



Online Sentence Processing During Reading of Temporally Ambiguous Gapping Sentences in Brazilian Portuguese

Processamento online na leitura de sentenças elípticas gapping com ambiguidade temporária no Português Brasileiro

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Abstract: This article aims to explore whether the online sentence processing of gapping sentences, with a temporary ambiguous DP at the second conjunct, such as “*Beatriz baked a pizza and Carla a lemon cake for snack*”, is more costly in terms of time course in comparison to other two coordinated sentences, coordinate with conjoined object such as “*Beatriz baked a pizza and a lemon cake for snack in the afternoon*”, and coordinate with conjoined clauses without ellipsis, such as “*Beatriz baked a pizza and Carla made a lemon juice*”. A Self-Paced Reading task in moving-window fashion was carried out with native speakers of Brazilian Portuguese. The results seem to indicate that temporary ambiguous DP and the resolution of the ellipsis site were more costly to process in comparison to the other two coordinated sentences.

Keywords: Sentence Processing; Ellipsis; Gapping; Brazilian Portuguese.

Resumo: Este artigo tem como objetivo explorar se o processamento online de sentenças elípticas gapping, com ambiguidade temporária do DP que inicia a segunda oração, como em “*A Beatriz assou a pizza e a Carla o bolo de limão pro lanche*”, é mais custoso em comparação com outros dois tipos de sentenças coordenadas, estrutura com coordenação

de objetos como em “*A Beatriz assou a pizza e o bolo de limão pro lanche da tarde*”, e estrutura com sentenças coordenadas sem elipse, como em “*A Beatriz assou a pizza e a Carla preparou um suco de limão*”. Aplicou-se uma tarefa de Leitura Automonitorada, com design *moving-window* a falantes do Português Brasileiro. Os resultados indicam que a ambiguidade temporária do DP e a resolução da elipse do verbo foram mais custosas no processamento em comparação com as outras duas sentenças coordenadas.

Palavras-chave: Processamento de Sentenças; Elipse; *Gapping*; Português Brasileiro.

1. Introduction

Ellipsis is a pervasive language phenomenon in natural languages – words and phrases that should be present in the linguistic signal go missing (MERCHANT, 2001). To avoid repetition of redundant information in sentences, linguistic material is omitted, deleted or simply left unpronounced. The missing material is generally recoverable from a preceding clause or even a wider context (KAAN *et al.*, 2013). Thus, the interpretation of elliptical structures relies just as much on what is left unsaid as to what is said. What is interesting about these sentences is that language users successfully interpret them despite the absence of overtly pronounced material. In this sense, it is relevant to investigate a lot of questions concerning ellipsis: how it is mentally represented, how the interpretation of the elided material is recovered, when during processing this occurs and by what mechanisms, what kind of information (syntactic, lexical, prosodic etc.) is available and when it is used (KAAN *et al.*, 2004, 2013; PHILIPS; PARKER, 2013).

There are a number of elliptical constructions across languages, some known types are sluicing, VP-ellipsis, pseudogapping, stripping, gapping, replacives and comparative deletion. The current research is particularly interested in gapping ellipsis in Brazilian Portuguese (hereafter BP). This type of ellipsis occurs only in coordinated sentences. It consists in eliding at least the finite verb, and adjacent material when possible (i.e., the object of the verb), in the second conjunct (ROSS, 1967; SAG, 1980; CARLSON 2002) of the coordinated structure. The omitted materials are identical to elements found in the first conjunct. See an instance of a gapping sentence:

- (1) *João gosta de filmes e Maria gosta de livros.*
 “John likes movies and Mary likes books.”

The second clause of (1) has the same verb found in the first clause: *gosta*. The finite verb can go unexpressed because it was already given in the first conjunct. Only new information is preserved in the second conjunct: *Maria* and *livros*. Gapping is a type of surface anaphor since the identity and the interpretation of the gapped element is derived from an element in the preceding clause (KANN *et al.*, 2004; JOHNSON, 2019).

The aim of this paper is to investigate the time course identification and resolution of a temporary syntactic ambiguity¹ and the ellipsis during the reading of gapping sentences in BP like (2):

- (2) *A Beatriz assou a pizza e a Carla o bolo de limão pro lanche.*
 “Beatriz baked a pizza and Carla a lemon cake for snack.”

Here there is an implausible combination between the noun *a Carla* and the verb *assou*. There is a conflict between the animacy feature of the ambiguous noun *a Carla* and the thematic requirements of the verb *assou*. This type of verb accepts only non-human nouns as arguments. As the noun *a Carla* is an animate noun, the parser (i.e., the sentence processor) must at some point reject it as part of the complex object and analyze it instead as the subject of a conjoined sentence.

The time course processing of sentences like (2) will be compared to another two types of coordinated sentences, coordinate with conjoined objects (3) and coordinate of two clauses without ellipsis (4):

- (3) *A Beatriz assou a pizza e o bolo de limão pro lanche da tarde.*
 “Beatriz baked a pizza and a lemon cake for snack in the afternoon.”

- (4) *A Beatriz assou a pizza e a Carla preparou um suco de limão.*
 “Beatriz baked a pizza and Carla made a lemon juice.”

In sentence (3), the DPs *a pizza* and *o bolo* are conjoined objects of the verb *assou*. Readers are inclined to interpret a DP as part of complex object whenever possible, because the processor chooses the simplest

¹ It is relevant to point out that this ambiguous reading is only feasible during reading comprehension. On listening, the language user has access to features of speech (i.e., prosodic features such as pause and intonation markers) that undoes the potential ambiguity.

syntactic structure in terms of nodes (HONKS *et al.*, 2002; FRAZIER, 1987a). Thus, there might be processing costs to parse the temporary ambiguous noun in sentence (2) since it cannot be conjoined within the VP. If that is the case, the second clause of sentence (3) is expected to be processed faster than sentence (2). On the other hand, readers might promptly recognize the noun as an implausible object and use the thematic information to resolve the temporary ambiguity and minimize processing difficulties (HOEKS *et al.*, 2006).

The coordinated structure with two clauses (4) has the same ambiguous noun *a Carla* in the second clause, with the difference that it is followed by the disambiguating verb *preparou*. This sentence will serve as a control, making it possible to verify whether the ambiguity is rapidly resolved by the use of thematic information in addition to the presence of a disambiguating verb, which clearly shows that the ambiguous noun *a Carla* is the subject of a new clause. On the other hand, this ambiguity in sentence (2) might be accentuated by the occurrence of an elided site.

There is controversy among authors about how the thematic information is used in sentence processing. Ferreira and Clifton (1986) argue that thematic information does not help to overcome a garden-path effect (FRAZIER, 1987b) while Clifton *et al.* (2003) affirm that it slightly reduces this effect, but there is still some processing difficulty. Trueswell *et al.* (1994), on the other hand, claim that thematic information can avoid the garden-path effect if this information is sufficiently strong. Thus, our study could contribute with evidence to support one of these accounts and shed light on this issue.

Therefore, this research intends to investigate whether processing of gapping is more costly than other coordinated sentences such as coordinate with conjoined objects and coordinate with two clauses without ellipsis. Additionally, the role of thematic information in resolving this syntactic ambiguity is also explored.

This study is relevant from a psycholinguistic perspective in the way that evidence about the processing of ellipsis could contribute to the improvement of theories of the grammar of ellipsis. Experimentally collected data can also in part help to determine what should be accounted for in the grammar and what in the processor (FRAZIER, 2019). Studies on the processing of gapping ellipsis in BP are also incipient.

2. Gapping

Gapping is a linguistic phenomenon restricted to coordination, a restriction found only in gapping and stripping² (or Bare Argument Ellipsis), not in other ellipsis constructions (JOHNSON, 2019). Gapping is an optional syntactic process that in head-initial languages, such as Portuguese and English, for instance, consists in eliding at least the finite verb in the second conjunct of a coordinated sentence.

(5) *O garoto comeu as bananas e a garota __ as maçãs.*

“The boy ate bananas and the girl __ apples.”

The first conjunct is the *antecedent clause* and the second one the *gapped clause*. The silent string represents the *ellipsis site* in second conjunct. The finite verb *comeu* is omitted, being recoverable in the first conjunct. It is deleted because of the structural information similarities held among the two conjuncts. It is for this reason that the repeated verb is unpronounced, leaving the second conjunct only with discourse-new information. The overt elements in the gapped clause are the *remnants* while the elements in the first conjunct they correspond to are their *correlates* (CITKO, 2011). Remnants and correlates together are contrasting pairs (REPP, 2009); the remnants *a garota* and *as maçãs* contrast respectively with their correlates *o garoto* and *as bananas*.

In addition to the verb, further elements such as direct or indirect objects may also be missing. In (6), the verb and its object *estudou inglês* is omitted in the second conjunct:

(6) *A Ana estudou inglês ontem e a Maria __ hoje.*

“Ana studied English yesterday and Maria today.”

Several properties distinguish gapping from other elliptical constructions. Repp (2009) and Citko (2011) list some basic features of gapping in English, which also applies to BP. First, the elided verb must be semantically identical to its overt antecedent, which means that it must have the same verb tense like its antecedent in the first conjunct, for instance:

² This paper will not discuss stripping constructions.

- (7) **A Ana estudou ontem e a Maria estuda hoje.*
 *Ana studied yesterday and Maria **studies** today.

On the other hand, non-semantic features do not have to be identical, the elided verb and its antecedent do not need to have identical person, number, and gender features. The elided verb in (8) has a subject that differs in number and gender features:

- (8) *Ana estudou ontem e Pedro e João estudaram hoje.*
 Ana studied yesterday and Pedro and João **studied** today.

Gaps must be surrounded by lexical material, thus there should be overt lexical elements in the second conjunct, usually the subject and some postverbal element. Example (9) must have had elements following the gapped verb:

- (9) **Ana estudou inglês e Pedro estudou.*
 *Ana studied English and Pedro **studied**.

As for the remnants, they must contrast with their correlates, that is, they must be distinct and present new information. The contrast between the elements could be, for instance, in relation to different locations, times, agents, etc. In (10), the remnants (*inglês* and *ontem*) are identical to their correlates:

- (10) **Ana estudou inglês ontem e Pedro estudou inglês ontem.*
 *Ana studied English yesterday and Pedro **studied** English yesterday.

Structural parallelism of remnants and correlates has played an important role in the analysis and processing of gapping. The syntactic category of a remnant and its correlate not necessarily have to be the same, but it is important that it fits the requirements of the gapped verb. In (11), the correlate is an adjectival predicate whereas the remnant a nominal predicate:

- (11) *Mary is rather foolish, and Peter is a complete idiot.*

3. Processing Gapping Sentences

According to Yoshida (2019), grammatical studies have listed three prominent aspects concerning ellipsis constructions: (i) when ellipsis is licensed, the ellipsis site normally has a salient linguistic antecedent in the first conjunct; (ii) the ellipsis site and its antecedent site must stand in a certain parallelism relation; (iii) the ellipsis site is often licensed in a specific syntactic configuration. Therefore, to successfully comprehend sentences with ellipsis, the parser has to identify the ellipsis site, then find its antecedent to recover the elided content of the ellipsis site by using the antecedent as a reference. Three major questions are answered by ellipsis psycholinguistic studies (SHAPIRO and colleagues, 1995, 2003, 2010; FRAZIER & CLIFTON 2000, 2005, 2006, DICKEY & BUNGER, 2011; YOSHIDA and colleagues, 2012, 2013; KAAAN and colleagues, 2004, 2013 apud YOSHIDA, 2019):

(a) What structure does the parser build in the ellipsis site, and how?

In order to infer and build the structure of the ellipsis site, the parser looks at the structure of the antecedent site in the first conjunct. The parser accesses the antecedent of an ellipsis when the ellipsis site is processed, and it is sensitive to the structural details of the antecedent site. With regard to how this process is done, it has been argued that the parser builds the silent syntactic structure within the ellipsis sites by copying the structural and lexical details from the antecedent site.

(b) When does the parser recognize ellipsis?

The parser recognizes the ellipsis site immediately when it finds a structure in which ellipsis can be grammatically licensed. Looking at ellipsis sites, it is possible to notice that they are compatible with both elliptical and non-elliptical syntactic structures. Thus, processing an ellipsis sentence, in many cases, involves resolving a kind of potential local ambiguity. The parser can employ two possible strategies to resolve it, a **delay strategy** or an **incremental strategy**. In the former, the parser does not decide immediately if an element is part of an elliptical structure or not, it waits until decisive bottom-up information becomes available. In the latter, the parser immediately decides if the element is part of an elliptical or non-elliptical structure, so it does not wait for later information.

Studies have shown that the parser uses the incremental strategy when processing ellipsis constructions.

(c) Where does the parser find the antecedent of ellipsis?

When processing ellipsis sentences successfully, the parser has to find an antecedent for the ellipsis site and decide what constituents are proper antecedents for the ellipsis site. Studies have shown that the parser looks for the antecedent in the position closest to the ellipsis site.

As for gapping ellipsis, there might be processing costs to parse such sentences because the processor obeys a local attachment bias with a preference for the structure which contains fewer nodes, what is compatible with the Minimal Attachment Principle (FRAZIER, 1987). On the other hand, the structural parallelism held among the conjuncts can reduce processing costs. Studies have been consensual in arguing that a coordinate structure is processed more easily if the conjuncts are parallel to each other, but when they are not, the coordinate structure induces some processing cost (KIM *et al.*, 2020).

4. Previous studies

Carlson (2002), which inspired the present research, investigated the processing of gapping sentences in English. In an off-line experiment, an end-of-sentence judgment questionnaire, she investigated gapping (12a), nongapping (12b) and globally ambiguous gapping sentences (12c-12e):

(12) Experimental sentences from Carlson (2002, p. 29)

- (a) Alice bakes cakes for tourists and Caroline for her family.
- (b) Alice bakes cakes for tourists and brownies for her family.
- (c) Josh visited the office during the vacation and Sarah during the week.
- (d) Josh visited Marjorie during the vacation and Sarah during the week.
- (e) Dan amazed the judges with his talent and James with his musicality.

Sentences (a) and (b) have only one plausible interpretation, gapping and nongapping (conjoined objects) respectively, whereas sentences (c-d) could be interpreted as a gapping or nongapping sentence.

Sentences (c-d) varied the lexical features between nouns in the two conjuncts. In (c), the ambiguous noun *Sarah* is more subject-like than object-like, thus more gapping responses are expected. In (d), *Sarah* is parallel to both the subject and the object. In (e), *James* is more subject-like, but it is also parallel to the object. Participants were asked to choose the best paraphrase for those sentences. They should also judge the rate of difficulty to understand the sentences. There was a strong dispreference for gapping interpretation. A considerable effect of lexical parallelism was found only in (c), it was able to increase gapping responses to 40%. Sentences (d) and (e) had 4% and 21% respectively of gapping responses. Only sentence (a) had the majority of gapping responses, 81%, due to the semantic implausibility of it as a nongapping sentence. But (a) was rated as the most difficult sentence to understand among the five conditions. The author argues that parallelism plays an important role in interpreting a gapping sentence, but the dispreference for choosing this interpretation is because nongapping is the simplest syntactic structure.

In BP, Silva *et al.* (2018) conducted a written questionnaire and a cumulative Self-paced Reading task in order to check if there is a preference for coordinated structure with conjoined objects over gapping sentences and also if there are any processing differences between them.

In the written questionnaire, BP speakers had to rank their preferences for completing main clauses such as “*Alice assou bolos para as amigas e...* (Alice baked cakes for her friends and...)”. There were three completing options: one that formed a coordinate with conjoined objects [*biscoitos para sua prima.* / cookies for her cousin.], one that formed a gapping sentence [*Camila para sua prima.* / Camila for her cousin.], and another that formed a coordinate with conjoined clauses [*o forno parou de funcionar* / the oven has stopped working.]. Participants were also encouraged to reject one of the options in case they considered it an unsuitable completion. The preference for the coordinate with conjoined objects as the best option was 75.5%, for the coordinate of clauses as the second-best option was 41.2%, and for the gapping structure as third-best option was 30.2%. The gapping completing option received the most rejection rate, 28.6% followed by 20% for the coordinate of clauses and 1.9% for the coordinate with conjoined objects. Overall, there was a strong dispreference for completing the sentences with a gapping structure. The authors found that the results seem to corroborate with

the Minimal Attachment principle and Carlson (2002), since there was a clear preference for coordinating objects instead of subjects.

The authors also conducted a cumulative³ Self-paced Reading, in order to evaluate the online processing of gapping sentences in comparison to coordinated sentences with conjoined objects (nongapping). The sentences were similar to those from the written questionnaire with the difference of an extra segment at the end of the sentences to avoid sentence-final wrap-up effects (KAAN *et al.*, 2018):

(13) Experimental sentences from Silva *et al.* (2018)

(a) Gapping:

Alice / assou / bolos / pras amigas / e / Camila / para sua prima / favorita.

Alice / baked / cakes / for her friends / and / Camila / for her cousin / (favorite).

(b) Nongapping:

Alice / assou / bolos / para suas amigas / e / biscoitos / para sua prima / favorita.

Alice / baked / cakes / for her friends / and / cookies / for her cousin / (favorite).

The underlined segments were the critical regions of the sentences considered for the analysis. Participants took longer to read the critic segments in nongapping than in gapping sentences (*Camila*: 743ms versus *biscoitos*: 884ms; *para sua prima*: 741ms in gapping versus 863ms in nongapping). That result was contrary to the result found in the off-line task. The participants showed a strong dispreference for the gapping sentences in the written questionnaire. Therefore, it was expected that the gapping sentences would be more difficult to parse than the nongapping sentences, that is, slower reading times were expected to be found for gapping sentences. However, participants read the critical regions of the gapping sentences faster than the critical regions of the nongapping sentences.

³ Sentences are presented word-by-word from left to the right; the preceding words remain on the screen (JIANG, 2012).

Some key issues might explain the puzzling results. Readers might have promptly used the thematic information of the noun *Camila* to recognize it as the subject of a new clause. This could explain why the critic segments in gapping condition were read faster. On the other hand, the cumulative design of the task might have affected the reading times. With this paradigm, the participant could have pressed the button several times to reveal a number of words at once before reading them. Also, as the preceding words were kept on the screen, participants could go back to read them as many times they judged necessary before deciding to move to the following words. Another problem is the fact that participants were only able to recognize the ellipsis site at the PP *para sua prima*. There were no other segments after it being measured. Thus, the experiment failed to capture possible spillover effects. But participants might have employed the incremental strategy and promptly decided when they saw the PP that there was an elliptical structure in the sentence, then there were no processing costs to parse the gapping sentences. Taking these issues into account, the authors decided to conduct a Self-paced Reading with a non-cumulative design, which is described in the next section.

5. Experiment: Self-paced Reading Task

This session presents a self-paced moving window experiment that aimed to investigate the time course processing of gapping sentences in comparison to coordinated structure with conjoined objects and coordinated structure with two clauses without ellipsis.

5.1. Materials

Three sets of 18 experimental sentences were constructed. They were all coordinated sentences: gapping, coordinate with conjoined objects, and coordinate with two clauses. The syntactic structure and the lexical content of the first conjunct were the same in the three versions: subject – verb – direct object – coordinating conjunction ‘e’. The chosen verbs were those that only allowed non-human direct objects. The sentences differed with regard to the second conjunct. Gapping sentences had a temporary ambiguous noun followed by the direct object of the gapped verb and some extra information of varied syntactic categories (DPs, adjectives, prepositional phrases). The coordinated sentences with conjoined objects had a conjoined direct object followed by extra

information. The coordinated sentences with conjoined clauses had a temporary ambiguous noun followed by a verb, its direct object and extra information. The three experimental conditions were named respectively as Gapping (GAP), Objects (OBJ) and Sentences (SEN):

(14) Experimental conditions

(a) **Gapping (GAP):** A Beatriz₁ / assou₂ / a₃ pizza₄ / e₅ / a Carla₆ / o bolo₇ / de limão₈ / pro lanche.

(b) **Objects (OBJ):** A Beatriz / assou / a pizza / e / o bolo / de limão / pro lanche / da tarde.

(c) **Sentences (SEN):** A Beatriz / assou / a pizza / e / a Carla / preparou / um suco / de limão.

The sentences were broken up into word-by-word segments, represented by the slashes. In GAP and SEN conditions, the noun *a Carla* is an incompatible object for the verb *assou* in the first conjunct, whereas in OBJ condition the DP *o bolo* is a feasible conjoined object for the verb *assou*. In GAP and SEN sentences, there are two conjoined clauses while in OBJ sentences there are two conjoined objects. SEN condition will serve as control, it will be possible to compare the processing costs of the same temporary ambiguous noun in an elliptical context (GAP condition) with a non-elliptical context.

The second conjunct is the relevant part of the sentence for measuring time course of processing, it is where possible processing difficulties can emerge. The underlined words in the second conjunct (segments 5, 6 and 7) were considered relevant for time measurement comparisons between the conditions. In GAP condition, segment 5 shows the temporary ambiguous noun (*a Carla*), followed by the ellipsis site (*assou o bolo*) in segment 6. There might be a spillover effect of resolution of the ellipsis in the object modifier (*de limão*) in segment 7. In OBJ condition, the conjoined object (*o bolo de limão*) is found in segments 5 and 6, followed by and an adjunct PP (*pro lanche*) in segment 7. Finally, in SEN condition, the temporary ambiguous noun (*a Carla*) is shown in segment 5, followed by the disambiguating verb and its direct object (*preparou um suco*) in segments 6 and 7. It is worth mentioning that the proper nouns in GAP and SEN conditions were always parallel in gender. This was done to maximize lexical parallelism as much as possible. Also,

the number of word syllables in the critic segments were controlled for size, they had three syllables in all experimental sentences.

Another 22 filler sentences from an unrelated experiment were combined with the experimental sentences. Another 4 unrelated sentences were presented at the practice session. The participants read 40 sentences in total during the experimental phase.

5.2. Procedures

The experiment was carried out on PCIBex (ZEHR & SCHWARZ, 2018). To perform the task, the participants had to access a link previously sent to them by the experimenters. When they opened the link, there was a “Welcome screen” giving instructions about how the experiment worked. They were asked to read the sentences carefully and with understanding at their normal rate of speed. They were also warned that the experiment only worked in a laptop or desktop computer because it was necessary to use the keyboard. Before start doing the experiment, there was a practice session to help them to get familiar with the procedures of the task. After this session, they were encouraged to start the experiment.

The participants read the sentences word-by-word in a moving-window fashion (KAISER, 2013). First, they saw on the computer screen a set of dashes representing each word in the sentence. To get the first word, they had to press the space bar on the keyboard. When they pressed it, the first set of dashes was replaced by the appropriate letters of the first word. After they finished reading it, they pressed space again, and then the first word was replaced by a set of dashes, and the second word appeared to its right. This process repeated until they reached the end of the sentence. The time they spent to read each word of the sentence was recorded.

A yes-no comprehension question appeared after the presentation of each sentence. For the experimental sentences, the comprehension question always asked about some information mentioned in the second conjunct. This was relevant to evaluate whether the participants were able to identify and resolve the ambiguity and the ellipsis in gapping sentences.

The experimental sentences appeared in an individually randomized order. Each participant was exposed to an equal number of items in each condition over the experiment in a Latin-square design. The task took approximately 10 minutes.

5.3. Participants

The participants were twenty-four adults (Mean Age = 27.3, SD = 6.67), native speakers of Brazilian Portuguese. They provided informed consent and volunteered to take part in the study. Other four students were not included in the sample because they did not perform accurately at the comprehension questions.

5.4. Results and discussion

The PCIbex recorded reading times (RTs) of each segment for all of the sentences as well as the answers given to the comprehension questions. The experimenters analyzed only segments 5, 6 and 7. RTs under 200ms and above 2000ms were dropped from the analysis. The mean RTs in milliseconds of the second conjunct critic words in the three conditions are shown on Table 1. As for segment 5, RT means in GAP were faster than in OBJ and SEN conditions, -13ms and -7ms respectively. On the other hand, GAP had slower RTs than OBJ and SEN conditions for segments 6 (+23ms and +40ms, respectively) and 7 (+70ms and +66ms, respectively).

Table 1 – Mean Reading Times (in ms) per critic word

<i>Conditions</i>	<i>Second Conjunct</i>		
	<i>Segment 5</i>	<i>Segment 6</i>	<i>Segment 7</i>
Gapping (GAP)	a Carla 615ms	o bolo 668ms	de limão 663ms
Objects (OBJ)	o bolo 628ms	de limão 645ms	pro lanche 593ms
Sentences (SEN)	a Carla 622ms	preparou 628ms	um suco 597ms

Source: Created by the authors.

Obtained data were analyzed using linear mixed effects regression models (BAYEN, 2008; BAYEN *et al.*, 2008), using R software (version 4.0.3), with the packages *lme4* and *lmerTest*. Each model included reading times as function of condition type (GAP, OBJ and SEN) as fixed effects, and participants and items as random effects.

First, the RT means of the three critic segments were Log-transformed and submitted to Kolmogorov-Smirnov and Levene statistical

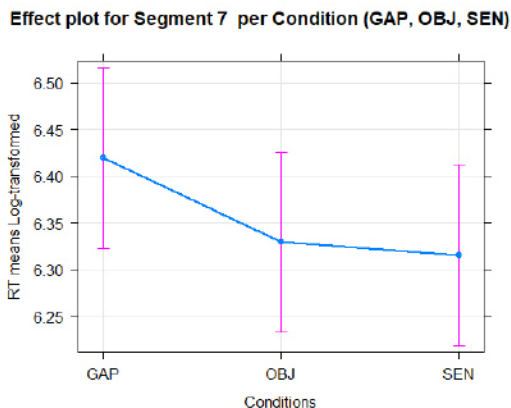
tests; both presented satisfactory results. The linear mixed effect model for Segment 5 did not reveal any significant statistical differences between the conditions: GAP x OBJ ($\beta = 0.03$, $CI = [-0.07 \sim 0.12]$, $SE = 0.049$, $t = 0.534$, $p = .59$) and GAP x SEN: ($\beta = 0.03$, $CI = [-0.08 \sim 0.11]$, $SE = 0.049$, $t = 0.268$, $p = .79$). Neither the linear mixed effect model for Segment 6 revealed any significant statistical differences between the conditions: GAP x OBJ ($\beta = -0.02$, $CI = [-0.10 \sim 0.07]$, $SE = 0.043$, $t = -0.350$, $p = .72$) and GAP x SEN: ($\beta = -0.07$, $CI = [-0.15 \sim 0.02]$, $SE = 0.043$, $t = -1.544$, $p = .12$). Only the linear mixed effect model for Segment 7 revealed significant results. There was a marginal statistical difference between GAP and OBJ conditions ($p = .058$) while there was a significant statistical difference between GAP and SEN conditions ($p = .03$). Table 2 shows a summary of the statistical analysis for Segment 7, and Graph 1 the effect plot with the differences between the three conditions.

Table 2 – Statistical analysis for Segment 7

Predictors	Estimates	SE	CI	P
(Intercept)	6.42	0.049	6.32 – 6.52	<0.001
condition [OBJ]	-0.09	0.047	-0.18 – 0.00	0.058
condition [SEN]	-0.10	0.047	-0.20 – -0.01	0.030

Source: Created by the authors.

Graph 1 – Effect plot for Segment 7 per condition (GAP, OBJ, SEN)



Source: Created by the authors.

Overall, sentences in GAP condition seem to have been more difficult to process in comparison to sentences in OBJ and SEN conditions. When participants read segment 5, the temporary ambiguous DP in GAP and SEN conditions and the conjoined object in OBJ condition, no processing difficulties were observed. The animate proper noun, an implausible direct object for the verb, were read faster than the inanimate conjoined object. This could sign that readers promptly used the thematic role information to avoid a garden-path effect. However, processing costs could emerge in spillover effects in the two next segments. As for segment 6, in GAP condition there was an increase of 53ms when the ellipsis site was found. The RT means remained similar in segment 7 as well, it dropped from 668ms to 663ms (-5ms). There might have been a spillover effect of ellipsis resolution from segment 6 to segment 7. Participants might have used the delay strategy to resolve the ellipsis. They identified an ellipsis site in segment 6 but waited for more bottom-up information become available (*de limão*) to decide that the DP *o bolo* was part of an elliptical structure. In SEN condition, there was an increase of only 6ms from segment 5 to 6. Participants seem to have rapidly used the thematic role information and recognized the ambiguous noun as the subject of a new clause. This was confirmed when they saw the disambiguating verb in segment 6. This could also explain why RT means dropped from 628ms in segment 6 to 597ms in segment 7. For sentences in OBJ condition, no processing costs were expected since this structure is the simplest in terms of syntactic nodes. There were no spillover effects in segments 6 and 7 as observed in GAP condition.

The results found for SEN and GAP conditions corroborate with Trueswell *et al.* (1994), thematic role information seem to have been strong enough to avoid processing difficulties. With regard to processing the ellipsis site, the spillover effect in segment 7 might indicate that readers waited for more information become available to resolve the ellipsis.

Conclusions

This work explored the time course in online processing of gapping sentences in comparison to coordinate of conjoined objects and coordinate of clauses without ellipsis. Overall, the results indicate that gapping sentences were more difficult to parse compared to the coordinate of conjoined objects and the coordinate of clauses without ellipsis.

It seems the presence of the ellipsis caused a processing cost, which was manifested in spillover effect after the ellipsis site. The temporary ambiguity in the coordinate of clauses without ellipsis seems to have been resolved more quickly with the presence of a disambiguating verb. As it was expected, no processing costs were observed in coordinate of conjoined objects since it is the simplest syntactic structure.

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Appendix – Set of experimental sentences

Set 1	<p>Gapping: A Beatriz / assou / a pizza / e / a Carla / o bolo / de limão / pro lanche. Objects: A Beatriz / assou / a pizza / e / o bolo / de limão / pro lanche / da tarde. Sentences: A Beatriz / assou / a pizza / e / a Carla / preparou / um suco / de limão.</p>
Set 2	<p>Gapping: O Ricardo / plantou / o cravo / e / o Marcos / a rosa / no jardim / dos fundos. Objects: O Ricardo / plantou / o cravo / e / a rosa / no jardim / dos fundos / da casa. Sentences: O Ricardo / plantou / o cravo / e / o Marcos / arrumou / o jardim / dos fundos.</p>
Set 3	<p>Gapping: A Simone / usou / a pulseira / e / a Leda / o anel / de ouro / na festa. Objects: A Simone / usou / a pulseira / e / o anel / de ouro / na festa / do bairro Sentences: A Simone / usou / a pulseira / e / a Leda / admirou / a joia / de ouro..</p>
Set 4	<p>Gapping: A Susana / serviu / a bebida / e / a Márcia / o lanche / da tarde / na creche. Objects: A Susana / serviu / a bebida / e / o lanche / da tarde / na creche / do bairro. Sentences: A Susana / serviu / a bebida / e / a Márcia / derrubou / o lanche / na festa.</p>
Set 5	<p>Gapping: A Marília / digitou / a prova / e / a Bruna / o texto / de inglês / pra aula. Objects: A Marília / digitou / a prova / e / o texto / de inglês / pra aula / da tarde. Sentences: A Marília / digitou / a prova / e / a Bruna / imprimiu / no xerox / do centro.</p>
Set 6	<p>Gapping: O Rodrigo / varreu / o quarto / e / o Carlos / a sala / durante / a manhã. Objects: O Rodrigo / varreu / o quarto / e / a sala / de jantar / durante / a manhã. Sentences: O Rodrigo / varreu / o quarto / e / o Carlos / estendeu / a colcha / na cama.</p>
Set 7	<p>Gapping: O Geraldo / limpou / o armário / e / o André / o quadro / da sala / de aula. Objects: O Geraldo / limpou / o armário / e / o quadro / da sala / de aula / do curso. Sentences: O Geraldo / limpou / o armário / e / o André / colocou / os livros / no lugar.</p>
Set 8	<p>Gapping: A Talita / comprou / a saia / e / a Lara / a blusa / de linho / no shopping. Objects: A Talita / comprou / a saia / e / a blusa / de linho / no shopping / do centro. Sentences: A Talita / comprou / a saia / e / a Lara / emprestou / a blusa / de linho.</p>
Set 9	<p>Gapping: A Alice / cortou / a laranja / e / a Kelly / a maçã / pro suco / natural. Objects: A Alice / cortou / a laranja / e / a maçã / pro suco / natural / do lanche. Sentences: A Alice / cortou / a laranja / e / a Kelly / preparou / o suco / natural.</p>
Set 10	<p>Gapping: A Priscila / escolheu / a estante / e / a Vera / o sofá / pra sala / de estar. Objects: A Priscila / escolheu / a estante / e / o sofá / de couro / pra sala / de estar. Sentences: A Priscila / escolheu / a estante / e / a Vera / sugeriu / um outro / modelo.</p>

Set 11	<u>Gapping</u> : A Isabel / lavou / a roupa / e / a Marta / a colcha / de crochê / no tanque. <u>Objects</u> : A Isabel / lavou / a roupa / e / a colcha / de crochê / no tanque / do quintal. <u>Sentences</u> : A Isabel / lavou / a roupa / e / a Marta / espanou / os móveis / da casa.
Set 12	<u>Gapping</u> : O Fernando / vendeu / o carro / e / o Denis / a moto / no ano / passado. <u>Objects</u> : O Fernando / vendeu / o carro / e / a moto / de trilha / no ano / passado. <u>Sentences</u> : O Fernando / vendeu / o carro / e / o Denis / consertou / a moto / antiga.
Set 13	<u>Gapping</u> : O Leandro / cozinhou / o arroz / e / o Fábio / o feijão / vermelho / pro jantar. <u>Objects</u> : O Leandro / cozinhou / o arroz / e / o feijão / vermelho / pro jantar / de ontem. <u>Sentences</u> : O Leandro / cozinhou / o arroz / e / o Fábio / esquentou / a carne / no forno.
Set 14	<u>Gapping</u> : A Mirela / remendou / a camisa / e / a Clara / a saia / com linha / vermelha. <u>Objects</u> : A Mirela / remendou / a camisa / e / a saia / rodada / com linha / vermelha. <u>Sentences</u> : A Mirela / remendou / a camisa / e / a Clara / arrumou / os botões / da saia.
Set 15	<u>Gapping</u> : O Henrique / derrubou / o prato / e / o Caio / o copo / de vidro / na sala. <u>Objects</u> : O Henrique / derrubou / o prato / e / o copo / de vidro / na sala / de jantar.. <u>Sentences</u> : O Henrique / derrubou / o prato / e / o Caio / recolheu / os cacos / zangado.
Set 16	<u>Gapping</u> : O Marcelo / consertou / o relógio / e / o Jonas / o rádio / no final / da tarde. <u>Objects</u> : O Marcelo / consertou / o relógio / e / o rádio / de pilha / no final / da tarde. <u>Sentences</u> : O Marcelo / consertou / o relógio / e / o Jonas / estragou / o rádio / de pilha.
Set 17	<u>Gapping</u> : O Murilo / colou / o bilhete / e / o João / o cartaz / no mural / da sala. <u>Objects</u> : O Murilo / colou / o bilhete / e / o cartaz / no mural / da sala / de aula. <u>Sentences</u> : O Murilo / colou / o bilhete / e / o João / retirou / o cartaz / do mural.
Set 18	<u>Gapping</u> : O Daniel / esqueceu / o caderno / e / o Lucas / o livro / na mesa / da sala <u>Objects</u> : O Daniel / esqueceu / o caderno / e / o livro / de inglês / na mesa / da sala. <u>Sentences</u> : O Daniel / esqueceu / o caderno / e / o Lucas / entregou / no curso / mais tarde.

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