

Agreement Patterns in Corpora*

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Abstract

Syntactically annotated corpora are very valuable resources that can be used to provide crucial evidence for the occurrence of particular linguistic constructions in a given language. In the case of agreement processes, the analysis of the different strategies found in a language with a rich agreement profile is paramount for testing the limits of current theories of agreement, and the availability of syntactically annotated corpora enables such cases to be unearthed. This paper discusses agreement patterns of postnominal adjectives in Portuguese, with evidence for different strategies gathered from corpora. We focus on cases of closest conjunct agreement in NP (and noun) coordinations. The results obtained are used to clarify the conditions under which agreement with the closest conjunct is grammatical and discuss the implications of these findings for an HPSG analysis of agreement.

1 Introduction

Syntactically annotated corpora are very valuable resources that can be used to provide crucial evidence for the occurrence of particular linguistic constructions in a given language. In the case of agreement processes, the availability of such corpora enables the investigation of the different strategies used in a given language. This data can subsequently be used, for example, for outlining a theory of agreement. In this paper we discuss how an annotated corpus can be used to investigate agreement patterns and the frequency with which they occur in data, helping to understand the conditions under which some of these patterns are used.

Agreement phenomena in general have received considerable attention in recent years from the linguistic community (e.g. Corbett (1991); Pollard and Sag (1994); Sadler (1999); Kathol (1999); Dalrymple and Kaplan (2000); Wechsler and Zlatić (2003); King and Dalrymple (2004), among others). Coordinate structures in particular present a challenging picture as they allow agreement patterns that are not found in non-coordinate structures, as coordinated nouns may jointly control agreement with dependents such as adjectives. For instance in the following Portuguese sentence, a masculine singular noun is coordinated with a feminine singular noun, and the coordinate structure has masculine plural agreement with the postnominal adjective:

*The research reported on here was carried out as part of a larger project on Noun Phrase Agreement and Coordination funded by the AHRB (RG/APN17606/AN109, to Sadler and Dalrymple), whose support we gratefully acknowledge.

- (1) Ele atribuía o erro e a inconstância humanos aos caprichos da
 He attributed the.MSG error.MSG and the.FSG inconstancy.FSG human.MPL to the caprices of
 experiência
 experience
 'He attributed the human error and inconstancy to the caprices of experience'

The analysis of the different agreement strategies found in a language with a rich agreement profile is paramount for defining the characteristics that a theory of agreement should have. In this paper we investigate agreement patterns between postnominal adjectives and nouns found in Portuguese NP (or N) coordinations, with evidence for different strategies as well as for their frequency gathered from corpora. We concentrate on agreement of gender and number between postnominal adjectives and the coordinated NPs, in particular closest conjunct agreement. The picture of agreement patterns in Portuguese NPs which emerges from the corpus study is a complex one and the results obtained are used for offering some observations on the conditions under which agreement with the closest conjunct is grammatical. This paper starts with an overview of agreement patterns between postnominal adjectives and coordinated NPs in Portuguese, in section 2, and a discussion of the findings gathered in the corpus study, in section 3. A discussion of the implications of the corpus study for a theory of coordination is presented in section 4, followed by the conclusions and future work.

2 Agreement Patterns in Portuguese

The current paper reports on part of an ongoing study of agreement within coordinate NPs in Portuguese, and focuses in particular on the agreement behaviour of postnominal adjectives in coordinate NPs, where the postnominal adjectives scope over the coordinate NPs as a whole. In non-coordinate structures, Portuguese postnominal adjectives agree straightforwardly in number and gender with the nouns they modify, as illustrated in the examples below:

- (2) a parede colorida/vermelha/*pintadas/*colorido/*vermelho/*pintados
 the.FSG wall.FSG coloured.FSG/red.FSG/*painted.FPL/*coloured.MSG/*red.MSG/*painted.MPL
- (3) o teto *colorida/*vermelha/*pintadas/colorido/vermelho/*pintados
 the ceiling *coloured.FSG/*red.FSG/*painted.FPL/coloured.MSG/red.MSG/*painted.MPL

Coordinate structures on the other hand present a much wider range of agreement patterns, since coordinated nouns often jointly control agreement on determiners, adjectives and other dependents within the NP. A strategy common to many languages (and widely discussed in the literature) involves a familiar type of syntactic resolution of agreement features. The following examples illustrate **Resolution Agreement** with coordinations of both same gender (see (4) and (5)) and different gender nouns (see (6)).

- (4) a banana e a pera maduras
 the.FSG banana.FSG and the.FSG pear.FSG ripe.FPL
- (5) o carro e o barco novos
 the.MSG car.MSG and the.MSG boat.MSG new.MPL

- (6) o homem e a mulher modernos
 the.MSG man.MSG and the.FSG woman.FSG modern.MPL
 the modern man and woman

Resolution Agreement in Portuguese involves semantic number resolution (to plural in the general case, excluding examples of single entity coordinations such as “my friend and colleague”) and resolution to the masculine for gender, a widespread strategy in the Romance languages and beyond:

- (7) If all conjuncts are GEN = FEM, resolve to FEM
 else, resolve to MASC

While syntactic resolution is a very widespread strategy, a second strategy which is well attested crosslinguistically involves a form of single conjunct agreement, namely **Closest Conjunct Agreement** (CCA). This strategy is also found in Portuguese and is exemplified by (8). In this example, syntactic resolution of both number and gender are suspended and the postnominal adjective bears agreement features coding the closest (i.e., final) coordinate noun.

- (8) estudos e profissão monástica
 studies.MSG and profession.FSG monastic.FSG

Note that some examples of closest conjunct agreement involve cases in which the conjuncts are synonyms (9) or are part of an enumeration (10):

- (9) As maldições se cumpriam no povo e gente hebreia
 The curses themselves fell in the.MSG people.MSG and persons.FSG hebrew.FSG

- (10) No cumprimento de seus deveres tinha aquele homem um zelo, uma
 In the fulfillment of his obligations had that man a.MSG zeal.MSG, a.FSG
 severidade, uma exatidão extraordinária
 severity.FSG, an.FSG exactness.FSG extraordinary.FSG

Although the existence of closest conjunct agreement within Portuguese coordinate NPs has not received attention in the theoretical linguistic literature and beyond, at least one detailed descriptive grammar of Portuguese does provide some discussion and exemplification of this phenomenon. The agreement possibilities discussed by Torres (1981) for postnominal adjectives with coordinate NPs are spelled out in table 1, where **NP1**, **NP2** and **Adj** refer to the number and gender of the first conjunct, second conjunct, and adjective, respectively.

Table 1: Summary of Agreement Strategies in Portuguese

	Strategy	NP1	NP2	Adj
1	Resolved(G,N)	MSG	FSG	MPL
2	CCA(G,N)	MSG	FSG	FSG
3	Resolved(G,N) (*)	MSG	FPL	MPL
4	CCA(G,N) (*)	MSG	FPL	FPL
5	Resolved(G,N)	MPL	FSG	MPL
6	CCA(G,N)	MPL	FSG	FSG
7	Resolved(G,N) (*)	MPL	FPL	MPL
8	CCA(G,N) (*)	MPL	FPL	FPL
9	Resolved(G,N) (*)	FSG	MSG	MPL
10	CCA(G,N) (*)	FSG	MSG	MSG
11	Resolved(G,N) or CCA(G,N) (*)	FSG	MPL	MPL
12	Resolved(G,N) (*)	FPL	MSG	MPL
13	CCA(G,N) (*)	FPL	MSG	MSG
14	Resolved(G,N) or CCA(G,N) (*)	FPL	MPL	MPL

As is evident from the table above, Torres assumes the existence of two patterns in Portuguese - CCA (in gender and number) and resolution (of gender and number). Note however that *in principle* the rows marked with an asterisk could be interpreted as displaying a “mixed” strategy. That is, given that a language permits the CCA pattern for both number and gender shown above, there are in principle two further closest conjunct agreement patterns which might operate. These are patterns in which the agreement features of number and gender “come apart”, that is cases in which gender agreement is with the closest conjunct while number is (semantically) resolved, and cases in which gender is (syntactically) resolved while number marking reflects the number value of the closest conjunct. Of course for the range of data that Torres gives, there is no reason to further hypothesize “mixed” controllers in this way, given that the two “simple” patterns of CCA and resolution cover the data. However, we note that there is positive existence for the first of these in Portuguese, evidence which is not discussed in Torres:

- (11) o sofrimento e a experiência vividas
the.MSG suffering.MSG and the.FSG experience.FSG lived.FPL

This is a clear case in which the postnominal adjective scopes over the NP coordination as a whole while the feminine gender on the adjective indicates gender agreement with the closest conjunct yet plurality on the adjective indicates a resolved feature, since each NP is actually singular. This strategy is shown in table 2.

Table 2: Further Agreement Strategies - I

	Strategy	NP1	NP2	Adj
15	CCA(G), Resolved(N)	MSG	FSG	FPL
16	CCA(G), Resolved(N)	MPL	FSG	FPL

The existence of this possibility is also noted by Camacho (2003) for Spanish NP/N coordinations, where CCA of gender is again combined with resolution of number - below we give further Portuguese examples preceded by an example for Spanish.

- (12) Ejerce influencia en el crecimiento y la reproducción genéticas
Exercises influence in the.MSG growth.MSG and the.FSG reproduction.FSG genetic.FPL
- (13) ... para um país com fome de capitais e tecnologia externas
... to a country with hunger for capital.MPL and technology.FSG external.FPL
To a country in need of external capital and technology
- (14) ... uma relação entre sobrecarga do organismo e envelhecimento e morte
... a relation between overload of the organism and aging.MSG and death.FSG
prematargas
premature.FPL
A relation between overload of the organism and the premature aging and death.
- (15) ... tendo um conhecimento e uma experiência acumuladas que
... having a.MSG knowledge.MSG and an.FSG experience.FSG accumulated.FPL that
permitem...
allow...
<http://www.jorplast.com.br/secoes/Jul98.htm>

The second possibility involves the options listed in table 3, with either gender resolution and number CCA or furthest conjunct agreement. However, these patterns are not possible for Portuguese, as illustrated by sentence 16, or for Spanish (Camacho, 2003), sentence 17.

Table 3: Further Agreement Strategies - II

	Strategy	NP1	NP2	Adj
17	Resolved(G) and CCA(N)	MSG	FSG	MSG
18	Resolved(G) and CCA(N)	MPL	FSG	MSG

- (16) *O currículo e a pesquisa universitário foram discutidos em ...
The.MSG program.MSG and the.FSG research.FSG university.MSG were discussed in ...
- (17) *Ejerce influencia en el crecimiento y la reproducción genético
Exercises influence in the.MSG growth.MSG and the.FSG reproduction.FSG genetic.MSG

From this investigation, a complex picture emerges, which is further investigated in the corpus analysis of NP internal agreement patterns in Portuguese, discussed in the next section.

3 A Corpus Investigation

To estimate the frequency with which these agreement strategies are used in coordinate nouns modified by postnominal adjectives, an investigation using an annotated corpus was performed. Of particular interest are cases that employ closest conjunct agreement.

For this analysis we searched the 32,091,996 word NILC/São Carlos corpus (available from <http://www.linguatca.pt/>) for occurrences of coordinated NPs/Ns modified by postnominal adjectives. This corpus contains Brazilian texts from newspapers, books and essays, among others. The searches specified concordances such as:

```
[pos="DET_artd"] [pos="N" & gen="M" & pessnum="P"]
[pos="KC.*" & word="e"] [pos="DET_artd"]
[pos="N" & gen="F" & pessnum="P"]
[pos="ADJ" & pessnum="P" & gen="F" ]
```

for the coordination of a Masculine Plural NP (determiner and noun) and a Feminine Plural NP using the conjunction *e* (*and*) postmodified by a Feminine Plural Adjective, and

```
[pos="N" & gen="M" & pessnum="P"] [pos="KC.*" & word="e"]
[pos="N" & gen="F" & pessnum="P"]
[pos="ADJ" & gen="F" & pessnum="P" ]
```

for the coordination of a Masculine Plural Noun and a Feminine Plural Noun using the conjunction *e* (*and*) postmodified by a Feminine Plural Adjective.

Searches for NP and N concordances such as these were done for each of the combinations of gender and number shown in tables 1, 2 and 3 where the second conjunct is feminine, since we want to focus on the cases where we can unambiguously detect CCA of gender. The other cases are ambiguous between a strategy of resolution to masculine, or a strategy of CCA with the masculine noun.

For NP coordinations a subset of the NILC corpus containing 305 sentences was obtained and for N coordinations a subset with 2,337 sentences. These sentences were manually post-processed so that any cases that involved adjectives that were common to both genders were removed. Only adjectives that overtly reflect gender distinction were kept, as we wanted to test the correlation between the gender of each of the conjuncts and the gender of the adjective. Sentences where the adjective scoped over only one of the conjuncts were also removed. As a consequence, 41 out of the 305 sentences with NP coordinations remained, and 374 out of 2,337 with N coordinations.

These sentences are distributed as shown in table 4 for coordinations of NPs, and table 5 for Ns, where **Initial Frequency** indicates the number of sentences found for the searches before post-processing and **Final Frequency** after post-processing. **Animacy** indicates whether the coordination included animate nouns, **Enumeration**, whether the nouns are part of an enumeration, **Synonyms**, if they are synonyms, and **Other**, if they include cases that are neither enumerations or synonyms. In the results for these aspects, the **Yes** value indicates a pattern that was found in the analysed data and **No** one that was not found.¹

In terms of number agreement, cases 1, 5, 15 and 16 signal the adoption of resolution to plural as the second conjunct is singular and the adjective is in plural form. Cases 2 and 6 are unambiguously of CCA where the adjective follows the number of the second conjunct. All other cases are ambiguous between a resolution to plural and a CCA strategy.

For gender, cases 1, 3, 5 and 7 adopt a resolution to masculine strategy, while cases 2, 4, 6, 8, 15 and 16 show CCA of gender with the last conjunct. One interesting point to observe is that CCA of gender seems to be frequently employed when compared to resolution to masculine (e.g. compare cases 1 and 2, and 7 and 8).

Some positive evidence was found in the corpus for the patterns that mix CCA of gender and resolution of number (15 and 16), suggesting that Portuguese, like Spanish, allows mixed controllers for gender and number. On the other hand, the lack of evidence for cases 17 and 18 in the corpus data suggests that even if mixed controllers were allowed in Portuguese, there may be some constraints on the acceptable combinations of number and gender.

¹No in particular does not indicate if a pattern is impossible, but only that given the data available, it has not been found.

Table 4: Frequency of Agreement Strategies in Portuguese NP Coordination

	NP1	NP2	Adj	Initial Frequency	Final Frequency	Animacy	Enumeration	Synonyms	Other
1	MSG	FSG	MPL	5	4	Yes	Yes	No	Yes
2	MSG	FSG	FSG	166	13	No	Yes	Yes	Yes
3	MSG	FPL	MPL	0	0				
4	MSG	FPL	FPL	54	7	Yes	Yes	Yes	Yes
5	MPL	FSG	MPL	0	0				
6	MPL	FSG	FSG	0	0				
7	MPL	FPL	MPL	1	1	Yes	No	No	Yes
8	MPL	FPL	FPL	67	15	Yes	Yes	Yes	Yes
15	MSG	FSG	FPL	11	1	Yes	No	No	Yes
16	MPL	FSG	FPL	1	0				
17	MSG	FSG	MSG	2	0				
18	MPL	FSG	MSG	0	0				

Table 5: Frequency of Agreement Strategies in Portuguese N Coordination

	N1	N2	Adj	Initial Frequency	Final Frequency	Animacy	Enumeration	Synonyms	Other
1	MSG	FSG	MPL	32	30	Yes	Yes	Yes	Yes
2	MSG	FSG	FSG	574	37	No	Yes	Yes	Yes
3	MSG	FPL	MPL	3	2	No	Yes	No	Yes
4	MSG	FPL	FPL	264	7	No	Yes	Yes	Yes
5	MPL	FSG	MPL	7	7	No	Yes	No	Yes
6	MPL	FSG	FSG	362	8	No	No	Yes	Yes
7	MPL	FPL	MPL	86	78	Yes	Yes	Yes	Yes
8	MPL	FPL	FPL	957	199	Yes	Yes	Yes	Yes
15	MSG	FSG	FPL	42	4	No	Yes	Yes	Yes
16	MPL	FSG	FPL	10	1	No	No	No	Yes
17	MSG	FSG	MSG	0	0				
18	MPL	FSG	MSG	1	0				

In terms of animacy of the coordinated nouns, there seems to be some indication that a sentence with a coordination of singular animate nouns is infelicitous if a feminine plural adjective adopts a strategy of CCA (e.g. sentence 18 but not sentences 6 and 19):

(18) *O professor e a aluna escolhidas ...
The.MSG teacher.MSG and the.FSG student.FSG selected.FPL

(19) Tratamentos como a quimioterapia podem deixar o homem e a
Treatments like the chemoteraphy can leave the.MSG man.MSG and the.FSG
mulher estéréis
woman.FSG sterile.PL

The cases of feminine adjectives in CCA of gender with singular nouns found in the corpus were overwhelmingly of conjuncts involving inanimate nouns. For these cases although all the adjectives

used have an inherent gender, they are all compatible with inanimate nouns. Some of these adjectives are: *prematura* (premature.FSG), *irrestrita* (irrestrict.FSG), *típica* (typical.FSG), *características* (characteristic.FPL) and *novas* (new.FPL). The same bias is not found when plural animate nouns are coordinated, where cases can be found of a feminine adjective in CCA with them. Whether for singular nouns this pattern is exclusively allowed for inanimates remains to be confirmed. However, unlike languages like Ndebele Moosally (1999) and Roumanian Farkas and Zec (1995), which have differential resolution according to whether the coordinated nouns are animate or inanimate, other agreement strategies are possible for inanimate nouns in Portuguese.

The results obtained also indicate that cases of CCA are not limited to synonyms or enumerations, but apply in other circumstances too:

- (20) ... a percepção que toda sociedade faz sobre o plano e a
 ... the perception that the whole society makes about the.MSG plan.MSG and the.FSG
 realidade econômica
 reality.FSG economic.FSG
 ... the perception that the whole society makes about the economic plan and the reality

To summarise, the corpus data gathered suggests that a strategy of CCA can be frequently found in Brazilian Portuguese, and at least for this corpus, as frequently as a strategy of resolution. CCA is not restricted to occur with enumerations or synonyms, but can be found with other cases as well. However, although CCA can be widely applied, it does not seem to be applicable to coordinations of singular animate nouns, making such sentences infelicitous.

One obstacle faced in this investigation is that although coordinations can be frequently found in corpora, those involving nouns with different genders, and with postnominal adjectives scoping over both conjuncts are much less numerous, as can be seen by the difference between the initial and final frequencies in these tables. This is the case even in a corpus as big as NILC, where only around 15% of the sentences fulfilled these two constraints. The limited availability of annotated data means that for some of the issues under investigation there was not enough data for providing conclusive evidence. For instance, although the analysed data provided evidence for the correlation between animacy and CCA in the coordination of singular nouns, discussed above, for some cases the sample analysed is not large enough (e.g. cases 3 and 16 in both tables) for the hypothesis to be confirmed. For these cases it may be necessary to turn to the largest (albeit unannotated) corpus available for NLP, the World Wide Web. For instance, for case 16, CCA of gender and resolution of number, even though the analysed data contained only 1 sentence, a preliminary investigation using the WWW provided more positive evidence, as reported in Villavicencio and Sadler (2005).

In the next section we discuss the implications of this corpus study for a theory of agreement.

4 Capturing Agreement Patterns

Closest conjunct agreement has been discussed by Corbett (1991), Sadler (1999), Moosally (1999), Abeillé (2004) and Yatabe (2004) *inter alia*, and it is a strategy of partial agreement that can be found in many languages such as Ndebele (Moosally, 1999) and Welsh (Sadler, 1999). Moosally (1999), for instance, proposes an HPSG formalisation for capturing partial agreement in Ndebele, where agreement constraints are defined in a multiple inheritance hierarchy capturing agreement with the last conjunct, while Yatabe (2004) formalises CCA as part of a unified treatment which also deals with

coordination of unlike categories. However, the Portuguese data discussed in the previous section indicates that, in order to capture cases like that in (21), where mixed gender nouns are coordinated, and they trigger masculine agreement with the determiner and feminine with the postnominal adjective, it is essential to take into account information about the conjuncts in both extremities.

- (21) Esta canção anima os corações e mentes brasileiras.
 This song animate the.MPL heart.MPL and mind.FPL Brazilian.FPL
 ‘This song animates Brazilian hearts and minds.’

Assuming an HPSG formalisation such as that of Pollard and Sag (1994), the attribute CONCORD, which is closely related to the noun’s inflected form, reflects the resolved gender and number of the coordinate structure. The value of CONCORD can be computed by adopting a resolution approach such as that of Dalrymple and Kaplan (2000), whereby if there is at least a masculine noun in the coordinate structure, CONCORD.GENDER is masculine. To account for cases of CCA it is important to store agreement information about the leftmost and rightmost noun conjuncts, introducing two additional agreement attributes: LAGR, for the leftmost conjunct, and RAGR for the rightmost conjunct. For a coordinate structure, the values of LAGR, RAGR may differ, since the first two reflect the agreement values of each of the edge conjuncts, and determiners and pronominal adjectives agree with the coordinate structure via LAGR, while postnominal adjectives agree via RAGR.

All of the agreement patterns discussed in section 3 must be taken into account when a theory of agreement is proposed. For a sentence like 21, both LAGR and CONCORD are masculine and RAGR is feminine and the correct agreement values are observed, since the adjective can either agree with RAGR or CONCORD, but it will correctly rule out sentence (22) as ungrammatical.

- (22) *Esta canção anima as mentes e corações brasileiras.
 This song animate the.FPL mind.FPL and heart.MPL Brazilian.FPL

This formalisation can also capture sentences like 11 and 14, which have CCA for gender, but resolved number agreement for the postnominal adjective, if GENDER agrees with RAGR and NUMBER with CONCORD. Sentences like 8 to 10 agree exclusively with RAGR, with CCA of gender and number, while others like 6 agree only with CONCORD, with resolution of gender and number.

CCA of number and resolution of gender is not possible for Portuguese (sentence 18). Indeed, this strategy is not discussed in the literature or found in corpora, but it should be ruled out by a theory of agreement.

Therefore, to capture the agreement patterns found in Brazilian Portuguese, a theory of agreement must only allow (a) CCA of gender and number (RAGR:GENDER and RAGR:NUMBER), (b) resolution of gender and number (CONCORD:GENDER and CONCORD:NUMBER) and possibly (c) CCA of gender and resolution of number (RAGR:GENDER and CONCORD:NUMBER), but not (d) resolution of gender and CCA of number (CONCORD:GENDER and RAGR:NUMBER).

5 Conclusions

In this paper we investigated agreement patterns found in Portuguese NP (and N) coordinations, with evidence for different strategies gathered from syntactically annotated corpora. We concentrated on gender and number agreement between nouns and postnominal adjectives. The results obtained show

that a complex picture of agreement patterns in Portuguese NPs emerges from the corpus study, which should be taken into account when proposing a theory of agreement. The use of corpora provided not only concrete information about the frequency of use of each strategy, but also gave the basis for determining the contexts in which they can be used. Based on these results we discussed some of the characteristics that a theory should have in order to capture the investigated data, storing information about the leftmost and the rightmost conjuncts.

As future work we intend to compare the occurrence of these strategies in Brazilian and Portuguese corpora, to see if they are restricted to Brazilian Portuguese or not, and if not, if there are any differences in the frequency with which each of these strategies occur. This investigation aims at formalising a general and crosslinguistic theory of agreement.

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