Pragmatic expectations and coreference: how alternative constructions and referring expressions can serve as cues

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Abstract

This paper addresses the question whether possible alternative constructions and alternative choices of referring expressions influence the resolution of anaphoric expressions. We present a questionnaire, a self-paced reading study and a corpus analysis, suggesting that alternative constructions and referring expressions help to constitute preferences for anaphora in referentially ambiguous sentences and also affect on-line sentence processing.

Keywords: Anaphora resolution, pragmatics, conversational implicatures, pronouns, sentence processing

Introduction

In many languages, the interpretation of non-reflexive pronouns is sensitive to a variety of factors. On the structural and syntactic level, there is evidence indicating a general preference for the first-mentioned antecedent (Gernsbacher & Hargreaves, 1988) and for the subject (Järvikivi, Gompel, Hyönä, & Bertram, 2005), while on the pragmatic/discourse level, topicality (Givón, 1983), the chain of causality, and general discourse relations (Sanders, 1997; Kehler, 2002) have been shown to influence anaphora resolution. One may thus argue that anaphora resolution is driven by the interaction of grammatical rules and pragmatic constraints, with the former being language-specific and the latter reflecting general principles of human cognition (cf. Thornton, Gil, & MacDonald, 1998).

One prominent set of pragmatic constraints are the conversational maxims formulated by Grice (1975), which listeners rely on and speakers exploit to convey meaning beyond the level of what is actually said. Out of the four maxims, two are of special interest here: the maxim of quantity ('do not make your contribution more informative than is required') and the maxim of manner ('avoid ambiguity'). They are the basis for most *conversational implicatures* used to describe the roles of different referring expressions in anaphora resolution. One such example is the contrast between pronouns and reflexives in English (Levinson, 1987): reflexives are more informative than pronouns in the sense that they entail immediate coreference and are to be bound within the local domain. When hearing a pronoun, a listener can thus infer that the speaker does not mean immediate coreference, because if so he would have used a reflexive.

While most work on conversational implicatures in anaphora resolution focuses on the role of alternative referring expressions, we would like to suggest that implicatures can also be formed on the basis of constructions, more specifically on possible alternative constructions that were not used.

Alternative Constructions

For the domain of relative clause attachment one such example of a conversational implicature based on alternative constructions can be found in Frazier and Clifton (1996): in order to explain why in sentences like (1) English shows low attachment (i.e. the colonel had an accident), while Spanish and many other languages prefer high attachment (as reported by Mitchell, Cuetos, & Corley, 1992), one may consider that English has an alternative construction to unambiguously express high attachment: the Saxon genitive (2). An English listener can presuppose that the speaker obeys the Gricean maxim of manner and chooses the most appropriate construction. In the referentially ambiguous sentence (1a), the listener can thus assume that the speaker intended a low-attachment reading, because he could have used the alternative construction to unambiguously express high attachment. For a Spanish speaker, on the other hand, there is only one way to express sentence (1b), and so the listener must assume that the more 'prominent' attachment site was intended by the speaker.

(1) a. The daughter of the colonel who had an accident . . .
    b. La hija del coronel que tuvo un accidente . . .

(2)   The colonel's daughter who had an accident . . .

First evidence that alternative constructions might also play a role in anaphora resolution was presented by Hemforth, Colonna, Pynte, and Konieczny (2004). In a cross-linguistic comparison they showed that sentences like (3) are interpreted differently in German and French: while Germans consider the subject '*Polizist*' ('policeman') as the antecedent of the pronoun, speakers of French prefer the object '*facteur*' ('postman').

(3) a. Le policier a rencontré le facteur avant qu'il rentre chez lui.
   b. Der Polizist hat den Briefträger getroffen, bevor er nach Hause ging.
      The policeman met the postman before he went home.

(4) Le policier a rencontré le facteur avant de rentrer chez lui.
   The policeman met the postman before going home.

These differences can be explained in terms of a conversational implicature: in French there is an alternative infinitive construction (4) for sentences like (3a), which allows to unambiguously express coreference of the subject of the second verb with the subject of the matrix clause. Therefore, speakers and listeners of French take the object of the matrix clause as the antecedent of the pronoun, while Germans cannot do so, because no such alternative construction exists in German.

In order to find out, whether the object preference in French *avant que*-clauses may indeed be the result of a conversational implicature, coreference patterns should be investigated in other languages that possess two (or more) interchangeable constructions with different degrees of referential ambiguity. One such language is Portuguese.

As a closely related Romance language, Portuguese provides the same two *before*-constructions (5) as French.

(5) a. O polícia encontrou o carteiro antes que ele fosse para casa.
      The policeman met the postman before he went home.
   b. O polícia encontrou o carteiro antes de ir para casa.
      The policeman met the postman before going home.

But unlike French, Portuguese is a pro-drop language and allows to omit the pronoun '*ele*' ('he') in (5a). The use or omission of the pronoun constitutes an alternative and may thus form the basis of yet another conversational implicature, this time based on the Gricean maxim of quantity.

Referring Expressions

A rather elaborate formulation of the maxim of quantity for referring expressions is the *Accessibility Scale* (Ariel, 1990), which states that lexically less informative anaphora tend to refer to more salient antecedents. For the special case of null pronouns and full pronouns the maxim of quantity was formulated in purely structural terms as the *Position of Antecedent Hypothesis* (Carminati, 2002, PAH). It says that null pronouns prefer to retrieve an antecedent in the (highest) Spec IP, usually the subject, whereas full pronouns prefer an antecedent in a lower syntactic position. The PAH was formulated using Italian data and seems to be consistent with data from Spanish (Alonso-Ovalle, Fernández-Solera, Frazier, & Clifton., 2002), Romanian (Geber, 2006) and Catalan (Perera & Bel, 2011). And so, one might assume that it holds for Portuguese, too.

In the remainder of this paper we present two experiments, a questionnaire and a self-paced reading study, and a corpus analysis. In the questionnaire we investigated the role of pronouns and alternative constructions as cues to determine coreference in Portuguese, partially replicating the findings of Hemforth et al. (2004). In the self-paced reading study we examined if the effect of alternative constructions on pronoun resolution also shows up in on-line sentence processing.

Questionnaire

The influence of the existence of a referentially unambiguous infinitive construction on anaphora resolution in ambiguous sentences containing the Portuguese conjunction '*antes que*' ('before') was examined by comparing the antecedent choices in *antes que*-clauses with the choices of antecedents in a referentially ambiguous second main clause, which was introduced by '*depois*' ('after that'), a conjunction expressing the same temporal configuration, but having no alternative infinitive construction. Additionally, we examined the role of the referring expression itself by either using or omitting the pronoun.

Materials and Design

We constructed 16 referentially ambiguous Portuguese sentences like (6), containing the conjunctions '*antes que*' ('before') and '*depois*' ('after that'). The verbs of the (first) main clauses were chosen to express no implicit causality and not to explicitly focus on either one of the referents. To minimize possible gender effects, half of the sentences contained female referents and the two referents in one sentence were chosen to be comparably stereotypical. Other possible semantic or pragmatic effects were controlled by switching the grammatical role of the two referents for half of participants. In addition, we varied whether a pronoun was used or not in the second clause, thus yielding a 2×2 design with the factors *Clause Type* (*main clauses ('*depois*')* vs. *subordinate clause ('*antes que*')*) and *Pronoun* (*with pronoun* vs. *without pronoun*).

(6) a. O pintor viu o pescador, antes que ele abrisse a janela.
      The painter saw the fisherman before he opened the window.
   b. O pintor viu o pescador. Depois ele abriu a janela.
      The painter saw the fisherman. After that he opened the window.
   c. O pintor viu o pescador, antes que abrisse a janela.
      The painter saw the fisherman before (he) opened the window.
   d. O pintor viu o pescador. Depois abriu a janela.
      The painter saw the fisherman. After that (he) opened the window.

In addition to the stimulus sentences, 32 unrelated filler sentences were constructed, containing pronouns in object position or ambiguously attached relative clauses. All sentences

were followed by a paraphrase of the second clause, containing a gap to fill in:

(7)   O _____ abriu a janela.

Participants and Procedure

Ten native speakers of Portuguese, mainly students from the *Instituto Superior Técnico* in Lisbon (Portugal), volunteered to fill out the questionnaire. The 16 stimulus sentences were divided into four lists, such that each list contained exactly one condition of each item, and in any given list, each condition occurred the same number of times. Each list was combined with the filler items and randomized for each participant. The questionnaire consisted of six pages and a cover sheet, which informed the participants that there were no incorrect responses to the questions and that they were supposed to answer spontaneously.

Results

The relative over-all distribution of antecedent choices for the two clause types is shown in Table 1. In the *main clauses ('depois') condition*, we observe a strong subject preference for the pronoun ($\approx 79\%$), while in the *subclause ('antes que') condition* the object is slightly preferred ($\approx 61\%$) to the subject. The preferences become clearer when looking at both

Table 1: Relative frequencies of choosing subject or object

	subclause ('antes que')	*main clauses ('depois')*
Object	0.61	0.21
Subject	0.39	0.79

factors, as shown in Figure 1. Without pronoun, the subject preference in the *main clauses ('depois') condition* is very clear ($\approx 95\%$), while in sentences with pronoun we observe a strong object preference in the *subclause ('antes que') condition* ($\approx 83\%$). In the other two cases, the *main clauses ('depois') condition* in sentences with pronouns and the *subclause ('antes que') condition* in sentences without pronouns, we observe a slight subject preference. To further evaluate these results, we fitted a logistic mixed-effects model to the questionnaire data, predicting (subject) answers by the two experimental factors *Clause Type* and *Pronoun* as fixed effects. To account for inter-individual differences among participants and words, we included the random factors *participant* and *item* into the model. For the experimental factors, labels were transformed into numerical values, and centered prior to analysis, so as to have a mean of 0 and a range of 1. This procedure minimizes collinearity between variables, and, in combination with sum coding of contrasts, allows coefficients to be interpreted in an analogous way to the main effects and interactions in an Analysis of Variance. The analysis yields estimates, standard errors and *z*-values for each fixed effect and interaction.[1] The reported *p*-values for the main

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[1]Analyses were carried out using the statistical software R and the *lme4* package for mixed effects models.
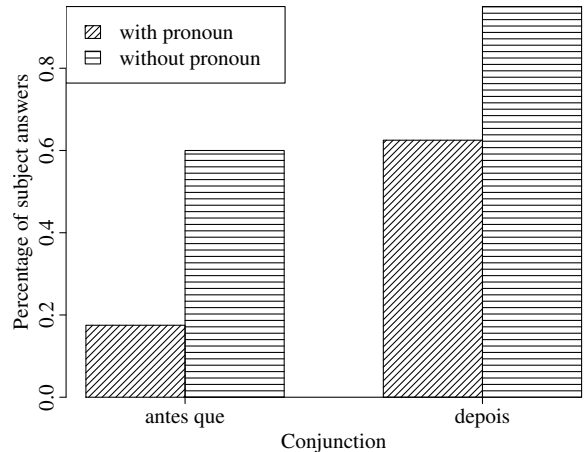

Figure 1: Relative frequencies of choosing subject coreference

effects are based on the *z*-statistics. Table 2 shows the results

Table 2: Logistic mixed effects model results for the questionnaire data

	Estimate	Std. Error	z	p_z
(Intercept)	0.66	0.41	1.62	0.11
Pronoun	-2.55	0.56	-4.59	0.00
Clause Type	2.67	0.53	5.07	0.00
Pronoun × Clause	-0.36	1.03	-0.35	0.73

of the logistic mixed-effects regression, indicating that there are reliable main effects of *Clause Type* ($z = 5.07$, $p < .001$) and *Pronoun* ($z = -4.59$, $p < .001$), but no interaction between the two.

Discussion

Our results show that the existence of a referentially unambiguous alternative construction does influence the resolution of an anaphor in an ambiguous sentence, thus replicating the findings of Hemforth et al. (2004). In addition, our results indicate that the use or omission of a pronoun itself constitutes an alternative that influences the establishment of coreference in a way that a non-subject antecedent is considered more likely if a pronoun is encountered in a sentence where it could be omitted. This supports the *Position of Antecedent Hypothesis* (Carminati, 2002) and is in line with the above mentioned results found in other Romance languages. The two effects, the alternative construction for the conjunction '*antes que*' ('before') and the use of the pronoun seem to be additive and thus independent. When they both add up, they yield a strong object preference for the pronoun, which is comparable to the one found in French by Hemforth et al. (2004).

Reading Study

Although the results of the questionnaire suggest that alternative constructions are considered during the process of anaphora resolution, there is at least one alternative explanations for our findings, namely that anaphora resolution within and across sentences is governed by different mechanisms (see e.g. Miltsakaki, 2002). To exclude such an explanation and to investigate, whether the effect of alternative constructions also shows up in on-line sentence processing, we conducted a self-paced reading experiment, comparing the effect of two different subordinating conjunctions, one of them, '*antes que*' ('before') having an alternative infinitive construction, the other one, '*quando*' ('when'), not. Since the effects of alternative constructions and pronoun use turned out to be additive, we restricted ourselves to further examining only the effect of the former.

Design and Materials

Twenty-four unambiguous experimental items like (8) were constructed, varying the factors *Antecedent* = Subject vs. Object and *Conjunction* = '*antes que*' ('before') vs. '*quando*' ('when'), yielding a 2 × 2 design.

(8) a. O polícia encorajou a actriz, antes que ele voltasse para casa.
          The policeman encouraged the actress before he went home.
     b. O polícia encorajou a actriz, antes que ela voltasse para casa.
          The policeman encouraged the actress before she went home.
     c. O polícia encorajou a actriz, quando ele voltou para casa.
          The policeman encouraged the actress when he went home.
     d. O polícia encorajou a actriz, quando ela voltou para casa.
          The policeman encouraged the actress when she went home.

As for the questionnaire, the verbs of the main clauses were chosen to express no implicit causality and not to explicitly focus on either one of the referents. To minimize possible gender effects, the two referents in one sentence where chosen to be comparably stereotypical for their respective gender. In addition to the stimulus sentences, 48 unrelated filler sentences without any pronouns were constructed.

Participants and Procedure

Twenty-four native speakers of Portuguese, mostly students from the Catholic University of Portugal in Lisbon, volunteered to participate in the experiment. The sentences were presented in a stationary window self-paced-reading fashion, i.e. participants pressed the spacebar to reveal each word of the sentence. As a new word appeared in the center of the screen, the preceding word disappeared. After the last word

of each item, a forced-choice comprehension question was presented and participants were not informed about the correctness of their responses. The experiment was set up using the self-paced reading software Linger, which recorded the time between key-presses and the correctness of the responses. Items were randomized and rotated onto four lists, such that each sentence was presented in only one condition to each participant and that each condition appeared the same number of times. Before the experiment started, participants read a description of the procedure to follow and were told to read the sentences as naturally as possible and to treat them as completely independent of one another.

Hypotheses

We expect effects to occur on the pronoun and the next word (spill-over), because in self-paced reading, effects often spill over to the next word (Sanford & Garrod, 1989). Faster reading times are assumed to reflect easier processing and higher predictability (Levy, 2008), and so we expect reduced reading times on the pronoun and the spill-over after '*antes que*' ('before') if the pronoun refers to the object, compared to when the pronoun refers to the subject. After '*quando*' ('when') we do not expect any difference in reading times between a pronoun referring to the subject and one referring to the object.
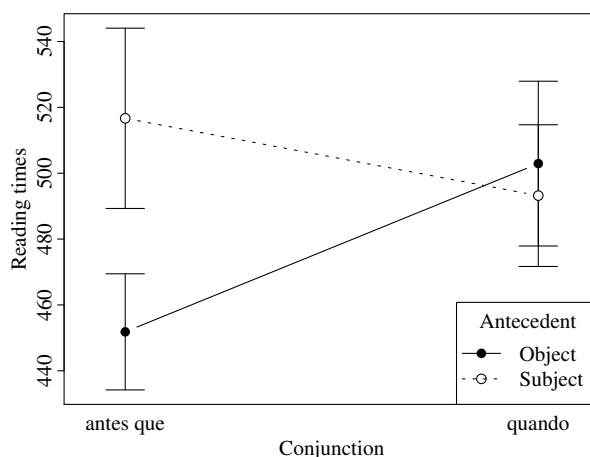
Results

Figure 2: Mean and standard error of raw reading times on the pronoun

Mean reading times on the pronoun and the spill-over are shown in Figure 2 and Figure 3, respectively. Residual reading times were calculated by fitting a linear mixed-effects model predicting logarithm transformed reading times of all words from word length, correctness of answers and item type. To account for inter-individual differences and longitudinal effects of training or fatigue, we included the random factor *participant* with *item position in the experiment* as random slope. The estimated residual log-transformed reading times on the pronoun and the spill-over were analyzed for effects of the experimental factors *Antecedent* and *Conjunction*
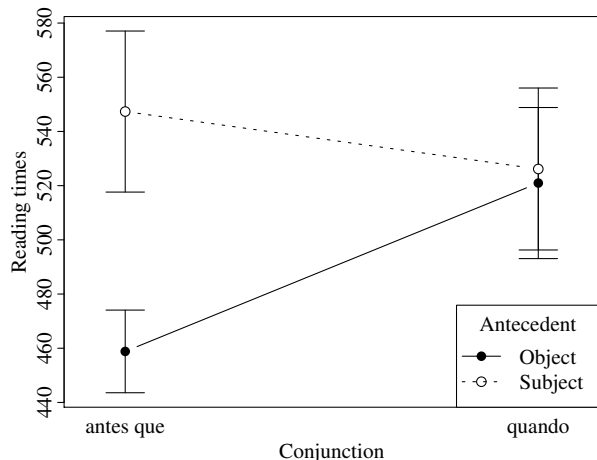
Figure 3: Mean and standard error of raw reading times on the spill-over

type, using a linear mixed effects model with these two fixed effects and *item* as random factor. As in the logistic regression, labels of the experimental factors were transformed into numerical values, and centered prior to analysis, so as to have a mean of 0 and a range of 1. The analysis yields estimates, standard errors and *t*-values for each fixed effect and interaction. The reported *p*-values for the main effects are based on Monte-Carlo-Markov-Chain (MCMC) sampling. Table 3

Table 3: Linear mixed effects model results on the pronoun

	Estimate	Std. Error	t	p_{MCMC}
(Intercept)	0.02	0.01	1.74	0.08
Antecedent	0.05	0.03	1.86	0.06
Conjunction	0.02	0.03	0.68	0.50
Ante. × Conj.	-0.12	0.06	-2.09	0.04

Table 4: Linear mixed effects model results on the spill-over

	Estimate	Std. Error	t	p_{MCMC}
(Intercept)	-0.02	0.02	-1.19	0.24
Antecedent	0.07	0.03	2.18	0.03
Conjunction	0.06	0.03	2.09	0.04
Ante. × Conj.	-0.13	0.06	-2.05	0.04

and Table 4 show the results of the linear mixed-effects model on the pronoun and the spill-over, respectively. On the pronoun we find a reliable interaction of *Antecedent* and *Conjunction* type ($t = -2.09$, $p < .05$). On the spill-over, both *Antecedent* ($t = 2.18$, $p < .05$) and *Conjunction* ($t = 2.09$, $p < .05$) showed significant main effects and a reliable interaction ($t = -2.05$, $p < .05$).

Discussion

The results of the self-paced reading study show that the interpretational preferences of pronouns can be observed during on-line sentence processing. As participants showed reliably

faster reading times on the pronoun and the spill-over when the pronoun referred to the object of the preceding clause and followed the conjunction '*antes que*' ('before'), this might indicate that alternative constructions are being considered and lead to pragmatic expectations based on the respective conversational implicature. However, our results cannot exclude the alternative explanation (see e.g. Gennari & MacDonald, 2009) that the effects found here directly mirror the statistical distributions of coreference preferences for specific constructions. This question will be addressed in the following corpus analysis.

Corpus Study

In more recent work, Hemforth et al. (2010) report the results of a questionnaire and a visual-world experiment conducted in English. Like French, English also has an alternative construction for subordinate clauses starting with '*before*':

(9) a. The policeman met the postman before he went home.

   b. The policeman met the postman before going home.

A purely Gricean account would thus predict that English patterns with French with respect to pronoun resolution, but the results of Hemforth et al. (2010) show a clear subject preference for the pronoun, though not as strong as the one found in German. The authors thus adopt a frequency-based explanation and show that the preferences found in questionnaires and visual-world experiments match frequencies obtained in a 'small-scale' corpus analysis. Such an explanation can also be applied to the Portuguese data presented above. However, it remains to be be explained, where the differing preferences in different languages originally come from (for a critical discussion of processing theories based on frequency alone, see Frazier & Clifton, 1996). Conversational implicatures and the Gricean maxims might provide such an explanation.

One possible reason why English does not show the coreference pattern of French may be that speakers of English do not perceive the *before doing*-construction in (9b) as an alternative construction for a subordinate clause starting with '*before*'. One might e.g. argue that the *before doing*-construction is preferably found in written registers as opposed to spoken language.

One necessary condition for a construction to be perceived as an alternative is to be frequent and so a good start is to examine the frequencies of the alternative constructions in our three languages. In order to do so, we analyzed the *Europarl* corpus (Koehn, 2005), a parallel corpus of approximately 55 million words (per language), which was extracted from the proceedings of the European Parliament. In the French and Portuguese part of the corpus, we searched for the strings 'avant que', 'avant qu'', and 'antes que'. The number of hits was interpreted as the number of subordinate clauses. For the alternative construction, we searched for 'avant de' and 'antes de', and looked at the word immediately follow-

ing these strings. If it was either an object pronoun or a word with an infinitive ending, it was counted as an instance of the alternative construction. The English part of the *Europarl* corpus has an annotation of phrasal nodes, and so subordinate clauses were counted based on all hits of the string `before` that were not annotated as part of a prepositional phrase (PP), while for the alternative construction all other hits were used.

Table 5: Corpus counts

	Portuguese	French	English
subordinate clause	376	1917	7460
alternative construction	3729	3043	1725
ratio	**9.91**	**1.58**	**0.23**

Table 5 shows the results of our analysis: in both French and Portuguese, the alternative infinitive construction is more frequent than the corresponding subordinate clause. This is in striking contrast to English, where the *before doing*-construction is more than 4 times less frequent than a *before*-clause. One may therefore assume that the English *before doing*-construction is not frequent enough not be considered as an alternative construction for a subordinate '*before*'-clause.

Conclusion

We presented evidence that conversational implicatures based on alternative constructions and the form of referring expressions influence the resolution of anaphora in referentially ambiguous sentences.

Acknowledgments

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