-0.775	1.0000
P M ENL2 - S M ENL2	-20.20	12.8	1569	-1.573	1.0000

The table below summarizes each condition with the bare singular (S+C) against the others. The symbol + represent that the S+C took more time to be processed in the post critical region compared to the other conditions and groups.

Table 5.85 — Bonferroni⁸¹ summary highlighting relevant comparisons

Comparison	S+C against P+C	S+C against P+M	S+C
EngL1	=	=	
EngL1 against BrPL1	=	=	=
EngL1 against EngL2	+	=	+
BrPL1	=	=	
BrPL1 against EngL2	=	=	=
EngL2	=	=	

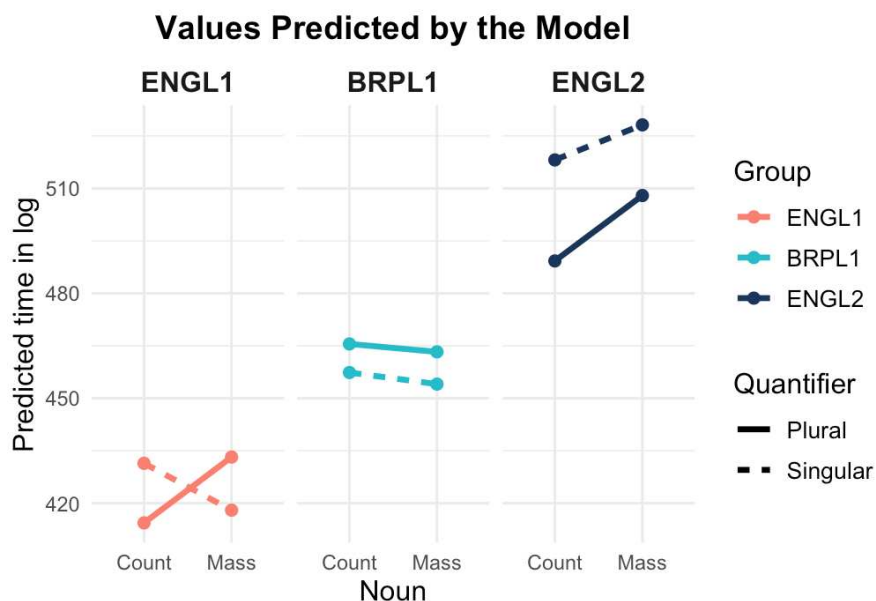
Source: designed by the researchers.

The pairwise comparison highlights that the bilinguals are slower to process the post critical region when compared to native speakers of English, especially in the S+C condition ($\beta = -86.73$, $SE = 25.1$, $t = -3.460$, $p < 0.044$) and the S+M condition ($\beta = -11.14$, $SE = 24.9$, $t = -4.420$, $p < 0.001$). This pairwise suggests that bilinguals are slower to process the singular quantifier ‘much’ for both noun types. As a result, the combination between this quantifier with these nouns, suggests a cognitive load that results in an effect that is noticeable in the post critical region. Most importantly, bilinguals display a difficulty in processing the S+C condition in comparison to native speakers of English and also in the P+C compared to S+C ($\beta = -103.75$, $SE = 25.0$, $t = -4.157$, $p < 0.003$). This adds to the evidence the singular quantifier combined with a count noun is a source of difficulty in processing this structure.

Additionally, the bilinguals were also slower to process the post-critical region when compared to native speakers of BrP in S+M condition ($\beta = -74.10$, $SE = 21.8$, $t = -3.405$, $p < 0.0535$), being in the limit of significance. The other comparisons do not add to our discussion or are non-significant comparisons. Below, we present the values predicted by the model:

⁸¹ Tukey correction revealed similar results.

Graph 5.44 — Values predicted by the model for the post critical region



Source: designed by the researchers on RStudio.

The graph above visually displays the values predicted by the model. In salmon color we have the native speakers of English, in light blue the native speakers of BrP, and in dark blue the bilingual group. While the dotted lines represent singular quantifiers, the solid ones represent the plural ones. At the bottom of the graph, we have the noun type, while in the vertical line we have the predicted reading times values in log.

The general trend of the graph suggests that count and mass nouns values are lower for English, suggesting a clear difference between count and mass nouns and their combination with quantifiers. As we have observed in Experiment 1, BrP does not show any differences in processing of the post critical region between count and mass noun, neither a strong effect for the quantifier, which is consistent with the graph above. For the bilingual group, the combination of a singular quantifier with a mass noun suggests an additional processing in the spill-over region, while the effect of combining the singular quantifier with a count noun is less cognitively demanding compared to singular quantifier with mass noun. Combining a plural quantifier with a count noun suggests the fastest condition for the bilinguals while combining the plural quantifier with a mass noun is more time demanding.

Taken together, these results suggest that the post critical region is processed in similar ways between the native speakers of BrP group and the bilingual group, while differing from the native speakers of English. The absence in differences between the pairwise comparison between BrP and bilinguals suggests that bilinguals behaved in a more similar manner to the

native speakers of BrP, than native speakers of English. This suggests that the processing patterns from the bilinguals are more aligned with the native speakers of BrP, than the native speakers of English. Next, we move forward to the Interpretations Task section.

5.5.4 Interpretation Task

The IT was the instrument designed to capture the interpretation nouns and the response time that participants took to decide their interpretation based on two figures. In the next subsection, we take a closer look at the response time, contrasting the bilingual group with the native speakers' groups.

5.5.4.1 Response Time

The response time in the IT allows us to infer aspects of language processing and interpretation, as it indicates the time taken by participants to determine whether their interpretation of the sentence participants had just read referred to a volume or cardinal interpretation. This data may enhance our understanding of language processing and representation among the three groups.

It is worth highlighting that response time for English was only significant for the singular quantifier combined with count noun, indicating that this condition led to slower response times while for BrP there was a marginally non-significant effect for noun itself. For bilinguals, there was an interaction between the quantifier and the noun, with the singular quantifier leading to slower response times when the noun was count than when it was compared to the plural ones.

5.5.4.2 Data Analysis

For the response time, we gathered *dataset3* in log of the three groups and tabled all the data in a single CSV file, all of which were already in log. After adding the new column group, we checked whether all participants' numbers were different and if all the data was correctly included. The final dataset comprised 1614 observations, nested within 112 participants and 16 items.

5.5.4.3 Statistical Analysis

In the response time, we used the logarithm of response times as the dependent variable and fitted a Linear Mixed-Effects Model using the Maximum Likelihood, with t-tests computed via Satterthwaite's method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used in this analysis can be checked below:

```
model1 <- lmer (log ~ Quantifier * Noun * Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)
```

```
model2 <- lmer (log ~ Quantifier + Noun + Speaker +
  (1|Participant) + (1|Item), data = rtat, REML = FALSE)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included an interaction between Quantifier, Noun, and Speaker which was on the limit of significance ($\chi^2 = 14.03$, $p < 0.05$). The model's results can be checked below:

Table 5.86 — Model's results

<i>Predictors</i>	<i>Estimates</i>	log	
		<i>CI</i>	<i>p</i>
(Intercept)	7.12	7.01 – 7.23	<0.001
Quantifier [S]	0.20	0.09 – 0.30	<0.001
Noun [M]	0.08	-0.02 – 0.19	0.108
Speaker [BRPL1]	0.17	0.03 – 0.30	0.020
Speaker [ENGL2]	0.12	-0.04 – 0.27	0.135
Quantifier [S] × Noun [M]	-0.13	-0.28 – 0.02	0.085
Quantifier [S] × Speaker [BRPL1]	-0.14	-0.27 – -0.01	0.039
Quantifier [S] × Speaker [ENGL2]	-0.02	-0.16 – 0.13	0.824
Noun [M] × Speaker [BRPL1]	-0.02	-0.15 – 0.11	0.784
Noun [M] × Speaker [ENGL2]	-0.05	-0.19 – 0.09	0.507
(Quantifier [S] × Noun [M]) × Speaker [BRPL1]	0.09	-0.09 – 0.28	0.319
(Quantifier [S] × Noun [M]) × Speaker [ENGL2]	-0.00	-0.20 – 0.20	0.992
Random Effects			
σ^2	0.14		
τ_{00} Participant	0.05		
τ_{00} Item	0.00		
ICC	0.28		
N _{Participant}	111		
N _{Item}	16		
Observations	1614		
Marginal R ² / Conditional R ²	0.027 / 0.301		

Source: designed by the researchers on RStudio.

The model above highlights a main effect for quantifier among the three groups, indicating a difference in response time that is highly affected by the quantifier, indicating that the singular quantifier provides a significant effect being slower to process while the effect for the interaction between the quantifier and noun is marginally significant. When looking at the effect for the groups, we find a statistically significant main effect for native speakers of BrP, indicating that they take more time in response times, being slower than our reference value that is the native speaker of English. Additionally, we did not see this effect for the bilingual group, indicating that the difference between the native speaker of English and the bilingual is not significant, which highlights that they behaved similarly. Thus, we also have a marginal effect of interaction between quantifier and noun. Taken together, the model suggests the same effects found in the comparison between native speakers of English and native speakers of BrP, as already reported in the Group Comparison 1. However, this effect did not show up for the bilingual group.

A Bonferroni Correction was carried out in the post-hoc analysis to account for multiple comparisons. The relevant comparisons here should be the S+C and P+M among the three groups, where we would possibly observe a transfer from BrP L1 to English L2. Below, we present the pairwise comparison:

contrast	estimate	SE	df	t.ratio	p.value
P C ENGL1 - S C ENGL1	-0.19753	0.0537	1506	-3.681	0.0159
P C ENGL1 - P M ENGL1	-0.08391	0.0523	1503	-1.603	1.0000
P C ENGL1 - S M ENGL1	-0.15084	0.0524	1506	-2.878	0.2675
P C ENGL1 - P C BRPL1	-0.16559	0.0717	224	-2.310	1.0000
P C ENGL1 - S C BRPL1	-0.22631	0.0719	227	-3.147	0.1237
P C ENGL1 - P M BRPL1	-0.23162	0.0720	228	-3.215	0.0985
P C ENGL1 - S M BRPL1	-0.25542	0.0723	230	-3.535	0.0325
P C ENGL1 - P C ENGL2	-0.11556	0.0781	224	-1.480	1.0000
P C ENGL1 - S C ENGL2	-0.29686	0.0795	240	-3.734	0.0155
P C ENGL1 - P M ENGL2	-0.15258	0.0782	226	-1.950	1.0000
P C ENGL1 - S M ENGL2	-0.20225	0.0793	238	-2.552	0.7488
S C ENGL1 - P M ENGL1	0.11362	0.0551	1509	2.063	1.0000
S C ENGL1 - S M ENGL1	0.04669	0.0550	1507	0.848	1.0000
S C ENGL1 - P C BRPL1	0.03194	0.0737	248	0.433	1.0000
S C ENGL1 - S C BRPL1	-0.02878	0.0739	251	-0.389	1.0000
S C ENGL1 - P M BRPL1	-0.03409	0.0741	253	-0.460	1.0000
S C ENGL1 - S M BRPL1	-0.05789	0.0742	255	-0.780	1.0000
S C ENGL1 - P C ENGL2	0.08197	0.0799	245	1.026	1.0000

S C ENGL1 - S C ENGL2	-0.09933	0.0813	261	-1.221	1.0000
S C ENGL1 - P M ENGL2	0.04496	0.0801	247	0.561	1.0000
S C ENGL1 - S M ENGL2	-0.00472	0.0811	259	-0.058	1.0000
P M ENGL1 - S M ENGL1	-0.06693	0.0538	1507	-1.243	1.0000
P M ENGL1 - P C BRPL1	-0.08168	0.0727	237	-1.123	1.0000
P M ENGL1 - S C BRPL1	-0.14241	0.0730	240	-1.951	1.0000
P M ENGL1 - P M BRPL1	-0.14771	0.0731	241	-2.020	1.0000
P M ENGL1 - S M BRPL1	-0.17151	0.0733	244	-2.339	1.0000
P M ENGL1 - P C ENGL2	-0.03165	0.0790	235	-0.400	1.0000
P M ENGL1 - S C ENGL2	-0.21295	0.0805	251	-2.645	0.5724
P M ENGL1 - P M ENGL2	-0.06867	0.0792	237	-0.867	1.0000
P M ENGL1 - S M ENGL2	-0.11834	0.0802	249	-1.475	1.0000
S M ENGL1 - P C BRPL1	-0.01475	0.0728	237	-0.203	1.0000
S M ENGL1 - S C BRPL1	-0.07548	0.0730	239	-1.034	1.0000
S M ENGL1 - P M BRPL1	-0.08079	0.0731	241	-1.105	1.0000
S M ENGL1 - S M BRPL1	-0.10459	0.0733	243	-1.427	1.0000
S M ENGL1 - P C ENGL2	0.03528	0.0790	235	0.446	1.0000
S M ENGL1 - S C ENGL2	-0.14602	0.0805	251	-1.814	1.0000
S M ENGL1 - P M ENGL2	-0.00174	0.0792	237	-0.022	1.0000
S M ENGL1 - S M ENGL2	-0.05141	0.0802	249	-0.641	1.0000
P C BRPL1 - S C BRPL1	-0.06073	0.0389	1501	-1.560	1.0000
P C BRPL1 - P M BRPL1	-0.06603	0.0391	1502	-1.687	1.0000
P C BRPL1 - S M BRPL1	-0.08984	0.0396	1505	-2.271	1.0000
P C BRPL1 - P C ENGL2	0.05003	0.0683	226	0.732	1.0000
P C BRPL1 - S C ENGL2	-0.13127	0.0700	247	-1.876	1.0000
P C BRPL1 - P M ENGL2	0.01301	0.0685	229	0.190	1.0000
P C BRPL1 - S M ENGL2	-0.03666	0.0697	244	-0.526	1.0000
S C BRPL1 - P M BRPL1	-0.00531	0.0396	1504	-0.134	1.0000
S C BRPL1 - S M BRPL1	-0.02911	0.0399	1502	-0.730	1.0000
S C BRPL1 - P C ENGL2	0.11076	0.0686	229	1.615	1.0000
S C BRPL1 - S C ENGL2	-0.07055	0.0702	251	-1.005	1.0000
S C BRPL1 - P M ENGL2	0.07374	0.0688	232	1.072	1.0000
S C BRPL1 - S M ENGL2	0.02407	0.0700	248	0.344	1.0000
P M BRPL1 - S M BRPL1	-0.02380	0.0401	1506	-0.593	1.0000
P M BRPL1 - P C ENGL2	0.11606	0.0687	231	1.689	1.0000
P M BRPL1 - S C ENGL2	-0.06524	0.0704	252	-0.927	1.0000
P M BRPL1 - P M ENGL2	0.07905	0.0689	234	1.147	1.0000
P M BRPL1 - S M ENGL2	0.02937	0.0701	249	0.419	1.0000
S M BRPL1 - P C ENGL2	0.13987	0.0689	234	2.030	1.0000
S M BRPL1 - S C ENGL2	-0.04144	0.0706	255	-0.587	1.0000
S M BRPL1 - P M ENGL2	0.10285	0.0691	236	1.488	1.0000

S M BRPL1 - S M ENGL2	0.05317	0.0703	252	0.757	1.0000
P C ENGL2 - S C ENGL2	-0.18130	0.0497	1504	-3.649	0.0180
P C ENGL2 - P M ENGL2	-0.03702	0.0477	1502	-0.776	1.0000
P C ENGL2 - S M ENGL2	-0.08669	0.0493	1502	-1.757	1.0000
S C ENGL2 - P M ENGL2	0.14428	0.0500	1506	2.884	0.2630
S C ENGL2 - S M ENGL2	0.09461	0.0516	1505	1.835	1.0000
P M ENGL2 - S M ENGL2	-0.04967	0.0496	1503	-1.001	1.0000

The table below summarizes each condition with the bare singular (S+C) against the others. The symbol + represent that the S+C increased response times, compared to the other conditions and groups.

Table 5.87 — Bonferroni⁸² summary highlighting relevant comparisons

Comparison	S+C against P+C	S+C against P+M	S+C
EngL1	+	=	
EngL1 against BrPL1	=	=	=
EngL1 against EngL2	+	=	=
BrPL1	=	=	
BrPL1 against EngL2	=	=	=
EngL2	+	=	

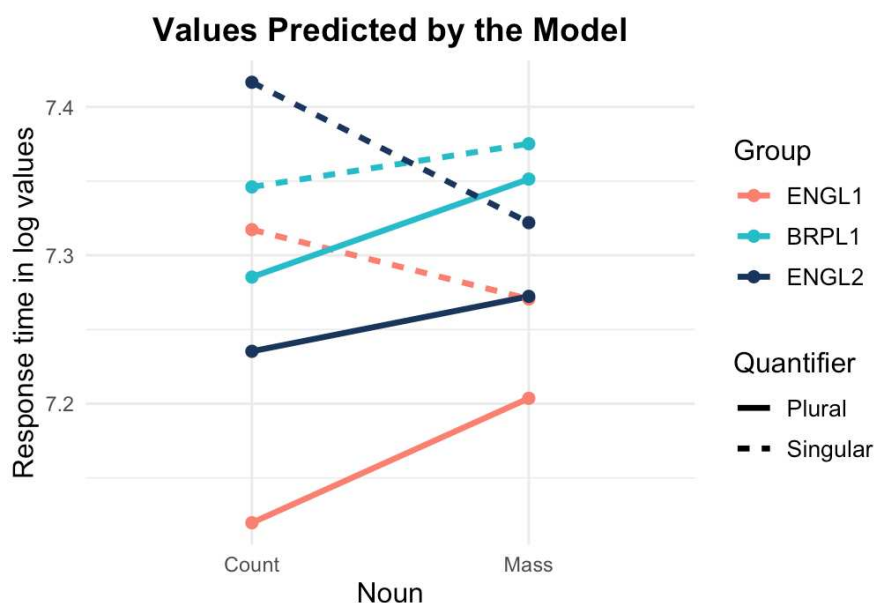
Source: designed by the researchers.

The summary provided by the table, helps us to better visualize what comparisons are relevant in the Bonferroni correction. The P+C against S+C shows an interesting result: For English, it shows that the singular quantifier combined with a count noun results in an additional more time for the participants to respond the IT ($\beta = -0.19753$, $SE = 0.0537$, $t = -3.681$, $p < 0.0159$). This effect is also observed for the bilinguals ($\beta = -0.29686$, $SE = 0.0795$, $t = -3.734$, $p < 0.0155$), but bilinguals were also significantly slower in the S+C against the P+C compared to native speakers of English ($\beta = -0.18130$, $SE = 0.0497$, $t = -3.649$, $p < 0.0180$). This indicates that the S+C condition is more difficult in English in general in the offline measurements, indicating that other sources of knowledge are accessed to provide the interpretation of the S+C, especially when compared to the P+C that leads to faster response times. The faster response

⁸² Tukey correction shown fairly the same tendency from Bonferroni, except for a marginal difference for P+C against S+C for EngL1 against BrPL1 ($\beta = -0.20067$, $SE = 0.0632$, $t = -3.74$, $p < 0.0764$) and a significant effect for BrPL1 ($\beta = -0.08618$, $SE = 0.0190$, $t = -4.531$, $p < 0.0004$).

times for the P+C might be explained by the plural morphology that is giving explicit clues on how to interpret the plural condition, therefore fostering response times. The other pairwise comparisons did not reveal any relevant comparison to further explore. Next, we take a look at the values predicted by the model.

Graph 5.45 — Values predicted by the model for the response time in log



Source: designed by the researchers on RStudio.

The graph above visually displays the values predicted by the model. In salmon color we have the native speakers of English, in light blue the native speakers of BrP, and in dark blue the bilingual group. While the dotted lines represent singular quantifiers, the solid ones represent the plural ones. At the bottom of the graph, we have the noun type, while in the vertical we have the response time values in log.

By observing the English group, we notice that the response times for the count noun is faster when combined with plural quantifiers while mass nouns take additional processing times, particularly for plural quantifiers. For BrP, response times are relatively consistent across noun types and quantifiers, with a slight increase for mass nouns compared to count nouns. The bilingual group has similar response times for count nouns, while mass nouns are increased slightly with plural quantifiers showing slower response times.

Taken together, the graph suggests that native speakers of English and bilinguals are more sensible to count and mass differences that are highlighted by the quantifier type than native speakers of BrP. This sensibility also shows up in the statistical analysis in the pairwise

observed when compared the plural quantifier and count nouns with the singular quantifier with count nouns. Next, we look at answer type in the following subsection.

5.5.4.4 Answer Type

Finally, the answer type will give specific information whether the nouns are interpreted as cardinal or volume, being mainly an offline measurement of language representation. Therefore, we look at the answers given by the participants and see how they differ between language groups.

It worths highlighting that for answer type in English we had a marginal effect for noun with mass nouns increasing the probability of getting a volume response while for BrP we had an interaction between quantifier and noun, with singular quantifiers increasing the probabilities of getting volume responses, with higher probabilities for mass nouns. In BrP, plural quantifiers have lower probabilities of getting a volume response and the count nouns the probability is even lower. For bilinguals, there was an effect for noun, with mass nouns leading to higher probabilities of getting a volume response.

5.5.4.5 Data Analysis

For the answer type, we gathered *dataset3* in log from the same file used in the response time in which the three groups were combined in the same csv file, therefore, assessing the statistics in the answer type column. The dataset comprised 1614 observations, nested within 112 participants and 16 items.

5.5.4.6 Statistical Analysis

In the answer type, we used answer type as the dependent variable and fitted a Generalized Linear Mixed Model using the Maximum Likelihood, with Laplace Approximation method with Quantifier, Noun, Speaker, and the interaction between these three factors as fixed effects, along with random intercepts for both Participants and Items. The models used can be checked below:

```
modell = glmer (Answer ~ Quantifier * Noun * Speaker +
               (1|Participant) + (1|Item), data = rtat, family = binomial)
```

```
model2 = glmer (Answer ~ Quantifier + Noun + Speaker +  
(1|Participant) + (1|Item), data = rtat, family = binomial)
```

A comparison of nested models with ANOVA revealed that the best-fitting model included an interaction between Quantifier, Noun, and Speaker, which was highly statistically significant ($\chi^2 = 24.23$, $p < 0.001$). The model's results can be seen below.

Table 5.88 — Model's results

<i>Predictors</i>	Answer		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
(Intercept)	0.11	0.05 – 0.27	<0.001
Quantifier [S]	8.61	3.98 – 18.63	<0.001
Noun [M]	1.61	0.72 – 3.61	0.245
Speaker [BRPL1]	0.85	0.29 – 2.51	0.775
Speaker [ENGL2]	0.34	0.10 – 1.18	0.089
Quantifier [S] × Noun [M]	0.91	0.32 – 2.58	0.852
Quantifier [S] × Speaker [BRPL1]	0.67	0.25 – 1.79	0.424
Quantifier [S] × Speaker [ENGL2]	3.07	0.96 – 9.78	0.058
Noun [M] × Speaker [BRPL1]	0.94	0.34 – 2.64	0.909
Noun [M] × Speaker [ENGL2]	1.09	0.32 – 3.72	0.890
(Quantifier [S] × Noun [M]) × Speaker [BRPL1]	2.88	0.75 – 11.06	0.124
(Quantifier [S] × Noun [M]) × Speaker [ENGL2]	1.85	0.39 – 8.75	0.440
Random Effects			
σ^2	3.29		
τ_{00} Participant	2.56		
τ_{00} Item	0.19		
ICC	0.46		
$N_{\text{Participant}}$	111		
N_{Item}	16		
Observations	1614		
Marginal R^2 / Conditional R^2	0.245 / 0.589		

Source: designed by the researchers on RStudio.

The model's results highlight that the singular quantifier has a highly significant effect of increasing the probability of getting a volume response, but neither the mass noun nor the native speaker of BrP nor the bilinguals have a strong effect on the outcome compared to the answers of the native speakers of English. In addition, we have a trend in the interaction between the singular quantifier and mass noun among groups, but they are mostly non-significant interactions.

An additional Bonferroni Correction was carried in the post-hoc analysis to account for multiple comparisons. The relevant comparisons here should be the S+C and P+M among the three groups, where we would possibly observe a transfer from BrP L1 to English L2. Below, we present the pairwise comparison:

contrast	estimate	SE	df	z.ratio	p.value
P C ENGL1 - S C ENGL1	-2.1526	0.394	Inf	-5.462	<.0001
P C ENGL1 - P M ENGL1	-0.4773	0.411	Inf	-1.162	1.0000
P C ENGL1 - S M ENGL1	-2.5303	0.395	Inf	-6.411	<.0001
P C ENGL1 - P C BRPL1	0.1573	0.549	Inf	0.286	1.0000
P C ENGL1 - S C BRPL1	-1.5937	0.526	Inf	-3.030	0.1613
P C ENGL1 - P M BRPL1	-0.2600	0.543	Inf	-0.479	1.0000
P C ENGL1 - S M BRPL1	-2.9682	0.531	Inf	-5.591	<.0001
P C ENGL1 - P C ENGL2	1.0810	0.636	Inf	1.700	1.0000
P C ENGL1 - S C ENGL2	-2.1924	0.567	Inf	-3.870	0.0072
P C ENGL1 - P M ENGL2	0.5171	0.605	Inf	0.855	1.0000
P C ENGL1 - S M ENGL2	-3.2702	0.576	Inf	-5.676	<.0001
S C ENGL1 - P M ENGL1	1.6753	0.380	Inf	4.410	0.0007
S C ENGL1 - S M ENGL1	-0.3777	0.344	Inf	-1.099	1.0000
S C ENGL1 - P C BRPL1	2.3099	0.523	Inf	4.416	0.0007
S C ENGL1 - S C BRPL1	0.5589	0.495	Inf	1.130	1.0000
S C ENGL1 - P M BRPL1	1.8926	0.515	Inf	3.678	0.0155
S C ENGL1 - S M BRPL1	-0.8156	0.497	Inf	-1.642	1.0000
S C ENGL1 - P C ENGL2	3.2336	0.613	Inf	5.276	<.0001
S C ENGL1 - S C ENGL2	-0.0398	0.537	Inf	-0.074	1.0000
S C ENGL1 - P M ENGL2	2.6697	0.580	Inf	4.602	0.0003
S C ENGL1 - S M ENGL2	-1.1176	0.546	Inf	-2.047	1.0000
P M ENGL1 - S M ENGL1	-2.0530	0.380	Inf	-5.406	<.0001
P M ENGL1 - P C BRPL1	0.6346	0.541	Inf	1.172	1.0000
P M ENGL1 - S C BRPL1	-1.1164	0.517	Inf	-2.161	1.0000
P M ENGL1 - P M BRPL1	0.2173	0.534	Inf	0.407	1.0000
P M ENGL1 - S M BRPL1	-2.4909	0.520	Inf	-4.787	0.0001
P M ENGL1 - P C ENGL2	1.5582	0.629	Inf	2.478	0.8718

P M ENGL1 - S C ENGL2	-1.7151	0.558	Inf	-3.076	0.1386
P M ENGL1 - P M ENGL2	0.9944	0.597	Inf	1.665	1.0000
P M ENGL1 - S M ENGL2	-2.7929	0.567	Inf	-4.927	0.0001
S M ENGL1 - P C BRPL1	2.6876	0.520	Inf	5.167	<.0001
S M ENGL1 - S C BRPL1	0.9366	0.491	Inf	1.908	1.0000
S M ENGL1 - P M BRPL1	2.2703	0.512	Inf	4.436	0.0006
S M ENGL1 - S M BRPL1	-0.4379	0.492	Inf	-0.890	1.0000
S M ENGL1 - P C ENGL2	3.6113	0.610	Inf	5.918	<.0001
S M ENGL1 - S C ENGL2	0.3379	0.534	Inf	0.633	1.0000
S M ENGL1 - P M ENGL2	3.0474	0.577	Inf	5.277	<.0001
S M ENGL1 - S M ENGL2	-0.7399	0.542	Inf	-1.365	1.0000
P C BRPL1 - S C BRPL1	-1.7510	0.319	Inf	-5.497	<.0001
P C BRPL1 - P M BRPL1	-0.4173	0.331	Inf	-1.259	1.0000
P C BRPL1 - S M BRPL1	-3.1255	0.340	Inf	-9.182	<.0001
P C BRPL1 - P C ENGL2	0.9236	0.578	Inf	1.599	1.0000
P C BRPL1 - S C ENGL2	-2.3497	0.503	Inf	-4.675	0.0002
P C BRPL1 - P M ENGL2	0.3598	0.543	Inf	0.662	1.0000
P C BRPL1 - S M ENGL2	-3.4275	0.515	Inf	-6.657	<.0001
S C BRPL1 - P M BRPL1	1.3338	0.304	Inf	4.385	0.0008
S C BRPL1 - S M BRPL1	-1.3745	0.280	Inf	-4.907	0.0001
S C BRPL1 - P C ENGL2	2.6747	0.557	Inf	4.802	0.0001
S C BRPL1 - S C ENGL2	-0.5986	0.474	Inf	-1.263	1.0000
S C BRPL1 - P M ENGL2	2.1108	0.521	Inf	4.052	0.0033
S C BRPL1 - S M ENGL2	-1.6764	0.485	Inf	-3.459	0.0358
P M BRPL1 - S M BRPL1	-2.7082	0.324	Inf	-8.364	<.0001
P M BRPL1 - P C ENGL2	1.3409	0.572	Inf	2.346	1.0000
P M BRPL1 - S C ENGL2	-1.9324	0.494	Inf	-3.910	0.0061
P M BRPL1 - P M ENGL2	0.7771	0.537	Inf	1.448	1.0000
P M BRPL1 - S M ENGL2	-3.0102	0.506	Inf	-5.948	<.0001
S M BRPL1 - P C ENGL2	4.0491	0.563	Inf	7.195	<.0001
S M BRPL1 - S C ENGL2	0.7758	0.477	Inf	1.626	1.0000
S M BRPL1 - P M ENGL2	3.4853	0.527	Inf	6.615	<.0001
S M BRPL1 - S M ENGL2	-0.3020	0.485	Inf	-0.622	1.0000
P C ENGL2 - S C ENGL2	-3.2733	0.445	Inf	-7.353	<.0001
P C ENGL2 - P M ENGL2	-0.5639	0.472	Inf	-1.193	1.0000
P C ENGL2 - S M ENGL2	-4.3511	0.468	Inf	-9.294	<.0001
S C ENGL2 - P M ENGL2	2.7094	0.398	Inf	6.807	<.0001
S C ENGL2 - S M ENGL2	-1.0778	0.348	Inf	-3.100	0.1277
P M ENGL2 - S M ENGL2	-3.7873	0.423	Inf	-8.946	<.0001

The table below summarizes each condition with the bare singular (S+C) against others. The symbol + represent the probability of the S+C getting a volume response compared to the other comparisons among groups.

Table 5.89 — Bonferroni⁸³ summary highlighting relevant comparisons

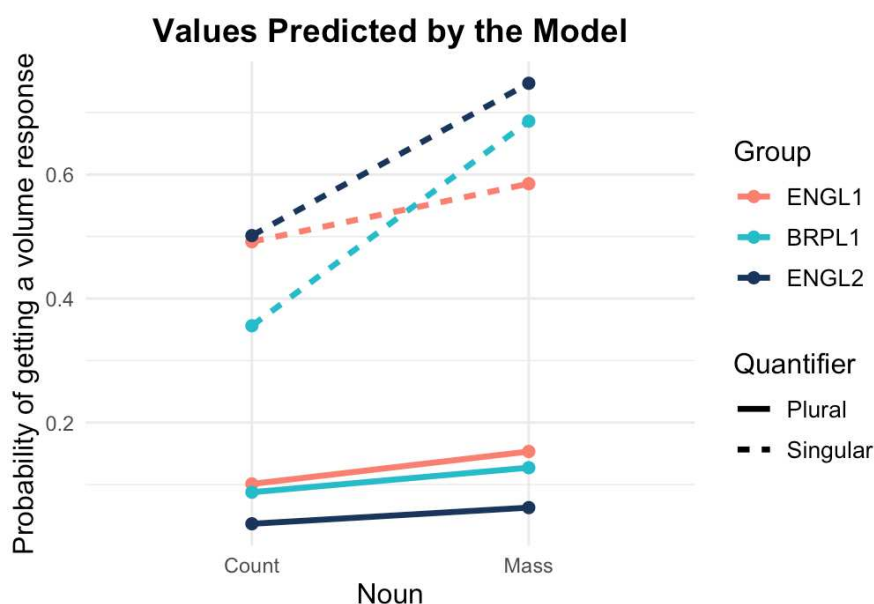
Comparison	S+C against P+C	S+C against P+M	S+C
EngL1	+	+	
EngL1 against BrPL1	=	+	=
EngL1 against EngL2	+	+	=
BrPL1	+	+	
BrPL1 against EngL2	+	+	=
EngL2	+	+	

Source: designed by the researchers.

The pairwise Bonferroni correction highlights that the singular quantifier combined with a count noun increases the probability of getting a volume response compared to the plural quantifier with count and mass nouns for all groups, except for the native speakers of English and BrP. However, they indicate that the main driver of the interpretation of the nouns is the quantifier. Below, we can check the values predicted by the model.

⁸³ Tukey correction revealed similar results, except for the P+C against S+C for EngL1 and BrPL1 ($\beta = -2.4672$, $SE = 0.450$, $t = -5.488$, $p < .0001$).

Graph 5.46 — Values predicted by the model for the answer type in log for the groups



Source: designed by the researchers on RStudio.

The graph above visually displays the values predicted by the model. In salmon color we have the native speakers of English, in light blue the native speakers of BrP, and in dark blue the bilingual group. While the dotted lines represent singular quantifiers, the solid ones represent the plural ones. At the bottom of the graph, we have the noun type, while in the vertical we have the probability of getting a volume response values in log.

The general trend of the data suggests that all groups show relatively low probabilities of getting a volume response when the noun is count with minor differences between plural and singular quantifiers. Mass nouns consistently deliver higher probabilities of getting volume responses, with the singular quantifiers also contributing to the delivery of higher values. The combination of singular quantifier and count nouns delivers consistent more probabilities of volume responses than plural quantifier with count or mass nouns. This indicates that the combination of a singular quantifier with count nouns gets higher probabilities of getting a volume response for all groups, but this probability is slightly lower for native speakers of BrP.

By observing the English group, count nouns delivers very slight probabilities of getting a volume response with plural quantifiers, while for mass nouns the probabilities increase substantially with a higher effect for singular quantifiers. For BrP, we have lower probabilities of getting a volume interpretation for count nouns, while mass nouns deliver higher probabilities of getting volume responses, especially with singular quantifiers. For the bilingual group, count nouns behaviour are similar to ENGL1, but slightly higher than BRPL1.

Thus, mass nouns probabilities of getting a volume responses increase especially for singular quantifiers.

In summary, BrP show less association of count nouns getting a volume responses, while the bilingual group shows more association between mass nouns and volume responses, especially with singular quantifiers. Therefore, these results suggest very likely possible transfer from BrP L1 to English L2, but indicates that bilinguals already have internalized the mass and count distinction for nouns required for English that, for BrP is underspecified. In the next subsection, we highlight the most important findings from this group comparison and take these results in great depth.

5.5.5 Summary of Key Findings from Group Comparison 4

The table below provides an overview of the Group Comparison 4.

Table 5.90 — Summary of key findings from group comparison 4 (Bilinguals)

Quantifier Type	Noun Type	Noun	Post-Critical	Response Time	Interpretation
Singular	Count	+	+	=	=
	Mass	+	=	=	=
Plural	Count	=	=	=	=
	Mass	+	=	=	=

Source: designed by the researchers.

Observations: The symbols mean: (=) we did not find statistical effect, and (+) we found statistically significant effect indicating additional processing time. The reference value for comparison is English; therefore, the data displayed on the table refers to Bilinguals.

- The evidence of an interference is observed in the noun region, as the statistical analysis highlights that the processing of the noun region is hindered for the bilingual for the S+C and P+M conditions;

- In the post critical region, bilinguals are also slower to process the singular quantifier and count noun conditions when compared to native speakers of English;
- Bilinguals and native speakers of English show a sensitivity to process the S+C condition;
- The count and mass distinction for nouns is stronger for English than for BrP and the bilinguals also show this sensibility comparing the groups. This sensibility is observed in the answer type.

5.5.6 General Discussion

When accounting for the noun region, this is where we most find differences among groups. The bilingual group is significantly slower to process the nouns in English when compared to the native speakers of English. In a fine-grained analysis, we could observe that sentences like ‘The man sold much feather in Madrid’, ‘The man sold much silver in Madrid’, and ‘The man sold many silvers in Madrid’ all take additional processing time to be computed by the bilinguals. This effect could be due to proficiency, since the bilinguals were intermediate learners of English, which could result in an additional time to carry out the analysis of the noun, but the condition in which we had sentences like ‘The man sold many feathers in Madrid’ did not show a statistically significant difference between the two groups, therefore highlighting that another cognitive process might be taking place while interpreting the noun and this difference might be driven by incongruent semantic information between languages.

This incongruency regarding semantic information might be related to count and mass distinctions. English encodes atomicity inherently in its grammar; therefore, a singular count noun already carries the grammatical information that signals in advance that this noun should be interpreted by cardinality — Frisson and Frazier (2005) calls it primitive meaning while Rothstein (2017) calls it ground meaning. In contrast, BrP does not carry this information in the structure and neither in the nouns, therefore a singular count noun might be interpreted by both, cardinal or volume. The bilingual, in some sense, carries from BrP the knowledge that this noun can be interpreted in both ways, however English does not allow this behaviour, imposing a primitive interpretation. The difficulty to process noun in this region might be a result of this competition in the bilingual mind in which the bilingual is not sure whether he is going to resort

on the knowledge of his language or is going to follow his knowledge of his additional language, providing an interference between grammar — which explains the additional processing out to carry out the noun analysis. Additionally, as already discussed in Experiment 6, bilinguals might have more immediate processing than native speakers of English, which might possibly explain why the effect is found in the post-critical region for native speakers of English while the effect is found in the noun region for bilinguals.

We could also observe a difference between the bilingual group and the native speakers of BrP in which the same sentences abovementioned had statistically significant differences, except for the plural mass condition that was marginally significant, and the plural count condition that was not significant. This underlies a process in which the processing of the noun does not resemble either the native speaker of BrP nor the native speaker of English, highlighting that the bilingual might possess a unique linguistic system that does not resemble both languages, but this linguistic system consists of a grammar that is formed by the two systems, as proposed by Grosjean (1982, 2008). The load of information from BrP and English might explain why bilinguals carried out the sentence analysis more slowly than the native speakers in each group.

While singular count nouns in BrP can be interpreted by volume and cardinality, in English they cannot, receiving random interpretations. This difference in the interpretations of the noun has processing correlates. In terms of processing, the singular count noun in BrP does not take additional processing time, but in English it does since a coercion process rules the derivation of singular count nouns. Even though in English we observed oscillation in the interpretation of singular count nouns when combined with a singular quantifier, we believe it was driven by divergent grammatical and semantic information as reading time in the relevant regions has shown. Most importantly, bilinguals display a difficulty in processing the singular quantifier combined with count nouns that stands out compared to native speakers of BrP and English. This highlights that the singular count noun is a source of difficulty between these two languages, hindering the processing of the noun region. Although the evidence so far does not allow to say that there is a transfer from the L1 to the L2 and neither a restructure, this additional processing provides evidence that the English grammar is a source of an interference in the singular count nouns. This interference might be attributed by the grammaticality of singular count nouns in BrP while in English they are ungrammatical and the atomicity features differences between each language.

The post-critical region is where BrP and English also differ, since we found in English spill-over processing in the post-critical region while in BrP we did not find it. Comparing these

two groups with the bilinguals, we did find a difference in processing the post-critical region. Delving deeper into this difference, bilinguals are slower to process the post-critical region than native speakers of English, especially for the singular count noun conditions. This difference reinforces that there is an interference between grammars that cause a hinder in the processing of the post critical region for bilinguals. This adds to the evidence of the mismatch between languages since this hindering is an effect of the mismatch. If there were not a mismatch between languages, the processing would not be affected as it is in bilinguals. It might indicate that although we have a difference and a possible bottleneck in the processing of singular count nouns, the bilinguals appear to still be in the process of overcoming this mismatch, therefore, the additional processing time in these conditions for this region seems to indicate that bilinguals are in the course of restructuring the knowledge from their L1 to the L2.

Taken together, these results inform us about the bilingual cognition, but also about the differences in processing regarding BrP and English. First, these two languages are different, not only in the linguistic form and grammatical organization, but also results in effects in terms of processing, as we have observed. These two languages have different grammars that results in different processing. While BrP does not have additional processing in the singular count nouns, and neither post-critical region, English has additional processing in the post-critical region⁸⁴. The bilingual is posed in a mismatch between languages that goes even further than linguistic form materialized by the singular count nouns and grammatical patterns, but process it differently.

As we have thoroughly discussed the differences in processing between BrP and English, we now turn our attention to the bilingual. The bilinguals are generally slower in terms of processing, which is consistent with the bilingualism literature since they have to juggle two or more languages, while suppressing all of them in order to focus on the one that is most activated, which in the case of our bilingual study, is English (KROLL; BIALYSTOK, 2013). Additionally, proficiency plays a key role in informing that they were slower to process the sentences during the course of derivation, possibly because of proficiency levels. Thus, the bilinguals in our study were also a non-WEIRD population, as we have discussed in the first group comparison.

Besides these aspects influencing our results, we have the processing patterns of the bilingual that although there are certain aspects that differ from the bilinguals' native language, they also show differences that are not consistent with their second language, probably

⁸⁴ As we have already discussed, this is due to the nature of the SPR Task.

attributed to the interference from the L1 to the L2. This processing patterns brings us evidence that is in line with Grosjean (2008), which argues that the bilingual possesses a unique linguistic system that is formed not only by their native language, but also the additional ones.

The response times, which correspond to the time that participants took to decide whether their interpretation was based on volume or cardinality after reading the sentence, we found a trend in the graphs that bilinguals are more sensitive to count and mass distinctions in English than when they are compared to native speakers of BrP. To put differently, as we have seen, English carries the semantic feature of atomicity in the nouns and in the syntax, while BrP does not carry this information. Both native speakers of English and bilinguals, took more time to respond to the IT for the conditions in which we had the combination of a singular quantifier and count noun, evidencing that this structure is difficult to process in English. This lag in responding the IT, might be attributed to the access of other sources of information, besides pragmatic, which we tried to suppress by the geometrical figures. The differences between languages hinders response times more for the bilinguals than for native speakers of English and this difference resulted in more time for them to decide whether the interpretation of the nouns would be based on volume or cardinality, therefore, this additional response time might indicate that the bilinguals would be attributing the specification of the nouns, as should be done during derivation in English. Although this was not statistically significant, this reasoning is consistent with our findings for the answer type.

In regard to Answer Type, for native speakers of English, singular count nouns were not interpreted. That is, native speakers of English failed to attribute meaning for the combination of a singular quantifier with singular count noun, therefore having random results due to incongruent grammatical and semantic information, as discussed in Experiment 2. We also observed the same randomness for native speakers of English and bilinguals in the singular quantifier combined with singular mass nouns. The same pattern was observed for our bilinguals in our study and this finding, even though were not what we were expecting, enlighten that the nature of nouns in English is atomic. This means that the grammar of English carries atomicity inherently in the nouns and in the grammatical structure, confirming our findings for the native speakers of English. The singular count nouns in English, although ungrammatical in argument position, it has higher probabilities of getting volume responses. This probability might be explained by the singular quantifier, providing clues to interpret the count noun as volume. Even though it is surprising that the bilinguals displayed this knowledge, it could inform us about restructuring, but also highlight that the atomicity feature is grammatically encoded in English and acquired as part of the language.

As discussed for Experiment 6, our intermediate English learners who participated in the study indicated that they possessed knowledge of English grammar, specifically recognizing that English exhibits atomicity in nouns and it is reflected in its grammatical structure. This provided sufficient evidence to refute our Working Hypothesis 1, suggesting that, at this stage of acquisition, they were in the process of overcoming the mismatch between the two languages, not providing evidence of grammatical transfer. Additionally, we found evidence to refute our Null Hypothesis. In this way, we have to resort on the Restructuring Hypothesis (RH) proposed by Slabakova (2016), which claims that not all linguistic features are directly transferred from the L1 to the L2. Instead, learners restructure their grammatical representations based on exposure to L2 input. Unlike the Bottleneck Hypothesis, which focuses on the challenges of acquiring functional morphology as a *bottleneck* in L2 acquisition, the RH emphasizes the central role of input in driving the restructuring process. Specifically, the RH posits that acquiring L2-specific features requires extensive input to trigger restructuring. Rather than assuming that L1 features are directly transferred, the RH suggests that bilinguals gradually adjust their grammatical representations to align with the L2, particularly for features that are absent or differ significantly from their L1. Additionally, this restructuring process would incur additional processing cost since the restructuring of features is highly cognitively demanding.

The findings in are in favor of the RH since it posits that the bilinguals in our study had restructured their knowledge from their L1 to their L2, or were at least in the process of doing so. This was supported by evidence showing that, although their behavior differed between the two languages, it more closely resembled that of native English speakers, since they displayed a processing difficulty in the noun and post critical regions that were more consistent with an interference cause by the singular count noun, which is ungrammatical in English. An alternative explanation is the atomicity build-in feature from English, that is acquired withing the English grammar being an alternative explanation as already discussed in Experiment 6. Additionally, the singular count noun has higher probabilities of getting volume responses for English than for BrP and the bilinguals also showed that they interpret the singular count nouns more as volume than cardinal, consistent with native speakers of English. Next, we retake our RQs in regard to this group comparison:

RQ1. Is there a transfer from BrP L1 to English L2 in bilinguals? *We did not find enough statistical evidence to claim that there is transfer from the L1 to the L2. What we could observe in fact is that there is an interference in the processing of the singular quantifier with singular count noun that might be*

attributed to these two different grammars, and this interference is observed by the additional processing time in the noun and post critical regions of the bilingual groups.

RQ2. Is the processing pattern from the bilingual's linguistic system similar to the processing pattern of BrP, to that of English, or to neither? *The bilingual seems to display processing patterns more in line with the English grammar than the BrP one, since the singular count nouns consistently hinders the processing of the noun and post critical regions.*

RQ3. Is language representation for the bilingual somewhat similar to the language representation pattern of BrP, from the English pattern, or neither? *Although the results suggest that there is not much of a difference between the groups, we could observe that the representation patterns are similar to English, since the singular count nouns consistently delivered higher probabilities of getting a volume response for English and for bilinguals while this probability were slower for BrP.*

5.5.7 Conclusion

Taken together, our findings suggest that while there is no strong statistical evidence for direct L1 transfer from BrP to English in bilinguals, there is a trend in processing. This trend is particularly evident when bilinguals process singular quantifiers combined with singular count nouns, as reflected in the additional processing time observed in the noun and post-critical regions. Nonetheless, the overall processing patterns of bilinguals align more closely with those of native English speakers than with BrP speakers. The consistent slowdown in response times when encountering singular count nouns suggests that bilinguals have internalized the grammatical constraints of English, which specify atomicity and disallow certain noun-quantifier combinations. Similarly, representation patterns point toward an English-like grammar: bilinguals, like native English speakers, showed higher probabilities of giving volume-based responses to singular count nouns — unlike BrP speakers, whose responses suggested greater interpretive flexibility. Therefore, while traces of L1 influence may still shape certain processing effects, the bilinguals' mental grammar and processing strategies largely reflect their L2, indicating a degree of allignment with the English system.

6 CHAPTER VI — LANGUAGE MISMATCH AND BILINGUALISM

Above all, Chapter VI presents a discussion that connects the ten texts analyzed in the previous chapters to one another and to earlier sections of the dissertation. It aims to relate acceptability, processing, and representation in Brazilian Portuguese (BrP), English, and bilingual language, drawing on the findings of this study, engaging with previous research, and proposing avenues for further discussion.

6.1 A MISMATCH IN THE NOMINAL DOMAIN AND GRAMMAR

In this section, we break down the characteristics of BrP and English, highlighting how they are both similar and different. First, we present the mismatch in the acceptability of non-edible bare nouns between the source and target languages, along with a formal semantic explanation for this contrast. Second, we discuss how the two languages differ in the processing of quantifier phrases. Third, we examine how these quantifiers phrases differ in terms of representation. Finally, we propose a formal semantic account for the mismatch observed in the quantifier domain.

6.1.1 Mismatches in the Bare Nouns of Brazilian Portuguese and English

BrP is a language that, so far, stands out among other Romance languages primarily by accepting both bare singular and bare plurals while other Romance languages have a very restricted use of bare nouns. When it comes to edibility, edible nouns are generally receiving higher judgment values in our study (mean = 4.3 or 85.8%), that is, the edible bare plural is the condition which is most accepted by native speakers of BrP alongside the non-edible plural (mean = 4.3 or 85%). Although edible nouns are also greatly accepted by native speakers of BrP (mean = 4.1 or 77.1%), non-edible singular nouns are generally the least accepted condition (mean = 3.3 or 52.2%). The acceptability of non-edible bare singular nouns observed highlight the key element that makes BrP differ from English: edible and non-edible bare singular nouns are grammatical in BrP in argument position in episodic sentences.

The results obtained by our experiments regarding acceptability reinforced previous studies conducted for BrP by Pires de Oliveira, Silva, and Bressane (2010), Braga, Sena, Mariano, and Pires de Oliveira (2010) alongside, providing further evidence of such

acceptability compared to other languages, in line with Ionin, Montrul, and Santos (2011), Ionin, Grolla, Montrul, and Santos (2014), and Beviláqua and Pires de Oliveira (2021).

BrP contrasts to English when we observe the acceptability patterns across these two languages, confirming Bevilaqua and Pires de Oliveira (2021). English also has the edible bare plural as the most accepted structure (mean = 4.3 or 82.6%), alongside non-edible bare plural (mean = 4.1 or 77.5%). However, the acceptability rates drop when native speakers of English judged edible bare singular nouns (mean = 2.8 or 35.8%), with the non-edible bare singular nouns receiving the lowest acceptability rate, being highly rejected by native speakers (mean = 1.6 or 5.8%). This result aligns with previous studies conducted by Ionin, Montrul, and Santos (2011), and Ionin, Grolla, Montrul, and Santos (2014) in which they show that the bare singular is not accepted in English. Here is important to highlight that count edible bare singulars are not accepted as well, since they received a 2.8 mean rate, indicating that the structure is not well accepted in English if we account that the threshold for acceptability is 3.0 — that is, more than the half of the scale which is also in line with Beviláqua and Pires de Oliveira (2021)

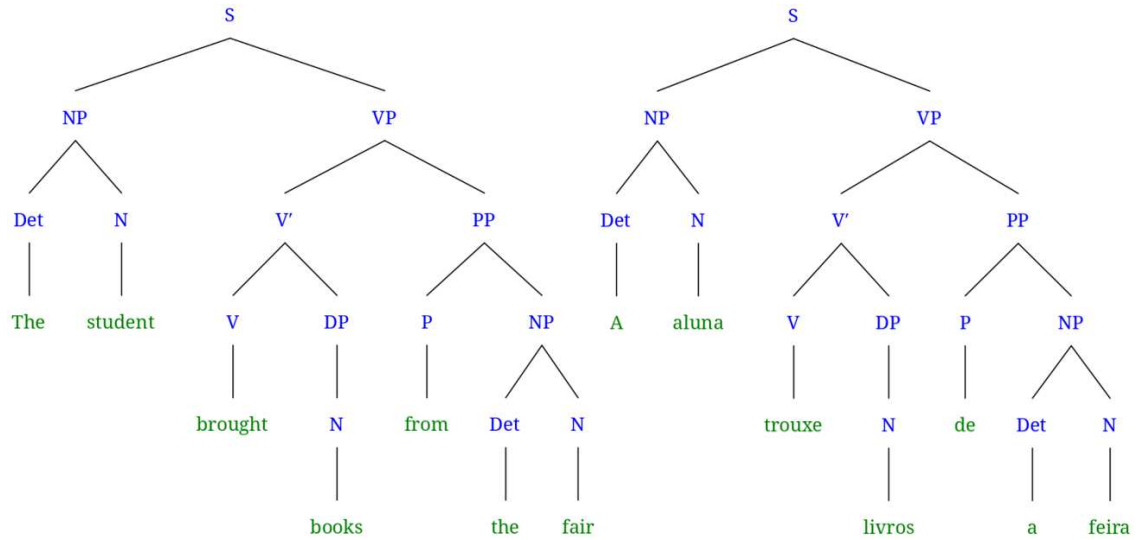
The acceptability results from both English and BrP highlight a mismatch in the use of bare singular nouns: while all bare nouns are accepted in BrP, English allows only bare plurals. These findings offer novel insights into the acceptability patterns across the two languages. Our additional statistical tests with the group comparison allowed us to find statistical evidence that the edible bare singular and non-edible bare singular nouns have statistically higher probabilities of being accepted in BrP while in English they have lower probabilities of being accepted, a difference that was already pointed out by Beviláqua and Pires de Oliveira (2021). Importantly, these results allow us to further propose where exactly this mismatch occurs.

To begin addressing this issue, we first analyze bare plurals — a structure in which the two languages seem to exhibit similar behavior. Based on Chierchia's proposal (1998), bare plurals denote the kind — it can refer to kinds or instantiations of the kind existentially bound. We can further explore the grammar of bare plurals in English and BrP by analysing the sentence (35.a) from our experiment below:

35. a) The student brought books from the fair.
 b) A aluna trouxe livros da feira.

The syntactic structure of the sentence in (35.a) and (35.b) can be represented in the figure 6.1 that follows:

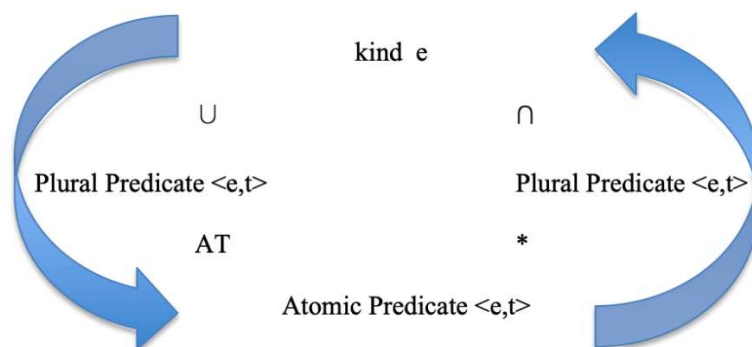
Figure 6.1 — Syntactic structure for non-edible bare plurals in English (left) and Brazilian Portuguese (right)



Source: designed by the researchers on RSyntaxTree.

Focusing on bare plurals, in the sentence above, the bare plural noun ‘books’ serve as the internal argument of the episodic verb ‘bought,’ contributing an existential reading that refers to instances involved in the described event. Taking into account semantic types, in line with Ferreira (2019), a transitive verb is of type $\langle e, \langle e, t \rangle \rangle$, which means it first takes an entity (such as the internal argument ‘books’), and returns a function that takes another entity (the external argument ‘the student’, a definite phrase) and finally returns a truth value. In other words, the verb semantically combines with the internal argument, forming a predicate over individuals, and then with the external argument to yield a proposition. When it comes to the bare plural, it is initially interpreted as a plural predicate type $\langle e, t \rangle$ that turns into kind type e with the $\cap$ (down) operator and then turns to a predicate again with the $\uparrow$ (up) operator (CHIERCHIA, 1998; FERREIRA, 2019). Figure 6.2 from Chierchia (2021) illustrates the process that happens with bare plurals:

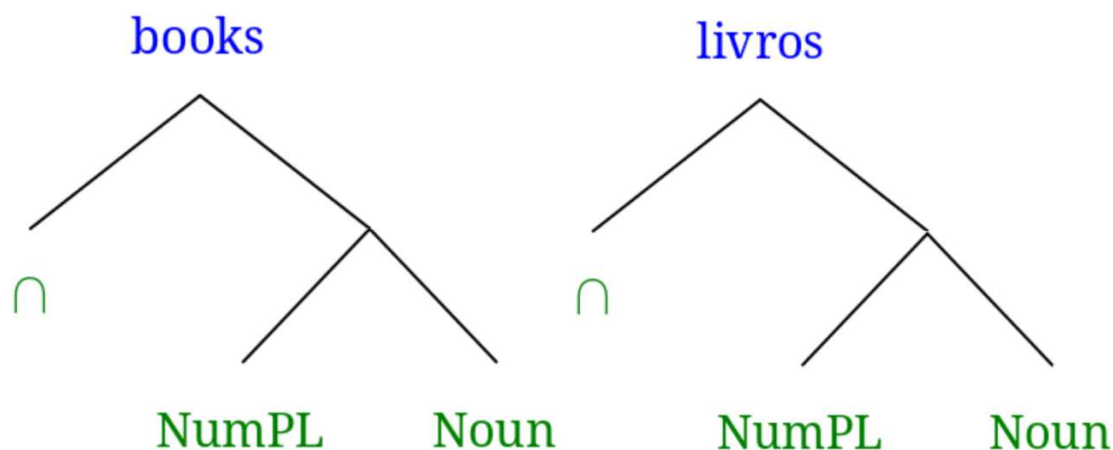
Figure 6.2 — Type shifting illustration from Chierchia (2021)



Source: extracted from Chierchia 2021.

This proposal for bare plurals not only generates English, but also the bare plurals in BrP, as encountered in our study.

Figure 6.3 — Semantic structure of non-edible bare plural for English (left) and BrP (right)



Source: designed by the researchers on RSyntaxTree.

In both languages, when native speakers encounter a bare plural, the derivation involves type-shifting. Specifically, according to Chierchia (1998), the pluralized noun ‘books’ is interpreted as a kind through the application of the $\cap$ (down) operator, which maps a property type $\langle e, t \rangle$ to a kind type e . In episodic contexts, an additional operator selects a set of instances from the kind, yielding an existential interpretation. In contrast, in generic contexts, the $\cap$ shift is applied to retrieve the characteristic property of the kind, leading to a kind-level or generic reading.

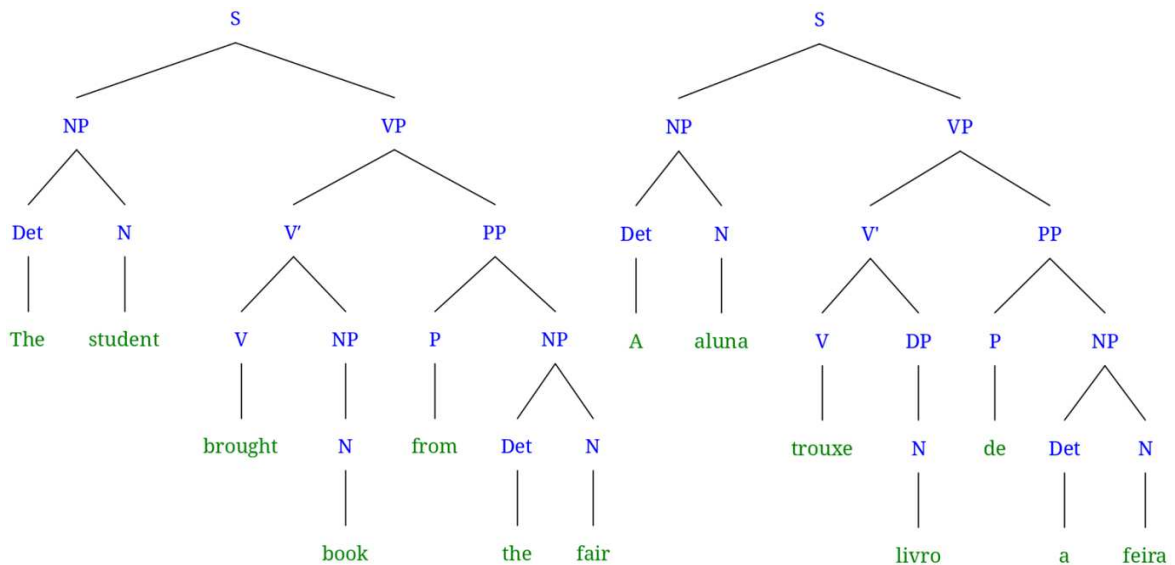
This scenario differs when it comes to bare singulars, which typically do not allow kind-level readings in the same way for English since it is ungrammatical in argument position.

As we have shown by our studies, the bare singular is the source of the mismatch between these two languages. Consider our experimental sentences in (36):

36. a) * The student brought book from the fair.
 b) A aluna trouxe livro da escola.

The syntactic structure for sentence (36.a) in English is the same for (36.b) in BrP. The sentences in (36.a) and (36.b) can be represented in the Figure 6.4 below:

Figure 6.4 — Syntactic structure for non-edible bare singular in English (left) and Brazilian Portuguese (right)



Source: designed by the researchers on RSyntaxTree.

According to Chierchia (1998), in English, bare singular count nouns like ‘book’ are of type $\langle e, t \rangle$ — that is, they function as atomic predicates and cannot serve as arguments without the presence of a determiner. In the sentence (36.a), the verb ‘brought’ selects for a Determiner Phrase (DP), which denotes an individual (type e). However, the bare singular ‘book’ cannot satisfy this requirement on its own because it does not project a DP.

Unlike plurals or mass nouns, which can undergo type-shifting operations to become arguments, English bare singulars cannot shift into kind-denoting expressions via the $\cap$ (down) operator. This is because $\cap$ requires a cumulative predicate, and ‘book’, as an atomic predicate that does not meet that condition. As a result, no type-shifting rule can apply to convert ‘book’ into an entity-denoting expression. Consequently, the derivation crashes, rendering the sentence

ungrammatical due to a mismatch between the verb’s syntactic and semantic requirements and the noun’s denotation. Below we can see the lexical entry for ‘book’:

Lexical Entry:

$[[book]] = \lambda x [book(x) \wedge ATOMIC(x)]$

Plain English: The function that takes individuals and generates the true if they are books and atomic.

Count nouns denote sets of atomic individuals by default, making atomicity a built-in the lexicon (CHIERCHIA, 1998). Because of this, the $\cap$ (down) operator — which maps properties to kinds — cannot apply to bare singulars in English, since it requires a cumulative (non-atomic) predicate as input. As a result, the derivation of a bare singular crashes, and speakers must reanalyze the structure — typically by inserting a determiner (turning the NP into a DP) or by coercing the noun’s meaning into a cumulative mass predicate — to rescue the interpretation. As shown by Frisson and Frazier (2005), and as our own processing studies will later address, such reanalysis incurs additional processing costs in English.

In English, the semantic information (or processor) signals to the parser that reanalysis is necessary, thereby requiring the syntax to reorganize — the processing implications of this reanalysis will be further discussed in the following subsection. This phenomenon is linked to the fact that atomicity is lexically encoded in English nouns: they inherently bear a primitive semantic specification that classifies them, from the root, as either count nouns — which denote sets of atomic individuals and typically receive a cardinal interpretation — or mass nouns — which denote cumulative predicates and receive a non-cardinal interpretation (CHIERCHIA, 1998).

In BrP, this reanalysis does not occur since the lexical entry for bare singular nouns remain open. According to Pires de Oliveira (2019, 2020, 2022, 2025) and our processing studies, bare singulars in BrP are underspecified. That is, native speakers of BrP can access the kind interpretation of ‘livro’ immediately, with the lexical entry remaining open to further specification as the derivation unfolds and contextual information is integrated. As a result, cardinal or volume interpretations are not assigned immediately during derivation, since further information is incrementally integrated as it becomes available.

The status of bare singular in BrP is still disputed in the literature (see SCHMITT; MUNN, 1999; MÜLLER, 2002; PIRES DE OLIVEIRA; ROTHSTEIN, 2011; CYRINO; SPINAL, 2015; PIRES DE OLIVEIRA, 2019; 2020; 2022; 2025), but our role here was to point

out that bare singular nouns represent a mismatch in the acceptability between BrP and English as previously reported by Beviláqua and Pires de Oliveira (2021). Importantly, highlight that this difference between these two grammars appears at the syntactic structure and in the semantic domain. Additionally, we advanced deeper in a difference in noun types encompassing the edibility. It is well discussed in the literature that edibility helps to easily shifts the interpretation of the nouns (see LINK, 1986; FRISSON; FRAZIER, 2005; LIMA, 2019 among others) since it is easy to understand in one context ‘chicken’ as an animal — a count noun —, and in another context as meat. We found that indeed edible bare singular is more acceptable than non-edible bare singulars for both English and BrP. However, the acceptability across our conditions, in general, points toward that bare singulars are, in general, part of BrP language and grammar with its use reflecting in acceptability judgment as the ones devised by us, but in English they are not so well accepted as seen for our studies and the additional processing observed in Frisson and Frazier (2005) studies. Evidence provided by our studies show that in English non-edible count bare singular nouns are rejected and have very low response times, indicating that native speakers of English do not have a doubt when rejecting the structure, because, according to the literature, it denotes a set of atomic individuals. This contrast of acceptability between these both languages highlights that non-edible bare singular nouns are indeed a mismatch between BrP and English, highlighted by the statistical tests conducted throughout the group comparisons, providing a novel finding regarding bare singulars and edibility for these languages.

In a nutshell, the mismatch occurs since in BrP there is no atomicity projection; therefore, all conditions are accepted by native speakers — whether the count noun will be interpreted as cardinal or volume depends on contextual information. However, in English, there is atomicity projection: the verb requires a cumulative predicate in the NP, which is not satisfied by a count noun. Therefore, one of the two rescue operations should be followed: or the NP is reanalyzed as a DP by inserting a determiner before the count noun, or the count noun should be massified via coercion. Either way, both paths in English seem to be dictated by grammar, something that is not observed for BrP. In the next section, we further explain the processing of quantity quantifier phrases, particularly those in which nouns are under the scope of determiner quantifiers.

6.1.2 Brazilian Portuguese and English Processing

As we explored in Chapter V — *Experiments in Language Processing*, we investigated quantifier phrases in a Self-Paced Reading (SPR) experiment combined with an Interpretation Task (IT). In the pluralized condition, the results were categorical: pluralized conditions always received cardinal interpretations, independently from the noun type — whether the noun was count or mass, both of them received cardinal interpretations. Based on our results, this allows us to conclude that the plural is specified for atomicity in both languages, always incurring cardinal interpretations, with atomicity being built into the plural inflection.

In contrast to the consistent behavior of plural forms, singulars conditions exhibit a different pattern, which leads us to the notion of underspecification in processing. The notion of underspecification adopted in this study assumes that the semantic processor leaves the lexical entry open, without immediately assigning an interpretation to the singular quantifier phrase — there is no commitment to any specific meaning. As a result, fewer cognitive resources are engaged compared to cases where an immediate interpretation is required, which in turn affects the reading time for quantifier singular phrases in our SPR task. In this way, the meaning remains temporarily underspecified, allowing subsequent information in the sentence or discourse to guide a more specific interpretation related to cardinality or non-cardinality (FRAZIER; RAYNER, 1990; BEZERRA, 2017).

We challenged the hypothesis that the quantifier singular phrases in BrP would be underspecified for atomicity while in English they would be specified, by proposing a SPR in which we tested singular and plural quantified phrases. The singular ones were where we could observe the mismatch between both languages that we have already observed in the acceptability tests. In BrP, the singular quantifier phrases — that is the singular quantifier ‘muita’ combined with a count singular noun and the singular quantifier with a mass singular noun — did not receive additional processing neither in the quantifier, noun, nor the post critical region. The lack of effect in our statistical tests allowed us to infer that indeed the quantifier singular phrases are subject of underspecification. That is, the semantic processor does not immediately assign an interpretation for the noun headed by the determiner quantifier, but later contextual information would assign its meaning in the absence of biasing evidence.

For English, the combination of the singular quantifier ‘much’ with a count singular noun generated an additional processing time in the post critical region of the quantified phrase. This additional processing is related to the grammatical instruction driven by the grammar. The singular quantifier gives a prior instruction that the following noun to be encountered in the

derivation is a non-count noun — it lexically presupposes that the following noun should be mass; however, what is encountered next in the derivation is a count noun. This generates an incongruency between the grammatical — which is lexically driven by the quantifier — and semantic instructions — which is the primitive meaning of the noun — and the semantic processor signals the parser that the syntactic structure should be reanalyzed. This reanalysis takes additional processing time since the quantifier ‘much’ requires a non-cardinal noun. When the following noun encountered in the derivation is a count noun, the speaker has to transform the count noun into a mass noun — in a process called grinding — therefore attributing a volume reading. In this sense, we have found evidence that English, in line with Chierchia (1998), grammatically carries whether a noun will be atomic, for count nouns, or it will be a cumulative predicate, for mass nouns, in line with previous experiments from Frisson and Frazier (2005) and Scontras et al. (2017). Additionally, the quantifiers in English also lexically encode the information whether they require a count or a mass noun — another aspect that differs from BrP since the singular quantifier papers to be number-neutral which will be latter addressed.

Our modular explanation for the processing of these two languages has an important psycholinguistic outcome: we propose that our processing model has an architecture in real-time processing that is composed by two specialized processors. In our proposal — which is based on our results and discussion — we have a parser, a syntactic processor, that is an informationally encapsulated mechanism that assigns syntactic representations during the course of derivation (FRAZIER; CLIFFTON, 1996), while semantic representations are assigned in parallel, carried out by a different and specialized semantic processor that is dedicated to interpretation (FRIEDERICI, 2011; BEZERRA, 2017, 2025; PYLKKÄNEN, 2019; BEZERRA, PIRES DE OLIVEIRA; CARDOZO; LOPES, 2024).

Additionally for English, we have found evidence for grinding and portioning, in line with Frisson and Frazier (2005) studies. However, our results are, in a sense, novel compared to those reported by Frisson and Frazier, since our experiment focused exclusively on non-edible nouns. This choice was motivated by findings in the literature suggesting that edible nouns are more easily coerced in contexts that favor one reading over another. For BrP, the absence of additional processing in the quantifier singular phrases provided evidence that we have underspecification, meaning that, both the singular quantifier and bare singular nouns do not immediately receive an interpretation. Both lexical entries — the quantifier and the noun — are left open to be latter filled in the derivation, therefore providing empirical support for

Pires de Oliveira (2019, 2020, 2025) and more specifically Pires de Oliveira (2022) argument that the same mismatch appears in other instances of the language.

When we statistically compared BrP and English in a group comparison, our results revealed an interaction between the quantifier and the noun in the noun region, in which native speakers of BrP were slower than native speakers of English. This is an interesting result, as it shows that the conditions in English, which is a language that grammatically carries the information whether a noun will be count or mass, are processed generally faster than BrP, which is underspecified. Although it might be counterintuitive, it appears to be easier for the semantic processor to immediately assign an interpretation than to leave a lexical entry open to be completed later in the derivation. One hypothesis we may propose for English is that, since the syntactic structure encodes atomicity for the quantifier, it acts as a predictive cue for the upcoming noun — constraining the semantic processor to either a count or mass interpretation in advance. This facilitates processing by allowing early semantic commitment.

In contrast, the grammar of BrP lacks overt cues that signal to the semantic processor that the structure is specified. As a result, it provides no information about atomicity and does not promote early semantic commitment. In this sense, although initial underspecification may facilitate early stages of processing, if subsequent elements continue to lack cues for atomicity, this may slow down later stages of the derivation or result in a generally slower processing pace as contextual information is integrated. This might be attributed to the two possible interpretive paths — cardinal or volume — when processing the following noun.

Importantly, specification only hinders processing when reanalysis is required. This supports the idea that specification for atomicity yields faster processing than underspecification — at least when comparing English, which is a language that encodes atomicity in its grammar, and BrP, a language that does not carry such information grammatically.

6.1.3 Brazilian Portuguese and English Representation

As discussed, our SPR task was combined with an IT which allowed us to capture information about the interpretation of the sentences tested alongside its response times. For BrP, the interpretation regarding the singular quantifier ‘muita’ combined with a singular count noun and a condition combined with a mass noun, captured oscillation in the interpretation of these conditions. The oscillation was 2/3 for cardinal for count nouns and 2/3 for volume with mass nouns. This indicated that BrP is not only subject of underspecification regarding the

singular nouns, but also in the quantifiers, since the singular quantifier also did not drive the interpretations, which may support our previous claim about the semantic commitment. These results were in line with Pires de Oliveira (2019, 2020, 2023, 2025), and Beviláqua and Pires de Oliveira (2014, 2017, 2019, 2020). In contrast, the plural quantifier ‘muitas’ combined with plural count and plural mass noun were closer to categorical cardinal interpretations.

The results for English were somewhat different. The singular quantifier ‘much’ when combined with a count noun, generated random answers. That is, native speakers of English did not know what to do when it comes to the interpretation of the sentence since there were two incongruent information: one morphological, provided by the quantifier which signaled that the following noun should be a mass noun; and one semantic, providing semantic information that the following noun was count. This generated a crash between morphological and semantic information and the speaker did not know how to interpret the sentence, providing random answers — half cardinal and half volume. Interestingly, the singular quantifier with a mass noun was not felicitous as well: 2/3 of the interpretations were volume, while others were cardinal while we were expecting close to categorical volume interpretation, they oscillated as well. The plural conditions all received cardinal interpretations, just like BrP.

In a sense, our studies on processing provided novel findings not only for BrP, bringing experimental evidence for the underspecification for Pires de Oliveira (2019, 2020, 2022), but also novel findings for English, which showed the processing and the semantics of quantity quantifier phrases, providing further evidence for Frisson and Frazier (2005).

Our group comparison for the processing studies highlighted that these two languages are different with respect to quantifier phrases. In English, the singular quantifier ‘much’ semantically refers to an unspecified large quantity that cannot be easily counted, while the plural quantifier ‘many’ semantically refers to an unspecified large number of things that we can directly combine with numbers. This implies grammatical consequences in which the singular quantifier selects mass nouns, while the plural quantifier selects count nouns. This is different for BrP, since ‘muita’ is semantically underspecified for atomicity, just like bare singular nouns, neither grammatically selecting a count noun nor a mass noun, but can appear to select both noun types.

The mismatch that permeates both grammars was the central object of study throughout this dissertation. This mismatch appears in bare nouns, as discussed in the literature, but also in quantifiers, as we have shown, providing empirical support for Pires de Oliveira (2022), who argued that the same mismatch encountered in bare nominals also appears in other parts of the grammar, such as quantifiers. That is, since BrP count nouns are semantically underspecified,

the grammar allows for the generation of number-neutral quantifiers in which both the quantifier and the count noun do not lexically encode atomicity. The semantics of the quantifiers are discussed in the following subsection.

6.1.4 Mismatches in the Quantifier Phrases in Brazilian Portuguese and English

Taking the processing and acceptability of the previously discussed structures, researchers have raised hypothesis related to how these constructions would be processed and interpreted in a system that has both bare plurals and bare singulars as BrP. Lima (2019) has investigated how these configurations would be processed and the lack of additional reading times in the researcher's experimental sentences containing bare nouns has led Lima to argue that bare singular nouns are interpreted via pragmatics. Even though pragmatics seems to explain the behaviour of bare singular nouns, Pires de Oliveira (2019, 2020, 2022) has claimed in a more semantic trend that bare singular nouns would have its processing underspecified. In other words, bare singular nouns would lack a primitive meaning tied to either cardinality or non-cardinality — they would not inherently denote volume, weight, or other interpretations — but would denote the kind being underspecified with respect to atomicity.

The results from our experiments with quantifier phrases combined with bare nouns have provided support in favor of the underspecification hypothesis from Pires de Oliveira (2019, 2020, 2022) not only for bare nouns, but encompassed the nominal domain. The experiment with quantified phrases has shown that in fact not only the bare nouns are underspecified for atomicity, but also the singular quantifier 'muita' in which both — singular quantifier and count noun — did not received additional processing during the course of derivation. This result pointed in the direction of confirming Pires de Oliveira (2020) hypothesis in which the underspecification for atomicity is not only present in the bare singular nouns, but spreads over BrP grammar, appearing also in the quantifiers. Scrutinizing the underspecification, we did not find additional processing neither for singular quantifiers combined with count and mass nouns nor for plural quantifier with plural count nouns. However, we did find additional processing time for plural quantifier combined with a pluralized mass noun.

This latter finding allow us to infer that the plural inflection is specified for atomicity. That is, this was the only condition in which there were morphological instruction to count, and this instruction was present in the plural inflection. The plural quantifier 'muitas' comes specified for atomicity in the derivation, therefore requiring a count noun. However, what was

present in the derivation was a pluralized mass noun, therefore the native speaker of BrP had to reanalyze the mass noun as a portionalized substance, undertaking a portioning process — incurring additional processing time to save the derivation of the noun that was firstly understood as a substance, but it had to be reinterpreted as portions of that substance. The plural conditions are the only ones in which we have a match between BrP and English in terms of processing. In this sense, we propose a lexical entry for the plural morphology for BrP in line with Pires de Oliveira and Cardozo (in preparation), since it presupposes a count noun:

Lexical Entry:

$[[-s]] = \lambda P: P \text{ is countable. Sum of } P(x)$

Plain English: The plural suffix ‘-s’ applies to a countable noun (P), and forms a new meaning that refers to the sum of all individual members of that noun’s set. This creates a plural entity that includes all instances of P — forming what is known in semantics as a lattice structure.

In English, the plural quantifier ‘many’ is specified for atomicity, requiring a pluralized count noun. When a native speaker of English encounters such construction, reading is unimpaired. However, if after the plural quantifier the native speaker encounters a pluralized mass noun, then processing is hindered since the English speaker has to reanalyze the structure — that is, take the mass noun reanalyzed as a count noun that has a cardinal interpretation, undertaking the portioning process and understanding that that noun is read as portions of a substance. This reanalysis takes additional processing times in English, and also for BrP. This is evidence that both languages have the same semantic underpinnings for pluralized quantifier phrases.

According to our results, ‘many’ in English and ‘muitas’ in BrP exhibit a cross-linguistic match. Based on this observation, we present a lexical entry for ‘many’, following Chierchia (1998) and Pires de Oliveira and Cardozo (in preparation):

Lexical Entry:

$[[\text{many}]] = \lambda Q. \lambda P: Q \text{ is a sum of atoms. } |Q(x) \cap P(x)| > n$

Plain English: ‘Many’ is a quantifier that takes two properties: (1) a restrictor (Q), which must be a predicate of sum of atoms such as ‘feathers’ and ‘tables’; and (2) a predicate (P) that applies to the elements of Q. This plural quantifier is true if the

number of individuals that are in both sets (Q and P) is greater than a contextually determined numeral (N).

The semantic type of ‘many’ is $\langle\langle e,t \rangle, \langle\langle e,t \rangle, t \rangle\rangle$ which takes two predicates (sets of individuals) and returns a truth value. The semantic feature that is lexically encoded in the plural quantifier ‘many’ is that it presupposes a plural count noun and operates over a contextually given value. That is, the plural quantifier ‘many’ selects for plural count nouns, as we can observe by the examples below:

37. a) Many children
 b) Many books
 c) * Many water
 d) * Many book

Its nature is quantificational. It encodes atomicity, presupposing that it combines with nouns that should be countable and it triggers the plural morphology on the noun. The same lexical entry can be proposed for ‘muitas’ in BrP since they behaved in a similar way in our study.

In BrP, ‘muita’ appears to be semantically number-neutral, as it can combine with both count and mass nouns. It does not reject either category, and it agrees morphologically in number⁸⁵ with the noun it modifies. Below we propose a lexical entry for ‘muita’ in BrP in line with Pires de Oliveira and Cardozo (in preparation) and in accordance with Chierchia (1998):

Lexical entry:

$$\llbracket \text{muita} \rrbracket = \lambda Q. \lambda P. [Q(x) \wedge P(x) \wedge \mu(x) \geq d]$$

Plain English: ‘Muita’ is a quantifier that applies to two properties Q which is the set of things being talked about, and P which is a property or action related to those things. It is true if there is amount (or some) x that belongs to both Q and P, and the measure (amount or quantity) of x is greater than some contextually determined threshold d.

⁸⁵ In BrP, ‘muita’ also agrees in gender, but this discussion is beyond the scope of our research.

The singular quantifier in BrP is number-neutral. That is, the BrP grammar does not presuppose any specific noun type or measure scale, with interpretation being solely contextually driven (PIRES DE OLIVEIRA; ROTHSTEIN, 2011). Therefore, this claim is in line with the underspecification hypothesis that we have raised throughout this dissertation, since BrP does not grammatically encode a semantic feature related to either count or mass. Below, we can observe some examples:

38. a) Muita criança
 b) Muita água

The difference between ‘muita’ in BrP and ‘much’ in English, is that ‘much’ has a preference to select non-cardinal items. That is, requires a cumulative predicate as we can observe the lexical entry for ‘much’ in English based on Chierchia (1998) and Pires de Oliveira and Cardozo (in preparation):

Lexical entry:

$\llbracket \text{much} \rrbracket = \lambda Q. \lambda P: Q \text{ is mass. } Q(x) \cap P(x) \geq \mu d$

Plain English: ‘Much’ is a relation between two predicates. The quantifier applies to Q that comes with a presupposition of mass and then examines whether the intersection with P is greater than a certain measure d given by the context.

In the lexical entry we can observe that P presupposes a mass predicate, for example ‘water’ or ‘rice’ while, $\mu(x)$ is a measure function operating over quantity, volume, amount, extent, or weigh, but not cardinality. The singular quantifier ‘much’ combines with mass nouns, as we can observe by the examples below:

39. a) Much water
 b) Much sand
 c) * Much child
 d) * Much children

Therefore, its nature is quantificational, expressing a large amount of a non-countable substance. Not only ‘much’ but also ‘many’ and ‘muitas’ are not number neutral. While the

plural quantifiers presupposes that the noun denotes a count predicate, the singular quantifier ‘much’ presupposes that the noun denotes a mass predicate.

In summary, ‘muita’ in BrP combines with both mass and count nouns, as observed by the examples in (39) above. Given the results from our studies, ‘muita’ is also underspecified for atomicity, just like bare singular nouns, since neither the bare singular nor the singular quantifier in BrP is subject to additional processing time. The bare singular can receive both cardinal and volume interpretations, and the singular quantifier can accept both noun types as predicates, providing evidence that the semantic underspecification of atomicity spreads across BrP grammar, as theoretically proposed by Pires de Oliveira (2020), for which we now provide empirical evidence throughout our studies. The following table summarizes the mismatch in the quantifier system between BrP and English:

Table 6.1 — Mismatch in the quantifier phrases summary

Quantifier	Presupposition	Scale	Observations
Many	Count noun	Cardinality (counting atomic individuals)	Only with count nouns; plural morphology mandatory
Much	Mass noun	Measure (volume, amount, furniture etc.)	Only with mass nouns; no plural morphology
Muitas	Count nouns	Cardinality (counting atomic individuals)	Only with count nouns; plural morphology mandatory in the quantifier
Muita	no presupposition	Measure; underspecified semantic scale	Number-neutral; flexible usage with mass and count nouns

Source: designed by the researchers.

In a nutshell, the singular quantifier in BrP, ‘muita’, is number-neutral, working with both count and mass nouns since the scale is open (PIRES DE OLIVEIRA; CARDOZO, in preparation). On a similar note, the plural quantifier in BrP, ‘muitas’, behaves like ‘many’, being used with count predicates and relying on cardinal interpretations, while the singular quantifier ‘much’ in English requires a mass predicate and relies on volume interpretations. The singular quantifier in English, ‘much’, and the plural quantifier, ‘many’, lexically encode

atomicity information, whereas ‘muitas’ carries atomicity information through plural inflection, and ‘muita’ in BrP does not carry any atomicity information. Such semantic outcomes have psycholinguistics implications about underspecification in which we have explored previously in this dissertation.

Having outlined the mismatch in the nominal domain between BrP and English, we now turn our focus to bilingual speakers, the primary group influenced by this contrast. This topic is the subject of our final discussion in the following subsection.

6.2 BILINGUALISM AND LANGUAGE MISMATCH

In this section, we examine the acceptability judgments of bare singular nouns by native speakers of BrP when evaluating bare nouns in English. Additionally, we explore the underlying processes involved in bilinguals’ processing of quantifier phrases, primarily drawing on Slabakova’s work, while also incorporating insights from Grosjean.

6.2.1 Language Mismatch and the Bilingual Behavior

The bilingual group in our study was the main experimental group. Although the experiments with native speakers helped us document how each language provides judgment values for bare nouns and response times — thus allowing us to conduct a group comparison to verify whether there was a mismatch between languages — the bilingual group informed us whether the mismatch between grammars resulted in transfer.

The results from our bilingual group were somewhat subtle but indicated a clear tendency: bilinguals tended to accept edible bare plurals (mean = 4.1 or 79.3%), non-edible bare plurals (mean = 4.3 or 85.3%), and edible bare singulars (mean = 3.0 or 45.7%), while tending not to accept non-edible bare singular nouns (mean = 2.7 or 42.2%).

Although bilinguals showed a tendency not to accept non-edible bare singular nouns, their mean scores and acceptance percentages were considerably higher than those of native speakers of English, who showed a mean of 1.6 or 5.8%. This indicates a substantial difference between the two groups.

The group comparison statistically confirmed that non-edible bare singular nouns were the main driver of transfer from BrP L1 to English L2. In other words, bilinguals were significantly more likely than native English speakers to accept non-edible bare singular nouns, revealing a clear effect of L1 influence.

Although the mean judgment values from bilinguals (mean = 2.7 or 42.2%) were lower than those from native speakers of BrP (mean = 3.3 or 52.2%), this difference was not statistically significant in the post hoc analysis. Nevertheless, this pattern still aligns with the overall evidence of transfer from L1 to L2.

Our findings provide empirical evidence of transfer, supporting Slabakova's (2016) account and contributing further to the transfer literature. Ionin, Grolla, Montrul, and Santos (2014) found evidence of transfer when native speakers of English judged the acceptability of bare nouns in BrP, but did not find comparable evidence for transfer in the opposite direction. Our results provided evidence that there is a transfer when native speakers of BrP provided judgment values for bare singular nouns in episodic sentences.

Because our bilingual participants were intermediate learners of English, we believe the AJT was well suited to capturing this phenomenon. The task allowed participants to read full sentences and reflect before rating them, giving room for post-processing reasoning to influence their judgments. This reflection likely involved drawing on knowledge from both their native and additional languages — both of which we have already discussed in the first subsection of the current chapter — allowing us to capture the transfer effect.

In summary, our results have shown that there was transfer from the acceptability patterns of BrP (L1) — the source language — to English (L2) — the target language. This suggests that our bilingual participants have an intermediate grammar composed of elements from both BrP and English, with the former exerting influence on the latter. This shows that the bilingual linguistic system is still under development. In the following subsection, we investigate whether quantifier phrases are also a source of transfer from L1 to L2.

6.2.2 Bilingual Language Processing and Representation

The results from our bilingual group indicated that bilinguals behaved more similarly to native speakers of English than to native speakers of BrP in terms of processing. Our interpretation, following Chierchia (1998), is that English grammatically encodes atomicity, such that the quantifier 'much' lexically presupposes a non-atomic (mass) noun, while 'many' presupposes an atomic (count) noun. These semantic distinctions are encoded in the grammar and are part of the lexical specification of quantifiers. The bilingual group's behavior suggests that such semantic distinction was acquired from English, guiding their processing and representation patterns. This aligns with Slabakova's (2008, 2016) claim that L2 learners can acquire L2-specific semantic features when these are grammatically encoded — providing an

explanation for why our bilinguals patterned more closely with native English speakers than with native speakers of BrP.

Delving deeper into a grammatical explanation, our proposal is in line with Slabakova's Bottleneck Hypothesis (2008, 2016), which suggests that functional morphology poses the greatest difficulty in L2 acquisition, while semantic features that are grammatically encoded can be successfully acquired. Since atomicity is encoded at the semantic-lexical interface in English — especially through the count/mass distinction and the lexical semantics of quantifiers like 'many' and 'much' — our results suggest that bilinguals acquired this semantic distinction and relied on it during processing, including in coercion contexts.

However, our group comparison has shown that bilinguals were, in fact, slower than native speakers of both English and BrP, especially in the noun regions for the conditions with the singular quantifier and count noun, and the plural quantifier with mass nouns. This indicates that although bilinguals have acquired the semantics of English, they still struggle to process quantifier—noun incongruencies.

Additionally, they showed increased processing effort for the singular quantifier with mass nouns. This result differs from both native speaker groups. Therefore, it suggests that although they have acquired the lexically encoded semantics of the nouns, they are still operating with an intermediate grammar, and the quantifier 'much' appears to be the most difficult for them. That is, learners of English whose L1 is BrP tend to use 'much' more often than 'many' — the plural quantifier with a count noun did not result in additional processing.

Building on the internalist perspectives discussed in the Theoretical Background section, our experimental results provide empirical evidence of both transfer and successful acquisition of L2-specific features. The bilinguals' acceptance of non-edible bare singular nouns aligns with Schwartz and Sprouse's Full Transfer/Full Access Hypothesis, while their acquisition of the count–mass distinction in quantifier processing corroborates Slabakova's Bottleneck Hypothesis, which predicts that semantic features encoded in the grammar are learnable. Taken together, these findings confirm that bilingual competence must be studied as a representational phenomenon, shaped by transfer, constrained by Universal Grammar, and gradually restructured through L2 input.

6.3 FINAL CONSIDERATIONS OF THE CHAPTER

In conclusion, Chapter VI has provided a comprehensive account of the mismatch between BrP and English in the nominal domain, focusing on bare nouns and quantifier phrases

across acceptability, processing, and interpretation. The results clearly demonstrate that BrP allows semantic underspecification — observable in both bare singular nouns and the quantifier ‘muita’ — while English grammar encodes atomicity more rigidly through its lexical and morphosyntactic constraints. These contrasts led to divergences in real-time processing and interpretive outcomes, especially when semantic expectations are violated. Crucially, bilingual data revealed signs of L1 transfer, particularly in the acceptability of non-edible bare singular nouns in English, confirming that mismatches between grammars can surface in L2 judgment patterns. Taken together, these findings support and extend the underspecification hypothesis for BrP and underscore the importance of functional morphology in cross-linguistic acquisition and processing, as predicted by Slabakova’s Bottleneck Hypothesis. The chapter thus not only characterizes the structural contrasts between BrP and English but also highlights their psycholinguistic consequences for bilingual speakers, setting the stage for the final discussion on how such mismatches influence language learning and representation in bilingual minds.

7 CHAPTER VII — FINAL REMARKS, LIMITATIONS, AND PEDAGOGICAL IMPLICATIONS

7.1 FINAL REMARKS

Our research has shown that there is a mismatch between languages, and this mismatch permeates Brazilian Portuguese (BrP) grammar, particularly in the quantifier system and in the use of bare nouns when compared with English. BrP is a language that accepts bare singular nouns in general. In other words, the presence or absence of plural morphology in bare singular nouns does not affect acceptability. Additionally, our acceptability tests have shown that the use of bare singular nouns is increasing in BrP, compared to previous studies such as Pires de Oliveira, Silva, and Bressane (2010), and Braga, Sena, Mariano, and Pires de Oliveira (2010). With respect to edibility, edible bare singular nouns are generally more accepted than non-edible ones.

English does not accept bare singular nouns in the same way, indicating differences that the two languages exhibit different acceptability patterns. This mismatch in acceptability has already been reported by Beviláqua and Pires de Oliveira (2021), which we have further confirmed.

Bilinguals are affected by these differences in acceptability. They show lower judgment values with respect to bare singular nouns but still accept them more often than native speakers of English. This suggests that bilinguals possess an intermediate grammar influenced by both competing languages. We interpret the bilinguals' results as indicating a sensitivity to this structure, while still relying on the grammar of their native language — providing evidence of transfer. These results are in line with the Bottleneck Hypothesis (BH) proposed by Slabakova (2006, 2008, 2016).

Our processing studies have provided evidence that this mismatch, which was observable in the acceptability tests, also manifests in terms of processing and representation.

Quantifier phrases in BrP have underspecified processing; that is, singular quantifier phrases do not receive an immediate interpretation by the semantic processor — the interpretation is left open, not incurring additional processing costs when different configurations of quantifiers and bare nouns are presented since the scale is given by the context. Assigning a cardinal or volume reading does not impose any cognitive load. Interpretations may oscillate for singular quantifiers with mass and count nouns, but they do not affect response times. Additionally, the singular quantifier 'muita' is number-neutral,

accepting count and mass nouns in the derivation. Our results are in line with the Underspecification Hypothesis, as proposed by Pires de Oliveira (2019, 2020, 2021, 2022, 2025).

On the other hand, English has atomicity built into its grammar. That is, English lexically encodes whether a noun should be interpreted as cardinal or volume. This information is also encoded in quantifiers. Because English carries this semantic information, when the quantifier and noun type are manipulated — for example, in incongruent combinations such as ‘much’ with a count noun — this results in increased processing time and leads native speakers of English to withhold interpretation, often producing random responses to sentences containing such ungrammatical constructions. Our results provide empirical support for Chierchia (1998), who argues that English has atomicity built-in.

Once again, this makes it clear that the two grammars are processed and interpreted differently. Consequently, bilinguals are exposed to this mismatch. Our bilingual participants exhibited longer processing times under the same conditions as native English speakers, along with spread cognitive load in the nouns and post-critical regions when processing singular quantifier phrases — particularly those combined with count nouns. Additionally, the bilinguals demonstrated that the semantic feature of atomicity, as encoded in English grammar, is learned early and acquired within the target language. This distinction is reflected in their interpretation patterns, which aligned closely with those of native English speakers. This provided further evidence that, while the acquisition of English is influenced by transfer, key semantic features are eventually acquired, allowing for native-like interpretations of quantifier phrases.

We take the bilinguals results as evidence that such semantic features are learned within the language, as hypothesized by Slabakova (2016). Additionally, we have found evidence supporting two competing hypotheses.

The first is the BH, which claims that certain aspects of additional language grammar are more difficult to acquire, particularly functional morphology. We argue that bare nouns exemplify such difficulty, since the relevant morphological cues are absent in BrP, and bilinguals must acquire this distinction when learning English. Although this is an unconscious process, it is reflected in reading times during key conditions involving quantifier phrases with bare singular nouns, which led to increased processing time in the noun and in the post-critical regions. This provides an explanation of the transfer observed in the Acceptability Judgment Task (AJT).

The second is the Restructuring Hypothesis (RH), which proposes that bilinguals are capable of acquiring semantic distinctions from an additional language, even where they differ

from the L1. Our bilingual participants, despite encountering difficulties when processing singular quantifier phrases, also displayed a processing pattern similar to that of native speakers of English, with increased processing times in the same regions. Strikingly, they provided the same interpretation patterns as native speakers, offering a support for the RH.

Taken together, these results, alongside Chierchia's (1998) claim that atomicity is encoded in English grammar and that in BrP the noun and the quantifier are neutral, lead us to believe that our data provide empirical support for both the Bottleneck Hypothesis and the Restructuring Hypothesis.

In conclusion, our findings do not refute our working hypothesis revealing a persistent mismatch between BrP and English in both grammatical representation and processing, particularly with respect to quantifier phrases and bare nouns. While BrP allows bare singular nouns freely and exhibits underspecified processing for quantifier phrases — resulting in no cognitive cost during interpretation — English encodes atomicity lexically, making incongruent quantifier-noun pairings semantically and cognitively disruptive. This cross-linguistic asymmetry was confirmed by both our acceptability and Self-Paced Reading (SPR) experiments. Bilingual speakers exposed to both systems showed an intermediate grammatical pattern: although they experienced increased processing costs when confronted with quantifier-noun mismatches in English, their interpretation patterns closely aligned with native speakers of English. These results provide compelling evidence for two theoretical accounts. First, in line with the BH (SLABAKOVA, 2006, 2008, 2016), in which bilinguals demonstrated difficulty with functional morphology due to the absence of relevant morphological cues in their L1, as reflected in their slower reading times for critical structures. Second, in support of the RH, since our bilinguals exhibited sensitivity to the semantic properties of English quantifiers, acquiring distinctions not present in their L1. Taken together, our study supports the view that certain semantic features — such as atomicity — are acquired within the target language and that bilingual grammars, while shaped by transfer, can restructure over time to reflect L2-specific properties. Next, we retake the general RQs from this dissertation.

7.1.1 Main Research Questions Retaken

RQ1. Is there a mismatch between BrP and English in the distribution and interpretation of bare nouns and quantity quantifier?

The mismatch manifests in the nominal domain. The quantifier ‘muita’ is number-neutral — accepting both count and mass nouns — and bare nouns have their interpretation initially open, which are later assigned either a cardinal or volume. This results in semantic underspecification: neither the quantifier nor the noun incurs additional processing cost.

In contrast, English lexically encodes atomicity in both quantifiers and nouns. That is, quantifiers like ‘much’ and ‘many’ lexically encode whether the following noun should be count or mass. Manipulating the quantifier type and noun type — especially in incongruent pairings — leads to increased processing time and inconsistent interpretations. As a result, the processing of such structures in English is semantically specified and more rigid.

In summary, BrP allows interpretive flexibility, with meaning often deferred to the noun, while English exhibits morphosemantic strictness, encoding atomicity directly in the grammar and generating increased processing costs when incongruencies occur between quantifier and noun.

RQ2. How do bilinguals process and resolve the mismatch between bare nouns and quantity quantifiers?

Bilinguals cope with the mismatch between quantifiers and bare nouns in Brazilian Portuguese and English by developing an intermediate grammar that reflects features of both languages. In BrP, quantifier phrases are underspecified: quantifiers like ‘muita’ are number-neutral and do not encode atomicity, while bare singular nouns have an open interpretation, later receiving cardinal or volume readings without additional processing costs since there is no unit given grammatically, being compatible with both count and mass nouns. In contrast, English quantifiers such as ‘much’ and ‘many’ and nouns lexically encode atomicity, making the language more

morphosemantically rigid. This difference results in asymmetries that extend to acceptability, processing and representation patterns.

When bilinguals encounter incongruent quantifier—noun combinations in English, they exhibit longer reading times and higher sensitivity to mismatches than monolingual BrP speakers. Although they show difficulty processing incongruent structures such as ‘much table’ as native speakers of English, their interpretation patterns often align with those of native English speakers. This suggests that bilinguals are gradually acquiring the L2-specific constraints and distinctions.

These findings support two complementary theoretical accounts. First, consistent with the Bottleneck Hypothesis, bilinguals struggle with functional morphology, due to the absence of comparable morphological cues in their L1. Second, they also provide evidence for the Restructuring Hypothesis, as bilinguals demonstrate the ability to internalize semantic features that differ from their L1 — namely, the encoding of atomicity in English.

In summary, bilinguals show evidence of cross-linguistic transfer, from BrP, but they also tend to exhibit a restructuring of their grammar to accommodate L2-specific semantic properties, coping with the mismatch through gradual adaptation and sensitivity to L2 patterns.

7.2 LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

A study of this size has many limitations. Some of them we highlight in the following:

The Acceptability Judgment Task (AJT): One possible limitation we may have encountered is the unrestricted time participants had to reread the sentences and reflect on their judgments. Although the results aligned with our expectations, we believe that a timed AJT might have been more informative, as it could have reduced the likelihood of participants assessing metalinguistic knowledge. By limiting reflection time, a timed task may better capture intuitive grammaticality judgments, rather than those influenced by conscious reasoning.

The Self-Paced Reading Task (SPR): Our SPR task yielded rich and valuable results, shedding light on the behavior of nouns and quantifiers in BrP. However, it remains a somewhat rudimentary tool in terms of capturing natural reading behavior. Notably, the task does not

allow participants to make regressions, which are a natural part of fluent reading and can provide important cues about reanalysis and processing difficulty. Future research could benefit from incorporating eye-tracking methodologies, which offer a more detailed and ecologically valid picture of real-time sentence processing by capturing fixations, regressions, and reading paths of quantifier phrases further challenging the underspecification of quantifier phrases.

The Interpretation Task (IT): This tool still requires further investigation at the interface between semantics and cognition. Since the linguistic input is the main driver of noun interpretation, the nouns selected for investigation must be carefully considered. In our study, one limitation we encountered involved the interpretation of mass nouns, as we possibly captured packaging and grinding effects. For example, the combination of the singular quantifier ‘much’ with the singular count noun ‘silver’ received more volume-based interpretations than cardinal ones, while we were expecting strictly categorical volume interpretations. This may have occurred because participants might have interpreted the noun as ‘pieces of silver,’ rather than as a single piece of silver. Additionally, the figures in our study only allowed for polarized interpretations. That is, we did not account for intermediate judgments — such as a greater tendency toward volume than cardinality, or vice versa — as Lopes (2024) did. This can be seen as a potential limitation. Furthermore, the IT still lacks a deeper discussion regarding what should be considered volume-based interpretations as triggered by the geometrical figures. Volume-based interpretations may involve volume, weight, size, area, among others since mass nouns denote non-atomic substances that are not naturally divided into countable units (CHIERCHIA, 1998). It remains unclear how to mitigate these additional interpretations, as our goal is not to quantify mass nouns in any physical sense.

7.3 PEDAGOGICAL IMPLICATIONS

This research carries several and important pedagogical implications for second language instruction, particularly in the context of English learning by native speakers of BrP. The observed mismatch between quantifier — noun structures in BrP and English — especially regarding bare noun usage and the encoding of atomicity — highlights the need for targeted instructional strategies.

First, because BrP allows bare singular nouns and treats quantifiers like ‘muita’ as semantically underspecified, learners may not intuitively recognize the ungrammaticality of analogous structures in English (e.g., ‘much feather’ instead of ‘many feathers’). As such,

teachers should explicitly highlight the morphosyntactic constraints of English quantifiers and the necessity of determiners or plural morphology with count nouns.

Second, instruction should address the fact that English quantifiers are morphosemantically stricter: quantifiers like ‘much’ and ‘many’ are sensitive to whether the noun is count or mass. Explicit focus on quantifier—noun agreement, perhaps through focused input, contrastive analysis, or form-focused tasks, can help learners internalize these distinctions and avoid fossilization of L1 transfer patterns. One instructional alternative is to teach students a semantic test to distinguish between count and mass nouns. Learners can be encouraged to check whether a noun can naturally combine with a numeral, as in ‘three tables, or whether it requires a measure phrase, as in ‘three drops of blood’. If the noun combines directly with a number, then ‘many’ is the appropriate quantifier. If the combination sounds odd or unnatural without a measure phrase, then ‘much’ should be used instead. This can be done even with their native language.

Third, the processing results suggest that mismatches between BrP and English not only affect grammaticality judgments but also impact real-time comprehension. This supports the use of processing-based approaches in the classroom, such as input enhancement, timed reading tasks, and structured output activities that encourage learners to notice and produce quantifier—noun pairings accurately under time pressure.

Finally, these findings contribute to broader models of bilingual development and suggest that semantic restructuring is possible even when L1 and L2 differ significantly. This encourages educators to adopt a developmental view of language learning, recognizing that learners may go through intermediate stages where transfer effects are still visible but gradually decrease as L2 sensitivity increases.

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APPENDICES

APPENDIX A — UFSC'S PROTOCOL APPROVAL

UNIVERSIDADE FEDERAL DE
SANTA CATARINA - UFSC



PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: VARIAÇÃO SEMÂNTICA E INFLUÊNCIA NO SISTEMA NOMINAL DO PORTUGUÊS DO BRASIL (L1) PARA O INGLÊS (L2): UM ESTUDO EXPERIMENTAL

Pesquisador: DIONATAN BASTOS CARDOZO

Área Temática:

Versão: 2

CAAE: 67809923.1.0000.0121

Instituição Proponente: Centro de comunicação e expressão

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 6.054.683

Apresentação do Projeto:

Projeto de pesquisa de Dionatan Bastos Cardozo, doutorando do Programa de Pós-Graduação em Inglês da UFSC, supervisionado por Roberta Pires de Oliveira (orientadora) e Gitanna Brito Bezerra (co-orientadora).

Busca verificar empiricamente a influência semântica da Língua Nativa (L1) Português do Brasil (PB) sob a Segunda Língua (L2) inglês através do Sintagma Nominal Nu (SNU) e os quantificadores cumulativos que mostram uma diferença entre essas duas gramáticas.

Dois experimentos serão realizados.

O experimento 1 tem como objetivo acessar a representação linguística, trazendo evidência empírica da semântica do Sintagma Nominal Nu (SNU) através da Tarefa de Julgamento de Quantidade (TJQ) para determinar se esses sintagmas recebem interpretação cardinal, de volume, ou ambas, e se há uma influência semântica entre o PB e o inglês quando um grupo bilíngue é submetido a uma TJQ com sentenças do inglês.

O experimento 2 tem como objetivo avaliar o processamento linguístico através de uma tarefa de

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UF: SC **Município:** FLORIANÓPOLIS
Telefone: (48)3721-6094 **E-mail:** cep.propesq@contato.ufsc.br

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Continuação do Parecer: 6.054.683

Leitura Auto-Monitorada (LAM) combinada com uma Tarefa de Interpretação (TI).

Objetivo da Pesquisa:

Objetivo primário:

Identificar, através de experimento empírico, se interpretação dos sintagmas nominais nus no português do Brasil tem a mesma interpretação que os sintagmas nominais no inglês, buscando acessar a representação linguística com uma tarefa de julgamento de quantidade.

Avaliação dos Riscos e Benefícios:

Avaliados no parecer 6.016.455.

Comentários e Considerações sobre a Pesquisa:

Estudo quantitativo

N = 80

Início da coleta de dados: 22/05/2023

Termo da coleta de dados: 20/11/2023

Considerações sobre os Termos de apresentação obrigatória:

Todos os termos obrigatórios foram apresentados.

Conclusões ou Pendências e Lista de Inadequações:

Todas as pendências foram resolvidas adequadamente. Não há impedimentos éticos para a realização da pesquisa.

Lembramos que a presente aprovação refere-se apenas aos aspectos éticos do projeto. Qualquer alteração nos documentos aprovados deve ser encaminhada para avaliação do CEP SH. Informamos que, obrigatoriamente, a versão do TCLE a ser utilizada deverá corresponder na íntegra à versão vigente aprovada.

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UF: SC **Município:** FLORIANOPOLIS
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Continuação do Parecer: 6.054.683

Considerações Finais a critério do CEP:

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_2095833.pdf	28/04/2023 00:28:59		Aceito
Outros	Carta_Resposta.pdf	25/04/2023 15:24:12	DIONATAN BASTOS CARDOZO	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Participante_Versao_2.pdf	25/04/2023 15:22:28	DIONATAN BASTOS CARDOZO	Aceito
Folha de Rosto	folhaderosto2.pdf	09/03/2023 10:56:16	DIONATAN BASTOS CARDOZO	Aceito
Outros	Questionario_de_Perfil.pdf	08/03/2023 15:53:42	DIONATAN BASTOS CARDOZO	Aceito
Declaração de Instituição e Infraestrutura	Declaracao_de_Anuenciaassinado.pdf	02/03/2023 12:19:38	DIONATAN BASTOS CARDOZO	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_de_Pesquisa.pdf	01/03/2023 15:29:54	DIONATAN BASTOS CARDOZO	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

FLORIANOPOLIS, 11 de Maio de 2023

Assinado por:
Luciana C Antunes
(Coordenador(a))

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UF: SC **Município:** FLORIANOPOLIS
Telefone: (48)3721-6094 **E-mail:** cep.propesq@contato.ufsc.br

APPENDIX B — U OF T'S PROTOCOL APPROVAL



UNIVERSITY OF
TORONTO

OFFICE OF THE VICE-PRESIDENT,
RESEARCH AND INNOVATION

RIS Protocol

Number: 45982

Approval Date: 12-Mar-24

PI Name: Dionatan Cardozo

Division Name:

Dear Dionatan Cardozo:

Re: Your research protocol application entitled, "Semantic Variation and Influence in the Nominal System from Brazilian Portuguese to English: an Experimental Study"

The Social Sciences, Humanities & Education REB has conducted a Delegated review of your application and has granted approval to the attached protocol for the period 2024-03-12 to 2024-05-10.

This approval covers the ethical acceptability of the human research activity; please ensure that all other approvals required to conduct your research are obtained prior to commencing the activity.

Please be reminded of the following points:

- An **Amendment** must be submitted to the REB for any proposed changes to the approved protocol. The amended protocol must be reviewed and approved by the REB prior to implementation of the changes.
- An annual **Renewal** must be submitted for ongoing research. Renewals should be submitted between 15 and 30 days prior to the current expiry date.
- A **Protocol Deviation Report (PDR)** should be submitted when there is any departure from the REB-approved ethics review application form that has occurred without prior approval from the REB (e.g., changes to the study procedures, consent process, data protection measures). The submission of this form does not necessarily indicate wrong-doing; however follow-up procedures may be required.
- An **Adverse Events Report (AER)** must be submitted when adverse or unanticipated events occur to participants in the course of the research process.
- A **Protocol Completion Report (PCR)** is required when research using the protocol has been completed.
- If your research is funded by a third party, please contact the assigned Research Funding Officer in Research Services to ensure that your funds are released.

Best wishes for the successful completion of your research.

Protocol #:47310					
Status:Delegated Review App	Version:0002	Sub Version:0000	Approved On:12-Mar-24	Expires On:10-May-24	Page 11 of 11
OFFICE OF RESEARCH ETHICS McMurrich Building, 12 Queen's Park Crescent West, 2nd Floor, Toronto, ON M5S 1S8 Canada Tel: +1 416 946-3273 • Fax: +1 416 946-5763 • ethics.review@utoronto.ca • http://www.research.utoronto.ca/for-researchers-administrators/ethics					

Protocol #: 47310

APPENDIX C — UFSC’S CONSENT FORM

UNIVERSIDADE FEDERAL DE SANTA CATARINA PROGRAMA DE PÓS-GRADUAÇÃO EM INGLÊS: ESTUDOS LINGÜÍSTICOS E LITERÁRIOS Termo de Consentimento Livre e Esclarecido — Participante

Prezada (o) Sra./Sr.

Meu nome é Dionatan Bastos Cardozo, estudante de Doutorado da UFSC. Faço pesquisa na área de Linguagem e Cognição sob a orientação da professora Dra. Roberta Pires de Oliveira e co-orientação da Profa. Dra. Gitanna Brito Bezerra e convidamos você para ser participante na pesquisa: “Variação Semântica e Influência no Sistema Nominal do Português do Brasil (L1) para o Inglês (L2): um Estudo Experimental”.

Por que esta pesquisa está sendo realizada?

Pesquisas na área de semântica apontam que as línguas possuem micro-variações semânticas entre elas, como apontado por (Lima, 2014; Pires de Oliveira, 2019, 2020). Uma dessas línguas que contém variação semântica é o sistema nominal do Português do Brasil. Não obstante, essa variação se mostra através da comparação entre o PB e o Inglês e podem gerar pontos de não correspondência entre essas duas línguas. Essa não-correspondência pode acarretar dificuldades no processamento e na aquisição do Inglês como L2. Por conta disso, o presente estudo procura investigar essa não-correspondência além do seu processamento entre essas duas línguas.

O que vai acontecer?

No único encontro que teremos para realizar o estudo, você será convidado a ler esse Termo de Consentimento Livre e Esclarecido e, caso concorde em participar do estudo, será convidado a assinar duas vias em que uma ficará com o pesquisador responsável pelo estudo, e outro com você. Depois disso, você: (i) realizará um teste de proficiência curto em inglês on-line, no qual cumprimos com o Ofício Circular No 2/2021/CONEP/SECNS/MS que regulamenta pesquisas com etapas virtuais; (ii) responderá um questionário de perfil; (iii) realizará uma tarefa de

julgamento de quantidade; e (iv) realizará uma tarefa de leitura auto-monitorada combinado com uma tarefa de interpretação.

Haverá algum risco ao participar dessa pesquisa?

Os riscos são mínimos. O participante pode ter desconforto, frustração, irritabilidade e/ou fadiga durante a realização das tarefas de julgamento e interpretação de sentenças. Caso o participante sinta qualquer desconforto, irritabilidade, e/ou fadiga, ele poderá informar o pesquisador que estará acompanhando e poderá fazer uma pausa para beber água e/ou abandonar o teste.

Haverá algum benefício?

Não há benefícios diretos. Entretanto, os achados desse estudo podem ajudar no desenvolvimento da área tanto para pesquisas futuras, como para auxílio do ensino de língua estrangeira em sala de aula. Também os participantes podem se beneficiar indiretamente através da aquisição de vocabulário relacionado as sentenças lidas.

A identidade dos participantes será revelada?

De forma alguma. Todos os dados serão confidenciais, ou seja, somente os pesquisadores terão acesso aos nomes dos participantes. Durante a coleta de dados, todos participantes serão identificados apenas por uma sequência de letras e números aleatórios. Entretanto, toda pesquisa corre o risco de quebra de sigilo, dessa forma, me comprometo a fazer tudo que estiver ao meu alcance para manter os nomes dos participantes confidenciais, respeitando os requisitos da Lei Geral de Proteção de Dados (Lei No 13.709, de 14 de agosto de 2018) quanto ao tratamento de dados pessoais sensíveis. A plataforma utilizada para rodar o teste gerará, de forma aleatória, uma sequência de letras e números para identificar o participante. Esse número deve ser mantido pelo participante.

Haverá acompanhamento de alguém?

Sim, durante todo o processo de coleta de dados eu estarei presente. Qualquer dúvida poderá ser sanada comigo ou com minha orientadora antes, durante ou depois da pesquisa.

A participação nessa pesquisa é obrigatória?

Não. A participação é totalmente voluntária. Esse documento é um convite. Caso haja a recusa na participação, o participante não será afetado de modo algum.

Haverá alguma despesa?

Não. A coleta de dados ocorrerá durante o horário de funcionamento da universidade, no Núcleo de Estudos Gramaticais (NEG) que fica localizado no quarto andar do Bloco B do CCE no Campus Universitário da UFSC, portanto, não há necessidade de deslocamento. Poderá haver ressarcimento no caso de eventuais despesas não previstas pelos pesquisadores.

Haverá benefício financeiro?

As resoluções não permitem compensação financeira pela sua participação, porém, os seguintes direitos lhe são assegurados: ressarcimento de quaisquer gastos oriundos da participação na pesquisa; e indenização por possíveis danos resultantes da participação na pesquisa.

É possível desistir de participar ou cancelar essa autorização?

Sim. É possível cancelar a participação a qualquer momento da pesquisa. Caso haja o cancelamento, não haverá prejuízo algum para o participante. Isso pode ser feito através do meu telefone (48) 99605-6446, e-mail: cardozo.dionatan@icloud.com ou pessoalmente. Caso opte, todos os dados já coletados poderão também ser destruídos ou devolvidos ao participante.

Como faço o contato para esclarecer dúvidas?

Eu responderei prontamente no telefone e e-mail acima. O e-mail da minha orientadora é: ropiolive@gmail.com

Ela também pode ser contatada através do seguinte endereço:

Universidade Federal de Santa Catarina - Centro de Comunicação e Expressão — CCE “B” —
Sala do NEG Campus Universitário — Trindade — Florianópolis — SC — CEP: 88.040-900

O Comitê de Ética em Pesquisas com Seres Humanos da UFSC (CEPSH) é um órgão colegiado interdisciplinar, deliberativo, consultivo e educativo, vinculado à Universidade Federal de Santa Catarina, mas independente na tomada de decisões, criado para defender os interesses dos participantes da pesquisa em sua integridade e dignidade e para contribuir no desenvolvimento da pesquisa dentro de padrões éticos.

Caso você queira entrar em contato com o CEPESH/UFSC, que é o órgão que aprova esse tipo de pesquisa, use uma dessas formas de contato:

Prédio Reitoria II, 7o andar, sala 701, localizado na Rua Desembargador Vitor Lima, no 222, Trindade, Florianópolis - Telefone (48) 3721-6094 - E- mail: cep.propesq@contato.ufsc.br

Essa pesquisa cumpre os termos das resoluções CNS 466/12 e 510/16 e também suas complementares, que são os documentos que normatizam pesquisas como essa no Brasil.

Ao assinalar a caixa de seleção abaixo, você declara dar seu consentimento para participar dessa pesquisa. Você pode solicitar uma cópia digital do TCLE que será enviado por e-mail.

☐ **Declaro estar ciente dos riscos e benefícios de participar dessa pesquisa e dou meu consentimento para a participação do estudo.**

APPENDIX D — U OF T'S CONSENT FORM

UNIVERSITY OF TORONTO INFORMED CONSENT FORM

Dear Mr./Mrs.,

My name is Dionatan Bastos Cardozo, a Ph.D. student at the Federal University of Santa Catarina in Brazil, conducting research at the University of Toronto under the guidance of Professor Suzi Lima, Ph.D. in Linguistics. I would like to invite you to participate in the research project titled "Semantic Variation and Influence in the Nominal System from Brazilian Portuguese (L1) to English (L2): An Experimental Study."

Why is this research being conducted?

This study focuses on the interpretation of nouns in Brazilian Portuguese and English. The study aims to explore how grammatical differences between Brazilian Portuguese and English may impact the acquisition of English as a Second Language by native speakers of Brazilian Portuguese.

What it is going to happen?

We will meet once for up to 40 minutes. If you agree to participate in the study, kindly click on the checkbox at the end of this page. A digital copy of this Informed Consent Form can be provided to you upon request. Following that, you will:

1. Answer a profile questionnaire.

And then participate in one of the two tasks described as follows:

2. Engage in a task where you will read a sentence word by word on a computer screen and assess the interpretation of the sentence at the end of your reading. Two geometrical figures will display on your screen, and you should click on the one you believe best represents the interpretation of the sentence.

3. Participate in another task within the study, which involves reading sentences and rating them on a scale of 1 to 5 based on how good the sentence is to you.

What are the risks?

The risks are minimal. Participants may experience discomfort, frustration, irritability, and/or fatigue during the tasks. If that happens, they can inform the accompanying researcher, take a break to drink water, and/or discontinue their participation.

Are there any benefits?

There are no direct benefits. However, the findings of this study can contribute to the development of the field, both for future research and for supporting foreign language teaching in the classroom. In addition, students will be compensated with course credits (usually 1~2%) if they are recruited from the Department of Linguistics participant pool. If they are not recruited from the pool of participants who are doing studies for credits in courses, they will be paid 10 dollars for their participation in the study, which lasts 40 minutes.

Will the identity of the participants be disclosed in future outcomes of this project?

Under no circumstances will the identity of the participants be disclosed. All information will be kept confidential, and participants will be identified solely by a random sequence of letters and numbers assigned by a computer program. While every effort will be made to maintain the confidentiality of participant names, I acknowledge the potential risk of a breach. The testing platform will generate a random alphanumeric code to identify each participant, and this code should be retained by the participant.

Is the researcher going to be in the room?

Yes, throughout the data collection process, I will be present. Any questions can be addressed to me before, during, or after the study is concluded, by email.

Is participation mandatory?

No, your participation is entirely voluntary and you will not be financially compensated. This document is an invitation. If you prefer to not participate in this task, you will not be affected in any way. You can just close the web browser.

Is it possible to withdraw from participating in this study?

Yes, it is possible to withdraw from participating in this study. Please send an email to dionatan.cardozo@mail.utoronto.ca. I can delete your data if you share the code generated by the system when you completed the study.

If you have any additional questions, you can ask them during the study or by email.

By checking the box below, you declare your consent to participate in this research. You can request a digital copy of the informed consent form (ICF) that will be sent by email.

Thank you for participating!

Participants can contact the Research Oversight and Compliance Office — Human Research Ethics Program at ethics.review@utoronto.ca or 416-946-3273 if they have questions about their rights as participants.

The research ethics program at the University of Toronto may have confidential access to data to help ensure participant protection procedures are followed.

☐ **I declare that I am aware of the risks and benefits of participating in this research project and give my consent to participate in the study.**

APPENDIX E — QUESTIONNAIRE IN BRP

1) Quantos anos você tem? Digite apenas o número e clique em OK para prosseguir.

OK

2) Qual é a sua escolaridade?

Ensino Fundamental

Ensino Médio

Ensino Superior incompleto

Ensino Superior completo

Pós-Graduação Lato Sensu (Especialização)

Pós-Graduação Stricto Sensu (Mestrado/Doutorado)

3) No teste de proficiência, qual nível foi atribuído a você? (Em caso tenha ficado entre A1 ou A2, por exemplo, considerar o nível mais baixo)

A1

A2

B1

B2

C1

C2

Não realizei o teste de proficiência

4) Qual a sua naturalidade?

Brasileiro

Canadense

Outra

5) Qual foi a primeira língua que você aprendeu quando criança?

Português do Brasil

Inglês

Francês

Outra

6) Você já estudou formalmente inglês? Por exemplo, em escolas de idiomas, cursos livres ofertados à comunidade acadêmica, etc.?

Sim

Não

7) Em caso afirmativo, por quanto tempo você estudou formalmente inglês?

Menos de 2 anos

Entre 2 a 4 anos

Entre 4 a 6 anos

Entre 6 a 8 anos

Mais de 8 anos

Não estudei inglês formalmente

8) Você já morou em algum país o qual a língua nativa seja inglês?

Sim

Não

9) Você já cursou ou cursa letras?

Sim

Não

APPENDIX F — QUESTIONNAIRE IN ENG

1) How old are you? Type only the number than click OKfor the next question to show up.

OK

2) Education (highest degree completed)

No schooling

Some elementary school (unfinished)

Completed elementary school

Some secondary/high school (unfinished)

Completed secondary/high school

Some technical, community college, CEGEP, Collège Classique (unfinished)

Completed technical, community college, CEGEP, Collège Classique

Some university (unfinished)

Bachelor's degree

Master's degree

Professional degree or doctorate

3) In the proficiency test, which level was given to you? (If your level is in between B1 and B2, please consider the lowest level)

A1

A2

B1

B2

C1

C2

I did not do a proficiency test

4) What is your nationality?

Brazilian

Canadian

Other

5) What is your first language?

Brazilian Portuguese

English

French

Other

6) Did you study English? For example, in English schools, English courses for the academic community, etc.?

Yes

No

7) If yes, for how long did you study English?

Less than two years

Between 2 and 4 years

Between 4 and 6 years

Between 6 and 8 years

More than 8 years

I did not study English as a second language

8) Did you live in a country which English is the official language?

Yes

No

9) Have you ever studied linguistics at the undergraduate level?

Yes

No

APPENDIX G — AJT TARGET SENTENCES IN BRP

group	item	sentence	lexicon	noun	condition
A	1	O cozinheiro colocou abacate no prato.	abacate	CE	CE+S
A	2	A mãe colocou flor no vaso.	flor	CNE	CNE+S
A	3	O professor trouxe maçãs da escola.	maçãs	CE	CE+P
A	4	A aluna trouxe livros da feira.	livros	CNE	CNE+P
A	5	A diarista encontrou pirulito no guarda-roupas.	pirulito	CE	CE+S
A	6	O homem vendeu revista no supermercado.	revista	CNE	CNE+S
A	7	O adolescente derrubou romãs na cozinha.	romãs	CE	CE+P
A	8	A vizinha deu travesseiros para o homem.	travesseiros	CNE	CNE+P
A	9	A criança jogou ovo na rua.	ovo	CE	CE+S
A	10	O trabalhador vendeu foto na praia.	foto	CNE	CNE+S
A	11	A veterinária deixou bananas na floresta.	bananas	CE	CE+P
A	12	O fazendeiro limpou gravetos do campo.	gravetos	CNE	CNE+P
A	13	O rancheiro pegou bergamota da fazenda.	bergamota	CE	CE+S
A	14	A menina perdeu calça na viagem.	calça	CNE	CNE+S
A	15	A mulher pediu bolos na cafeteria.	bolos	CE	CE+P
A	16	O menino viu bolas no jardim.	bolas	CNE	CNE+P
B	1	O cozinheiro colocou colher no prato.	colher	CNE	CNE+S
B	2	A mãe colocou batatas no vaso.	batatas	CE	CE+P
B	3	O professor trouxe canetas da escola.	canetas	CNE	CNE+P
B	4	A aluna trouxe pera da feira.	pera	CE	CE+S

B	5	A diarista encontrou meia no guarda-roupas.	meia	CNE	CNE+S
B	6	O homem vendeu abacaxis no supermercado.	abacaxis	CE	CE+P
B	7	O adolescente derrubou pratos na cozinha.	pratos	CNE	CNE+P
B	8	A vizinha deu laranja para o homem.	laranja	CE	CE+S
B	9	A criança jogou pedra na rua.	pedra	CNE	CNE+S
B	10	O trabalhador vendeu melancias na praia.	melancias	CE	CE+P
B	11	A veterinária deixou madeiras na floresta.	madeiras	CNE	CNE+P
B	12	O fazendeiro limpou uva do campo.	uva	CE	CE+S
B	13	O rancheiro pegou pá da fazenda.	pá	CNE	CNE+S
B	14	A menina perdeu biscoitos na viagem.	biscoitos	CE	CE+P
B	15	A mulher pediu garfos na cafeteria.	garfos	CNE	CNE+P
B	16	O menino viu cenoura no jardim.	cenoura	CE	CE+S
C	1	O cozinheiro colocou abacates no prato.	abacates	CE	CE+P
C	2	A mãe colocou flores no vaso.	flores	CNE	CNE+P
C	3	O professor trouxe maçã da escola.	maçã	CE	CE+S
C	4	A aluna trouxe livro da feira.	livro	CNE	CNE+S
C	5	A diarista encontrou pirulitos no guarda-roupas.	pirulitos	CE	CE+P
C	6	O homem vendeu revistas no supermercado.	revistas	CNE	CNE+P
C	7	O adolescente derrubou romã na cozinha.	romã	CE	CE+S
C	8	A vizinha deu travesseiro para o homem.	travesseiro	CNE	CNE+S
C	9	A criança jogou ovos na rua.	ovos	CE	CE+P
C	10	O trabalhador vendeu fotos na praia.	fotos	CNE	CNE+P

C	11	A veterinária deixou banana na floresta.	banana	CE	CE+S
C	12	O fazendeiro limpou graveto do campo.	graveto	CNE	CNE+S
C	13	O rancheiro pegou bergamotas da fazenda.	bergamotas	CE	CE+P
C	14	A menina perdeu calças na viagem.	calças	CNE	CNE+P
C	15	A mulher pediu bolo na cafeteria.	bolo	CE	CE+S
C	16	O menino viu bola no jardim.	bola	CNE	CNE+S
D	1	O cozinheiro colocou colheres no prato.	colheres	CNE	CNE+P
D	2	A mãe colocou batata no vaso.	batata	CE	CE+S
D	3	O professor trouxe caneta da escola.	caneta	CNE	CNE+S
D	4	A aluna trouxe peras da feira.	peras	CE	CE+P
D	5	A diarista encontrou meias no guarda-roupas.	meias	CNE	CNE+P
D	6	O homem vendeu abacaxi no supermercado.	abacaxi	CE	CE+S
D	7	O adolescente derrubou prato na cozinha.	prato	CNE	CNE+S
D	8	A vizinha deu laranjas para o homem.	laranjas	CE	CE+P
D	9	A criança jogou pedras na rua.	pedras	CNE	CNE+P
D	10	O trabalhador vendeu melancia na praia.	melancia	CE	CE+S
D	11	A veterinária deixou madeira na floresta.	madeira	CNE	CNE+S
D	12	O fazendeiro limpou uvas do campo.	uvas	CE	CE+P
D	13	O rancheiro pegou pás da fazenda.	pás	CNE	CNE+P
D	14	A menina perdeu biscoito na viagem.	biscoito	CE	CE+S
D	15	A mulher pediu garfo na cafeteria.	garfo	CNE	CNE+S
D	16	O menino viu cenouras no jardim.	cenouras	CE	CE+P

APPENDIX H — AJT TARGET SENTENCES IN ENG

group	item	sentence	lexicon	noun	condition
A	1	The cook put avocado on the plate.	avocado	CE	CE+S
A	2	The mother placed flower in the vase.	flower	CNE	CNE+S
A	3	The teacher brought apples from school.	apples	CE	CE+P
A	4	The student bought books at the fair.	books	CNE	CNE+P
A	5	The cleaner found lollipop in the wardrobe.	lollipop	CE	CE+S
A	6	The man sold magazine at the supermarket.	magazine	CNE	CNE+S
A	7	The teenager dropped pomegranates in the kitchen.	pomegranades	CE	CE+P
A	8	The neighbour gave pillows to a man.	pillows	CNE	CNE+P
A	9	The child threw egg on the street.	egg	CE	CE+S
A	10	The worker sold photo at the beach.	photo	CNE	CNE+S
A	11	The veterinarian left bananas in the forest.	bananas	CE	CE+P
A	12	The farmer cleaned sticks from the field.	sticks	CNE	CNE+P
A	13	The rancher got clementine from the farm.	clementine	CE	CE+S
A	14	The girl lost trouser on the trip.	trouser	CNE	CNE+S
A	15	The woman ordered cakes at the cafe.	cakes	CE	CE+P
A	16	The kid saw balls in the yard.	balls	CNE	CNE+P
B	1	The cook put spoon on the plate.	spoon	CNE	CNE+S
B	2	The mother placed potatoes in the vase.	potatos	CE	CE+P
B	3	The teacher brought pens from school.	pens	CNE	CNE+P
B	4	The student bought pear at the fair		CE	CE+S
B	5	The cleaner found sock in the wardrobe.	sock	CNE	CNE+S
B	6	The man sold pineapples at the supermarket.	pineapples	CE	CE+P
B	7	The teenager dropped plates in the kitchen.	plates	CNE	CNE+P

B	8	The neighbour gave orange to a man.	orange	CE	CE+S
B	9	The child threw stone on the street.	stone	CNE	CNE+S
B	10	The worker sold watermelons at the beach.	watermelons	CE	CE+P
B	11	The veterinarian left logs in the forest.	logs	CNE	CNE+P
B	12	The farmer cleaned grape from the field.	grape	CE	CE+S
B	13	The rancher got shovel from the farm.	shovel	CNE	CNE+S
B	14	The girl lost cookies on the trip.	cookies	CE	CE+P
B	15	The woman ordered forks at the cafe.	forks	CNE	CNE+P
B	16	The kid saw carrot in the yard.	carrot	CE	CE+S
C	1	The cook put avocados on the plate.	avocados	CE	CE+P
C	2	The mother placed flowers in the vase.	flowers	CNE	CNE+P
C	3	The teacher brought apple from school.	apple	CE	CE+S
C	4	The student bought book at the fair.	book	CNE	CNE+S
C	5	The cleaner found lollipops in the wardrobe.	lollipops	CE	CE+P
C	6	The man sold magazines at the supermarket.	magazines	CNE	CNE+P
C	7	The teenager dropped pomegranate in the kitchen.	pomegranate	CE	CE+S
C	8	The neighbour gave pillow to a man.	pillow	CNE	CNE+S
C	9	The child threw eggs on the street.	eggs	CE	CE+P
C	10	The worker sold photos at the beach.	photos	CNE	CNE+P
C	11	The veterinarian left banana in the forest.	banana	CE	CE+S
C	12	The farmer cleaned stick from the field.	stick	CNE	CNE+S
C	13	The rancher got clementines from the farm.	clementines	CE	CE+P
C	14	The girl lost trousers on the trip.	trousers	CNE	CNE+P
C	15	The woman ordered cake at the cafe.	cake	CE	CE+S
C	16	The kid saw ball in the yard.	ball	CNE	CNE+S
D	1	The cook put spoons on the plate.	spoons	CNE	CNE+P

D	2	The mother placed potato in the vase.	potato	CE	CE+S
D	3	The teacher brought pen from school.	pen	CNE	CNE+S
D	4	The student bought pears at the fair.	pears	CE	CE+P
D	5	The cleaner found socks in the wardrobe.	socks	CNE	CNE+P
D	6	The man sold pineapple at the supermarket.	pineapple	CE	CE+S
D	7	The teenager dropped plate in the kitchen.	plate	CNE	CNE+S
D	8	The neighbour gave oranges to a man.	oranges	CE	CE+P
D	9	The child threw stones on the street.	stones	CNE	CNE+P
D	10	The worker sold watermelon at the beach.	watermelon	CE	CE+S
D	11	The veterinarian left log in the forest.	log	CNE	CNE+S
D	12	The farmer cleaned grapes from the field.	grapes	CE	CE+P
D	13	The rancher got shovels from the farm.	shovels	CNE	CNE+P
D	14	The girl lost cookie on the trip.	cookie	CE	CE+S
D	15	The woman ordered fork at the cafe.	fork	CNE	CNE+S
D	16	The kid saw carrots in the yard.	carrots	CE	CE+P

APPENDIX I — AJT FILLER SENTENCES IN BRP

group	item	sentence	lexicon	noun	condition
NA	1	John viu feliz Mary.	NA	NA	NA
NA	2	Camilla comeu raiozamente o jantar.	NA	NA	NA
NA	3	Rod escreveu quietamente um poema.	NA	NA	NA
NA	4	Carol leu silenciosamente as instruções.	NA	NA	NA
NA	5	Vlad bebeu rapidamente vinho.	NA	NA	NA
NA	6	Marry carregou graciosamente responsabilidade.	NA	NA	NA
NA	7	A menina estudou tristemente matemática.	NA	NA	NA
NA	8	O menino fechou sonolentemente seus olhos.	NA	NA	NA
NA	9	Gia chutou a bola furiosamente.	NA	NA	NA
NA	10	Tom acordou preguiçosamente.	NA	NA	NA
NA	11	Laura desmaiou rapidamente.	NA	NA	NA
NA	12	Marcus ensinou pacientemente.	NA	NA	NA
NA	13	Jane bebeu ansiosamente.	NA	NA	NA
NA	14	Will dirigiu lentamente.	NA	NA	NA
NA	15	A senhora apresentou confidentemente.	NA	NA	NA
NA	16	O caminhoneiro abraçou seu cachorro gentilmente.	NA	NA	NA
NA	17	Benjamin viu Emma carro vermelho.	NA	NA	NA
NA	18	Scarlet estragou seu computador novo.	NA	NA	NA
NA	19	Liam esbarrou na Michaela bicicleta azul.	NA	NA	NA
NA	20	Zoe comeu uma maçã verde.	NA	NA	NA
NA	21	Ava quebrou Noah garrafa branca.	NA	NA	NA
NA	22	Charlotte comprou Calvin casa velha.	NA	NA	NA
NA	23	A mãe lavou sua filha vestido fedorento.	NA	NA	NA

NA	24	O jardineiro molhou sua esposa flor seca.	NA	NA	NA
NA	25	Harper limpou Chloe nova casa.	NA	NA	NA
NA	26	Emily derrubou Luca azul celular.	NA	NA	NA
NA	27	Ian encontrou Renne rosa bolsa.	NA	NA	NA
NA	28	Dylan fez Kacey nova lição de casa.	NA	NA	NA
NA	29	Ethan arranhou Madison madeira mesa.	NA	NA	NA
NA	30	Olivia cortou Jack longo cabelo.	NA	NA	NA
NA	31	O produtor gravou o cantor gentil voz.	NA	NA	NA
NA	32	O pai comprou a criança amarela bicicleta.	NA	NA	NA

APPENDIX J — AJT FILLER SENTENCES IN ENG

group	item	sentence	lexicon	noun	condition
NA	1	John saw happily Mary.	NA	NA	NA
NA	2	Camilla ate eagerly dinner.	NA	NA	NA
NA	3	Rod wrote quietly a poem.	NA	NA	NA
NA	4	Carol read silently instructions.	NA	NA	NA
NA	5	Vlad drank quickly wine.	NA	NA	NA
NA	6	Marry carried gracefully responsibility.	NA	NA	NA
NA	7	The girl studied sadly math.	NA	NA	NA
NA	8	The boy closed sleepily his eyes.	NA	NA	NA
NA	9	Gia kicked the ball furiously.	NA	NA	NA
NA	10	Tom woke up lazily.	NA	NA	NA
NA	11	Laura fainted rapidly.	NA	NA	NA
NA	12	Marcus taught patiently.	NA	NA	NA
NA	13	Jane drank anxiously.	NA	NA	NA
NA	14	Will drove slowly.	NA	NA	NA
NA	15	The lady presented confidently.	NA	NA	NA
NA	16	The trucker hugged his dog gently.	NA	NA	NA
NA	17	Benjamin saw Emma's car red.	NA	NA	NA
NA	18	Scarlet damaged her computer new.	NA	NA	NA
NA	19	Liam bumped into Michaela's bike blue.	NA	NA	NA
NA	20	Zoe ate an apple green.	NA	NA	NA
NA	21	Ava broke Noah's bottle white.	NA	NA	NA
NA	22	Charlotte bought Calvin's house old.	NA	NA	NA
NA	23	The mother washed the daughter's dress smelly.	NA	NA	NA
NA	24	The gardener watered his wife's flower dry.	NA	NA	NA

NA	25	Harper cleaned Chloe's new house.	NA	NA	NA
NA	26	Emily dropped Luca's blue phone.	NA	NA	NA
NA	27	Ian found Renee's pink purse.	NA	NA	NA
NA	28	Dylan did Kacey's new homework.	NA	NA	NA
NA	29	Ethan scratched Madison's wood table.	NA	NA	NA
NA	30	Olivia cut Jack's long hair.	NA	NA	NA
NA	31	The producer recorded the singer's kind voice.	NA	NA	NA
NA	32	The father bought the child's yellow bicycle.	NA	NA	NA

APPENDIX K — AJT PRACTICE SENTENCES IN BRP

group	item	sentence	lexicon	noun	condition
NA	1	O motorista entregou trigo na fazenda.	NA	NA	NA
NA	2	Jessica destruiu seu vermelho livro.	NA	NA	NA
NA	3	Tonny juntou o lego de sua irmã do chão.	NA	NA	NA
NA	4	O arquiteto construiu a sua mãe casa.	NA	NA	NA
NA	5	O motorista transferiu as pessoas para a estação.	NA	NA	NA
NA	6	Matthew levantou a sua mochila azul.	NA	NA	NA

APPENDIX L — AJT PRACTICE SENTENCES IN ENG

group	item	sentence	lexicon	noun	condition
NA	1	The trucker delivered wheat to the farm.	NA	NA	NA
NA	2	Jessica smashed her book red.	NA	NA	NA
NA	3	Tonny piked his sister's lego from the ground.	NA	NA	NA
NA	4	The architect built his house mother.	NA	NA	NA
NA	5	The driver transferred people to the station.	NA	NA	NA
NA	6	Matthew lifted his blue backpack.	NA	NA	NA

APPENDIX M — SPR TARGET SENTENCES IN BRP

group	item	sentence	lexicon	quantifier	noun	condition	imga	imgb
A	1	A adolescente comprou muita régua em Roma.	régua	QS	NC	QS+NC	img1.png	img2.png
A	2	O homem vendeu muitas penas em Madrid.	penas	QP	NCP	QP+NCP	img1.png	img2.png
A	3	O empresário viu muita paina em Lisboa.	paina	QS	NM	QS+NM	img1.png	img2.png
A	4	O bombeiro achou muitas lavas em Oslo.	lavas	QP	NMP	QP+NMP	img1.png	img2.png
A	5	A camponesa acumulou muita sela em Macau.	sela	QS	NC	QS+NC	img1.png	img2.png
A	6	O detetive coletou muitas fotos em Manaus.	fotos	QP	NCP	QP+NCP	img1.png	img2.png
A	7	A turista encontrou muita ralé em Boston.	ralé	QS	NM	QS+NM	img1.png	img2.png
A	8	O ladrão roubou muitas gentes em Paris.	gentes	QP	NMP	QP+NMP	img1.png	img2.png
A	9	A empregada limpou muita festa em Dublin.	festa	QS	NC	QS+NC	img1.png	img2.png
A	10	O pesquisador procurou muitas praças em Londres.	praças	QP	NCP	QP+NCP	img1.png	img2.png
A	11	A depiladora encomendou muita cera em Dallas.	cera	QS	NM	QS+NM	img1.png	img2.png
A	12	O estudante relatou muitas fomes em Berlim.	fomes	QP	NMP	QP+NMP	img1.png	img2.png
A	13	A motorista tomou muita multa em Praga.	multa	QS	NC	QS+NC	img1.png	img2.png
A	14	A menina desenhou muitas cartas em Denver.	cartas	QP	NCP	QP+NCP	img1.png	img2.png
A	15	O homem juntou muita brita em Mumbai.	brita	QS	NM	QS+NM	img1.png	img2.png

A	16	O mecânico perdeu muitas forças em Moscou.	forças	QP	NMP	QP+NMP	img1.png	img2.png
B	1	A adolescente comprou muitas régua em Roma.	reguas	QP	NCP	QP+NCP	img1.png	img2.png
B	2	O homem vendeu muita pena em Madrid.	pena	QS	NC	QS+NC	img1.png	img2.png
B	3	O empresário viu muitas painas em Lisboa.	painas	QP	NMP	QP+NMP	img1.png	img2.png
B	4	O bombeiro achou muita lava em Oslo.	lava	QS	NM	QS+NM	img1.png	img2.png
B	5	A camponesa acumulou muitas selas em Macau.	selas	QP	NCP	QP+NCP	img1.png	img2.png
B	6	O detetive coletou muita foto em Manaus.	foto	QS	NC	QS+NC	img1.png	img2.png
B	7	A turista encontrou muitas ralés em Boston.	ralés	QP	NMP	QP+NMP	img1.png	img2.png
B	8	O ladrão roubou muita gente em Paris.	gente	QS	NM	QS+NM	img1.png	img2.png
B	9	A empregada limpou muitas festas em Dublin.	festass	QP	NCP	QP+NCP	img1.png	img2.png
B	10	O pesquisador procurou muita praça em Londres.	praça	QS	NC	QS+NC	img1.png	img2.png
B	11	A depiladora encomendou muitas ceras em Dallas.	ceras	QP	NMP	QP+NMP	img1.png	img2.png
B	12	O estudante relatou muita fome em Berlim.	fome	QS	NM	QS+NM	img1.png	img2.png
B	13	A motorista tomou muitas multas em Praga.	multas	QP	NCP	QP+NCP	img1.png	img2.png
B	14	A menina desenhou muita carta em Denver.	carta	QS	NC	QS+NC	img1.png	img2.png
B	15	O homem juntou muitas britas em Mumbai.	britas	QP	NMP	QP+NMP	img1.png	img2.png
B	16	O mecânico perdeu muita força em Moscou.	força	QS	NM	QS+NM	img1.png	img2.png

C	1	A adolescente comprou muita base em Roma.	base	QS	NM	QS+NM	img1.png	img2.png
C	2	O homem vendeu muitas pratas em Madrid.	pratas	QP	NMP	QP+NMP	img1.png	img2.png
C	3	O empresário viu muita bolsa em Lisboa.	bolsa	QS	NC	QS+NC	img1.png	img2.png
C	4	O bombeiro achou muitas bombas em Oslo.	bombas	QP	NCP	QP+NCP	img1.png	img2.png
C	5	A camponesa acumulou muita raiva em Macau.	raiva	QS	NM	QS+NM	img1.png	img2.png
C	6	O detetive coletou muitas fibras em Manaus.	fibras	QP	NMP	QP+NMP	img1.png	img2.png
C	7	A turista encontrou muita capa em Boston.	capa	QS	NC	QS+NC	img1.png	img2.png
C	8	O ladrão roubou muitas boinas em Paris.	boinas	QP	NCP	QP+NCP	img1.png	img2.png
C	9	A empregada limpou muita crina em Dublin.	crina	QS	NM	QS+NM	img1.png	img2.png
C	10	O pesquisador procurou muitas floras em Londres.	floras	QP	NMP	QP+NMP	img1.png	img2.png
C	11	A depiladora encomendou muita mesa em Dallas.	mesa	QS	NC	QS+NC	img1.png	img2.png
C	12	O estudante relatou muitas sagas em Berlim.	sagas	QP	NCP	QP+NCP	img1.png	img2.png
C	13	A motorista tomou muita chuva em Praga.	chuva	QS	NM	QS+NM	img1.png	img2.png
C	14	A menina desenhou muitas matas em Denver.	matas	QP	NMP	QP+NMP	img1.png	img2.png
C	15	O homem juntou muita tela em Mumbai.	tela	QS	NC	QS+NC	img1.png	img2.png
C	16	O mecânico perdeu muitas pinças em Moscou.	pinças	QP	NCP	QP+NCP	img1.png	img2.png
D	1	A adolescente comprou muitas bases em Roma.	bases	QP	NMP	QP+NMP	img1.png	img2.png

D	2	O homem vendeu muita prata em Madrid.	prata	QS	NM	QS+NM	img1.png	img2.png
D	3	O empresário viu muitas bolsas em Lisboa.	bolsas	QP	NCP	QP+NCP	img1.png	img2.png
D	4	O bombeiro achou muita bomba em Oslo.	bomba	QS	NC	QS+NC	img1.png	img2.png
D	5	A camponesa acumulou muitas raivas em Macau.	raivas	QP	NMP	QP+NMP	img1.png	img2.png
D	6	O detetive coletou muita fibra em Manaus.	fibra	QS	NM	QS+NM	img1.png	img2.png
D	7	A turista encontrou muitas capas em Boston.	capas	QP	NCP	QP+NCP	img1.png	img2.png
D	8	O ladrão roubou muita boina em Paris.	boina	QS	NC	QS+NC	img1.png	img2.png
D	9	A empregada limpou muitas crinas em Dublin.	crinas	QP	NMP	QP+NMP	img1.png	img2.png
D	10	O pesquisador procurou muita flora em Londres.	flora	QS	NM	QS+NM	img1.png	img2.png
D	11	A depiladora encomendou muitas mesas em Dallas.	mesas	QP	NCP	QP+NCP	img1.png	img2.png
D	12	O estudante relatou muita saga em Berlim.	saga	QS	NC	QS+NC	img1.png	img2.png
D	13	A motorista tomou muitas chuvas em Praga.	chuvas	QP	NMP	QP+NMP	img1.png	img2.png
D	14	A menina desenhou muita mata em Denver.	mata	QS	NM	QS+NM	img1.png	img2.png
D	15	O homem juntou muitas telas em Mumbai.	telas	QP	NCP	QP+NCP	img1.png	img2.png
D	16	O mecânico perdeu muita pinça em Moscou.	pinça	QS	NC	QS+NC	img1.png	img2.png

APPENDIX N — SPR TARGET SENTENCES IN ENG

group	item	sentence	lexicon	quantifier	noun	condition	imga	imgb
A	1	The teenager bought much ruler in Rome.	ruler	QS	NC	QS+NC	img1.png	img2.png
A	2	The man sold many feathers in Madrid.	feathers	QP	NCP	QP+NCP	img1.png	img2.png
A	3	The businessperson saw much kapok in Lisbon.	kapok	QS	NM	QS+NM	img1.png	img2.png
A	4	The fireman found many lavas in Oslo.	lavas	QP	NMP	QP+NMP	img1.png	img2.png
A	5	The farmer accumulated much saddle in Macau.	saddle	QS	NC	QS+NC	img1.png	img2.png
A	6	The detective collected many pictures in Manaus.	pictures	QP	NCP	QP+NCP	img1.png	img2.png
A	7	The tourist found much paper in Boston.	paper	QS	NM	QS+NM	img1.png	img2.png
A	8	The woman noticed many peoples in Paris.	peoples	QP	NMP	QP+NMP	img1.png	img2.png
A	9	The maid cleaned much nightclub in Dublin.	nightclub	QS	NC	QS+NC	img1.png	img2.png
A	10	The researcher searched many plazas in London.	plazas	QP	NCP	QP+NCP	img1.png	img2.png
A	11	The beautician ordered much beewax in Dallas.	beewax	QS	NM	QS+NM	img1.png	img2.png
A	12	The student reported many hungers in Berlin.	hungers	QP	NMP	QP+NMP	img1.png	img2.png
A	13	The driver got much ticket in Praga.	ticket	QS	NC	QS+NC	img1.png	img2.png
A	14	The girl draw many letters in Denver.	letters	QP	NCP	QP+NCP	img1.png	img2.png
A	15	The man gathered much gravel in Mumbai.	gravel	QS	NM	QS+NM	img1.png	img2.png

A	16	The mechanic lost many powers in Moscou.	powers	QP	NMP	QP+NMP	img1.png	img2.png
B	1	The teenager bought many rulers in Rome.	rulers	QP	NCP	QP+NCP	img1.png	img2.png
B	2	The man sold much feather in Madrid.	feather	QS	NC	QS+NC	img1.png	img2.png
B	3	The businessperson saw many kapoks in Lisbon.	kapoks	QP	NMP	QP+NMP	img1.png	img2.png
B	4	The fireman found much lava in Oslo.	lava	QS	NM	QS+NM	img1.png	img2.png
B	5	The farmer accumulated many saddles in Macau.	saddles	QP	NCP	QP+NCP	img1.png	img2.png
B	6	The detective collected much picture in Manaus.	picture	QS	NC	QS+NC	img1.png	img2.png
B	7	The tourist found many papers in Boston.	papers	QP	NMP	QP+NMP	img1.png	img2.png
B	8	The woman noticed much people in Paris.	people	QS	NM	QS+NM	img1.png	img2.png
B	9	The maid cleaned many nightclubs in Dublin.	nightclubs	QP	NCP	QP+NCP	img1.png	img2.png
B	10	The researcher searched much plaza in London.	plaza	QS	NC	QS+NC	img1.png	img2.png
B	11	The beautician ordered many beeswax in Dallas.	beeswax	QP	NMP	QP+NMP	img1.png	img2.png
B	12	The student reported much hunger in Berlin.	hunger	QS	NM	QS+NM	img1.png	img2.png
B	13	The driver got many tickets in Praga.	tickets	QP	NCP	QP+NCP	img1.png	img2.png
B	14	The girl draw much letter in Denver.	letter	QS	NC	QS+NC	img1.png	img2.png
B	15	The man gathered many gravels in Mumbai.	gravels	QP	NMP	QP+NMP	img1.png	img2.png
B	16	The mechanic lost much power in Moscou.	power	QS	NM	QS+NM	img1.png	img2.png

C	1	The teenager bought much primer in Rome.	primer	QS	NM	QS+NM	img1.png	img2.png
C	2	The man sold many silvers in Madrid.	silvers	QP	NMP	QP+NMP	img1.png	img2.png
C	3	The businessperson saw much handbag in Lisbon.	handbag	QS	NC	QS+NC	img1.png	img2.png
C	4	The fireman found many balloons in Oslo.	balloons	QP	NCP	QP+NCP	img1.png	img2.png
C	5	The farmer accumulated much anger in Macau.	anger	QS	NM	QS+NM	img1.png	img2.png
C	6	The detective collected many fibers in Manaus.	fibers	QP	NMP	QP+NMP	img1.png	img2.png
C	7	The tourist found much cover in Boston.	cover	QS	NC	QS+NC	img1.png	img2.png
C	8	The woman noticed many berets in Paris.	berets	QP	NCP	QP+NCP	img1.png	img2.png
C	9	The maid cleaned much horsehair in Dublin.	horsehair	QS	NM	QS+NM	img1.png	img2.png
C	10	The researcher searched many floras in London.	floras	QP	NMP	QP+NMP	img1.png	img2.png
C	11	The beautician ordered much table in Dallas.	table	QS	NC	QS+NC	img1.png	img2.png
C	12	The student reported many sagas in Berlin.	sagas	QP	NCP	QP+NCP	img1.png	img2.png
C	13	The driver got much rainfall in Praga.	rainfall	QS	NM	QS+NM	img1.png	img2.png
C	14	The girl witnessed many forests in Denver.	forests	QP	NMP	QP+NMP	img1.png	img2.png
C	15	The man gathered much frame in Mumbai.	frame	QS	NC	QS+NC	img1.png	img2.png
C	16	The mechanic lost many tweezers in Moscou.	tweezers	QP	NCP	QP+NCP	img1.png	img2.png
D	1	The teenager bought many primers in Rome.	primers	QP	NMP	QP+NMP	img1.png	img2.png

D	2	The man sold much silver in Madrid.	silver	QS	NM	QS+NM	img1.png	img2.png
D	3	The businessperson saw many handbags in Lisbon.	handbags	QP	NCP	QP+NCP	img1.png	img2.png
D	4	The fireman found much balloon in Oslo.	balloons	QS	NC	QS+NC	img1.png	img2.png
D	5	The farmer accumulated many angers in Macau.	angers	QP	NMP	QP+NMP	img1.png	img2.png
D	6	The detective collected much fiber in Manaus.	fiber	QS	NM	QS+NM	img1.png	img2.png
D	7	The tourist found many covers in Boston.	covers	QP	NCP	QP+NCP	img1.png	img2.png
D	8	The woman noticed much beret in Paris.	benet	QS	NC	QS+NC	img1.png	img2.png
D	9	The maid cleanned many horsehairs in Dublin.	horsehairs	QP	NMP	QP+NMP	img1.png	img2.png
D	10	The researcher searched much flora in London.	flora	QS	NM	QS+NM	img1.png	img2.png
D	11	The beautician ordered many tables in Dallas.	tables	QP	NCP	QP+NCP	img1.png	img2.png
D	12	The student reported much saga in Berlin.	saga	QS	NC	QS+NC	img1.png	img2.png
D	13	The driver got many rainfalls in Praga.	rainfalls	QP	NMP	QP+NMP	img1.png	img2.png
D	14	The girl draw much forest in Denver.	forest	QS	NM	QS+NM	img1.png	img2.png
D	15	The man gathered many frames in Mumbai.	frames	QP	NCP	QP+NCP	img1.png	img2.png
D	16	The mechanic lost much tweezer in Moscou.	tweezer	QS	NC	QS+NC	img1.png	img2.png

APPENDIX O — SPR FILLER SENTENCES IN BRP

group	item	sentence	lexicon	quantifier	noun	condition	imga	imgb
NA	1	A menina tem gatos demais em Bogotá.	NA	NA	NA	NA	img1.png	img2.png
NA	2	O vendedor comeu pouco arroz na China.	NA	NA	NA	NA	img1.png	img2.png
NA	3	A taxista fez mais corridas em Toronto do que em Vancouver.	NA	NA	NA	NA	img1.png	img2.png
NA	4	Teve um vazamento de petróleo em Luanda.	NA	NA	NA	NA	img1.png	img2.png
NA	5	Os turistas comeram pouco espaguete na Itália.	NA	NA	NA	NA	img1.png	img2.png
NA	6	O amigo mandou vários vídeos de São Francisco.	NA	NA	NA	NA	img1.png	img2.png
NA	7	A mulher trouxe alguns presentes de Madagascar.	NA	NA	NA	NA	img1.png	img2.png
NA	8	A padreira fez pães demais em São Paulo.	NA	NA	NA	NA	img1.png	img2.png
NA	9	A professora é mais alta que a reitora da universidade.	NA	NA	NA	NA	img3.png	img4.png
NA	10	O piloto viaja mais à Paris que o padeiro.	NA	NA	NA	NA	img3.png	img4.png
NA	11	A banqueira tem mais dinheiro que a faxineira.	NA	NA	NA	NA	img3.png	img4.png
NA	12	O homem sente mais amor pela mulher do que a mulher pelo homem.	NA	NA	NA	NA	img3.png	img4.png
NA	13	A garrafa é maior que o copo.	NA	NA	NA	NA	img3.png	img4.png
NA	14	A mulher é mais velha que a irmã.	NA	NA	NA	NA	img3.png	img4.png
NA	15	A cidade São Paulo é maior que Florianópolis.	NA	NA	NA	NA	img3.png	img4.png

NA	16	A cidade de Moscou é mais populosa que Toronto.	NA	NA	NA	NA	img3.png	img4.png
NA	17	O país Rússia é maior que o Brasil.	NA	NA	NA	NA	img3.png	img4.png
NA	18	O homem é mais alto que seu irmão.	NA	NA	NA	NA	img3.png	img4.png
NA	19	A cozinheira ganha mais que a garçonete.	NA	NA	NA	NA	img3.png	img4.png
NA	20	O piloto trabalha mais que o caminhoneiro.	NA	NA	NA	NA	img3.png	img4.png
NA	21	A cidade de Nova York tem mais transito que Tóquio.	NA	NA	NA	NA	img3.png	img4.png
NA	22	Os brasileiros fazem tantas compras pela internet quanto em lojas físicas.	NA	NA	NA	NA	img3.png	img4.png
NA	23	Os pais têm tanta energia quanto os filhos.	NA	NA	NA	NA	img3.png	img4.png
NA	24	A mulher é tão talentosa quanto o homem.	NA	NA	NA	NA	img3.png	img4.png
NA	25	O homem é tão rico quanto a mulher.	NA	NA	NA	NA	img3.png	img4.png
NA	26	A manicure comprou a mesma quantidade de alicates e tesouras.	NA	NA	NA	NA	img3.png	img4.png
NA	27	O médico tem o mesmo número de casas que o dentista.	NA	NA	NA	NA	img3.png	img4.png
NA	28	A empresária tem tantas padarias quanto mercados.	NA	NA	NA	NA	img3.png	img4.png
NA	29	A criança compra a mesma quantidade de pães na segunda-feira e no domingo.	NA	NA	NA	NA	img3.png	img4.png
NA	30	O mesmo número de pessoas moram na cidade e interior.	NA	NA	NA	NA	img3.png	img4.png
NA	31	O avô tem tanto cabelo quanto seu neto.	NA	NA	NA	NA	img3.png	img4.png
NA	32	A cidade de Fortaleza tem tantos carros quanto Curitiba.	NA	NA	NA	NA	img3.png	img4.png

APPENDIX P — SPR FILLER SENTENCES IN ENG

group	item	sentence	lexicon	quantifier	noun	condition	imga	imgb
NA	1	The girl has too many cats in Bogota.	NA	NA	NA	NA	img1.png	img2.png
NA	2	The salesman ate some rice in China.	NA	NA	NA	NA	img1.png	img2.png
NA	3	The taxist did more rides in Toronto than in Vancoover.	NA	NA	NA	NA	img1.png	img2.png
NA	4	There was a leak of oil in Luanda.	NA	NA	NA	NA	img1.png	img2.png
NA	5	The tourists ate a few pasta in Italy.	NA	NA	NA	NA	img1.png	img2.png
NA	6	The friend sent many videos of San Francisco.	NA	NA	NA	NA	img1.png	img2.png
NA	7	The woman brought some gifts from Madagascar.	NA	NA	NA	NA	img1.png	img2.png
NA	8	The baker did too much bread in São Paulo.	NA	NA	NA	NA	img1.png	img2.png
NA	9	The teacher is taller than the dean.	NA	NA	NA	NA	img3.png	img4.png
NA	10	The pilot travels more to Paris than the baker.	NA	NA	NA	NA	img3.png	img4.png
NA	11	The banker has more money than the cleaner.	NA	NA	NA	NA	img3.png	img4.png
NA	12	The man loves more the woman than the woman loves the man.	NA	NA	NA	NA	img3.png	img4.png
NA	13	The bottle is bigger than the cup.	NA	NA	NA	NA	img3.png	img4.png
NA	14	The woman is older than her sister.	NA	NA	NA	NA	img3.png	img4.png
NA	15	The city of São Paulo is bigger than Florianópolis.	NA	NA	NA	NA	img3.png	img4.png
NA	16	The city of Moscow is more populated than Toronto.	NA	NA	NA	NA	img3.png	img4.png
NA	17	The country of Russia is bigger than Brazil.	NA	NA	NA	NA	img3.png	img4.png
NA	18	The man is taller than his brother.	NA	NA	NA	NA	img3.png	img4.png

NA	19	The cooker earns more money than the waitress.	NA	NA	NA	NA	img3.png	img4.png
NA	20	The pilot works more than the trucker.	NA	NA	NA	NA	img3.png	img4.png
NA	21	The city of New York has more traffic than Tokio.	NA	NA	NA	NA	img3.png	img4.png
NA	22	The Brazilians buy as well as items online than at stores.	NA	NA	NA	NA	img3.png	img4.png
NA	23	The parents has as well as energy as their children.	NA	NA	NA	NA	img3.png	img4.png
NA	24	The woman is tallented as the man.	NA	NA	NA	NA	img3.png	img4.png
NA	25	The mas is rich as the woman.	NA	NA	NA	NA	img3.png	img4.png
NA	26	The beautician bought the same amount of clippers and scissors.	NA	NA	NA	NA	img3.png	img4.png
NA	27	The doctor has the same number of houses as the dentist.	NA	NA	NA	NA	img3.png	img4.png
NA	28	The businesswoman has as many bakeries as markets.	NA	NA	NA	NA	img3.png	img4.png
NA	29	The kid buys the same amount of bread on Monday and Sunday.	NA	NA	NA	NA	img3.png	img4.png
NA	30	The same number of people live in the city and the countryside.	NA	NA	NA	NA	img3.png	img4.png
NA	31	The grandfather has as much hair as his grandson.	NA	NA	NA	NA	img3.png	img4.png
NA	32	The city of Fortaleza has as many cars as Curitiba.	NA	NA	NA	NA	img3.png	img4.png

APPENDIX Q — SPR PRACTICE SENTENCES IN BRP

group	item	sentence	lexicon	quantifier	noun	condition	imga	imgb
NA	1	A menina encontrou muito musgo na praia.	NA	NA	NA	NA	img1.png	img2.png
NA	2	O edifício Empire State era mais alto que o edifício Chrysler em Nova York.	NA	NA	NA	NA	img3.png	img4.png
NA	3	A anciã coletou muito cacto na mata.	NA	NA	NA	NA	img1.png	img2.png
NA	4	O piloto viajava tanto quanto o motorista.	NA	NA	NA	NA	img3.png	img4.png
NA	5	O carteiro acariciou muitos cachorros na casa.	NA	NA	NA	NA	img1.png	img2.png
NA	6	O banqueiro tinha mais dinheiro do que o governo da Rússia.	NA	NA	NA	NA	img3.png	img4.png
NA	7	O professor leu muitos livros na biblioteca.	NA	NA	NA	NA	img1.png	img2.png
NA	8	A cozinheira comia tanto quanto cozinava.	NA	NA	NA	NA	img3.png	img4.png

APPENDIX R — SPR PRACTICE SENTENCES IN ENG

group	item	sentence	lexicon	quantifier	noun	condition	imga	imgb
NA	1	The girl found much moss at the beach.	NA	NA	NA	NA	img1.png	img2.png
NA	2	The Empire State Building was taller than the Chrysler in New York.	NA	NA	NA	NA	img3.png	img4.png
NA	3	The old lady collected much cactus at the forest.	NA	NA	NA	NA	img1.png	img2.png
NA	4	The pilot made the same amount of travels as the driver.	NA	NA	NA	NA	img3.png	img4.png
NA	5	The mailman petted many dogs at the house.	NA	NA	NA	NA	img1.png	img2.png
NA	6	The banker had the same amount of money as the Russian Government.	NA	NA	NA	NA	img3.png	img4.png
NA	7	The teacher read many books at the library.	NA	NA	NA	NA	img1.png	img2.png
NA	8	The cooker ate the same amount of food that she cooked.	NA	NA	NA	NA	img3.png	img4.png