THE PROCESSING OF CONCEPTUAL ANAPHORS AND FULLY SPECIFIED PRONOUNS IN INTRA-SENTENTIAL CONTEXTS IN BRAZILIAN PORTUGUESE[1]

Marcus Maia[2]

Daniela Cid de Garcia[3]

Cristiane de Oliveira[4]

maiamarcus@gmail.com

cid.daniela@gmail.com

cristianeolivers@gmail.com

ABSTRACT: This paper describes a set of 4 experiments that examined fully specified pronouns and conceptual anaphors in intra-sentential contexts to argue that both are subject to structural constraints and interact with collective and distributive predicates without displaying main effects. Experiments 1 and 2 employed a self-paced reading task of sentences in which pronouns (P) and conceptual anaphors (C) were potentially coreferential with NPs. In Experiment 1, P or C would have, as potential antecedents, NPs which could be in Principle B legitimate position (+B) or illegitimate position (-B). In Experiment 2, P or C were in Principle C legitimate (+C) or illegitimate (-C) positions to be cataphorically coreferential with an NP in the main clause. In Experiment 3, we submitted +B sentences to eye-tracking. Finally, in Experiment 4, we used a self- paced listening technique, crossing type of predicate (distributive - D/generic - G) and type of anaphoric element (P ou C). Based on these experimental results, we claim that, at least from an intra-sentential perspective, conceptual anaphors seem to be as pronominal as fully specified pronouns.

KEYWORDS: conceptual anaphor, c-command, self-paced reading/listening, eye-tracking.

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[2] Associate Professor of Linguistics at the Federal University of Rio de Janeiro and CNPq researcher
[3] Doctoral student in the Linguistics Graduate Program of the Federal University of Rio de Janeiro
[4] Doctoral student in the Linguistics Graduate Program of the Federal University of Rio de Janeiro

INTRODUCTION

Plural pronouns that do not have an explicit coreferential antecedent (conceptual anaphors) have been shown to be rated as natural and to be readily understood in intersentential contexts. Gernsbacher (1991) and Oakhill et al. (1992) report seminal experiments comparing the comprehension of so called legal pronouns, that is, pronouns which match in number with antecedents, and illegal pronouns, which are plural in their surface form, but refer to singular collective antecedents. Their results indicated that illegal pronouns or conceptual anaphors were read more quickly than legal pronouns in sentences with collective antecedents.

Previous studies on the comprehension of Brazilian Portuguese (BP) conceptual and surface anaphors in intersentential contexts have also found that these elements display distinct processing properties. Silva (2008) uses the Frames Theory (Barsalou, 1992) to explain how people understand the relation between anaphors and antecedents in a text, using their world knowledge and the context. Godoy (2010) presents results of a sentence completion and of a self-paced reading (SPR) experiment in which conceptual anaphors and pronouns are shown to differ in contexts of collective and distributive predication. However, these studies relied exclusively on intersentential pronoun resolution to distinguish between these two kinds of pronouns. In contrast, the present paper examines fully specified and underspecified pronouns in intra-sentential contexts to argue that both are subject to structural constraints and interact with collective and distributive predicates without displaying main effects.

As reviewed on Nicol & Swinney's (1989) seminal work on coreference, the role of structural factors in coreference assignment has been established through different methodologies. These authors report results of several on-line experiments that examine the time-course of coreference processing supporting the view that this process is restricted by grammatical constraints when they are available. On the other hand, there are also models that conceive anaphoric resolution as mainly a semantic inference process (cf. Oakhill et al., 1992). In the present study, we intend to demonstrate that, in situations in which a structural condition can apply (Principle B or Principle C of Binding Theory), both pronominal and conceptual anaphors in Brazilian Portuguese sentences are sensitive to it. Our main claim is, therefore, that conceptual anaphors are basically pronouns and not a special type of element.

The paper is organized as follows. In Section 1, we present a self-paced reading experiment in which pronouns and conceptual anaphors in an embedded clause were potentially coreferential with collective antecedent DPs that could be in a c-commanding or in a non c-commanding position in the matrix clause. Results of experiment 1 indicated that both pronouns and conceptual anaphors in +B (Principle B legitimate) configurations are read faster than in −B (Principle B illegitimate) configurations, but there was no main effect of type of pronoun. In Section 2, another self-paced reading experiment is presented in which pronouns and conceptual anaphors were construed in Principle C legitimate (+C) or illegitimate (-C) positions to be cataphorically coreferential with a DP in the main clause. Results of experiment 2 indicated that names with both pronouns or conceptual anaphors antecedents in +C configurations are read slower than in -C configurations, but, again, there was no main effect of type of pronoun. In Section 3, we compare the results of experiments 1 and 2. In Section 4, we present experiment 3, in which we submitted the +B sentences of Experiment 1 to eye-tracking. Again, we did not find differences in fixation durations of pronouns and conceptual anaphors. In Section 5, we present experiment 4, in which we used a self-paced listening technique, crossing the factors type of predicate (distributive - D/generic - G) and type of anaphoric element (pronominal – P or conceptual – C). Results showed no main effect of type of anaphora and type of predicate, but only a significant interaction of the two factors. Finally, in Section 6, we present the conclusions of the paper.

1. EXPERIMENT 1: PRINCIPLE B EFFECTS FOR PRONOUNS AND CONCEPTUAL ANAPHORS

Silva (2008)[5] reports the results of a self-paced reading experiment in which 27 subjects read sentences such as:

(1) O jornalista acompanhou **os times** ao estádio. Eles fizeram uma partida importante.
    The journalist accompanied the teams to the stadium. They made an important match.
(2) O jornalista acompanhou **o time** ao estádio. Eles fizeram uma partida importante.
    The journalist accompanied the team to the stadium. They made an important match.

Following Gernsbacher (1991) and Oakhill et al. (1992), Silva analyses *eles* "they", which matches in number and gender features with the antecedent DP *os times* "the teams",

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[5] Silva compares conceptual anaphor structures (singular collective antecedents recovered by plural pronouns) with pronominal anaphor structures in which both antecedents and their coreferential pronouns are plural. In our studies we tested the comprehension of pronominal anaphor structures in which singular antecedents are recovered by singular pronouns.

in (1), as a case of pronominal anaphora (P). In contrast, *eles* "they", in (2), which has the singular DP *o time* "the team" as antecedent, is analysed as   an example of conceptual anaphora (C), a case of coreference in which there is a violation of morphological agreement between an antecedent and a proform. Following Oakhill et al. (1992), Silva entertains the hypothesis that conceptual anaphors require inference to be coreferential with collective DPs, such as *o time* "the team", in (2), which has a plural meaning, but a singular form, and should not be as readily comprehended as matched plural pronouns with explicit plural antecedents, such as *eles* "they" and *os times* "the teams", in (1). Silva proposes to explain the inference process required by conceptual anaphors using the Frames Theory (Barsalou, 1982). Even though overall differences in reading times for the two conditions were not significant, subanalyses for the group of slowest readers revealed significant differences between P and C, which Silva interpreted as indicative that the coreference process does not always depend on linguistic factors (as agreement feature matching), as readers could make rapid use of other sources of information such as world knowledge and frames, which would explain the conceptual relations between linguistic, contextual and cognitive factors in reading comprehension.

In experiment 1, our objective was to assess whether a conceptual anaphor could be shown to be sensitive to a structural principle as well as a pronoun in an intra-sentential context, namely, Principle B of Binding Theory (cf. Chomsky, 1981), which postulates that a (non-anaphoric) pronominal (expression) must be free within its local domain. In other words, a pronoun must not be c-commanded[6] by a coreferential antecedent in its domain[7]. Our hypotheses were that Principle B would apply for both pronouns and conceptual anaphors and that there would be no differences between these entities, even though the former fully matched in number, gender and person features with its antecedent and the latter did not match in number with its antecedent. In order to test these hypotheses, we designed a word by word self-paced reading experiment in which the independent variables were (1) the type of anaphora (pronoun – P / conceptual anaphor – C) and (2) the structural position of the antecedent DP (Principle B legitimate position +B / Principle B violation –B). The crossing of these variables generated four experimental conditions: P+B, P –B, C+B, C-B, as exemplified in Table 1:

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[6] We assume the basic definition of c-command: A node A c-commands a node B if and only if: (i) A does not dominate B; (ii) B does not dominate A ; (iii) the first branching node that dominates A, also dominates B.

[7] Even though there is controversy as to the notion of local domain in relation to binding, for present purposes we assume that the local domain of the pronoun is the TP in which it is contained.

P+B: A /delegação /do /time/ indicou/ ele /para/ o/ jogo/ de/ estréia.

C+B: A /delegação /do/ time/ indicou /eles /para /o /jogo /de /estréia.

P-B: O /time /da/ delegação/ indicou/ ele/ para/ o/ jogo/ de/ estréia.

C-B: O/ time/ da/ delegação/ indicou/ eles/ para/ o/ jogo/ de/ estréia.

O time foi indicado para o jogo de estréia? (YES or NO)

[The delegation of the team appointed it/them for the opening game]

**Table 1:** Example of Experiment 1 conditions

METHOD

Subjects: The subjects were 24 volunteer undergraduate students from the student body of the College of Letters of the Federal University of Rio de Janeiro with normal or corrected vision, all of whom were naïve as to the objectives of the experiment.

Materials: 16 groups of sentences similar to the ones in Table 1 were constructed. The design of the experiment was 2x2, generating 4 conditions. Each of these conditions was composed by four sentences which were organized in a Latin Square design and presented for reading in 11 segments (as indicated by slashes in the examples), followed by an end of sentence interpretation question, as exemplified in Table 1. Segment 6 was the critical segment, containing either the pronoun (P) or the conceptual anaphor (C). There were four versions of the experiment. Each version was made up by 16 experimental sentences randomly interspersed among 32 distractive sentences.

Procedure: Subjects were seated individually in a quiet room in front of a MacBook Air computer. Data were collected using the Self-Paced Reading task. The software used was Psyscope (cf. Cohen et al.). Sentences were presented word by word in random order on the computer screen. Presentation was centered between the top and the bottom of the screen, with each word being called onto the screen non-cumulatively by pressing the space bar on the computer keyboard. The time taken to read each word was recorded automatically in milliseconds. Once the last word had disappeared, the program prompted the participant to record a YES/NO decision on a statement about the previous sentence, by pressing a green or a red button in the keyboard. All participants completed the entire task in 10-12 minutes.

RESULTS

The average reading times of the critical segment containing P or C are presented in Graph 1 and in Table 2, below. Results indicated that both P and C in +B configurations were read faster than in -B configurations ($F(1,44)=13.35$, $p=0.0003$), but there was no main effect of type of pronoun ($F(1,44)=1.75$, $p=0.1865$). There was no interaction between the two factors, namely type of anaphora and structural position of antecedent ($F(1,44)=0.95$, $p=0.33$).
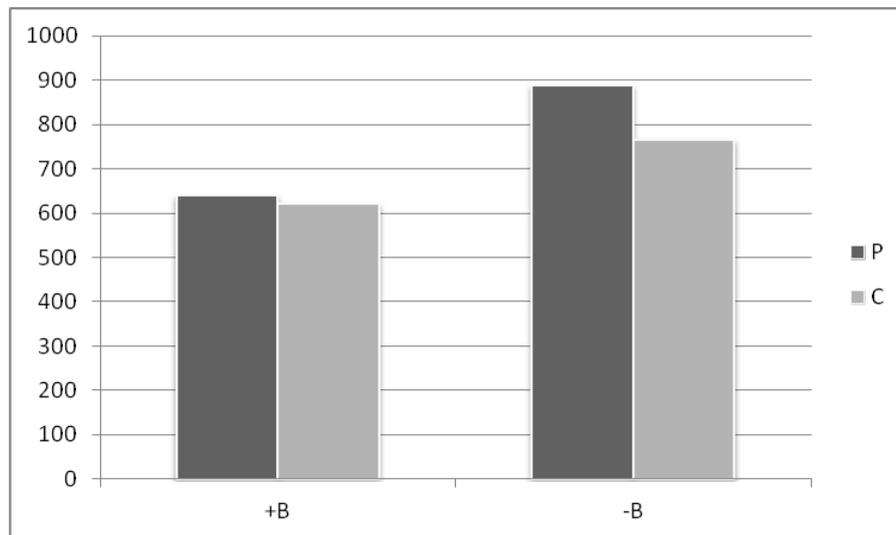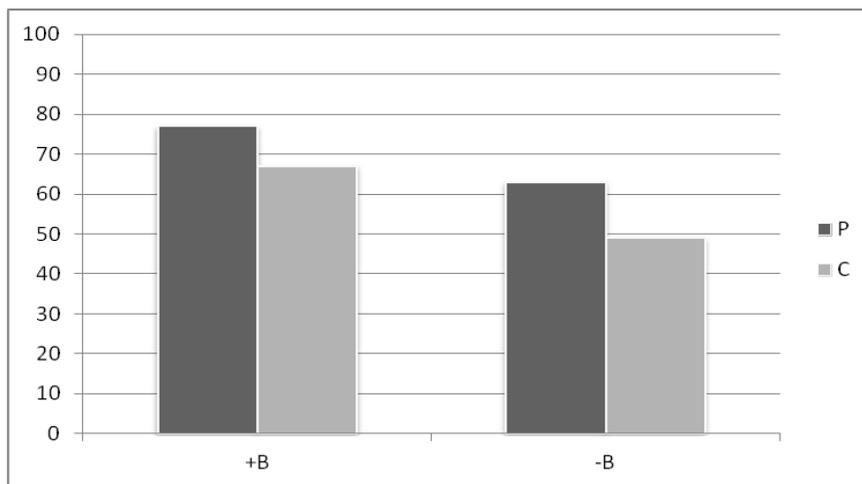

Graph 1: Average reading times of critical segment 6

Colunas1	+B	-B
P	640	889
C	621	766

Table 2: Average reading times of critical segment 6

Answer rates indicating coreference were significantly greater in the C+B condition, when Principle B licensed coreference for conceptual anaphors, than in the C-B condition, when Principle B blocked coreference for conceptual anaphors ($X^2(1)=5.6$, $p=0.02$). Even though coreference rates were visually higher in the P+B condition than in the P-B condition, there was no Principle B significant effect for pronouns ($X^2(1)=2.8$, $p=0.09$). Likewise, P-B does not differ significantly from C-B ($X^2(1)=0$, $p=1$), nor P+B differ significantly from C+B ($X^2(1)=1.4$, $p=0.2$).

Graph 2: Coreference rates of P+B, P-B, C+B and C-B answers

Fatores	+B	-B
P	55%	45%
C	58%	42%

Table 3: Coreference rates of P+B, P-B, C+B and C-B answers

CONCLUSIONS

- The average reading times of the critical segment confirm the hypothesis that conceptual anaphors and pronouns are both subject to Principle B of the Binding Theory. P and C were read faster when they were not c-commanded by their antecedents (+B conditions).

- Coreference answer rates indicated that coreference is significantly greater in the C+B condition than in the C-B condition. For the P conditions there is only a tendency in favor of +B.

- The inferential calculus which would establish coreference between conceptual anaphors and their potential antecedents do not seem to affect C average reading times in comparison with P. Likewise, they do not seem to significantly affect the answer rates in the end of sentence questions. Coreference rates for P do not differ from coreference rates for C.

- Therefore, conceptual anaphors do not escape a structural principle that rules pronominal resolution.

2. EXPERIMENT 2: PRINCIPLE C EFFECTS FOR ANTECEDENTS OF PRONOUNS AND CONCEPTUAL ANAPHORS

In experiment 2, P or C were in adjunct clauses preceding a potentially coreferential DP in the following matrix clause. P or C could be in structural configurations from which they could not bind the DP in the matrix clause – cases in which names would be free (+C) – or in a position to potentially bind the DP – cases in which names would not be free (-C). Our objective was to verify whether cataphoric antecedents of conceptual anaphors could be shown to be sensitive to a structural principle, namely, Principle C of Binding Theory (cf. Chomsky, 1981), as well as cataphoric antecedents of pronouns in intrasentential context (e.g. ele…o time "he…the team"). Our hypotheses were that Principle C, which postulates that names must be free, would apply for names with both pronouns and conceptual anaphors as antecedents, and that there would be no differences between these entities, even though the former fully matched in number, gender and person features with its cataphoric antecedent and the latter did not match in number with its cataphoric antecedent. In order to test these hypotheses, we designed a word by word self-paced reading experiment in which the independent variables were (1) the type of anaphora (pronoun – P / conceptual anaphor – C) and (2) the structural position of P or C in relation to names (Principle C legitimate position +C / Principle C violation –C). The crossing of these variables generated four experimental conditions: P+C, P-C, C+C, C-C, as exemplified in Table 4:

P+C: Quando/ ele/ praticava/ com/ muito/ afinco,/ **o time/** sempre/ marcava/ vários/ gols.

C+C: Quando/ eles/ praticavam/ com/ muito/ afinco,/ **o time/** sempre/ marcava/ vários/ gols.

P-C: Ele/ sempre/ marcava/ vários/ gols,/ quando/ **o time/** praticava/ com/ muito/ afinco.

C-C: Eles/ sempre/ marcavam/ vários/ gols/ quando/ **o time/** praticava/ com/ muito/ afinco.

Quando o time praticava com muito afinco, marcava vários gols? (SIM ou NÃO)

[When it/they practiced hard, the team always scored several goals]

**Table 4:** Example of Experiment 2 conditions

METHOD

Subjects: The subjects were 24 volunteer undergraduate students from the student body of the College of Letters of the Federal University of Rio de Janeiro with normal or corrected vision, all of whom were naïve as to the objectives of the experiment.

Materials: 16 groups of sentences similar to the ones in Table 4 were constructed. The design of the experiment was 2x2, generating 4 conditions. Each of these conditions was composed by four sentences which were organized in a Latin Square design and presented for reading in 11 segments (as indicated by slashes in the examples), followed by an end of sentence interpretation question, as exemplified in Table 1. Segment 7, the target DP, was the critical segment. There were four versions of the experiment. Each version was made up by 16 experimental sentences randomly interspersed among 32 distractive sentences.

Procedure: Subjects were seated individually in a quiet room in front of a MacBook Air computer. Data were collected using the Self-Paced Reading task. The software used was Psyscope (cf. Cohen et al.). Sentences were presented word by word (except for the critical segment which was a DP made up by a Determinant and a Noun), in random order, on the computer screen. Presentation was centered between the top and the bottom of the screen, with each word being called onto the screen non-cumulatively by pressing the space bar on the computer keyboard. The time taken to read each word was recorded automatically in milliseconds. Once the last word had disappeared, the program prompted the participant to record a YES/NO decision on a statement about the previous sentence, by pressing a green or a red button in the keyboard. All participants completed the entire task in 10-12 minutes.

RESULTS

The average reading times of the critical segment containing the DP are presented in Graph 3 and in Table 5, below. The result of a two-way ANOVA by subjects reveal a main effect of the factor Principle C. Names potentially able to be bound by both C or P antecedents (-C), in violation to Principle C, were read significantly faster than names which had no potentially binders (+C), in compliance with Principle C ($F(1,44)=6.53$, $p=0.014$). In contrast, there was no main effect of type of anaphora, that is, the average reading times of the target DPs did not differ, no matter whether they were potentially coreferential with P or C antecedents ($F(1,44)=0.5$, $p=0.48$). There is no significant interaction between the two factors, namely, Principle C and type of anaphora ($F(1,44)=0.02$, $p=0.89$).
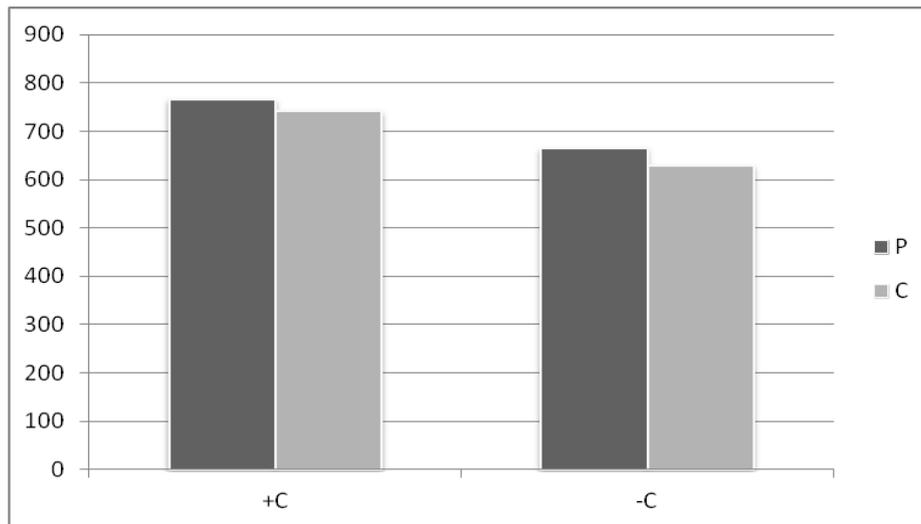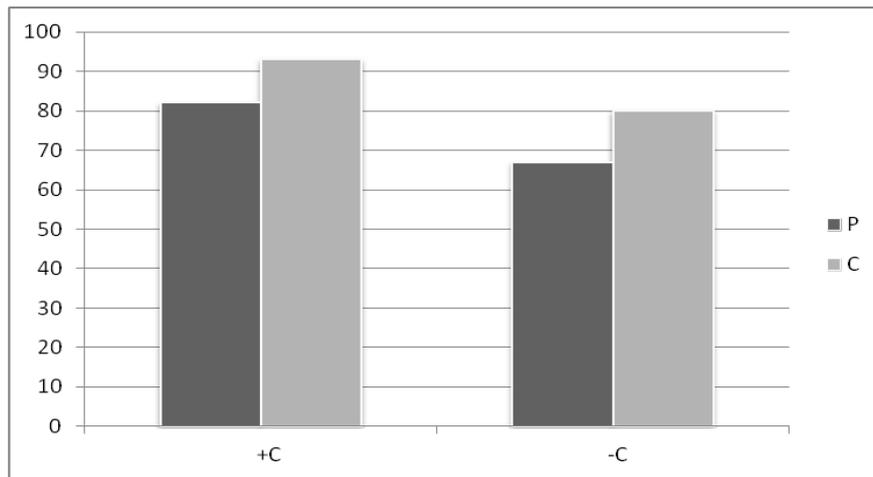
Graph 3: Average reading times of critical segment 7

Fatores	+C	-C
P	766	664
C	741	629

Table 5: Average reading times of critical segment 7

Even though answer rates indicating coreference were in the expected direction, they were not significantly greater in the C+C condition, when Principle C licensed coreference for conceptual anaphors, than in the C-C condition, when Principle C blocked coreference for conceptual anaphors ($X^2(1)=1.95$, $p=0.16$). Likewise, even though coreference rates were visually higher in the P+C condition than in the P-C condition, there was no Principle C significant effect for pronouns either in this measure ($X^2(1)=3.02$, $p=0.08$). Crucially, there was no significant effect either between P and C, both in the –C condition ($X^2(1)=2.29$, $p=0,31$) and in the +C condition ($X^2(1)=1.38$, $p=0.23$). The off-line measure in this experiment was not, thus, as informative as the on-line measures, which indicated a significant facilitation in the reading of -C names in comparison to the reading of +C names expressed in the average reading times of the critical segment. Such a difference between on-line and off-line measures is not uncommon in the Sentence Processing literature and is an important argument in favor of the use of on-line methodologies which are able to capture *snapshots* of the comprehension processes as they are unfolding (cf. Mitchell, 2004). On the other hand, end of sentence questions are subject to the interference of extraneous factors and may not be so accurate in the establishment of subtle effects such as the ones in examination in the present study.

Graph 4: Coreference rates of P+C, P-C, C+C and C-C answers

Fatores	+C	-C
P	55%	45%
C	53%	47%

Table 6: Coreference rates of P+C, P-C, C+C and C-C answers

CONCLUSIONS

- The average reading times of the critical segments confirm the hypothesis that names potentially coreferential with conceptual anaphors and pronouns are both subject to Principle C of the Binding Theory. Names were read faster when they were bound by either their P or C potential antecedents (-C conditions) than when they were not bound by P or C (+C conditions).

- The off-line measure presented results which were in the expected directions (more coreference in +C than in -C), but which were not significantly different.

- In both the on-line and in the off-line measures, however, there is no significant difference between pronouns and conceptual anaphors.

3. THE PSYCHOLOGICAL REALITY OF PRINCIPLES B AND C

Experiments 1 and 2 offer evidence in favor of the psychological reality of Binding Principles B and C in Brazilian Portuguese sentences containing fully specified pronouns and conceptual anaphors, showing that both these elements seem to be sensitive to these structural principles in on-line measures. For the purposes of the present research it would be enough to find that there are significant differences related to structural factors which are operative both in sentences containing conceptual anaphors and pronouns.

However, an interesting discrepancy in the direction of the relevant results in the two experiments needs to be further discussed. Why is it that both P and C in Principle B configurations are read significantly **faster** when they are licensed (+B conditions) than when they are not licensed (-B conditions)? In contrast, why is it that names were read significantly **slower** when they were not bound by P or C (+C conditions) than when they were bound by either their P or C potential antecedents (-C conditions)?

The answers to these questions seem to be straightforward and constitute an interesting by-product of the present research: a name is free, it has its own reference by default; therefore, coreference should be costlier for names. Not surprisingly, names with legitimate Principle C antecedents in which coreference can be entertained, are harder to process. On the other hand, a pronoun does not have its own reference, therefore coreference is the default process for pronouns and it is only natural that Principle B licensed configurations should be processed faster than their non-licensed counterparts. As a bonus for the present research, this interesting discrepancy is true, as we showed, both for fully specified pronouns and conceptual anaphors.

4. EXPERIMENT 3: EYE-TRACKING OF +B SENTENCES[8]

As experiments 1 and 2 did not find any significant differences between the average reading times of P and C in SPR experiments, we decided to submit a subset of the sentences of Exp 1, namely, the sentences in which coreference is licensed by Principle B, to eye-tracking, a more direct technique in which there is no segmentation of the stimuli. The independent variable in this study was only the type of anaphora (P or C) and the main dependent variable was the fixation durations in the areas of interest (AOI) of the pronoun and the conceptual anaphor, as well as the contiguous spillover area immediately following P or C. Additionally, subjects were asked to answer an end of sentence question to check whether coreference could be established between the non c-commanding NP and the pronoun or conceptual anaphor. Table 7 provides one set of examples of the materials.

P+B: A assembléia do eleitorado denunciou ele para as autoridades.
[The assembly of the electorate denounced it to the authorities]
C+B: A assembléia do eleitorado denunciou eles para as autoridades.
[The assembly of the electorate denounced it to the authorities]
O eleitorado foi denunciado para as autoridades (Yes or No)
[The electorate was denounced to the authorities]

Table 7: Example of materials of experiment 3

METHOD

Subjects: The subjects were 18 volunteer undergraduate students from the student body of the State University of the West Side of Rio de Janeiro (UEZO), with normal or corrected vision, all of whom were naïve as to the objectives of the experiment.

Materials: 16 sentences of the P+B type and 16 sentences of the C+B type distributed in a Latin Square design in two versions of the experiment. Target sentences were randomly interspersed among 32 distracting sentences. Sentences were written in Font CALIBRI 21.

Procedures: Subjects were seated 60 cm away from a TOBII T120Hz eye-tracker at a quiet room at UEZO. After an initial session of calibration in which subjects followed a red ball on the screen, subjects were instructed to call sentences onto the screen by clicking a mouse. They were told to read each sentence rapidly for comprehension and click the mouse again when they were ready to answer a question about the sentence. This end-of-sentence question should be answered by subjects by fixating their gaze on the word SIM (Yes) or on the word NÃO (No) on the screen that appeared immediately after they clicked the mouse after reading each sentence. Subjects should then click the mouse again to call another sentence onto the screen, proceeding as indicated above until the end of the experiment, which lasted between 10-15 minutes.

RESULTS

The average total fixation durations in the P area was 683ms and the average total fixation durations in the C area was 578ms. A pairwise t-test did not find significance difference between these means (t= 1.76, p=0.08). The spillover area produced average total fixation durations of 520ms in the P condition and 482ms in the C condition. The difference between these means were not considered significant in a pairwise t-test either (t=0.95,

p=0.34). Regressive saccades to the non c-commanding antecedent area were also monitored, but did not reveal significant differences between the two conditions (p> 0.05). Figure 1 illustrates a heatmap of a P and a C sentence read by a subject.
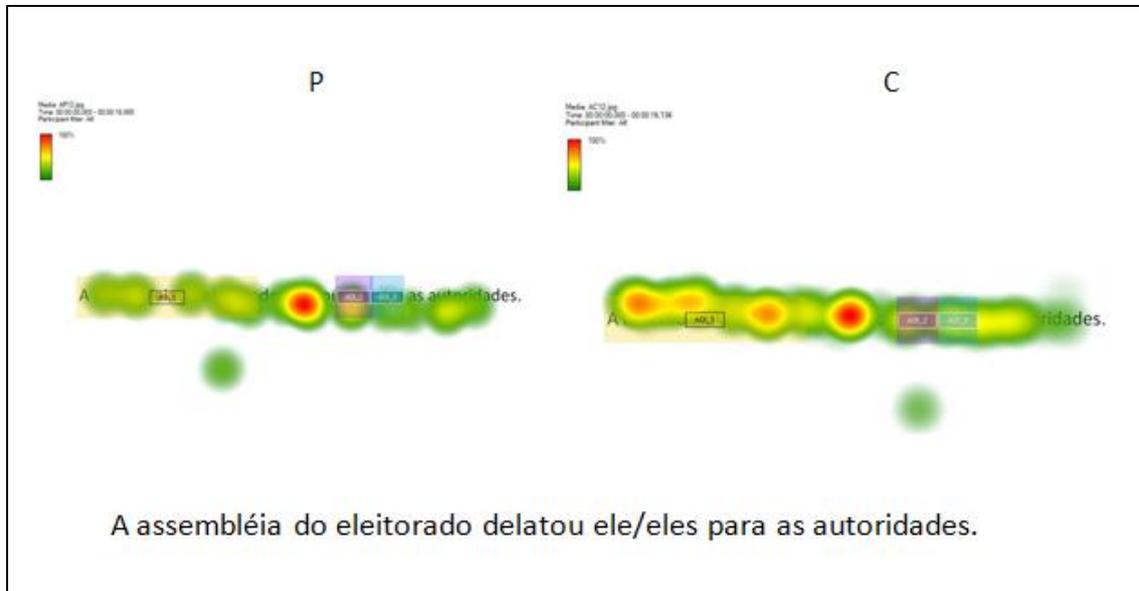

Figure 1: Illustration of a heatmap of a P and a C sentence read by a subject

The end of sentence questions produced a SIM (Yes) answer in 98% of the cases, regardless the type of anaphora, indicating that coreference could be established, as expected, between P or C and a preceding non c-commanding antecedent.

CONCLUSIONS

Similarly to the findings of Experiment 1, no significant differences could be established between the average reading times of P and C in the eye-tracking experiment neither in the anaphora area nor in the contiguous spillover area. No significant regressive patterns to the non c-commanding antecedent were detected, suggesting that conceptual anaphors produce reading patterns very similar to pronouns.

5. EXPERIMENT 4: SELF-PACED LISTENING OF P AND C SENTENCES WITH GENERIC AND DISTRIBUTIVE PREDICATES

Godoy (2010) examined the resolution of conceptual anaphors and fully specified prononuns in intersentential contexts in BP in two psycholinguistic experiments: a sentence completion questionnaire and a self-paced reading instrument. Godoy included a singular collective antecedent in coreference with C and P and also manipulated the distributive and collective readings of the predicate, assuming that these factors could influence anaphoric resolution. Godoy reports that results of both experiments indicate correlations between distributive predicates and plural conceptual anaphors (C) and between collective predicates and singular pronouns (P).

In the present experiment, our focus was to examine whether the nature of the predicate could be rapidly accessed during intra-sentential coreference resolution of P and C. In the previous experiments we found that P and C intra-sentential coreference resolution is subject to structural constraints (Binding Principles B and C) and that P and C did not seem to differ in terms of reading times, both in the SPR tests and in eye-tracking. This fourth experiment aimed at trying to establish intra-sentential differences between P and C seeking to find the correlation established by Godoy in inter-sentential contexts. Since the three reading tests had failed in producing significant results between the two types of anaphora, we decided to present stimuli in oral modality in this experiment.

This experiment used a self paced listening technique followed by interpretation questions, in a 2x2 design, crossing the independent variables *type of predicate* (distributive - D/generic - G) and *type of anaphoric element* (pronominal - P or conceptual - C), generating four experimental conditions, as exemplified by the set below:

<div style="border: 1px solid black; padding: 10px;">

DP: Quando/ o time /foi entrevistado/ **ele** /marcou /muitos/ gols

   O time marcou muitos gols [The team scored many goals]

DC: Quando/ o time/ foi entrevistado /**eles /**marcaram /muitos /gols

   Os jogadores marcaram muitos gols [The players scored many goals]

GP: Quando/ o time/ foi organizado/ **ele** /marcou /muitos /gols

   O time marcou muitos gols

GC: Quando/ o time/ foi organizado/ **eles/** marcaram/ muitos /gols

   Os jogadores marcaram muitos gols

[When the team was interviewed/organized, he/they scored several goals]

</div>

Table 8: Examples of experiment 4 conditions

As in the previous experiments, antecedents were singular nouns which admitted a collective reading. Subjects pressed buttons to listen to sentences divided in segments as indicated by slashes in the examples. After each sentence, subjects had to judge a written statement about the sentence. The on-line dependent variable was the average listening time of the critical segment 4 (pronoun / conceptual anaphor) and the off-line measure was the accuracy rate and reaction times of the answers given to the final questions. We predict that pronominal anaphors should be more readily processed in conditions G than in conditions D, whereas conceptual anaphors should be more readily processed in D than in G.

METHOD

Subjects: The subjects were 28 volunteer undergraduate students from the student body of the College of Letters of the Federal University of Rio de Janeiro with normal or corrected vision, all of whom were naïve as to the objectives of the experiment.

Materials: 16 groups of sentences similar to the ones in Table 8 were constructed. The design of the experiment was 2x2, generating 4 conditions. Each of these conditions was composed by four sentences which were organized in a Latin Square design and presented for self-paced listening in 7 segments (as indicated by slashes in the examples), followed by an end of sentence interpretation question probing generic and distributive coreference, as exemplified in Table 7. Segment 4 was the critical segment, containing either the pronoun (P) or the conceptual anaphor (C). There were four versions of the experiment. Each version was made

up by 16 experimental sentences randomly interspersed among 32 distractive sentences. Sentences were pre-recorded and split, controlling the relative durations of the target segments, in Digital Zoom H4n Portable Professional audio and voice recorder, with four channels, PCM 24-bit.

Procedure: Subjects were seated individually in a quiet room in front of the 21" screen of an Apple iMac Core i5 computer. The software used was Psyscope (cf. Cohen et al.). Sentences were orally presented segment by segment in stereo audio speakers. As subjects pressed the space bar in the keyboard each oral segment was launched. The time taken to listen to each segment was recorded automatically in milliseconds. Once the last word had been spoken, the program prompted the participant to record a YES/NO decision on a statement about the previous sentence, by pressing a green or a red button in the keyboard. All participants completed the entire task in 10-15 minutes.

RESULTS

As indicated in Graph 4 and Table 9, there seems to be a visual correlation between the factors in the 2x2 design. The two-way ANOVAs by subjects, however, did not find a significant main effect of the factor type of anaphora (F_1=0.015, $p = 0.9025$), nor a significant main effect of the factor type of predicate (F_1=0.787, $p = 0.3752$). However, crucially, there is a significant interaction of the two factors (F_1= 54.85, $p < 0.001$).
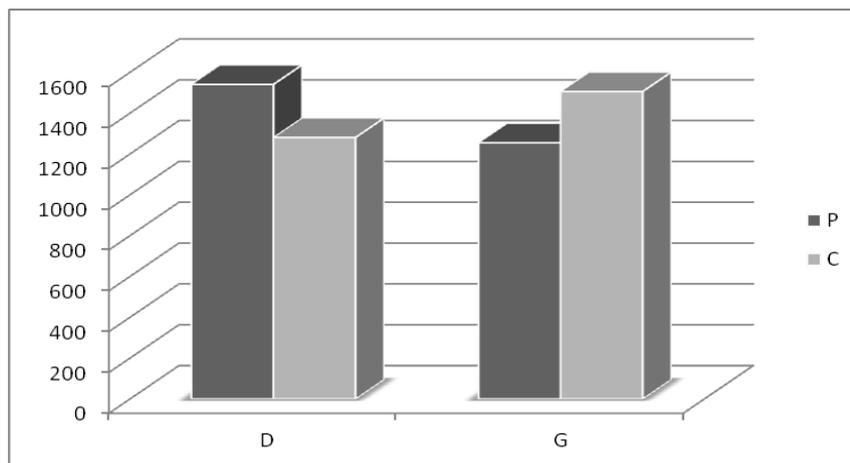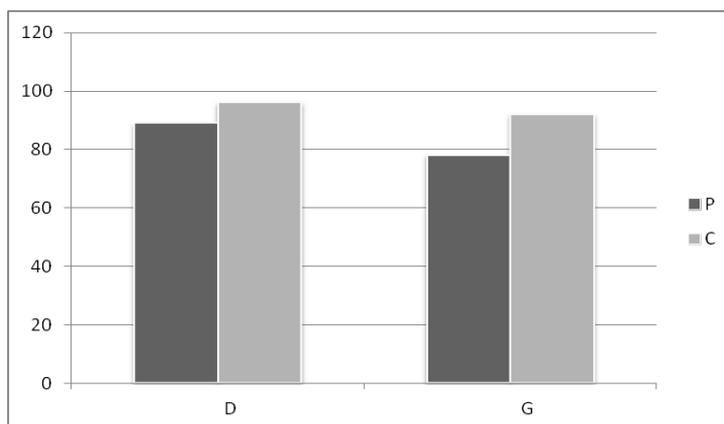

Graph 4: Average listening times of critical segment 4 in the four conditions

Fatores	D	G
P	1541	1255
C	1281	1506

Table 9: Average listening times of critical segment 4 in the four conditions

Notice that the off-line measures did not produce significant differences with respect to the crossing of the factors in pairwise comparisons:

Graph 5: Average off-line measures in the four conditions

Fatores	D	G
P	89	78
C	96	92

Table 9: Average off-line measures in the four conditions

Significance is not found in any of the relevant comparisons **DP x GP** ($X^2(1)=0.72$, p=0.3947); **DC & GC** ($X^2(1)= 0.085$, p=0.77); **DP & DC** ($X^2(1)= 0.26$, p=0.6); **GP & GC** ($X^2(1)=1,15m$ p=0.28).

CONCLUSIONS

The analysis of the on-line measures of the self-paced listening experiment do not show any significant main effects of the factors type of anaphora (P/C) or type of predicate (G/D), but only an interaction between these factors. Therefore, it does not seem to be the case that C in itself is different from P, but as well as pronouns, conceptual anaphors **interact** with predicates, generating differences between their generic/distributive coreference resolution properties.

6. CONCLUSIONS

The four experiments presented in this article used on-line and off-line measures in order to investigate the processing properties of fully specified pronouns and conceptual anaphors in intra-sentential contexts, that is, plural pronouns which do not match in number with the surface forms of their collective antecedents in the same sentences. Experiments 1

and 2 showed that these two types of elements (P & C) do not seem to display any significant differences with respect to their sensitivity to structural constraints (Principles B and C of the Binding Theory). As a bonus, Principles B and C were thereby shown to be psychologically real in an interesting way: coreference is costlier for names and faster for pronouns. Experiment 3 tried to explore further the existence of different patterns of reading of P and C through the eye-tracking technique. Results did not find any significant differences in Total Fixation Durations of the critical areas and of the contiguous spillover areas. Additionally, no interesting regressions to the area of the non c-commanding antecedents were found either. Finally, a self-paced listening experiment intended to establish differences between P and C with respect to distributive and generic predicates could only indicate an interaction between the two factors, without establishing main effects of either factors. This pattern is interpreted to mean that P and C, in itself, do not actually differ: fully specified pronouns as well as so called conceptual anaphors interact with predicates, generating differences between their generic/distributive coreference resolution properties.

Based on these experimental results, we claim that conceptual anaphors do not seem to exhibit a status of its own. At least from an intra-sentential perspective, they seem to be as pronominal as fully specified pronouns.

Finally, the article also intends to adduce evidence in favor of the claim that the field of Experimental Syntax is here to stay. Differences between on-line and off-line measures indicate the existence of effects which can only be captured if we take direct *snapshots* of the sentence comprehension processes as they unfold.

REFERENCES

1. BARSALOU, L. W. (1992). Frames, concepts, and conceptual fields. In: LEHRER, A.,KITTAY, E. F. Frames, fields, and contrasts: new essays in semantic andlexical organization. New Jersey: Lawrence Erlbaum Associates, 1992. p. 21-74.
2. CHOMSKY, N. (1981). Lectures on Government and Binding. Dordrecht: Foris.
3. COHEN J.D., MACWHINNEY B., FLATT M. and PROVOST J. (1993). Psycope: A new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments, and Computers*. 25(2), 257-271.
4. GERNSBACHER, M. A. (1991). Comprehending conceptual anaphors. *Language and cognitive processes*, v. 6, n. 2, p. 81-105.

5. GODOY, M. (2010) Resolvendo a anáfora conceitual: um olhar para além da relação antecedente/anafórico. Dissertação de Mestrado, Unicamp.

6. MITCHELL, D. C. (2004). On-line Methods in Language Processing. In M. Carreiras & C. Clifton, Jr. (Eds), bThe on-line study of sentence comprehension: Eyetracking, ERPs and beyond (pp. 15-32). New York, NY: Psychology Press.

7. NICOL, J. and D. SWINNEY (1989). The role of structure in coreference assignment during sentence processing. Journal of Psycholinguistic Research 18, 5-19.

8. OAKHILL, J.; GARNHAM, A.; GERNSBACHER, M. A.; CAIN, K. (1992). How natural are conceptual anaphors? *Language and cognitive processes*, v.7, p. 257-280.

9. SILVA, A. (2008). A leitura e o processamento da anáfora conceitual. Linguagem em (Dis)curso – LemD, v. 8, n. 2, p. 265-287.

RESUMO: Este artigo descreve um conjunto de experimentos sobre correferência em que são examinados pronomes plenamente especificados e anáforas conceituais, argumentando-se que ambos estão sujeitos a restrições estruturais e interagem com predicados distributivos e genéricos sem apresentarem efeito principal. Nos Experimentos 1 e 2 foi realizada uma tarefa de leitura automonitorada utilizando-se sentenças em que pronomes (P) e anáforas conceituais (C) potencialmente retomavam NPs. No Experimento 1, P ou C tinham, como possíveis correferentes, NPs que poderiam estar em posição legitimada (+B) ou não (-B) pelo Princípio B. No Experimento 2, P ou C poderiam estar em uma posição legitimada (+C) ou não (-C) pelo Princípio C, em correferência catafórica com um NP na oração principal. No Experimento 3, as sentenças +B foram submetidas a uma tarefa de rastreamento ocular. No Experimento 4, uma tarefa de audição automonitorada foi realizada, cruzando-se tipo de predicado (distributivo – D / genérico – G) e tipo de elemento anafórico (P ou C). Os resultados nos permitem afirmar que, ao menos no nível intrassentencial, as anáforas conceituais apresentam as mesmas características de pronomes completamente especificados, o que não justifica a necessidade de se atribuir a elas um *status* distinto.
PALAVRAS-CHAVES: anáfora conceitual, c-comando, leitura/audição automonitorada, rastreamento ocular.