

## DIFFERENCES BETWEEN STEREOTYPICAL GENDER AND DEFINITIONAL GENDER IN PRONOMINAL ANTECEDENT RETRIEVAL IN BRAZILIAN PORTUGUESE

### AS DIFERENÇAS ENTRE GÊNERO DE ESTEREÓTIPO E GÊNERO DEFINIDO NA RECUPERAÇÃO DE ANTECEDENTES PRONOMINAIS EM PORTUGUÊS BRASILEIRO

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Together with Alves (2019), this paper is part of a research work dedicated to investigating the role of gender cues in pronominal antecedent retrieval in Brazilian Portuguese. The main aim is to determine whether Principle B structural constraints work as an initial filter in pronominal antecedent retrieval in Brazilian Portuguese, or whether gender cues play a major role at early processing phases since this language has visible redundant morphological markings. It is also examined whether antecedent candidates carrying different gender cues have different weights in memory. In the present work, a comparison between antecedent candidates carrying stereotypical gender and definitional gender was provided. The results of two eye-tracking experiments conducted with native speakers of Brazilian Portuguese showed that gender morphological cues play a role at the very beginning of pronoun resolution processing, and only at a later processing phase, structural constraints of Principle B seemed to help the parser to select the correct antecedent. Like the previous work, the results indicated Principle B structural constraints do not work as an initial filter blocking structurally unacceptable candidates in Brazilian Portuguese; on the contrary, all candidates seemed to be taken into account despite of violating Principle B structural constraints. Similarly to the previous work, masculine antecedent candidates were preferable to be retrieved by memory in comparison to feminine candidates. Moreover, the results indicated that candidates with definitional gender rather than stereotypical gender are preferable to be retrieved by memory since the former is lexically specified, while the latter relies on probabilities based on world knowledge inferences.

**Palavras-chave:** Pronoun resolution. Gender cues. Memory retrieval. Brazilian Portuguese.

Juntamente com Alves (2019), este artigo é parte de uma pesquisa dedicada a investigar o papel das pistas de gênero na recuperação de antecedentes pronominais em português brasileiro. O objetivo principal é determinar se as restrições estruturais do Princípio B atuam como um filtro inicial na recuperação de antecedentes pronominais em português brasileiro, ou se as pistas de gênero são predominantes em fases iniciais do processamento uma vez que trata-se de uma língua com marcas morfológicas visíveis redundantes. Também examinou-se se candidatos que carregam diferentes marcas de gênero têm diferentes pesos na memória. Neste trabalho, serão

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comparados candidatos a antecedentes com gênero de estereótipo e com gênero definido. Os resultados de dois experimentos de rastreamento ocular realizados com falantes nativos de português brasileiro mostraram que as pistas de gênero participam desde o início do processamento da resolução pronominal, e que somente em um estágio mais tardio, as restrições estruturais do Princípio B pareceram ajudar o processador sintático a selecionar o antecedente correto. Assim como no último trabalho, os resultados indicaram que as restrições estruturais do Princípio B não atuam como um filtro inicial bloqueando candidatos inaceitáveis sob o ponto de vista estrutural; ao contrário, todos os candidatos pareceram ser levados em conta apesar de violarem as restrições estruturais do Princípio B. Em semelhança com o último trabalho, nossa memória parece preferir recuperar candidatos a antecedentes masculinos em comparação com antecedentes femininos. Além disso, os resultados indicaram que nossa memória também parece preferir recuperar candidatos a antecedentes com gênero definido ao invés de candidatos com gênero de estereótipo já que o primeiro é especificado no léxico, enquanto o segundo é resultado de probabilidades baseadas em inferências de conhecimento de mundo.

**Keywords:** Resolução pronominal. Pistas de gênero. Recuperação na memória. Português brasileiro.

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## 1. Introduction

One of psycholinguists concerns is about the mental processes that underlie language comprehension. What kinds of information are involved in language processing? Can one piece of linguistic information be more important than the other or do they all weigh the same? Can non-linguistic information play a role as well? How is the relation between language and other cognitive systems such as memory? This paper seeks to answer these questions by investigating pronouns and how they retrieve antecedents in discourse.

The syntactic constraints involved in pronoun resolution are known in the generative binding theory as Principle B, which states that pronouns must be free in their local (c-command) domains, roughly the clause where they are located (Chomsky 1993, 1995). In other words, pronouns and antecedents cannot be too close to each other. Besides that, Principle B also states that pronouns and antecedents must agree in gender and number. Finally, pronouns tend to retrieve discursive salient antecedents (Arnold *et al.* 2000; Gordon & Hendrick 1998; Foraker & McElree 2007; Greene, McKoon & Ratcliff 1992; Grosz, Weinstein & Joshi 1995; Kehler 2007; Rigalleau, Caplan & Baudiffier 2004). Given the fact that pronoun resolution processing involves syntactic, morphological, and discursive factors, it is an interesting way to investigate how mind deals with different types of information. Pronoun processing is also a good way to study the relation between language and memory since antecedents must be retrieved from a set of previous stored items. And one way to study the influence of non-linguistic factors in language processing is through gender stereotypes, as they are socially natured and depends on world knowledge. This way, this paper will study how gender-stereotyped antecedents are processed in pronoun resolution.

Previous research in Psycholinguistics have shown controversial results over the role of syntactic cues on how pronouns retrieve their antecedents. The traditional view

argues that the syntactic constraints work as an initial filter, blocking all candidates that violate Principle B structural constraints (Leitão, Peixoto & Santos 2008; Nicol & Swinney 1989; Sturt 2003, among others). However, a few works have shown that Principle B structural constraints do not work as an initial filter since structurally unacceptable antecedent candidates that agree with the pronouns can interfere in pronoun resolution at early processing phases (Alves 2019; Badecker & Straub 2002; Patil, Vasisht & Lewis 2016), even being occasionally misretrieved (Alves 2019; Engelmann, Jäger and Vasisht 2015). One may find a complete discussion over this question in Alves (2019).

The present paper aims at determining whether Principle B structural constraints work as initial filter in pronoun resolution in Brazilian Portuguese. The study reported here will investigate the role of gender morphology in pronoun resolution processing in order to find out whether structurally unacceptable candidates that agree in gender with the pronouns can interfere in pronoun resolution processing despite of violating Principle B structural constraints. In Alves (2019), it was shown that Principle B structural constraints do not work as an initial filter in Brazilian Portuguese. However, unlike our previous paper, which investigated semantic gender and grammatical gender, the experiment reported here will investigate stereotypical gender and definitional gender.

In Alves (2019), the results revealed that masculine antecedents are more prominent in memory than feminine antecedents in pronoun resolution processing in Brazilian Portuguese, because masculine works as a default gender in Romance languages (Alves 2019). Cacciari and Padovani (2007) explained that masculine spreads activation to conceptually masculine and feminine units because masculine is unmarked in Italian; on the other hand, feminine is marked, and it only activates the feminine unit. Similarly, according to Casado, Palma and Paolieri (2017), speakers include female and male representations when they process masculine nouns in Spanish. And Alves (2014) found out that masculine pronouns can equally retrieve either masculine or feminine antecedents in Brazilian Portuguese. One may find a complete discussion over masculine in Alves (2019). This way, the present paper will examine whether masculine and feminine definitional/stereotypical antecedent candidates weigh different in memory.

## 2. Stereotypical gender

According to Oakhill, Garnham and Reynolds (2005), background knowledge influences the construction of the information providing cognitive economy. The authors studied one specific type of background knowledge: stereotypical gender information. Psycholinguists often use the following riddle to exemplify stereotypical gender:

This morning a father and his son were driving along the highway to work, when they were involved in a horrible accident. The father was killed, and the son was quickly driven to the hospital, severely injured. When the boy was taken into the operating theatre, the surgeon exclaimed: “Oh, my God, this is my son!”

The riddle is based on the fact that when there is not any specific information about the gender associated with an occupation or role noun, as *surgeon*, prior knowledge, in

this case, gender stereotype, would be used by the reader to infer the more likely gender, which, in this case, is masculine. However, once that inference is proved incorrect by the end of the story, readers would have to reconstruct their character representation, which is more costly for processing.

In English, most terms for occupations are not gender marked, and many of them are gender stereotyped. So, if a reader supposes a surgeon is male and a secretary is female, it is so due to real statistics and world knowledge. However, a big question in the literature is whether stereotyped information is immediately activated by the time a stereotyped word is encountered, or only later, when required by discourse, as for example, when a pronoun needs to be resolved.

Oakhill *et al.* (2005) conducted a series of experiments in English to check whether gender stereotypical information is automatic and unable to be suppressed. In their experiments, the participants were instructed to decide whether two terms (an occupation and a kinship term) could refer to the same person (e.g.: nurse-aunt; nurse-uncle). The authors found out people were biased by gender stereotypes. For example, participants made more errors or had longer reaction times to accept pairs like *engineer-mother* than *engineer-father* or with gender-neutral terms. This way, both accuracy and reaction time suffered when stereotypical gender conflicted with the gender of the kinship term. Since the authors did not find facilitation effects of the congruent pairs, they affirmed stereotyped information is a case of interference. Moreover, according to Oakhill *et al.* (2005), gender stereotype might have a very strong and persistent effect because participants could not suppress it even after being strongly warned about it. The authors concluded gender stereotype associated with occupations and roles is incorporated into the information representation immediately as soon as an occupation or a role name is read. In other words, it is automatic.

Carreiras *et al.* (1996) argued that when reading, a representation of the situation is incrementally formed in our mental model through text input, context, and world knowledge. A particular type of world knowledge is gender stereotype. However, the authors alerted that, unlike English, in Spanish, stereotype information is not used to infer a person's gender because gender is explicitly given by the definite article. In order to compare how stereotypical gender influences comprehension in those two languages, self-paced reading was used to present short texts with a stereotypical role name followed by a pronoun (he/she). In (1), "futebolista" (footballer) is masculine stereotyped:

- (1) Examples of the materials in Carreiras *et al.* (1996)
  - a. The footballer wanted to play in the match.  
He/She had been training very hard during the week.
  - b. El futbolista quería jugar el partido.  
El había estado entrenando mucho durante la semana.
  - c. La futbolista quería jugar el partido.  
Ella había estado entrenando mucho durante la semana.

On the one hand, the results in Carreiras *et al.* (1996) showed reading times for the second sentences in English were longer when there was a mismatch between the gender of the pronoun and the stereotyped gender of the role noun. On the other hand, the results for Spanish showed reading times for the first sentences were longer when there was a mismatch between the gender of definite article and the gender of the stereotyped role noun. Carreiras *et al.* (1996) concluded stereotypes can influence the representation for a particular character in a text as soon as they become available. When they are the only source of gender information (as in the first sentences of the examples in English) they can be used to infer the gender of the characters in the mental model. However, if some upcoming information that mismatches the stereotyped inference appears in the text, that previous inference must be overridden, which might explain the difficulties the readers had in these cases. Although gender assignment in Spanish does not require a stereotyped inference as in English since gender information is already given in the articles, readers may also have to encode something new in their mental models: the clash between the gender of the articles and the stereotypical gender of the characters.

Kennison and Trofe (2003) also examined the role of gender-stereotyped nouns during language comprehension. First, they conducted a rating study with 405 nouns and compound nouns. Out of these nouns, 32 words were strongly stereotyped to refer to males and 32 to females. Thus these 64 nouns were used in a self-paced reading study on pronoun resolution, but unlike Carreiras *et al.* (1996), in which the participants saw the whole sentence, Kennison and Trofe (2003) used the phrase-by-phrase moving window paradigm. This way, they believed they would obtain more information about the time course of information than Carreiras *et al.* (1996). With respect to the self-paced reading study, reading times were longer at two regions after the pronouns when the gender stereotype of the antecedent mismatched the gender of the pronoun than when they matched. This result replicated Carreiras *et al.* (1996). Moreover, reading times at the pronoun *she* were longer than at the pronoun *he*. The authors believed it was because *he* is more frequent than *she*. Kennison and Trofe (2003) concluded word-specific gender stereotypes influence resolution of pronouns. They hypothesized comprehenders must have a representation for each word stored in memory, and this representation includes information about the word's gender stereotype, which is computed according to the relative frequency of usage in referring to males and females.

Cacciari and Padovani (2007) conducted two priming experiments aiming at investigating gender stereotypes in Italian. In Experiment 1, participants were shown pairs of stimuli formed by a prime word and a target gender-marked pronoun. The participants were asked to decide the grammatical gender of the pronoun ignoring the prime word. The primes were role nouns with and without gender stereotypes, and the stereotyped gender of the role nouns would match or mismatch the gender of the pronouns. No statistically significant priming results were found in Experiment 1. Thus, the authors decided to give the participants more time to process the prime in Experiment 2 so that the stimulus presentation time increased from 200 to 300ms and the interval between the prime and the target increased from 100 to 200ms. The results of Experiment 2 in Cacciari and Padovani (2007) showed reaction times were faster when the gender of the pronoun, matched the stereotyped gender of the role noun. Thus, although it is less

stable than semantic gender, the authors concluded stereotypical gender might be part of the nouns's mental representation. In addition, the results indicated when feminine stereotyped role nouns mismatched the pronouns (teacher-he), an inhibition effect was found in the response. However, no inhibition effect was found for masculine stereotyped nouns that mismatched the gender of the pronouns (engineer-she). The authors stated since masculine is unmarked in Italian, it might spread activation to conceptually masculine and feminine units, while the marked feminine would activate only the feminine unit.

Duff and Keir (2004) analyzed whether processing of individual words could be modified by discourse context. Their first goal was to show how gender stereotypes are accessed during comprehension and how they interfere in processing when stereotypes are violated. Their second goal was to investigate whether such interference effect could be reduced by discourse context. In Experiment 1, Duff and Keir (2004) monitored the participants' eye movements while reading sentences containing role nouns or occupation terms followed by reflexives, which could match or mismatch the stereotypical gender of the antecedents. In Experiment 2, the authors created a series of paragraphs focused on a particular character identified with a stereotyped role or occupation. In the disambiguating condition, the gender of the character was explicitly stated before the character was introduced informing the participants whether the character was a woman or a man. On the other hand, in the neutral condition, the gender of the character was not stated.

Duff and Keir (2004) found out in Experiment 1 and in the neutral condition of Experiment 2 reading processing suffered interference when text and the gender stereotyped information conflicted (mismatch-cost). This could possibly mean gender stereotypes are immediately activated by the time the role names were found, resulting in a conflict when the reflexives were subsequently encountered, or that gender information was not activated until the reflexives were encountered. Their study could not disentangle between these two possibilities. It should be highlighted there was no interference in the disambiguating condition in Experiment 2, that is, when prior context specified the gender of the role names. Duff and Keir (2004) concluded gender stereotypes are automatic, but they can be overridden, at least for a short time, by early explicit specification of gender in the discursive context.

### **3. Comparing stereotypical gender and definitional gender**

Kneiner, Sturt and Garrod (2008) were concerned with the nature of the stereotypical gender. According to the mental models approach, stereotypical gender is inferred from world knowledge, while according to the lexical view it is stored in the lexicon as part of the lexical representation. A good way to disentangle between these two proposals is comparing stereotypical gender with definitional gender. Both lexical and inferential approaches predict processing difficulty in mismatching conditions, that is, when stereotypical or definitional genders mismatch the gender of the reflexives. However, according to the lexical account, there may be some quantitative probabilistic differences between definitional and stereotypical nouns. Definitional gender is more polarized, or

even categorical, whereas stereotypical gender is more graded biased. This way, a larger mismatch-cost would be expected for definitional gender than for stereotypical gender. On the other hand, according to the inferential view, definitional gender and stereotypical gender are qualitative different, that is, the former might be specified in the lexicon, while the latter might be a result of probabilities based on world knowledge.

Kneiner *et al.* (2008) showed the results of two eye-tracking experiments differed in function of the order by which the gender information is given in discourse. In Experiment 1, the role nouns were presented earlier than the reflexives (anaphora), while in Experiment 2, the reflexives were presented earlier than the role nouns (cataphora). In Experiment 1, the mismatch-cost were similar for both stereotypical and definitional gender. However, in Experiment 2, the mismatch-cost was only found for definitional gender nouns. The authors concluded that, unlike definitional gender, stereotypical gender could be overridden by prior discourse. This way, there is a qualitative difference between definitional gender and stereotypical gender, which is evidence in favor of the inferential approach. The gender of definitional nouns might be lexically represented, while stereotypical gender might be pragmatically inferred. Finally, Kneiner *et al.* (2008) argued in favor of an interactive model in which lexical, pragmatic, and syntactic representations would efficiently communicate throughout processing allowing readers to incrementally integrate information from different linguistic levels.

Osterhout, Bersick and McLaughlin (1997) were concerned about the mental representation and processes underlying stereotype-violating reflexives compared to reflexives that are consistent with the stereotypes. In addition, they were concerned whether the stereotype violation in an ERP study would resemble to pragmatically implausible words (N400) or syntactically anomalous words (P600). In the second scenario, a P600 brain response would be similar to the brain response elicited by definitional male or female nouns whose grammatical features are associated with the word's lexical representation.

The materials used for reflexive antecedents in Osterhout *et al.* (1997) were nouns specifying occupations (as words like *actress*), states (as words like *bachelor*) and titles (as words like *duke*). The first type of nouns was gender stereotyped, while the latter two types were definitional male or female nouns. Half of the definitional nouns were male (as *king*) or female (as *queen*), and half of the stereotypical nouns were female stereotyped (as *babysitter*) or male stereotyped (as *pilot*).

Osterhout *et al.* (1997) reported violations of definitional gender evoked a larger P600 than violations of gender stereotypes. Moreover, the positive wave of P600 evoked for violations of gender stereotypes persisted even when the participants judged the sentences to be acceptable. The fact that both types of violations evoked P600 effects indicate the lexical representation of definitional and stereotypical nouns is similar, and they participate in the grammatical rules requiring agreement, that is, their gender information is encoded within grammar.

According to Osterhout *et al.* (1997), the different amplitudes of P600 between violations of definitional and stereotypical gender might suggest participants experienced more difficulties from recovering from a definitional gender violation than a stereotypical gender violation. In other words, violations with gender definitions result in an

unavoidable ungrammaticality, whereas violations with gender stereotypes result in reanalysis. It seems initially, readers assign the stereotypical reading, but by the time they encounter the reflexives and they realize their first reading was not adequate, they are ultimately forced to assign the less preferred gender feature.

Canal, Garnham and Oakhill (2015) aimed at replicating the results found by Osterhout *et al.* (1997). Unlike them, Canal *et al.* (2015) claimed the difference between definitional and stereotypical nouns is not quantitative. Instead of finding P600 effects in the mismatch conditions for both types of antecedents as Osterhout *et al.* (1997), Canal *et al.* (2015) found out that when the gender of the reflexives mismatched the stereotypical gender of the antecedents, the ERP results were biphasic showing negative effects in frontal left electrodes (Nref) and a positive effect in parietal electrodes (P600). It is worth mentioning that like Osterhout *et al.* (1997), they also found P600 effects when the gender of the reflexives mismatched the gender of the definitional antecedents. Based on other works, Canal *et al.* (2015) interpreted the Nref effect reflecting a search for additional information to link the reflexives to the stereotypical antecedents. In other words, as stereotypical gender does not determine gender categorically, but it is based on a probabilistic bias, comprehenders might need to look for additional information to realize antecedents and reflexives are coreferential. They explained the difference between their results and Osterhout *et al.* (1997)'s may be linked to a couple of factors: (a) Osterhout *et al.* (1997) used less electrodes, which might indicate they could have missed some effects; (b) the materials in Osterhout *et al.* (1997) were more stereotypically biased due to the use of modifiers; or (c) a social change - today's society is more liberal than 15 years ago.

#### 4. The present study

The present study aimed at investigating the differences between definitional gender and stereotypical gender in memory during antecedent retrieval in Brazilian Portuguese. By comparing these two types of genders, it would be possible to verify whether processing coreference dependencies with structurally unacceptable candidates carrying definitional gender would be more costly than processing sentences with structurally unacceptable candidates carrying stereotypical gender. It is hypothesized that antecedent candidates with definitional gender are preferable to be retrieved in memory than antecedent candidates with stereotypical gender. A reason for that would lie in the fact that definitional gender is lexically specified, while stereotypical gender is a result of probabilistic world knowledge inferences (Carreiras *et al.* 1996; Kneiner *et al.* 2008; Oakhill *et al.* 2005). Thus, if definitional gender were preferable than stereotypical gender, pronoun processing with structurally unacceptable antecedents carrying definitional gender would cause larger interference effects, because there would be more competition between them and structurally acceptable antecedents, and, consequently, antecedent retrievals would be slower.

Similarly, it is hypothesized that masculine antecedent candidates are more preferable than feminine antecedent candidates in memory. Masculine seems to weigh more than feminine because masculine is the default gender in languages like Portuguese



(Alves 2014, 2019; Cacciari & Padovani, 2007; Casado *et al.* 2017). Therefore, it is expected that masculine structurally unacceptable candidates would be responsible for slower antecedent retrievals as they would cause greater interference effects as a stronger competition between them and the structurally acceptable antecedents would occur.

Both Experiments 1a and 1b tested for structurally unacceptable antecedents with definitional and stereotypical genders; however, the former tested for those types of gender in the feminine and the latter in the masculine. It was necessary to divide the stimuli into two experiments due to the number of conditions.

#### 4.1. Participants

32 native speakers of Brazilian Portuguese (21 female and 11 male, mean age of 22 years) participated in Experiment 1a; and 36 (24 female and 12 male, mean age of 22 years) participated in Experiment 1b. The participants were undergraduate students with normal or corrected-to-normal vision. They were randomly selected to participate in the experiments as volunteers and they were not aware of the object of study of this research. They all signed a consent form giving permission to the experimenter to publish the results. The participants have not received any credits for their participation in the study; instead, they received 3 hours of Cultural-Scientific Activities (*Atividades-Científico-Culturais Discentes*, AACC) as compensation for their work.

#### 4.2. Materials and design

The experimental materials of each experiment consisted of 48 sentences distributed in 4 conditions. The experimental trials were arranged into 4 lists using a Latin Square. Each list was pseudo-randomized and contained 12 experimental items and 24 fillers. Each and every trial was followed by a comprehension question. The experimental trials were composed by embedded third person singular pronouns (*ele/ela*), whose antecedents in the main clause could be masculine or feminine common nouns. However, between the antecedents and the pronouns there were structurally unacceptable antecedents that could match or mismatch the third person pronouns in gender.

The materials followed the same structure [Subject DP1] [VP1 [Object DP2<sub>i</sub>]] [que [Subject t<sub>1</sub>] [VP2 [Object *ele/ela*] Adv PP]] and there was length control in the regions before and after the pronouns. The antecedent was in the subject position within DP1 and was composed by a definite article and a masculine/feminine common noun. Following DP1, there was a transitive verb within VP1, which also included the object DP2, composed by a definite article and a feminine/masculine definitional or stereotypical noun. After that, there was a subject relative clause introduced by the relative pronoun *que*. The relative pronoun was followed by VP2, which contained a transitive verb with 5-6 characters. The subject of the relative clause was the moved Object DP2 in the main clause and the object of relative clause was the personal pronoun *ele/ela*. After the pronoun there was a manner adverb ending in *-mente* from 9 to 11 characters followed by a PP. The personal pronouns *ele/ela* were used in the materials instead of the oblique pronouns *o/a*, because the latter are less salient and attached to the verb, which makes it

difficult to get them analyzed. Besides that, the oblique pronouns are very rare in colloquial Brazilian Portuguese nowadays.

It should be highlighted that the accessibility of the structurally acceptable antecedents and the distractors were quite balanced in the materials. On one hand, the structurally acceptable antecedents used in the materials would be the preferable antecedent candidates not only due to structural constraints related to Principle B, but also due to discursive factors. They were the subjects of the main clause, which means they were highly accessible, and they could be considered as the discursive topic. On the other hand, the structurally unacceptable antecedent candidates used in the materials were the subject of the embedded clause, and even though they were not as prominent as the structurally acceptable antecedents, they are also highly accessible in discourse due to its recentness.

The independent variables of the experiment were: a) *antecedent matching the gender of the pronoun*, which is a factor that is directly related to Principle B structural constraints; and b) *distractor matching the gender of the pronoun*, which is factor that relies purely on agreement cues. This way, the experimental design was 2x2, with four main conditions. There was also a control for the *distractor type of gender*; therefore, half of the experimental trials contained distractors with definitional gender and the other half contained distractors with stereotypical gender. It should be noticed that all distractors of Experiment 1a were feminine and all distractors of Experiment 1b were masculine. A sample of the materials of Experiment 1a can be found in Tables 2 and 3 and a sample of the materials of Experiment 1b can be found in Tables 4 and 5. Brackets delimit the region of interest, which was the pronoun. One may find a complete list of the materials in the Appendix.

**Table 1. Sample of materials for distractors with feminine definitional gender used in Experiment 1a**

	Antecedent mismatch	Antecedent match
Distractor mismatch	A <u>enfermeira</u> conhecia a <u>mulher</u> que matou [ <b>ele</b> ] brutalmente na frente da casa da família.  (The <sub>[fem]</sub> nurse <sub>[fem]</sub> knew the <u>woman</u> who brutally killed <b>him</b> in front of the family's house.)	O <u>enfermeiro</u> conhecia a <u>mulher</u> que matou [ <b>ele</b> ] brutalmente na frente da casa da família.  (The <sub>[masc]</sub> nurse <sub>[masc]</sub> knew the <u>woman</u> who brutally killed <b>him</b> in front of the family's house.)
Distractor match	O <u>enfermeiro</u> conhecia a <u>mulher</u> que matou [ <b>ela</b> ] brutalmente na frente da casa da família.  (The <sub>[masc]</sub> nurse <sub>[masc]</sub> knew the <u>woman</u> who brutally killed <b>her</b> in front of the family's house.)	A <u>enfermeira</u> conhecia a <u>mulher</u> que matou [ <b>ela</b> ] brutalmente na frente da casa da família.  (The <sub>[fem]</sub> nurse <sub>[fem]</sub> knew the <u>woman</u> who brutally killed <b>her</b> in front of the family's house.)

**Table 2. Sample of the materials for distractors with feminine stereotypical gender used in Experiment 1a**

	Antecedent mismatch	Antecedent match
Distractor mismatch	<p>A <u>bibliotecária</u> seguiu a <u>recepcionista</u> que guiou [<b>ele</b>] brevemente através do corredor do grande gabinete real.</p> <p><i>(The<sub>[fem]</sub> <u>librarian</u><sub>[fem]</sub> followed the<sub>[fem]</sub> <u>receptionist</u> who briefly guided <b>him</b> through the hallway of the large royal office.)</i></p>	<p>O <u>bibliotecário</u> seguiu a <u>recepcionista</u> que guiou [<b>ele</b>] brevemente através do corredor do grande gabinete real.</p> <p><i>(The<sub>[masc]</sub> <u>librarian</u><sub>[masc]</sub> followed the<sub>[fem]</sub> <u>receptionist</u> who briefly guided <b>him</b> through the hallway of the large royal office.)</i></p>
Distractor match	<p>O <u>bibliotecário</u> seguiu a <u>recepcionista</u> que guiou [<b>ela</b>] brevemente através do corredor do grande gabinete real.</p> <p><i>(The<sub>[masc]</sub> <u>librarian</u><sub>[masc]</sub> followed the<sub>[fem]</sub> <u>receptionist</u> who briefly guided <b>her</b> through the hallway of large royal office.)</i></p>	<p>A <u>bibliotecária</u> seguiu a <u>recepcionista</u> que guiou [<b>ela</b>] brevemente através do corredor do grande gabinete real.</p> <p><i>(The<sub>[fem]</sub> <u>librarian</u><sub>[fem]</sub> followed the<sub>[fem]</sub> <u>receptionist</u> who briefly guided <b>her</b> through the hallway of the large royal office.)</i></p>

**Table 3. Sample of the materials for distractors with masculine definitional gender used in Experiment 1b**

	Antecedent mismatch	Antecedent match
Distractor mismatch	<p>O <u>advogado</u> hostilizou o <u>rei</u> que tratou [<b>ela</b>] rudemente na frente de alguns convidados na festa.</p> <p><i>(The<sub>[masc]</sub> <u>lawyer</u><sub>[masc]</sub> antagonized the <u>king</u> who treated <b>her</b> rudely in front of some guests at the party.)</i></p>	<p>A <u>advogada</u> hostilizou o <u>rei</u> que tratou [<b>ela</b>] rudemente na frente de alguns convidados na festa.</p> <p><i>(The<sub>[fem]</sub> <u>lawyer</u><sub>[fem]</sub> antagonized the <u>king</u> who treated <b>her</b> rudely in front of some guests at the party.)</i></p>
Distractor match	<p>A <u>advogada</u> hostilizou o <u>rei</u> que tratou [<b>ele</b>] rudemente na frente de alguns convidados na festa.</p> <p><i>(The<sub>[fem]</sub> <u>lawyer</u><sub>[fem]</sub> antagonized the <u>king</u> who treated <b>him</b> rudely in front of some guests at the party.)</i></p>	<p>O <u>advogado</u> hostilizou o <u>rei</u> que tratou [<b>ele</b>] rudemente na frente de alguns convidados na festa.</p> <p><i>(The<sub>[masc]</sub> <u>lawyer</u><sub>[masc]</sub> antagonized the <u>king</u> who treated <b>him</b> rudely in front of some guests at the party.)</i></p>

**Table 4. Sample of the materials for distractors with masculine stereotypical gender used in Experiment 1b**

	Antecedent mismatch	Antecedent match
Distractor mismatch	<p>O <u>cabeleireiro</u> detestou o <u>piloto de corrida</u> que olhou [ela] lentamente dos pés a cabeça antes da entrevista no camarim.</p> <p>(The<sub>[masc]</sub> <u>hairdresser</u><sub>[mas]</sub> disliked the<sub>[masc]</sub> <u>race car driver</u> who slowly stared at <b>her</b> in the dressing room before the interview.)</p>	<p>A <u>cabeleireira</u> detestou o <u>piloto de corrida</u> que olhou [ela] lentamente dos pés a cabeça antes da entrevista no camarim.</p> <p>(The<sub>[fem]</sub> <u>hairdresser</u><sub>[fem]</sub> disliked the<sub>[masc]</sub> <u>race car driver</u> who slowly stared at <b>her</b> in the dressing room before the interview.)</p>
Distractor match	<p>A <u>cabeleireira</u> detestou o <u>piloto de corrida</u> que olhou [ele] lentamente dos pés a cabeça antes da entrevista no camarim.</p> <p>(The<sub>[fem]</sub> <u>hairdresser</u><sub>[fem]</sub> disliked the<sub>[masc]</sub> <u>race car driver</u> who slowly stared at <b>him</b> in the dressing room before the interview.)</p>	<p>O <u>cabeleireiro</u> detestou o <u>piloto de corrida</u> que olhou [ele] lentamente dos pés a cabeça antes da entrevista no camarim.</p> <p>(The<sub>[masc]</sub> <u>hairdresser</u><sub>[masc]</sub> disliked the<sub>[masc]</sub> <u>race car driver</u> who slowly stared at <b>him</b> in the dressing room before the interview.)</p>

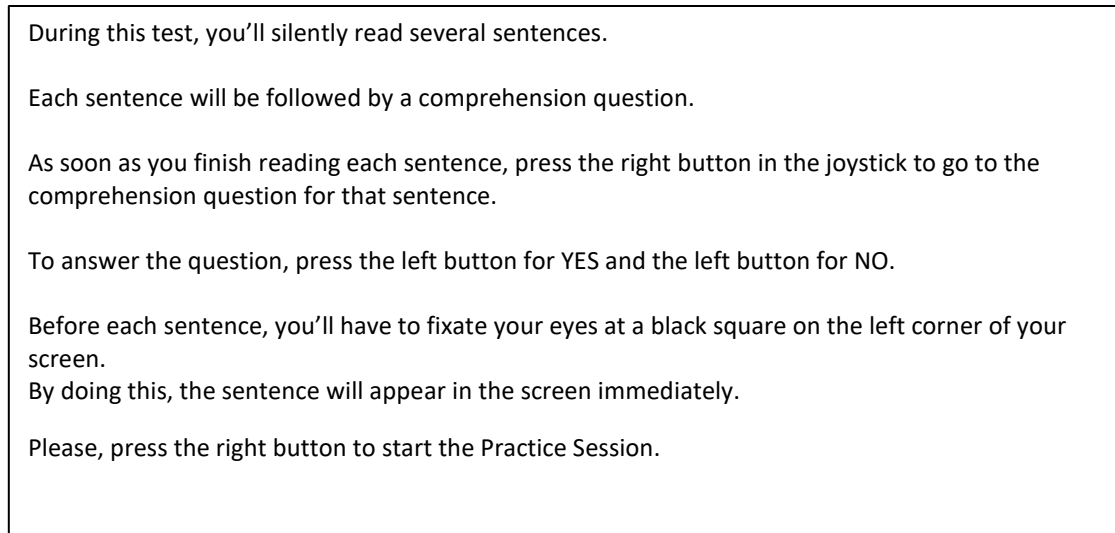
The dependent variables were First Fixation Duration, First Pass, and Regression Path at the pronoun region. First Fixation corresponds to the very beginning of reading processing, and it measures the duration of the first eye fixation at a certain region in the text. First Pass also captures early processing phases as it measures the sum of all eye fixations at a certain region of the text before our eyes move to the right or left. Finally, Regression Path, or Go-Past Time, captures late processing phases. It corresponds to the duration of all fixations from first fixation at a region to first moving to the right – including regressions back to earlier parts of the sentence before moving on.

### 4.3. Procedure

The experiment was conducted in a psycholinguistics laboratory (Laboratório de Psicolinguística Experimental – LAPEX) in Rio de Janeiro, Brazil. The eye-tracker used in this experiment was *Eye Link 1000* and the experiment was programmed and conducted on *Eye Track 7.10*<sup>1</sup> software. All trials were typed in font *Monaco* size 12. The participants were instructed to seat comfortable and were given written and oral instructions. The instructions screen is illustrated in Figure 1.<sup>2</sup>

<sup>1</sup> The primary developers of *Eye Track* were David Stracuzzi and Jeff Kinsey and it is conceptually based on software written by Saarbruken and provided to UMASS by Christoph Scheepers. *Eye Track* can be downloaded for free on <https://blogs.umass.edu/eyelab/software/>.

<sup>2</sup> The participants received the instructions in Portuguese; the translation to English is only for the purpose of this paper.



**Figure 1. Instructions screen of Experiments 1a and 1b**

After receiving the instructions, the calibration process would start followed by a short practice with 6 filler sentences so that the experimenter would check whether the participants understood the task and were performing it at a natural speed. The experiment duration was of 20 minutes approximately.

#### 4.4. Analysis

The eye-tracking data was analyzed using the following tools: Visual EDF to ASC, to convert the .EDF files that Eye Link 1000 generates; *Robodoc.py*<sup>3</sup>, to clean eye blinks and long saccades (longer than 80ms); *Question\_acc.py*<sup>4</sup> to compute the comprehension questions accuracy; *EyeDry*<sup>5</sup> to compute the reading measures; and R for the data exploration and statistical analysis.

Some experimental trials had to be excluded due to eye blinks and long saccades at the regions of interest (22% in Experiment 1a, and 15% in Experiment 1b).

As Experiment 1a and Experiment 1b contained the same materials, except for the distractors, the data was analyzed together in a between-subjects analysis. The observations were normalized with log-transformations and the means were centered in order to minimize the effect of data variability and outliers. After that, linear mixed effects models (LMEs) were created with the help of *lmerTest*<sup>6</sup> package in order to analyze the role of each independent variable in the results. The fixed effects of the lmes were: a) antecedent matching the gender of the pronoun (match/mismatch); b) distractor matching the gender of the pronoun (match/mismatch); c) distractor type of gender

<sup>3</sup> *Rododoc.py* is a python script created by Adrian Staub and Chuck Clifton, and the 2016 version was revised by Jesse Harris. It can also be downloaded on <https://blogs.umass.edu/eyelab/software/>.

<sup>4</sup> *Question\_acc.py* is a python script that comes with *Robodoc.py* utils to check questions accuracy and their reaction times.

<sup>5</sup> *EyeDry* was created by Chuck Clifton and can be downloaded on <https://blogs.umass.edu/eyelab/software/>.

<sup>6</sup> Alexandra Kuznetsova, Per Bruun Brockhoff and Rune Haubo Bojesen Christensen (2015). *lmerTest: Tests in Linear Mixed Effects Models*. R package version 2.0-29 on <https://CRAN.R-project.org/package=lmerTest>.

(definitional/stereotypical); and d) distractor gender (masculine/feminine). On the other hand, the random effects were the participants and the items. LME analysis was chosen as it verifies the influence of the independent variables as well as any “noise” influence such as items peculiarities and participants differences.

Full random LME models (with random slopes for each of the random effects) were created to analyze the data. For space reasons, only the statistically significant results were reported in the text. One may check the Appendix for a complete list of the LME results. After running the LME models, post-hoc tests were conducted in order to figure out which pairwise comparisons among the conditions of the experiments were statistically significant. Differences between the least squared means (lsmeans), which are predicted marginal means of LME models, were estimated with the help of emmeans package.<sup>7</sup>

Aiming to clarify the statistically significant results, histograms with error bars were created using ggplot2 package.<sup>8</sup> In order to facilitate the comprehension of the graphs, all statistically significant pairwise comparisons were indicated in the figures with “\*\*”.

## 4.5. Results

It should be mentioned that the participants answered the comprehension questions with an average of accuracy of 90% in Experiment 1a and 89% in Experiment 1b, which means that the participants were paying attention to the task and reading the sentences properly.

Results for the eye-tracking measures, chosen as dependent variables – First Fixation, First Pass, and Regression Path – will be reported and discussed below.

### 4.5.1. First Fixation

The results of the LME for First Fixation at the pronoun region can be seen in Table 5.

**Table 5. LME results for First Fixation at the pronoun region.**

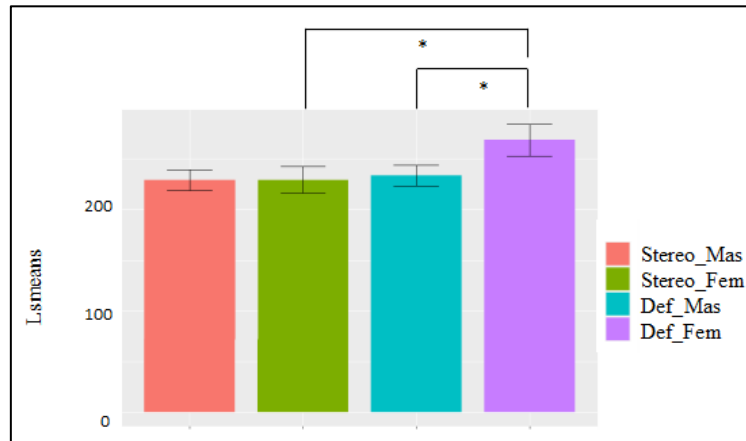
Parameter	Pronoun			
	$\beta_0$	SE	t-value	p-value
(Intercept)	0.11	0.23	0.48	0.63
Type of gender x Gender	1.20	0.41	2.90	0.004
Antecedent x Type of gender x Gender	-1.15	0.57	2.00	0.046

In post-hoc tests, the interaction *Type of gender x Gender* was found statistically significant in two pairwise comparisons. The differences between the lsmeans ( $\beta_0=39.26$ ,  $SE=16.53$ ,  $t\text{-value}=2.37$ ,  $p=0.019$ ) indicated that reading times at the pronoun region were longer in sentences containing distractors with feminine definitional gender (lsmean=269,  $SE=15.5$ ) than in sentences containing distractors with feminine stereotypical gender

<sup>7</sup> Russel Lenth (2019). emmeans: estimated marginal means, aka Least-Squares Means. R package version 1.4. <https://CRAN.R-project.org/package=emmeans>.

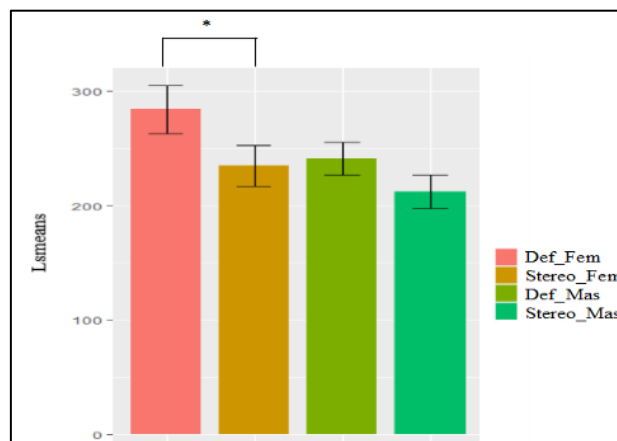
<sup>8</sup> H.Wickham. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2016.

( $l_s$ mean=229, SE=13.3). Besides that, the differences between the  $l_s$ means ( $\beta_0=34.95$ , SE=16.81,  $t$ -value=2.07,  $p=0.043$ ) indicated that reading times at the pronoun region were longer in sentences containing distractors with feminine definitional gender ( $l_s$ mean=269, SE=15.5) than in sentences containing masculine definitional gender ( $l_s$ mean=234, SE=10.1). Figure 2 illustrates the interaction *Type of gender x Gender* for First Fixation Duration at the pronoun region.



**Figure 2.** First Fixation at the pronoun region by the type of gender and gender of the distractors.

The post-hoc tests of the interaction *Antecedent x Type of gender x Gender* was only statistically significant in one pairwise comparison. The differences between the  $l_s$ means ( $\beta_0=49.12$ , SE=23.83,  $t$ -value=2.06,  $p=0.044$ ) indicated that sentences in which the antecedents mismatched the pronouns, reading times at the pronoun region were longer in sentences containing distractors with feminine definitional gender ( $l_s$ mean=284, SE=20.9) than in sentences containing distractors with feminine stereotypical gender ( $l_s$ mean=235, SE=17.9). Figure 3 illustrates the interaction [*Mismatching*] *Antecedent x Type of gender x Gender* for First Fixation Duration at the pronoun region.



**Figure 3.** First Fixation at the pronoun region by mismatching antecedents, type of gender and gender.

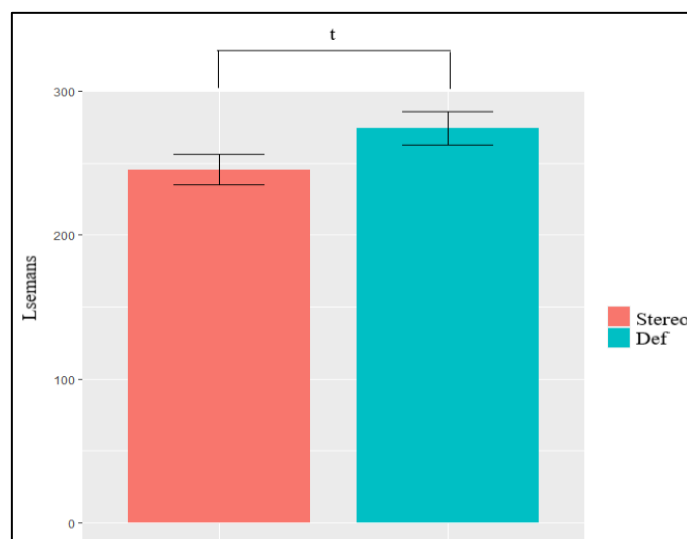
#### 4.5.2. First Pass

The results of the LME for First Pass at the pronoun region can be seen in Table 6.

**Table 6. LME results for First Pass at the pronoun region.**

Parameter	Pronoun			
	$\beta_0$	SE	t-value	p-value
(Intercept)	0.10	0.21	0.48	0.63
Type of gender	-0.69	0.30	-2.24	0.026
Type of gender x Gender	1.10	0.39	2.80	0.005

The post-hoc test of the main effect of *Type of Gender* showed a trend towards statistical significance regarding the difference between stereotypical gender and definitional gender ( $\beta_0=28.57$ ,  $SE=14.57$ ,  $t\text{-value}=1.96$ ,  $p=0.068$ ). Reading times at the pronoun were longer in sentences containing distractors with definitional gender ( $l\text{mean}=274$ ,  $SE=11.8$ ) than in sentences containing distractors with stereotypical gender ( $l\text{mean}=246$ ,  $SE=10.8$ ). Figure 4 illustrates the main effect of *Type of Gender* for First Pass Duration at the pronoun region.



**Figure 4. First Pass at the pronoun region by the type of gender of the distractors.**

The interaction *Type of gender x Gender* was found statistically significant in the two pairwise comparisons. The differences between the  $l\text{means}$  ( $\beta_0=52.39$ ,  $SE=21.14$ ,  $t\text{-value}=2.47$ ,  $p=0.02$ ) indicated that reading times at the pronoun region were longer in sentences containing distractors with definitional feminine gender ( $l\text{mean}=293$ ,  $SE=18.56$ ) than in sentences containing distractors with feminine stereotypical gender ( $l\text{mean}=241$ ,  $SE=15.6$ ). Besides that, the differences between the  $l\text{means}$  ( $\beta_0=37.96$ ,  $SE=18.74$ ,  $t\text{-value}=2.02$ ,  $p=0.047$ ) indicated that reading times at the pronoun region were longer in sentences containing distractors with feminine definitional gender ( $l\text{mean}=293$ ,  $SE=18.1$ ) than in sentences containing distractors with masculine definitional gender



(lsmean=255, SE=12.3). Figure 5 illustrates the interaction *Type of gender x Gender* for First Pass Duration at the pronoun region.

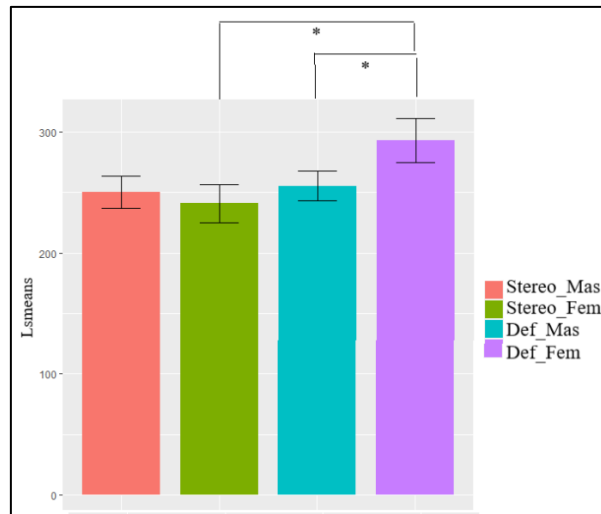


Figure 5. First Pass at the pronoun region by the type of gender and gender of the distractors.

#### 4.5.3. Regression Path

The results of the LME for Regression at the pronoun region can be seen in Table 7.

Table 7. LME results for Regression Path at the pronoun region.

Pronoun				
Parameter	$\beta_0$	SE	t-value	p-value
(Intercept)	-0.44	0.25	-1.73	0.101
Antecedent	0.89	0.33	2.65	0.009
Antecedent x Distractor	-0.99	0.42	-2.33	0.020
Antecedent x Gender	-0.97	0.39	-2.45	0.015
Distractor x Gender	-1.01	0.37	-2.70	0.007
Antecedent x Distractor x Gender	1.62	0.53	3.02	0.002

The post-hoc test of the main effect of *Antecedent* showed that the difference between the lsmeans ( $\beta_0=-146.66$ ,  $SE=57.49$ ,  $t\text{-value}=-2.55$ ,  $p=0.018$ ) indicated that reading times at the pronoun region were faster when the antecedents and pronouns matched in gender (lsmean=375,  $SE=38.6$ ) than when they mismatched (lsmean=521,  $SE=64.5$ ). Figure 6 illustrates the main effect of *Antecedent*.

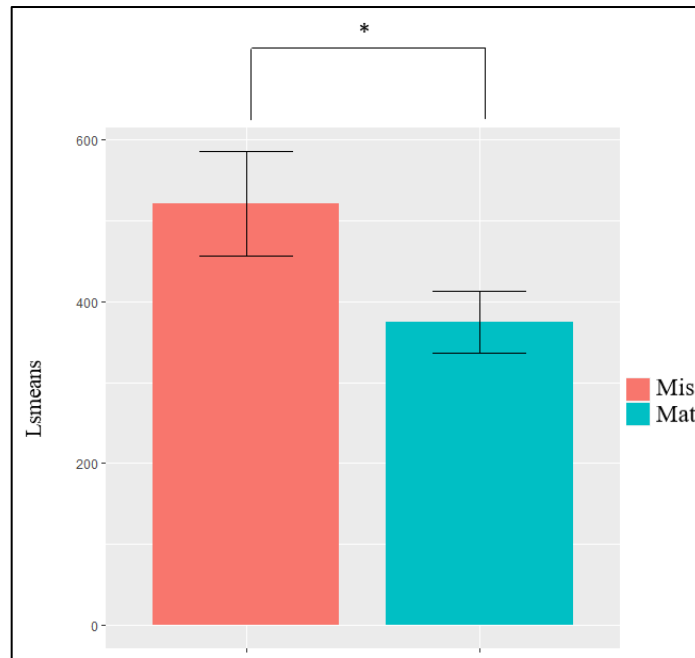


Figure 6. Regression Path at the pronoun region by antecedents.

The post-hoc tests of the interaction *Antecedent x Distractor* showed that the differences between the lsmeans ( $\beta_0 = -151.03$ ,  $SE = 72.65$ ,  $t\text{-value} = -2.07$ ,  $p = 0.042$ ) indicated that when distractors matched the pronouns in gender, reading times at the pronoun region in sentences in which the antecedents also matched the pronouns (lsmean=347,  $SE = 55.9$ ) were faster than in sentences in which the antecedents mismatched the pronouns in gender (lsmean=498,  $SE = 78.3$ ). Figure 7 illustrates the interaction *Antecedent x Distractor*.

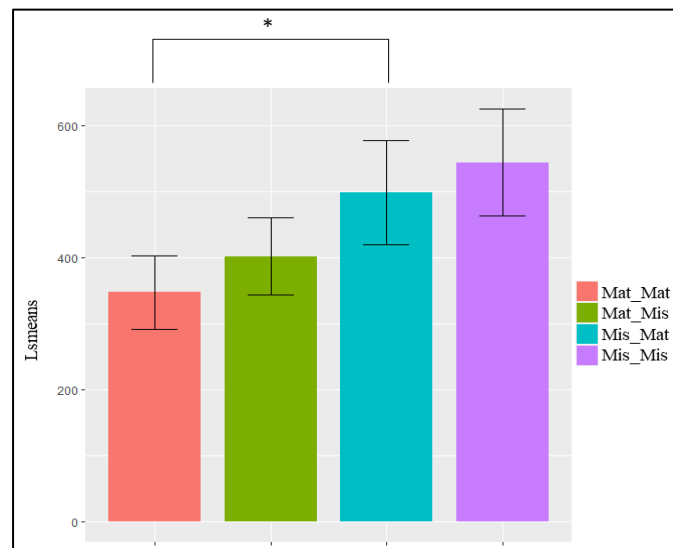
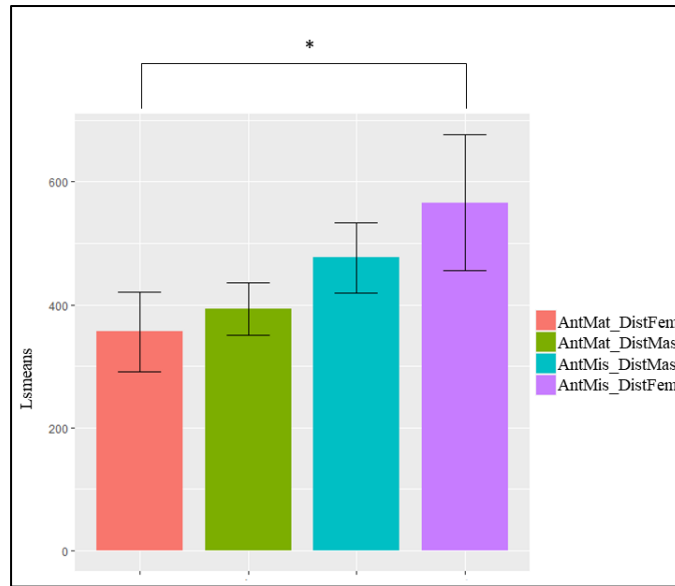


Figure 7. Regression Path at the pronoun region by antecedents and distractors.

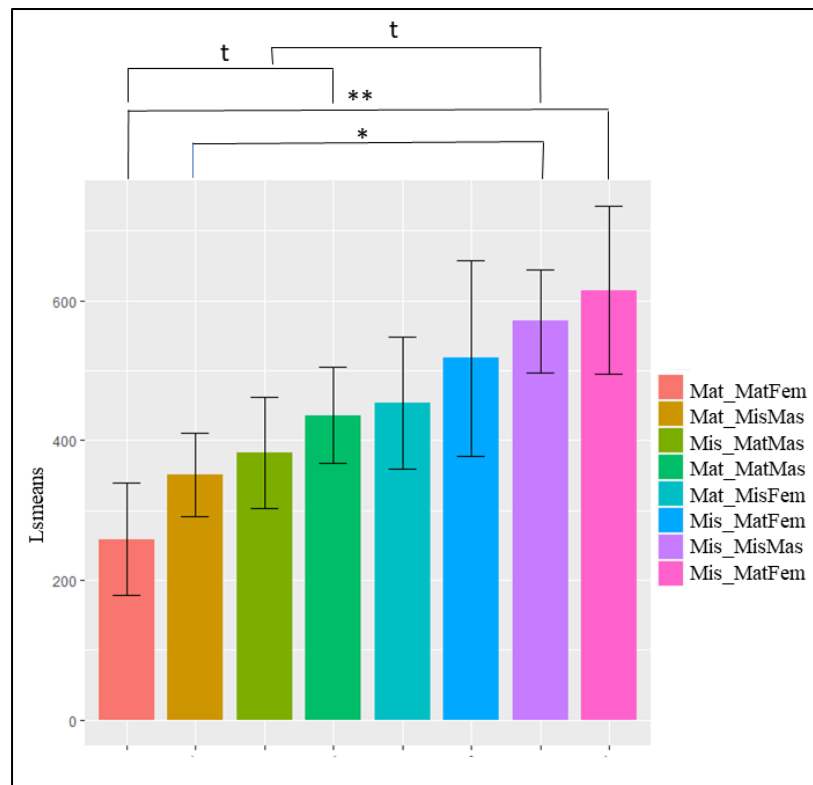
Post-hoc tests of the interaction *Antecedent x Gender* showed that the differences between the lsmeans ( $\beta_0 = -210.3$ ,  $SE = 91.74$ ,  $t\text{-value} = -2.29$ ,  $p = 0.030$ ) indicated that in sentences with feminine distractors, reading times at the pronoun region were faster when antecedents matched the pronoun in gender (lsmean=356,  $SE = 64.7$ ) than when they

mismatched (lsmean=566, SE=110.7). Figure 8 illustrates the interaction *Antecedent x Gender*.



**Figure 8.** Regression Path at the pronoun region by antecedents and distractors gender.

Post-hoc tests of the interaction *Antecedent x Distractor x Gender* indicated two statistically significant pairwise comparisons. The differences between the lsmeans ( $\beta_0 = -356.01$ , SE=113.9, t-value=-3.12, p=0.0027) indicated that when distractors matched the pronouns in feminine gender, reading times at the pronoun region were faster when antecedents also matched the pronouns in gender (lsmean=259, SE=79.6) than when they mismatched (lsmean=615, SE=120.4). The differences between the lsmeans ( $\beta_0 = -219.98$ , SE=85.7, t-value=-2.56, p=0.011) also indicated that when masculine distractors mismatched the pronouns, reading times at the pronouns region were faster when antecedents matched the pronouns in gender (lsmean=351, SE=60.2) than when they mismatched (lsmean=571, SE=73.5). Besides that, two pairwise comparisons showed a trend towards significance. The differences between the lsmeans ( $\beta_0 = -177.1$ , SE=92.61, t-value=-1.91, p=0.059) showed that when both antecedents and distractors matched the pronouns in feminine (lsmeans=259, SE=79.6), reading times at the pronoun region tended to be faster than when they matched in masculine (lsmeans=436, SE=68.5). The differences between the lsmeans ( $\beta_0 = -188.76$ , SE=98.88, t-value=-1.90, p=0.063) also showed that when antecedents mismatched the pronouns in gender, reading times at the pronoun region tended to be faster when masculine distractors matched the pronouns (lsmean=382, SE=79.7) than when they mismatched (lsmean=571, SE=73.5). Figure 9 illustrates the *Antecedent x Distractor x Gender* interaction.



**Figure 9. Regression Path at the pronoun region by antecedents and distractors and gender.**

## 5. Discussion

The results reported in this paper corroborates Alves (2019), that is, Principle B structural constraints do not work as an initial filter in Brazilian Portuguese since structurally unacceptable antecedent candidates interfered in pronoun resolution processing at very early processing phases as shown by First Fixation and First Pass eye-tracking measures. More than that, it seems that Principle B structural constraints only play a role at late processing phases as shown by Regression Path results. This way, it seems that in the beginning of processing all candidates are taken into account by memory as potential candidates; and at a later stage, Principle B structural constraints help the parser to select the correct candidate.

As predicted, definitional gender weighs more in memory than stereotypical gender since structurally unacceptable candidates with definitional gender caused more inhibitory effects than structurally unacceptable candidates with stereotypical gender. Candidates with definitional gender are more preferable to be retrieved, increasing the competition between them and the structurally acceptable candidates, resulting in longer processing.

With respect to masculine, the case is more complex since both facilitatory and inhibitory effects were found. At early processing stages, as shown by First Fixation and First Pass, the facilitatory effect of masculine distractors when compared to feminine distractors might indicate the former are being misretrieved by memory (Alves 2019; Engelmann *et al.* 2015). On the other hand, at late processing phases, as shown by Regression Path (although the results only show a trend towards statistical significance),

when the structurally acceptable antecedents agree with the pronouns, pronoun resolution tends to take longer with masculine distractors than with feminine distractors. This inhibitory effect happens because the competition between structurally acceptable antecedents and masculine distractors is greater compared to the competition between structurally acceptable antecedents and feminine distractors. This means that masculine structurally unacceptable antecedents tend to interfere in pronoun resolution even when there is already a structurally acceptable antecedent available in the sentence. In addition, when structurally unacceptable antecedents do not agree with the pronouns, masculine distractors that agree with the pronouns are responsible for faster pronoun resolutions than masculine distractors that do not agree with the pronouns. This seems to be another case of masculine structurally unacceptable antecedent misretrieval. Causing either facilitatory or inhibitory effects, masculine seems to be more preferable to be retrieved by memory than feminine, indicating that masculine weighs more in memory than feminine since it is the default gender in Brazilian Portuguese (Alves 2014, 2019; Cacciari & Padovani, 2007; Casado *et al.* 2017).

Finally, the results found in Regression Path indicate that Principle B is relevant to pronoun resolution in Brazilian Portuguese since there were longer reading times at the pronoun when structurally acceptable antecedents mismatched the pronouns in gender.

Our results show that morphological cues as well as Principle B structural constraints are very important in antecedent retrieval in Brazilian Portuguese. However, the results reported here indicate that gender cues play a role before Principle B structural constraints in the time course of pronoun resolution processing. This means that memory tends to retrieve more easily masculine candidates and candidates with definitional gender. Masculine weighs more in memory because it is the default gender, while definitional gender might be lexically specified unlike stereotypical gender. Stereotypical gender seems to depend on probabilities based on world knowledge inferences, which might be more cognitively costly.

The results reported here seemed to contradict Carreiras *et al.* (1996), Duff and Keir (2004), and Kneiner *et al.* (2008). The definite articles before the gender stereotyped distractors in our materials were not enough to override stereotyped inferences as it was clear in our results that sentences with distractors with stereotypical gender and definitional gender were processed differently. In other words, stereotypical gender inferences are strong and cannot be suppressed even in cases where they would not be needed to comprehend and process a sentence, as in our materials. This corroborates the hypothesis that stereotypical gender is automatic and computed as soon as the word is encountered, and not only when this information is needed (Oakhill *et al.* 2005).

Contradicting the lexical approach (Cacciari & Padovani, 2007; Kennison & Trofe, 2003; Osterhout *et al.* 1997) this paper corroborates the inferential approach suggesting that stereotypical gender seems to be qualitatively different from definitional gender (Canal *et al.* 2015; Carreiras *et al.* 1996; Kneiner *et al.* 2008; Oakhill *et al.* 2005). In other words, while definitional gender might be lexically specified, as an idiosyncrasy, stereotypical gender might be a result of probabilities based on world knowledge inferences. This way, stereotypical gender is more cognitively demanding than

definitional gender, which explains why items with definitional gender are more preferable to be retrieved by memory.

The conclusion is that this paper showed evidence that language processing relies on both morphological (gender) and syntactic information, for instance. Corroborating Alves (2019), it seems that Principle B structural constraints do not work as an initial filter in pronoun resolution in Brazilian Portuguese; and that stereotypical gender does not seem to be lexically specified, but it is a result of world knowledge inferences. This means that language processing makes use of both linguistic and non-linguistic information. However, it seems that not all information weighs the same; memory retrieves more easily items that carry default linguistic information as it seems to be the case of masculine and definitional gender in opposition to feminine and stereotypical gender.

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## References

- Alves, M. C. dos S. (2014). *Processamento do traço de gênero na correferência pronominal com antecedentes sobrecomuns e comuns de dois gêneros no português do Brasil* (Dissertação de mestrado, UFRJ, Rio de Janeiro).
- Alves, M. C. dos S. (2019). As diferenças entre gênero gramatical e gênero semântico na recuperação de antecedentes pronominais em Português Brasileiro. *Diacrítica*, 33(2), 89–115. <https://doi.org/10.21814/diacritica.403>
- Arnold, J., Eisenband, J., Brown-Schmidt, S., & Trueswell, J. (2000). The rapid use of gender information: evidence of the time course of pronoun resolution from eyetracking. *Cognition*, 76(1), 13–26. [https://doi.org/10.1016/s0010-0277\(00\)00073-1](https://doi.org/10.1016/s0010-0277(00)00073-1)
- Badecker, W. & Straub, K. (2002). The processing role of structural constraints on the interpretation of pronouns and anaphora. *Journal of Experimental Psychology Learning Memory and Cognition*, 28, 748–769. <https://doi.org/10.1037/0278-7393.28.4.748>
- Cacciari, C., & Padovani, R. (2007). Further evidence of gender stereotype priming in Language: Semantic facilitation and inhibition in Italian role nouns. *Applied Psycholinguistics*, 28, 277–293. <https://doi.org/10.1017/S0142716407070142>
- Canal, P., Garnham, A., & Oakhill, J. (2015). Beyond gender stereotypes in language comprehension: self sex-role descriptions affect the brain's potentials associated with agreement processing. *Frontiers in Psychology*, 6. <https://doi.org/10.3389/fpsyg.2015.01953>
- Carreiras, M., Garnham, A., Oakhill, J., & Cain, K. (1996). The use of stereotypical gender information in constructing a mental model: evidence from English and Spanish. *The Quarterly Journal of Experimental Psychology*, 49A(3), 639–663. <https://doi.org/10.1080/713755647>
- Casado, A., Palma, A., & Paolieri, D. (2017). The influence of sex information on gender word processing. *Journal of Psycholinguistic Research*, 47(3), 1–27. <https://doi.org/10.1007/s10936-017-9546-3>
- Chomsky, N. (1993). A minimalist program for linguistic theory. In K. Hale, S. J. Keyser (Eds.). *The view from building 20* (pp. 1–52). Cambridge: The MIT Press. <https://doi.org/10.1007/s10936-017-9546-3>

- Chomsky, N. (1995) *The Minimalist Program*. Cambridge: The MIT Press.
- Duff, S., & Keir, J. (2004). Violating stereotypes: Eye movements and comprehension processes when text conflicts with world knowledge. *Memory and Cognition*, 32(4), 551–559. <https://doi.org/10.3758/BF03195846>
- Engelmann, F., Jäger, L., & Vasishth, S. (2015). *The determinants of retrieval interference in dependency resolution: Review and computational modeling*. Unpublished manuscript.
- Foraker, S., & McElree, B. (2007). The role of prominence in pronoun resolution: active versus passive representations. *Journal of Memory and Language*, 56(3), 357–383. <https://psycnet.apa.org/doi/10.1016/j.jml.2006.07.004>
- Gordon, P., & Hendrick, R. (1998). The representation and processing of coreference in discourse. *Cognitive Science*, 22(4), 389–424. [https://doi.org/10.1016/S0364-0213\(99\)80045-7](https://doi.org/10.1016/S0364-0213(99)80045-7)
- Greene, S. B., McKoon, G., & Ratclif, R. (1992). Pronoun resolution and discourse models. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 18(2), 266–283. <https://doi.org/10.1037//0278-7393.18.2.266>
- Grosz, B., Weinstein, S., & Joshi, A. (1995). Centering: A framework for modeling the local coherence of discourse. *Computational Linguistics*, 21(2), 203–225.
- Kehler, A. (2007). Rethinking the SMASH approach to pronoun interpretation. In J. Gundel & N. Hedberg (Eds.), *Interdisciplinary perspectives on reference processing* (pp. 95–122). Oxford: Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195331639.001.0001>
- Kneiner, H., Sturt, P., & Garrod, S. (2008). Processing definitional and stereotypical gender in reference resolution: Evidence from eye-movements. *Journal of Memory and Language*, 58(2), 239–261. <https://doi.org/10.1016/j.jml.2007.09.003>
- Leitão, M., Peixoto, P., & Santos, S. (2008). Processamento da co-referência intra-sentencial em português brasileiro. *Veredas*, 12(2), 50–61.
- Nicol, J., & Swinney, D.A. (1989). The role of structure in coreference assignment during sentence comprehension. *Journal of Psycholinguistics Research*, 18(1), 5–19. <https://doi.org/10.1007/BF01069043>
- Oakhill, J., Garnham, A., & Reynolds, D. (2005). Immediate activation of stereotypical gender information. *Memory and Cognition*, 33(6), 972–983. <https://doi.org/10.3758/BF03193206>
- Osterhout, L., Bersick, M., & McLaughlin, J. (1997). Brain potentials reflect violations of gender stereotypes. *Memory and Cognition*, 25(3), 273–285. <https://doi.org/10.3758/BF03211283>
- Patil, U., Vasishth, S., & Lewis, R. (2016). Retrieval interference in syntactic processing: The case of reflexive binding in English. *Frontiers of Psychology*, 7, 329. <https://doi.org/10.3389/fpsyg.2016.00329>
- Rigalleau, F., Caplan, D, Baudiffier, V. (2004). New arguments in favor of an automatic gender pronominal process. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, 57(5), 893–933. <https://doi.org/10.1080/02724980343000549>
- Sturt, P. (2003). The time-course of the application of binding constraints in reference. *Journal of Memory and Language*, 48(3), 542–562. [https://doi.org/10.1016/S0749-596X\(02\)00536-3](https://doi.org/10.1016/S0749-596X(02)00536-3)

## Appendix

### List of the experimental sentences of Experiment 1a

#### *Distractors with definitional gender*

a) O veterinário/A veterinária reconheceu a nora que feriu ele/ela fortemente por trás da cabeça no momento do assalto.

O ferimento por trás da cabeça foi no momento do assalto?

*The<sub>[MASC]</sub>vet<sub>[MASC]</sub>/The<sub>[FEM]</sub>vet<sub>[FEM]</sub> recognized the daughter-in-law who forcefully hit him/her behind the head at the moment of the assault.*

*Was the wound behind the head at the moment of the assault?*

b) O comissário de bordo/A comissária de bordo processou a moça que xingou ele/ela ferozmente devido ao um mal entendido.

A moça xingou devido ao um mal entendido?

*The<sub>[MASC]</sub>flight attendant<sub>[MASC]</sub>/The<sub>[FEM]</sub>flight attendant<sub>[FEM]</sub> sued the young lady who fiercely cursed him/her due to a misunderstanding.*

*Did the young lady curse due to a misunderstanding?*

c) O pedagogo/A pedagoga elogiou a mãe que tocou ele/ela totalmente com uma das lições mais belas de coragem.

A mãe deu uma bela lição de coragem?

*The<sub>[MASC]</sub>pedagogue<sub>[MASC]</sub>/The<sub>[FEM]</sub>pedagogue<sub>[FEM]</sub> complimented the mother who completely touched him/her with one of the most beautiful lessons of courage.*

*Did the mother give a beautiful lesson of courage?*

d) O advogado/A advogada hostilizou a rainha que tratou ele/ela rudemente na frente de alguns convidados na festa.

A rainha foi rude no café-da-manhã?

*The<sub>[MASC]</sub>lawyer<sub>[MASC]</sub>/The<sub>[FEM]</sub>lawyer<sub>[FEM]</sub> antagonized the queen who treated him/her rudely in front of some of guests at the party.*

*Was the queen rude at the breakfast?*

e) O criminoso/A criminosa ameaçou a dama que notou ele/ ela de repente próximo ao prédio alguns dias depois do crime.

A dama foi assassinada?

*The<sub>[MASC]</sub>criminal<sub>[MASC]</sub>/The<sub>[FEM]</sub>criminal<sub>[FEM]</sub> threatened the lady who suddenly noticed him/her near the building some days after the crime.*

*Was the lady murdered?*

f) O enfermeiro/A enfermeira conhecia a mulher que matou ele/ela brutalmente na frente da casa da família.

O crime aconteceu na frente do shopping?



*The<sub>[MASC]</sub> nurse<sub>[MASC]</sub>/The<sub>[FEM]</sub> nurse<sub>[FEM]</sub> knew the woman who brutally killed him/her in front of the family's house.*

*Did the crime happen in front of the shopping mall?*

*Distractors with stereotypical gender*

a) O perito/A perita acatou a assistente social que chamou ele/ela novamente por volta do meio dia no escritório.

A assistente social chamou alguém por volta do meio-dia no escritório?

*The<sub>[MASC]</sub> investigator<sub>[MASC]</sub>/The<sub>[FEM]</sub> investigator<sub>[FEM]</sub> answered the<sub>[FEM]</sub> social worker who called him/her again around noon at the office.*

*Did the<sub>[FEM]</sub> social worker call someone around noon at the office?*

b) O cenógrafo/A cenógrafa despediu a modelo que ofendeu ele/ela puramente por causa de fofocas nos bastidores.

Houve fofocas nos bastidores?

*The<sub>[MASC]</sub> set designer<sub>[MASC]</sub>/The<sub>[FEM]</sub> set designer<sub>[FEM]</sub> fired the<sub>[FEM]</sub> model who solely offended him/her due to gossips in the side scenes.*

*Were there gossips in the side scenes?*

c) O bibliotecário/A bibliotecária seguiu a recepcionista que guiou ele/ela brevemente através do corredor do grande gabinete real.

Há um corredor no grande gabinete real?

*The<sub>[MASC]</sub> librarian<sub>[MASC]</sub>/The<sub>[FEM]</sub> librarian<sub>[FEM]</sub> followed the<sub>[FEM]</sub> receptionist who briefly guided him/her through the hallway of the large royal office.*

*Is there a hallway in the large royal office?*

d) O cozinheiro/A cozinheira agradeceu a nutricionista que ajudou ele/ela rapidamente no meio da confusão daquele restaurante.

A confusão foi na padaria?

*The<sub>[MASC]</sub> cook<sub>[MASC]</sub>/The<sub>[FEM]</sub> cook<sub>[FEM]</sub> thanked the<sub>[FEM]</sub> nutritionist who quickly helped him/her in the middle of the mess of that restaurant.*

*Was the mess at the bakery?*

e) O bailarino/A bailarina admira a ginecologista que ajudou ele/ela gentilmente depois de uma das fases mais difíceis de sua vida.

A ginecologista é cruel com seus pacientes?

*The<sub>[MASC]</sub> dancer<sub>[MASC]</sub>/The<sub>[FEM]</sub> dancer<sub>[FEM]</sub> admires the<sub>[FEM]</sub> gynecologist who gently helped him/her after one of the most difficult times in life.*

*Is the<sub>[FEM]</sub> gynecologist cruel with his patients?*

f) O cabeleireiro/A cabeleireira detestou a esteticista que olhou ele/ela lentamente dos pés a cabeça durante a entrevista.

A esteticista foi quem conduziu a entrevista?

*The<sub>[MASC]</sub> hairdresser<sub>[MASC]</sub>/The<sub>[FEM]</sub> hairdresser<sub>[FEM]</sub> disliked the<sub>[FEM]</sub> beautician who slowly stared at him/her before the interview.*

*Was the<sub>[FEM]</sub> beautician who conducted the interview?*

### **List of the experimental sentences of Experiment 1b**

*Distractors with definitional gender*

a) O veterinário/A veterinária reconheceu o genro que feriu ele/ela fortemente por trás da cabeça no momento do assalto.

O ferimento por trás da cabeça foi no momento do assalto?

*The<sub>[MASC]</sub> vet<sub>[MASC]</sub>/The<sub>[FEM]</sub> vet<sub>[FEM]</sub> recognized the son-in-law who forcefully hit him/her behind the head at the moment of the assault.*

*Was the wound behind the head at the moment of the assault?*

b) O comissário de bordo/A comissária de bordo processou o rapaz que xingou ele/ela ferozmente devido ao um mal entendido.

O rapaz xingou devido ao um mal entendido?

*The<sub>[MASC]</sub> flight attendant<sub>[MASC]</sub>/The<sub>[FEM]</sub> flight attendant<sub>[FEM]</sub> sued the young man who fiercely cursed him/her due to a misunderstanding.*

*Did the young man curse due to a misunderstanding?*

c) O pedagogo/A pedagoga elogiou o pai que tocou ele/ela totalmente com uma das lições mais belas de coragem.

O pai deu uma bela lição de coragem?

*The<sub>[MASC]</sub> pedagogue<sub>[MASC]</sub>/The<sub>[FEM]</sub> pedagogue<sub>[FEM]</sub> complimented the father who completely touched him/her with one of the most beautiful lessons of courage.*

*Did the father give a beautiful lesson of courage?*

d) O advogado/A advogada hostilizou o rei que tratou ele/ela rudemente na frente de alguns convidados na festa.

O rei foi rude no café-da-manhã?

*The<sub>[MASC]</sub> lawyer<sub>[MASC]</sub>/The<sub>[FEM]</sub> lawyer<sub>[FEM]</sub> antagonized the king who treated him/her rudely in front of some of guests at the party.*

*Was the king rude at the breakfast?*

e) O criminoso/A criminosa ameaçou o cavalheiro que notou ele/ela de repente próximo ao prédio alguns dias depois do crime.

O cavalheiro foi assassinado?

*The<sub>[MASC]</sub> criminal<sub>[MASC]</sub>/The<sub>[FEM]</sub> criminal<sub>[FEM]</sub> threatened the gentleman who suddenly noticed him/her near the building some days after the crime.*

*Was the gentleman murdered?*

f) O enfermeiro/A enfermeira conhecia o homem que matou ele/ela brutalmente na frente da casa da família.

O crime aconteceu na frente do shopping?

*The<sub>[MASC]</sub> nurse<sub>[MASC]</sub>/The<sub>[FEM]</sub> nurse<sub>[FEM]</sub> knew the man who brutally killed him/her in front of the family's house.*

*Did the crime happen in front of the shopping mall?*

*Distractors with stereotypical gender*

a) O perito/A perita acatou o detetive que chamou ele/ela novamente por volta do meio-dia no escritório.

O detetive chamou alguém por volta do meio-dia no escritório?

*The<sub>[MASC]</sub> investigator<sub>[MASC]</sub>/The<sub>[FEM]</sub> investigator<sub>[FEM]</sub> answered the<sub>[MASC]</sub> detective who called him/her again around noon at the office.*

*Did the<sub>[MASC]</sub> detective call someone around noon at the office?*

b) O cenógrafo/A cenógrafa despediu o electricista que ofendeu ele/ela puramente por causa de fofocas nos bastidores.

Houve fofocas nos bastidores?

*The<sub>[MASC]</sub> set designer<sub>[MASC]</sub>/The<sub>[FEM]</sub> set designer<sub>[FEM]</sub> fired the<sub>[MASC]</sub> electrician who solely offended him/her due to gossips in the side scenes.*

*Were there gossips in the side scenes?*

c) O bibliotecário/O bibliotecária seguiu o guarda que guiou ele/ela brevemente através do corredor do grande gabinete real.

Há um corredor grande no gabinete real?

*The<sub>[MASC]</sub> librarian<sub>[MASC]</sub>/The<sub>[FEM]</sub> librarian<sub>[FEM]</sub> followed the<sub>[MASC]</sub> guard who briefly guided him/her through the hallway of the large royal office.*

*Is there a hallway in the large royal office?*

d) O cozinheiro/A cozinheira agradeceu o taxista que ajudou ele/ela rapidamente no meio da confusão daquele restaurante.

A confusão foi na padaria?

*The<sub>[MASC]</sub> cook<sub>[MASC]</sub>/The<sub>[FEM]</sub> cook<sub>[FEM]</sub> thanked the<sub>[MASC]</sub> taxi driver who quickly helped him/her in the middle of the mess of that restaurant.*

*Was the mess at the bakery?*

e) O bailarino/A bailarina admira o surfista que ajudou ele/ela gentilmente depois de uma das fases mais difíceis de sua vida.

O surfista é cruel com seus amigos?

*The<sub>[MASC]</sub> dancer<sub>[MASC]</sub>/The<sub>[FEM]</sub> dancer<sub>[FEM]</sub> admires the<sub>[MASC]</sub> surfer who gently helped him/her after one of the most difficult times in life.*

*Is the<sub>[MASC]</sub> surfer cruel with his friends?*

f) O cabeleireiro/A cabeleireira detestou o piloto de corrida que olhou ele/ela lentamente dos pés a cabeça antes da entrevista no camarim.

O piloto de corrida foi quem conduziu a entrevista?

*The<sub>[MASC]</sub> hair dresser<sub>[MASC]</sub>/The<sub>[FEM]</sub> hairdresser<sub>[FEM]</sub> disliked the<sub>[MASC]</sub> race car driver who slowly stared at him/her before the interview.*

*Was the<sub>[MASC]</sub> race car driver who conducted the interview?*

**LME results for First Fixation at the pronoun region.**

Pronoun				
Parameter	$\beta_0$	SE	t-value	p-value
(Intercept)	0.11	0.23	0.48	0.63
Antecedent	0.44	0.32	1.393	0.16
Distractor	0.16	0.32	0.49	0.62
Type of gender	-0.61	0.33	-1.84	0.070
Gender	-0.51	0.29	-1.74	0.084
Antecedent x Distractor	-0.44	0.45	-0.98	0.32
Antecedent x Type of gender	0.18	0.47	0.39	0.69
Distractor x Type of gender	0.35	0.44	0.79	0.42
Antecedent x Gender	-0.11	0.39	-0.29	0.77
Distractor x Gender	0.30	0.39	0.75	0.44
Type of gender x Gender	1.20	0.41	2.90	0.004
Antecedent x Distractor x Type of gender	-0.24	0.64	-0.37	0.70
Antecedent x Distractor x Gender	1.19	0.55	0.34	0.73
Antecedent x Type of gender x Gender	-1.15	0.57	2.00	0.046
Distractor x Type of gender x Gender	-1.01	0.56	-1.80	0.072
Antecedent x Distractor x Type of gender x Gender	0.97	0.81	1.18	0.23

**LME results for First Pass at the pronoun region.**

Pronoun				
Parameter	$\beta_0$	SE	t-value	p-value
(Intercept)	0.10	0.21	0.48	0.63
Antecedent	0.38	0.32	1.17	0.24
Distractor	0.005	0.31	0.016	0.98
Type of gender	-0.69	0.30	-2.24	0.026
Gender	-0.37	0.27	-1.39	0.16
Antecedent x Distractor	-0.05	0.44	-0.12	0.89
Antecedent x Type of gender	0.40	0.47	0.85	0.39
Distractor x Type of gender	0.63	0.43	1.46	0.14
Antecedent x Gender	-0.21	0.38	-0.54	0.58
Distractor x Gender	0.18	0.39	0.48	0.62
Type of gender x Gender	1.10	0.39	2.80	0.0054
Antecedent x Distractor x Type of gender	-0.97	0.64	-1.51	0.13
Antecedent x Distractor x Gender	0.23	0.55	0.41	0.67
Antecedent x Type of gender x Gender	-1.02	0.57	-1.78	0.074
Distractor x Type of gender x Gender	-0.93	0.55	-1.69	0.090
Antecedent x Distractor x Type of gender x Gender	1.06	0.81	1.31	0.19

## LME results for Regression Path at the pronoun region.

Pronoun				
Parameter	$\beta_0$	SE	t-value	p-value
<i>(Intercept)</i>	-0.44	0.25	-1.73	0.10
<i>Antecedent</i>	0.89	0.33	2.65	0.0098
<i>Distractor</i>	0.68	0.34	1.98	0.051
<i>Type of gender</i>	-0.02	0.34	-0.08	0.93
<i>Gender</i>	0.39	0.26	1.49	0.13
<i>Antecedent x Distractor</i>	-0.99	0.42	-2.33	0.020
<i>Antecedent x Type of gender</i>	-0.04	0.45	-0.09	0.92
<i>Distractor x Type of gender</i>	-0.40	0.46	-0.86	0.38
<i>Antecedent x Gender</i>	-0.97	0.39	-2.45	0.015
<i>Distractor x Gender</i>	-1.01	0.37	-2.70	0.0072
<i>Type of gender x Gender</i>	0.12	0.37	0.32	0.74
<i>Antecedent x Distractor x Type of gender</i>	0.36	0.60	0.60	0.54
<i>Antecedent x Distractor x Gender</i>	1.62	0.53	3.02	0.0026
<i>Antecedent x Type of gender x Gender</i>	-0.07	0.54	-0.14	0.088
<i>Distractor x Type of gender x Gender</i>	0.87	0.52	1.66	0.096
<i>Antecedent x Distractor x Type of gender x Gender</i>	-0.26	0.77	-0.33	0.73

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