Theoretical, empirical and computational approaches to agreement with coordination structures

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Theoretical, Empirical and Computational Approaches to Agreement with Coordination Structures

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Titre: Les approches théoriques, empiriques et computationnelles pour l'accord avec les structures coordonnées

Résumé:

L'accord avec les structures coordonnées (*le garçon et la fille viendra/viendront*, *Le/les garçon et fille*) utilise au moins trois stratégies de l'accord : l'accord avec le conjoint le plus proche (ou l'accord de proximité, CCA), l'accord avec l'ensemble de la coordination (ou l'accord total, RA), l'accord avec le premier conjoint (ou l'accord précoce, EA) (Peterson, 1986). Cette thèse présente des données de corpus, ainsi que une série des études empiriques de 12 expériences de jugement d'acceptabilité en français et une expérience de lecture en auto-présentation segmentée examinant l'accord avec les structures de coordination dans les différents domaines (nominal/verbal), les différents traits (nombre/genre), les différentes directions (la cible précède/suit la coordination). Les résultats montrent que l'accord avec le conjoint le plus proche est très répandu en français, contrairement à la plupart des grammaires normatives et de la littérature linguistique (cf. Corbett 1991). L'accord de proximité est plus acceptable dans le domaine nominal que dans le domaine verbal, pour l'accord de genre que pour l'accord de nombre.

Sur la base de ces données, cette thèse propose un nouveau modèle linéaire avec plusieurs dimensions, pour prédire la grammaticalité de l'accord avec un NP coordonné. Un nombre croissant d'études expérimentales commencent à explorer cette question (e.g., Willer-Gold et al. 2017), mais elles ne s'appuient que sur une combinaison (comme genre/verbal). Étant donné la sparsité des données obtenues par des expériences humaines, nous proposons un modèle flexible qui peut apprendre les poids des contraintes à travers un nombre limité de structures et se généraliser à d'autres structures. Le présent travail, d'une part, fournit une comparaison détaillée de plusieurs expériences d'acceptabilité humaine, en utilisant une méthodologie de validation croisée. D'un autre côté, nous montrons que le degré de l'acceptabilité peut capturer les tendances typologiques, par exemple la hiérarchie d'accord proposée par Corbett (1991). On propose que cette hierarchie est valable pour l'accord en genre et en nombre, pour l'accord en *et* et en *ou*.

Mots clefs: accord, coordination, genre, nombre, acceptabilité, degré de grammaticalité, modélisation, expérience de judgement d'acceptabilité, lecture en auto-présentation segmentée, corpus

Title: Theoretical, empirical and computational approaches to agreement with coordination structures

Abstract:

Agreement with coordinate structures (*the boy and the girl is/are ready*, *this/these boy or girl*) deploys at least three agreement strategies: agreement with the closest conjunct (CCA), agreement with the whole coordination (or 'resolution rule', RA), agreement with the first conjunct(or 'early agreement') (Peterson, 1986). This thesis presents empirical evidences from corpus studies, as well as 12 acceptability judgment experiments and 1 self-paced reading task in French, examining agreement with coordination structures in different domains (attributive/predicative), different features (gender/number), different positions (target precedes/follows the conjoined NP). The results show that agreement with the closest conjunct is very pervasive in French, in contrary to most prescriptive grammars and linguistic literature (cf. Corbett 1991). This agreement pattern is more acceptable in the attributive domain than in the predicative domain, for gender agreement than for number agreement. On the basis of this evidence, this dissertation proposes a new sum-weighted model, to handle the gradient grammaticality of agreement with a conjoined NP. A growing number of experimental studies begin to explore this question (e.g. Willer-Gold et al. 2017), but they only rely on a few coordination patterns. Given the sparsity of data obtained through human experiments, we propose a flexible model which can learn the constraints' weights through a limited number of structures and generalize to other structures. The present work, on the one hand, provides a detailed comparison of multiple human acceptability experiments, using cross- validation methodology. On the other hand, we show that gradient acceptability captures the typological tendencies, for instance the agreement hierarchy proposed by Corbett (1991). We propose that this hierarchy is true for both gender and number agreement, for *and-coordination* and *or-coordination.*

Keywords: agreement, coordination, gender, number, acceptability, gradience of grammaticality, computational modeling, acceptability rating experiment, self-paced reading experiment, corpus

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Contents

Chapter 1

Introduction

The assumption that the knowledge of language is characterized by a categorical system of grammar has been dominant in linguistic theories for a long while (Chomsky 1968). This idealization has been fruitful, but it ultimately underestimates human language capacities. For instance, gradient grammaticality presents a serious problem for classical binary grammaticality. If this judgment is gradient in nature as proposed by Keller (2000); Lau et al. (2017), it cannot straightforwardly be accommodated.

The massive growth of language toolkits, such as the creation of large annotated corpora and the use of statistical methods to derive general information from the sample these corpora form, as well as the controlled experimental methods, allow us to consider gradience in grammar differently.

On the one hand, this dissertation shows how to use a computational model to handle gradient grammaticality judgement data in order to understand the detailed statistical knowledge that native speakers have about regularities and subregularities surrounding the languages. Through a particular language phenomenon, agreement with coordinate structures (*the boy and the girl is/are ready*, *this/these boy or girl is ready*), we illustrate that such a model is able to: i) assess the relative strength of some fundamental syntactic regularities. ii) generalize them to novel items based on their relative strength. iii) explain why speakers generalize certain statistical properties of the data and not others.

Morover, extensive work has been done by typologists to account for the variation within and across languages. Their results (e.g., the agreement hierachy by Corbett (1991)) are often at odds with the formalization of mainstream generative grammar. Mainstream generative grammarians often view typological hierarchies as coming from language external pressures, probably relevant for language change, but of no interest for modeling the individual grammar of a present day speaker (since they have no obvious structural representation in syntactic trees). However, some approaches integrate those typological variations. For instance, OT-LFG proposes a formal model of a given synchronic grammar which takes into account typological hierarchies (see Bresnan and Aissen 2002). One of the goals of this thesis is to bridge the gap between typological work, experimental psycholinguistic data and formal models of the grammar of a present day speaker.

Before proceeding, it is important to clarify some important issues.

1.1 Some important issues

1.1.1 Competence and Performance

Chomsky (1965, p. 5) makes the distinction between language competence (the speaker-hearers' intrinsic knowledge of his/her language) and performance (the actual use of the language in concrete situations). This definition seems to be largely shared among generative linguists and "the goal of linguistic theory, under this view, is to describe knowledge of language, independent of (and logically prior to) any attempt to describe the role that this knowledge plays in the production, understanding, or judgment of language" (Schütze 1996, p. 20).

This distinction leads to a division between *grammaticality* and *acceptability*. Acceptability is a concept that belongs to the study of performance, whereas grammaticality belongs to the study of competence (Chomsky 1965, p. 11). A sentence is grammatical if it is generated by the grammar of the speaker (the intrinsic knowledge that the speaker has). The performance of a native speaker may be affected "by such grammatically irrelevant factors as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of the language" (Chomsky 1965, p. 3). That is, grammaticality is only one of many factors that interact to determine acceptability. A grammatical sentence may be unacceptable because it is hard to process, or an ungrammatical sentence can be judged acceptable because of various features of the processing system. Acceptability judgments generated by native speakers are indubitably part of performance data.

However, it is important to recognize that grammatical competence is a theoretical construct, which empirical work is unable to access. The primary evidence available for ascertaining its properties is carefully collected speakers' acceptability judgments (e.g., Schütze 1996; Keller 2000).

In the present thesis, we assume the competence and performance distinction in the traditional sense. We use 'grammaticality' to refer to the theoretical competence that underlies the performance of speakers' acceptability judgements. We measure acceptability in experiments when we ask subjects to rate sentences where grammaticality is one of the possible elements in determining an acceptability judgment. This thesis takes grammatical agreement for example on the assumption that the device that encodes grammatical agreement is part of language competence.

1.1.2 Grammaticality and Probability

Even though Chomsky's influential remarks on recursive categorical syntax have been dominant in linguistics for more than half a century, non-categorical approaches started to become more important in linguistics by the end of the 20th century, such as the optimality theory (e.g., Smolensky and Prince 1993) or the maximum entropy model of phonotactics and phonotactic learning (Hayes and Wilson 2008), or the Bayesian Rational Speech Act framework in pragmatics (Frank and Goodman, 2012). However, few works connect the computational models to gradient grammaticality (see Keller 2000).

In recursive categorical syntax, the grammar assumes some kind of representation, commonly involving tree structures and/or attribute/value representations of grammatical features (cf. Sag 2003; Abeillé 2007). The grammar defines a number of categorical constraints on the representations underlying languages, and the output is either grammatical or ungrammatical. A grammatical sentence must satisfy all the constraints, otherwise, the sentence is regarded as syntactically ill-formed or ungrammatical.

In fact, Chomsky acknowledges that there exist degrees of grammaticality in his early work (Chomsky 1965):

> In particular, when a sentence is referred to as semi-grammatical or as deviating from some grammatical regularity, there is no implication that this sentence is being "censored" or ruled out or that its use is being forbidden.(p. 384)

However, this more nuanced perspective quickly disappears in the wake of Chomsky's criticism. The probabilistic approach is considered of no interest by Chomsky only a few years later (Chomsky 1968):

> It must be recognized that the notion probability of a sentence is an entirely useless one, under any known interpretation of this term. (p. 57)

One of the main arguments that Chomsky makes is that accurately modeling linguistic facts is just butterfly collecting and statistical models provide no insight on the underlying linguistic principles. Chomsky only considers lexical frequencies and not probabilities associated with more abstract structures as relevant (see Manning 2003 for a more detailed discussion). The present thesis is not a detailed criticism of a categorical view of grammaticality, but demonstrates that applying computational methods to syntax can help explain some underlying language regularities.

In probabilistic syntax, the core idea is that the sum of the probabilities of all individuals in the sample space would add to one. However, it is not easy to connect probability to grammaticality directly. First of all, the probability of a given sentence also depends on lexical frequency and sentence length, and sentences with zero frequency can be fully acceptable. But if one associates probabilities to structures, there is a positive correlation between frequency and acceptability. Lau et al. 2017 demonstrate that human acceptability judgments correlate strongly with the probability that a language model assigns to the entire sentence once sentence length and lexical frequency are controlled for. Secondly, human language is not a simple combinatory system of linguistic symbols, but "reflects the nature of the world, and this clearly needs to be filtered out to determine a notion of grammatical acceptability independent of context" (Manning, 2003, p.15). Manning (2003) propose that a profitable way to do this is to assume that probability is a joint distribution $P(form, meaning, context)$ and achieve the probability of forms by marginalizing out the context and meaning to be expressed.

In this thesis, the grammaticality we address is not the probability since in probability theory, the sum of the probabilities of all possible outcomes in the sample space is equal to 1. This is not the case for grammaticality. We assume that the gradience of the grammatical intuition can be represented by numbers (i.e. 0-10). Bigger numbers represent that the sentences accord more to the grammatical intuitions that native speakers have.

1.2 A brief history of Gradience in Syntax

Bolinger (1961a) introduces the terms "gradience" and "gradient" in linguistics, with a wealth of evidence showing that linguistic notions, especially in phonology, are continuous, rather than discrete. Bolinger (1961b) later provide arguments about gradience in syntax. For instance, the sentence becomes less acceptable from passive *He is destined to suffer* to active *We destine him to suffer*, while the active transformation is unacceptable from *He is bound to suffer* to **We bind him to suffer* . In the meanwhile, a group of generative grammarians worked in the framework of Fuzzy Grammar, which is based on the assumption that linguistic categories are not discrete, but are organized hierarchically and annotated with application probabilities (cf. Lakoff 1973; Quirk 1965; Ross 1972, 1973a,b)

After a significant lack of interest for gradience in grammar since then, one remarkable advance was made in the mid 1990s by the advent of optimality theory (Smolensky and Prince 1993) as a new theoretical framework. Optimality theory assumes that constraints are inherently ranked and violable, it is based on an intrinsically relative notion of grammaticality, and therefore provides the conceptual repertoire for tackling the issue of gradience in a principled way. This theory triggered a surge of interest in theoretical and empirical aspects of gradient data. The most important contributions in syntax were made by Keller (cf. Keller 2000). He develops a linear optimality theory which allows more than one optimal output to adapt to the gradient data.

The beginning of the 2000s has seen a fast development of using constraint-based probabilistic theories to examine the preference of alternative syntactic structures or word orders (gives the roses to Mary / give Mary roses, Arnold et al. 2000; Bresnan et al. 2007). Another fruitful question investigated probabilistically is binomial ordering, such as *flowers and roses* and *roses and flowers* (Benor and Levy 2006).

This thesis is part of this generation of studies that tackle gradience using experimental and corpus data. It relies extensively on psychological experiments as a means of collecting reliable gradient judgment data, and uses statistical methods to formulate a model of gradience that is grounded in linguistic theory and linguistic typology.

1.3 Agreement

Grammatical agreement is a widespread and varied phenomenon. Almost three quarters of the world's languages have agreement (Mallinson and Blake 1981). Grammatical agreement is one of the major morpho-syntactic resources, which serves to link separate elements in the sentence and establish dependencies between them. Patterns of agreement vary dramatically both within and across languages. It can involve different features, in particular, gender, number, person and case. And it can also involve different constituents in the sentence, for example, attributive adjectives and nouns, determiners and nouns, or subjects and verbs.

Grammatical agreement is not only a morphological and syntactic question, but also a matter of semantics. In (1), *committee* may be conceptualized as an entity or as several individuals and thus trigger singular or plural agreement depending on the interpretation.

As well, agreement serves to keep record of discourse referents (Corbett 1991; Pollard and Sag 1994; Corbett 2000, 2006; Wechsler and Zlatić 2003): *vous* in (2) can refer to a second person singular or second person plural, but a singular predicative adjective is used if *vous* refers to a single person.

(1) The committee has/have agreed. (Corbett 2006, P.6)

(2) Vous êtes magnifique
you be.2PL magnificent.SG
'You are pretty.'

Agreement is also of great interest in psycholinguistics. Much of psycholinguistic literature focuses on naturally occurring agreement errors in production (e.g., Bock and Miller 1991; Franck et al. 2002; Vigliocco and Nicol 1998; Vigliocco et al. 1995, 1996; Haskell and MacDonald 2005, etc.). Their debate concerns primarily one-modular (e.g., MacDonald 1994; Tanenhaus et al. 1995) or multiple-modular language models in language production (e.g., Bock and Levelt 1994). In one-modular models, all the syntactic, semantic, lexical, phonetic, etc. information play a role at the same stage. However, only the syntactic information is used for computing at the first stage in multiple-modular language models. Some literature studies the cognitive representation of number and gender: whether they are processed simultaneously or in a different way (e.g., De Vincenzi 1999; Barber and Carreiras 2003, 2005).

In this work, I will use the terminology introduced by Corbett. CONTROLLER refers to the element which determines the agreement (such as nouns). TARGET refers to the element whose form is determined by agreement (such as determiners, adjectives, verbs). Agreement DOMAIN refers to the syntactic environment where agreement occurs (such as noun-adjective agreement, noun-determiner agreement). Agreement FEATURE includes person, gender, number, case, etc.

Agreement with a conjoined noun phrase is extremely variable and complex because the conjoined noun phrase has to compute the agreement features on the basis of its conjuncts. Koulaguina et al. (2019) show that French toddlers can correctly process conjoined subjects as plural starting at 24 months, as early as the processing of non-conjoined subjects. Certain languages permit several agreement strategies on the target. Slovenian, for example has three genders: masculine, feminine and neuter. Corbett (1983) shows that the target in (3-a) can agree with the whole coordination , or with the linearly closest conjunct (3-b), or even with the first conjunct (3-c) when the subject is before the verb.

(3) a. Knjige in peresa so se **podražili**.
book.F.PL and pen.N.PL AUX.PL REFL become-more-expensive.M.PL

b. Knjige in peresa so se **podražila**.
book.F.PL and pen.N.PL AUX.PL REFL become-more-expensive.N.PL

c. Knjige in peresa so se **podražile**.
book.F.PL and pen.N.PL aux.PL REFL become-more- expensive.F.PL
'Books and pens have become more expensive.' (Willer-Gold et al., 2016, p. 188)[1]

French number agreement is not a controversial issue, and normative grammars allow for both plural and singular verb forms with singular nouns conjoined by *ou* 'or' (e.g. Grevisse and Goosse 2016), contrary to English grammars who recommend the singular (Fowler and Aaron 2001):

(4) a. Paul ou Marie viendra/viendront demain.
Paul or Mary come.FUT.SG/.FUT.PL tomorrow
'Paul or Mary will come tomorrow.'

b. Paul or Mary is /??are coming tomorrow.

On the other hand, gender agreement is very controversial in French: conjoined nouns of different genders are supposed to be resolved to the masculine, and this masculine primacy is challenged by feminists who would like to promote closest conjunct agreement (Viennot et al. 2018).

(5) a. Paul et Marie sont venus
Paul and Mary AUX come.PTCP.M.PL

[1] The examples are adapted from Corbett 1983, p. 101, ex. (18)

'Paul and Mary came.'

b. Nous voulons construire un monde où les hommes et les
we want build a world where the.PL man.M.PL and the.PL
femmes seront égales.
woman.F.PL be.FUT.PL equal.F.PL
'We want to build a world where men and women are equal' (`http://www.elianeviennot.fr/Langue-proxi.html`)

This present thesis investigates agreement with conjoined NP in French, in which the features used to compute agreement are gender and number. In previous linguistic literature, only RESOLUTION RULES (or RESOLUTION AGREEMENT, RA) is assumed to apply in French for *and-coordination* (Corbett 1991). For number agreement, a coordination of two singular nouns is resolved to plural. For gender agreement, a coordination of a masculine noun and feminine noun is resolved to masculine. With a rich set of human acceptability experiments, this work shows that agreement with the linearly closest conjunct is very pervasive in French with both *and-coordination* and *or-coordination*. Agreement with the closest conjunct illustrates that linear order does play a role in agreement, contrary to the main claim in the generative grammar that only hierarchical structure determines agreement (Chomsky 1968). We discover that CCA is active in French, and sometimes even the preferred option. A well-formed structure should satisfy at the same time closest conjunct agreement (CCA), Resolution Agreement (RA). The violation of each will cause a penalty on the structures' well-formedness. Meanwhile, this penalty is determined by various factors: DOMAIN, FEATURE, word order in the relation between CONTROLLER and TARGET.

Based on our empirical work, we present a computational model with a detailed comparison of multiple human acceptability experiments, using cross-validation methodology in order to handle the gradience raised by agreement with coordination structures. First of all, agreement with coordination structures can occur in different domains (attributive/predicative), with different features (number/gender). The experimental results can only deal a limited set of agreement patterns. We demonstrate that a computational model can learn linguistic generalizations from a limited input and generalize to larger coordination patterns.

Secondly, such a computational model links qualitative theoretical observations to quantitative predictions about acceptability. It demonstrates that the effects of linear proximity are stronger in the nominal domain (e.g., determiner-noun agreement, adjective-noun agreement) than in the verbal domain (e.g., subject-verb agreement). This discovery confirms the agreement hierarchy proposed by Corbett (1991), which suggests that the likelihood of CCA decrease from attributive to predicative agreement. Furthermore, the model reveals that gender is more sensitive to the linear proximity than number, especially in the attributive domain. Hence, number and gender are not accessed in the same manner, at least with respect to agreement with coordination structures. This tendency has also been found in South Slavic languages, in which CCA is only found for gender, but not for number (see Nevins and Weisser 2019 for a overview).

Furthermore, the model presented in this thesis compares *and-coordination* to *or-coordination* and suggests that they share some common ground. Both of them are subject to the effects of linear proximity and the directionality between the target and the controller in a similar way. For French native speakers, there exists to some extent an implicit resolution rule with *or-coordination*. But the strength is not as same as that in *and-coordination*.

1.4 Overview of the Thesis

This thesis is divided into four parts: a background part (Chapter 2), a theoretical part (Chapter 3), an experimental part (Chapters 4 and 7), and a computational part (Chapter 8).

Chapter 2 spells out the background assumptions on which this thesis rests. Agreement with coordination structures is extremely variable and debated cross-linguistically. The chapter also discusses the syntactic structures of the coordination phrase and why agreement with such a structure is special. Finally, an overview of different theoretical linguistic approaches and cognitive models to handle this phenomenon is provided.

Chapter 3 presents the factors that will be examined in the following experiments. Meanwhile, the chapter delves into the theoretical motivations for these factors, as well as previous experimental evidences.

Chapter 4-7 report a series of corpus studies and experiments that aim to establish a number of general properties of agreement with coordination structures in French. We choose French as a target language, because French nouns can trigger both gender and number agreement. French also allows different word order: attributive adjectives can be in both pre- and post-nominal position (cf. Wilmet 1981); both subject-verb and verb-subject order exist in French (cf. Damourette and Pichon 1911; Kayne 1994).

The data we will present deal with attributive number agreement (**Chapter 4**), attributive gender agreement (**Chapter 5**), predicative number agreement (**Chapter 6**), and predicative gender agreement (**Chapter 7**). The aim is to investigate how agreement varies across domains, features, and how these properties of agreement determine the degree of grammaticality. In agreement with coordination structures, the number (gender) of each conjunct can vary, the coordinator can be different *and/or*, and the target can precede or follow the coordination, which result in quite a great deal of patterns and it is impossible to examine all of them with experimental methods in this thesis. The experiments presented in this thesis investigate only certain conditions, in particular those which are controversial (e.g., when there is a mismatch, N1m + N2f).

The experimental findings indicate that in French the agreement patterns are very different in different domains (attributive/predicative). Closest conjunct is acceptable in French, even preferred under some circumstances. For instance, the violation of CCA in the attributive domain leads to strong unacceptability, but only to a slight degradation of acceptability in predicative agreement. For both agreement strategies, violations are cumulative, i.e., the unacceptability of the structure increases with the number of agreement strategies it violates.

Chapter 8 develops a computational model, motivated by optimality theory (Smolensky and Prince, 1993; Keller, 2000) and harmonic grammar (Legendre et al., 1990). The core assumption of this model is that grammaticality of agreement with coordination structures is determined by the weighted sum of the constraints that they violate. The constraint set is defined by properties related to four canonical aspects of agreement: CONTROLLER, TARGET, FEATURE, DOMAIN. In order to deal with the sparsity of experimentally collected data, we use a high-dimensional regression model over two subgroups (gender/number) by adding regularization pathes. Cross-validation is used to demonstrate that the predictions of a model generalize to unseen data. On a theoretical level, the model links the qualitative theoretical finding (the agreement hierarchy) to a quantitative/predicative framework. Furthermore, it reveals that gender and number are subject to these constraints in a different manner.

Chapter 2

Agreement with Coordination Phrases

In general, when the controller involves a coordination phrase, the target follows two agreement strategies: closest conjunct agreement (CCA) or resolution agreement (RA). The preference for CCA varies within and across languages (Corbett 1991) and is determined by various constraints, which reflects some fundamental questions for both linguistic theories and psycholinguistic theories.

We first present the structure of coordination phrases in section 2.2. The syntactic structure of coordination phrase is special, intense debates in linguistic theories are about whether the coordination phrase is a headed or non-headed structure (e.g. Kayne 1994; Munn 1999; Borsley 2009). The peculiarity of the syntactic structure predicts that agreement with coordination structures is especially complex. Besides, it offers agreement patterns unseen elsewhere.

Within a nominal coordination, the conjuncts have their own agreement features and the coordination phrase may compute its agreement features on the basis of the features of the conjuncts. Different formal linguistic theories have proposed different feature computation mechanisms. In lexicalized constraint-based grammar, the Head-Driven Phrase Structure Grammar (HPSG) distinguishes INDEX and CONCORD (Pollard and Sag 1994;

Wechsler and Zlatić 2000). In Lexical Functional Grammar (LFG), Dalrymple and Kaplan (2000). King and Dalrymple (2004) distinguish between distributive features and non-distributive features: INDEX features are non-distributive and CONCORD features are distributive. Using a minimalist approach, Bošković (2009) and Marušič et al. (2015) propose that the coordination phrase has a number feature but no gender feature, so that the target should agree in plural for number but should look for the gender feature among its conjuncts through some syntactic operations, which allows the possibility of CCA for gender (but not for number).

Apart from a linguistic point of view, CCA is also a fascinating phenomenon from psycholinguistic perspectives (e.g., Haskell and MacDonald 2003; Keung and Staub 2018). Agreement is of particular interest in psycholinguistic literature, especially when it produces attraction errors (cf. Bock and Miller 1991). Different cognitive models have been proposed or used to explain attraction errors, like Marking and Morphing models, constrain-based competition model, cue-based retrieval model. However, CCA should be considered differently from attraction errors (Keung and Staub 2018). In this chapter, I will discuss these models and their relevance to closest conjunct agreement.

The remainder of this chapter is organized as follows: In section 2.1, I will discuss the possible agreement strategies used with a coordination phrase, with both *and* and *or*, and their variability in French and cross-linguistically. Section 2.2 will address the debate as to the syntactic structure of coordination phrases. Section 2.3 examines how different linguistic formalisms include closest conjunct agreement in their grammar, as well as how their framework handles the three major factors that we will examine in the following chapters: domain, feature, and word order between controller and target. To conclude this chapter, section 2.4 will present the existing cognitive models of agreement.

2.1 Agreement Strategies in Coordination

In certain linguistic theories, such as LFG and HPSG, the grammatical information (such as category, number, gender) is encoded into feature structures. Regarding coordination phrases, features can be divided into distributive features (must be shared between conjuncts and the whole coordination phrase) and non-distributive features (must be resolved). Categories and extraction features (such as Slash in HPSG) are usually considered distributive. For instance, the conjuncts must share the same part of speech (all nominal, all adjectival), (1-a), but cases of unlike categories exist (Sag et al., 1985), (1-c):

(1) a. John and Mary will come.
b. *John and pretty will come.
c. Mary is pretty and a good doctor.

Extraction is also distributive: the extracted element should be out of each conjunct (2-a), but cases of asymmetric extraction exist as well (Goldsmith 1985; Lakoff 1986) (2-c):

(2) a. Which book did Paul buy - and Mary read -?
b. ?* Which book did Paul buy - and Mary read the introduction?
c. Which exam can you fail- and still have your diploma ?

Some of non-distributive features are agreement features: person, number and gender [1]. In terms of person, 1^{st} and 2^{nd} person (or 3^{rd} person) are resolved to 1^{st} person (3-a), and 2^{nd} and 3^{rd} person are resolve to 2^{nd} (3-b).

(3) a. I and you behave ourselves
b. You and he behave yourselves
c. He and she behave themselves

But agreement with the closest conjunct in person is found in some languages, such as Moroccan Arabic (Munn 1999, p.650): the verb agrees in second person with a pronoun of 1^{st} and 2^{nd} person.

[1] In the original proposal of King and Dalrymple (2004), INDEX features are non-distributive agreement features and CONCORD features are distributive agreement features.

(4) tlaqitu ntuma w ana qəddam l-žamiʕa.
met.2.PL you.PL and I before DEF.university
'You and I met in front of the university.'

This section will firstly highlight the possible agreement strategies used with coordination phrases, in particular regarding gender and number, in French and other languages. On the basis of previous studies, we present the wide range of attested patterns in order to illustrate that the feature resolution strategy varies largely cross-linguistically.

2.1.1 and-coordination

2.1.1.1 Resolution Rules

The term *resolution rule*[2] was first proposed by Givón (1970), referring to the agreement rules which determine verb agreement with coordinated noun phrases. Corbett (1983, 1991) then introduced a set of resolution rules with conjoined nouns for the features person, number and gender.

At first sight, number resolution rules seems to be simple. According to Corbett (1991), for languages such as French, which does not have dual, the number for coordination of two non-coreferent singular nouns (5-a) or a singular and a plural (5-b) is resolved to plural.

(5) a. Paul et son frère viendront.
Paul and POSS.M.SG brother.SG come.FUT.3.PL
'Paul and his brother will come.'

b. Paul et ses frères viendront.
Paul and POSS.PL brother.PL come.FUT.3.PL
'Paul and his brothers will come.'

However, three different strategies are available for gender resolution: syntactic resolution, semantic resolution and a mixed strategy combining these two formers. Corbett claims that French only displays syntactic gender resolution, that is to say "only the gender of

[2]There are other terminologies, such as *full agreement* but we will use the term *resolution rule* in line with Corbett.

the conjoined nouns involved is what counts, rather than their meaning" (Corbett 1991, p. 279). For instance, if a noun phrase consists of a masculine noun, the masculine form is used, otherwise the feminine is used, both for non-human nouns (6) and human nouns (7). Likewise, number also shows the resolution agreement in these examples.

(6) un savoir et une adresse merveilleux.
a.M.SG knowledge.M.SG and a.F.SG skill.F.SG marvellous.M.PL
'a marvellous knowledge and skill' (Corbett 1991, p. 186)

(7) un père et une mère excellents.
a.M.SG father and a.F.SG mother excellent.M.PL
'an excellent father and mother' (Corbett 1991, p. 186)

But Wechsler and Zlatić (2003) suggest that gender agreement in the coordination phrase in French is not purely syntactic. They show that inanimate coordinate nouns are subject to syntactic resolution while animate coordinate nouns are subject to semantic resolution when grammatical and social gender diverge. In example (9), the noun *la sentinelle* ("the sentry") is grammatically feminine but the social gender of "the sentry" is more likely to be male. When it is used alone the predicate is feminine (8), but when it refers to a male and a female *la femme*, the result is masculine resolution (9). It is the social gender rather than grammatical gender which is determining agreement with human NPs.

(8) La sentinelle à la barbe a été prise/*pris en
the.F.SG sentry.F.SG with the.F.SG bear has been take.PTCP.F.SG/PTCP.M as
otage.
hostage.
'the beared (male) sentry was taken hostage' (Wechsler and Zlatić 2003, p. 177)

(9) La sentinelle et sa femme ont été pris/*prises en
the.F.SG sentry.F.SG and his wife.F.SG have been take.PTCP.M.PL/*PTCP.F.PL as
otage.
hostage
'the (male) sentry and his wife were taken hostage' (Wechsler and Zlatić 2003, p. 177)

Masculine agreement is sometimes considered as default agreement (Grevisse and Goosse 2016) as it is used for expressions without grammatical gender. It is the gender used with sentential or verbal subjects (10-a) and with the expletive pronoun (10-b).

(10) a. Bien dormir est important.
well sleep is important.M.SG
'It's important to sleep well.'

b. Il pleut.
3.M.SG rain.PRS.3SG
'It's raining.'

The difference between resolution rules and default agreement for conjoined NPs has been debated (e.g., Willer-Gold et al. 2016; Nevins and Weisser 2019). The first strategy is viewed as a process that computes the new feature set of the coordination phrase on the basis of the feature sets of each of the conjuncts. Default agreement (which is masculine singular is French) is perceived as some kind of morphological last resort used when regular grammatical process fails to provide a feature value. We assume that, in French, the masculine agreement in case M+F =F+M =M is the resolution rule rather than default agreement, since when there are two conjoined feminine nouns, masculine agreement is not acceptable (11) except for the special case in (9).[3] If the masculine is considered as the default agreement, the default agreement should also be masculine for F+F condition.

(11) Les chaises et les tables sont mises/*mis à
the.PL chair.F.PL and the.PL table.F.PL are put.PTCP.F.PL/PTCP.M to
disposition.
disposition
'Chairs and tables are available.'

However, in these previous works, resolution rules refer to only *and-coordination*. Few or almost no research mentions the resolution rule for *or-coordination*, for example, whether speakers also compute "pl or sg" as plural like "pl and sg". We will further discuss this

[3] In certain languages, like Serbo-Croatian, a masculine plural verb is found with subjects consisting entirely of feminine (Corbett 1982; Willer-Gold et al. 2016). Willer-Gold et al. 2016 assume that the masculine in this case is default agreement.

issue in section 2.1.2.

2.1.1.2 Closest Conjunct Agreement

Apart from the resolution rule, agreement may occur with the closest conjunct, namely "closest conjunct agreement" [4]. Crosslinguistically, closest conjunct agreement is quite common, especially when the verb agrees with postverbal conjoined subjects. In Moroccan Arabic (Aoun et al. 1994) and Welsh (Sadler 1999; Borsley 2009), agreement with the closest conjunct is obligatory when the verb precedes the subject (12-a). By contrast, when the conjoined subject is preverbal, the verb can agree only with the resolution rule (12-b).

(12) a. Mša ʕumar w ʕali
leave.PST.M.SG Omar and Ali
'Omar and Ali left'

b. ʕumar w ʕali Mšaw/*Mša.
Omar and Ali leave.PST.PL/M.SG
'Omar and Ali left'

(Moroccan Arabic, Aoun et al. 1994)

CCA is observed in Romance languages. Villavicencio et al. (2005) conduct an empirical study about attributive adjective agreement in Portuguese based on Google queries. They show that for prenominal adjectives, CCA is the only strategy for gender agreement (13); while both CCA (14) and resolution agreement (15) are observed for number agreement.

(13) suas proprias reações ou julgamentos
POSS.F.PL own.F.PL reactions.F.PL or judgements.M.PL
'his own reactions or judgements'

(14) a correcta gestão e preservações
DEF.F.SG correct.F.SG management.F.SG and conservation.F.PL

[4] This is alternatively termed 'partial agreement', 'proximity agreement', 'first conjunct agreement' or 'last conjunct agreement' according to the position of controller and target.

'the correct management and conservation'

(15) Os prováveis director e ator principal
DEF.M.PL probable.PL director.M.SG and actor.M.SG principal.M.SG
'the likely director and main actor'

In postnominal position, both RA (16) and CCA (17) are observed for gender and number. Note that gender and number can show different patterns in example (18).

(16) o homem e a mulher modernos
DEF.M.SG man.M.SG and DEF.F.SG woman.F.SG modern.M.PL
'the modern man and woman'

(17) estudos e profissăo monástica
study.M.PL and profession.F.SG monastic.F.SG
'monastic studies and profession'

(18) todo o constrangimento e a dor
all.M.SG DEF.M.SG embarrassment.M.SG and DEF.F.SG pain.F.SG
sofridas
suffer.PCPT.F.PL
'all the embarrassment and pain suffered'

Demonte and Perez-Jimenez (2012) suggest that in Spanish, CCA (19) is categorical for determiners and prenominal attributive adjectives number agreement, while postnominal attributive adjectives may take singular (20) or plural form (21).

(19) su (verdadero)/ *sus (verdaderos) desarrollo
POSS.SG true.M.SG/POSS.PL true.M.PL development.M.SG and
y expansión
expansion.F.SG
'its true development and expansion'

(20) el trigo y sorgo disponible
DEF.M.SG wheat.M.SG and sorghum.M.SG available.SG
'the wheat and sorghum available '

(21) la agricultura y ganadería europeas
DEF.F.SG farming.F.SG and cattle.F.SG European.F.PL

'the European farming and cattle'

King and Dalrymple (2004) shows that in English agreement is distributive. The determiner should agree not only with the closest conjunct, but also with each of the conjunct. In (22-a) a singular D requires both conjuncts to be singular, and nouns with different numbers cannot be coordinated (22-b), (22-c).

(22) a. This boy and girl are eating a pizza.
b. *these boys and girl
c. *this boy and girls

But Le Bruyn and de Swart (2014) suggested that (plural) CCA is possible with nouns of different number providing an appropriate context (23).

(23) These children and mother were living on charity of good people.

Another pattern which is relatively rare is the agreement with the distant first conjunct, like in Slovenian (24) [5].

(24) groza in strah je prevzela vso
horror.NOM.F.SG and fear.NOM.M.SG AUX.3.SG seize.PST.F.SG whole.ACC.F.SG
vas.
village.ACC.F.SG
'Horror and fear seized the whole village.' (Corbett 2006, p. 170)

According to most linguistic literature, French does not allow for closest conjunct agreement for *and-coordination* (e.g., Corbett 1991; Heycock and Zamparelli 2005). A few French grammar books (Curat 1999; Grevisse and Goosse 2016) suggest that CCA exists, but under certain conditions. For instance, Curat (1999) observes that for gender, closest conjunct agreement can be observed in determiner agreement and prenominal adjective agreement only if it is compatible with each of the conjuncts, as illustrated by examples

[5] We will show that the agreement with the second conjunct is not an available strategy in French when the second noun is not the closest, thus we will not go further into it here.

(25-a)-(25-b). Example (25-c) is not acceptable because the determiner agrees only with the closest conjunct.

(25) a. l' estafette et cuisinier
the.SG estafette.F.SG and cook.M.SG
'the estafette and cook'

b. les sentinelle et cuisinier
the.PL sentry.F.SG and cook.M.SG
'the sentry and cook'

c. *la sentinelle et cuisinier
the.F.SG sentry.F.SG and cook.M.SG

(Curat 1999, p. 60)

Prenominal adjectives should agree simultaneously with the closest conjunct and the whole coordination (26-a). Examples showing either only CCA or only RA is difficult to accept (26-b)- (26-c). But these examples are mostly human nouns.

(26) a. *les nouveaux étudiantes et étudiants
the.PL new.M.PL student.F.PL and student.M.PL

b. ?les nouvelles étudiantes et étudiants
the.PL new.F.PL student.F.PL and student.M.PL

c. les nouveaux étudiants et étudiantes
the.PL new.M.PL student.M.PL and student.F.PL
'the new students' (Curat 1999, p. 61)

The *Bon Usage* (Grevisse and Goosse 2016), based on literary texts, spells out some circumstances under which CCA is possible:

(i) CCA can be observed in both attributive and predicative agreement. However, it is more frequent with attributive adjectives than verb or predicative adjectives.

(27) L' être qui pouvait me jeter dans un désespoir et
the being who could ACC.1.SG throw into a.M.SG despair.M.SG and
une agitation pareille...
a.F.SG agitation.F.SG similar.F.SG

'The being who could throw me into such despair and agitation...' (Proust, Grevisse and Goosse 2016, p443)

(28) Leur sommeil et leur réveil en fut tout
their.SG sleep.M.SG and their.M.SG awakening.M.SG GEN.3.SG was all
parfumé.
perfumed.M.SG
'Their sleep and awakening was all perfumed by it.' (France, Grevisse and Goosse 2016, p443)

In example (27), the attributive adjective *pareille* ("similar") takes feminine gender and singular number morphology, as its closest conjunct. In (28), the particular *fut* ("be") and the attributive adjective *parfumé* ("perfumed") shows CCA in number.

(ii) CCA is also observed more frequently when the target precedes the controller, both with predicative and attributive agreement.

(29) De nombreuses décisions et échanges avaient été
INDF numerous.F.PL decision.F.PL and debate.M.PL had been
reportés [. . .]
postpone.PTCP.M.PL
'Many decisions and debates had been postponed' (le Monde, Grevisse and Goosse 2016, p. 445)

(30) Tant est grande la discipline, le respect
So is great.F.SG the.F.SG discipline.F.SG, the.M.SG respect.F.SG
humain, au Ministère de la Justice [. . .]
human, at.M.SG Ministry of the.F.SG Justice
'So great is discipline, human respect at the Ministry of Justice' (Giraudoux, Grevisse and Goosse 2016, p. 445)

In (29), the prenominal adjective *nombreuses* ("numerous") agrees in gender with the closest conjunct when the gender of two conjuncts differs. But the predicative participle *reportés* ("postponed") agrees in masculine, which can be viewed as RA or as CCA (the masculine noun is the closest). In (30), the prenominal adjective *grande* ("great") agrees in (singular) number with the first noun (closest noun) (non-human, non-coreferent but closely related), as well as in (feminine) gender with the closest noun. But the two nouns are conjoined by a comma rather than a coordinator *and/or*.

2.1.2 or-coordination

As for *or-coordination*, the *Bon Usage* (Grevisse and Goosse 2016), points out that number agreement can trigger plural agreement (31-a), but (singular) agreement (with only one conjunct) is also very common, in particular when only an inclusive reading is plausible in the context (31-b) (there will be only one colonel of one regiment, thus it is not possible for both to be the colonel.).

(31) a. Je ne serais pas étonné que son père ou sa mère fussent alcooliques
I NEG be.COND.1.SG NEG surprise.PTCP.M.SG that his father.M.SG or his mother.F.SG be.SBJV.3.PL alcoholic.PL
'I wiil not be surprised if his father or mother were alcoholic.' (Barrès, Grevisse and Goosse 2016, p. 441)

b. Pierre ou Paul sera colonel de ce régiment.
Pierre or Paul be.FUT.3.SG colonel.M.SG of this regiment
'Pierre or Paul will be colonel of this regiment.' (there is only one colonel per regiment) (Grevisse and Goosse 2016, p. 449)

In case of coordination involving a gender mismatch, agreement can be resolved to the masculine (32-a) or CCA can favor the feminine (32-b). There is no further work commenting on the conditions under which agreement with one disjunct is acceptable.

(32) a. un sentiment ou une expression original
a.M.SG feeling.M.SG or a.F.SG expression.F.SG original.M.SG
an original feeling or expression (Desnos, Grevisse and Goosse 2016, p. 450)

b. celui ou celle qui était restée à écrire
DEM.M.SG or DEM.F.SG who was remain.PTCP.F.SG to write
the man or the woman who had remained writing (Proust, Grevisse and Goosse 2016, p. 450)

This difference between *and-coordination* and *or-coordination* can be accounted for by the different semantics of *and* and *or*. The conjunction *and* (non-coreferent) implies a group interpretation, while the disjunction *or* can involve either an inclusive or exclusive meaning[6]. Foppolo and Staub (2020) provide experimental evidence showing that in English which has a clear prescriptive rule for singular agreement with disjunct singular nouns, plural agreement is licensed not only when *or* has an inclusive reading (33-a). Even when it has an exclusive reading (33-b), there is only a small penalty for plural agreement.

(33) a. The lawyer or the accountant is/are coming to the meeting.
b. The lawyer or the accountant is/are going to become the next CEO of the company.

Like English, Italian grammar (Scorretti, 1988) claims that the rule for *or* agreement is singular (with only one conjunct). But that plural agreement is also possible 'especially when the subject is post verbal' and that 'inclusive interpretation is possible only with plural agreement'. The acceptability experiments in Foppolo and Staub (2020) show that both singular and plural agreement are equally acceptable.

a. Un italiano o un francese ordina/ordinano sempre del
a.M.SG Italian.M.SG or a.M.SG French.M.SG order.PRS.SG/.PRS.PL always some
vino bianco.
white wine
'An Italian or a Frenchman always order white wine.'

Having examined the different strategies with *and* and *or*, the following question we would like to investigate is the syntactic structure of coordination phrases which gives rise to the

[6] *or* might have been used to express lexical uncertainty (Potts and Levy, 2015), we avoid such cases in our experiments

different agreement patterns. The coordination NP is different from the normal NP which has an explicit head , such *the key to the cabinets*. The following section will review the special syntactic properties of the coordination NP.

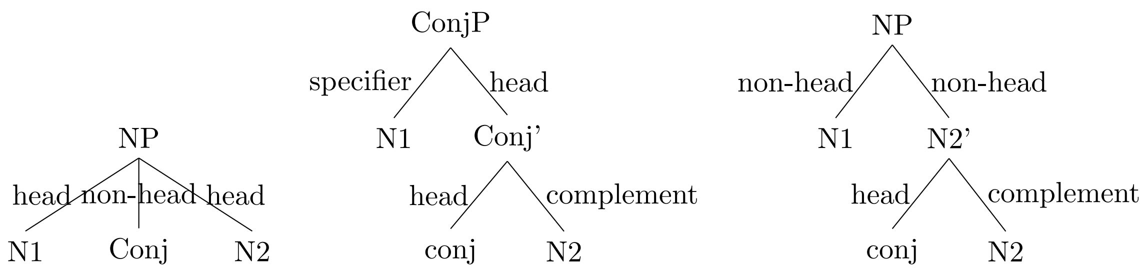
2.2 The Syntactic Structure of Coordination Phrases

The syntactic structure of coordination phrases is at the centre of linguistic debates. Different theories have proposed different structures for coordination: some consider that conjuncts are the head of the coordination phrase while others consider that the conjunction is the head.

There are three prominent syntactic structures for coordination (Figure 2.1): one flat structure and two asymmetric syntactic structures. The ternary structure of coordination is represented in (Figure 2.1a), in which the conjuncts have all been merged as multiple heads with the conjunct (e.g., Chomsky 1965; Lakoff and Peters 1966). The category of this structure is typically provided by all conjuncts simultaneously.

In the second proposal, both conjuncts are merged as arguments of the conjunction and NP1 as its specifier, NP2 as its complement (e.g., Kayne 1994; Johannessen 1996, 1998). Borsley (2005) points out that ConjP analysis faces a variety of problems. For example, under the Xbar hypothesis, coordinate phrase is ConjP= &P or DisP depending on whether 'and' or 'or' is the head, which does not account for the category of the whole phrase that behaves as an NP, an AP or a VP depending on the conjuncts and not on the conjunction. It also faces problems with more than binary coordination (Paul, John and Bill) since there is supposed to be only one specifier per structure. It faces problems with correlative conjunctions such as 'and and' or 'or or' in many languages where the same Conj may introduce each conjunct (since there is supposed to be only one head).

Borsley argues in favor of a hierarchical non headed structure (Figure 2.1c), inside of which the conjunction can be a marker (Sag et al. 1999), a weak head Abeillé (2005) or a functor (Chaves, 2012). In this approach, the conjunction forms a subconstituent with the following element N2 (if it is a weak head, it inherits most of its syntactic features from its N2 complement).[7]



(a) Flat structure **(b)** Headed structure **(c)** Unheaded hierarchical structure

Figure 2.1 – syntactic structure of coordination

These different syntactic structures of coordination lead to different predictions of agreement with nominal coordination. With a flat structure, the two conjuncts are at the same level and should be equally accessible for the target. It predicts no differences between cases when the target is before the coordination phrase and cases when the target is after the coordination phrase. That is to say, when the target precedes the coordination, it is N1 that is the closest, and when the target is after the coordination, it is N2 that is the closest; since N1 and N2 are at a same hierarchical level, CCA should be equally accessible in these two positions.

With the asymmetric structure, even though they differ from each other as to whether the conjunction is the head (Figure 2.1b) or the structure is non headed (Figure 2.1c), they both consider that the first conjunct is in a structurally higher position than the last conjunct. If taking into account only structural distance (number of intermediate nodes) and not linear distance (number of intermediate words), there must be differences between CCA with N1 and CCA with N2, that is to say, when the target is before the controller and the target is after the controller.

Given its particular syntactic status, coordination phrases yield interesting phenomena, such as, flexible word order (e.g., Malkiel 1959; Cooper and Ross 1975; Benor and Levy

[7] This unheaded hierarchical structure is usefull for correlative coordination, with the same conjunction combined with each conjunct *ou Paul ou Marie* 'either Paul or Mary', *ni Paul ni Marie* 'neither Paul nor Mary'

2006) and multiple agreement strategies as investigated in this work. Agreement with the closest conjunct ("the keys or the cabinet is far") is different with attraction error ("the keys to the cabinet is lost") where NP1 ("the keys") is no doubt the head. CCA is a grammatical issue which stems from the fact that coordination phrase has a weak head or no head.

In the following section, I will present different syntactic theories regarding how the features are computed within a coordination phrase and how the target obtains feature values from the controller under different assumptions of syntactic structures of coordination phrase.

2.3 Closest Conjunct Agreement in the Grammar

There are two main approaches to agreement: asymmetric feature copying from a probe to a c-commanding target, namely that of the Mainstream Generative Grammar (MGG, see Chomsky 1965), or (symetrical) feature sharing between target and controller (with no necessity of a c-command relation), proposed by the the unification-based theories, including among others Lexical-Functional Grammar (see Bresnan et al. 1982; Dalrymple 2001 for an overview) or Head-Driven Phrase Structure Grammar (see Pollard and Sag 1994, Sag et al. 1999 for an overview).

These approaches take into account the four properties of agreement differently: domain, feature, target, controller. For instance, since the target can precede or follow the controller, MGG has to postulate movement (that the operation AGREE happens before or after movement); on the other hand, unification-based approaches can account more easily for more flexible patterns (for instance, DOM feature for linearization). This section will discuss these theories and their ability to handle variances of these four agreement properties.

2.3.1 Unification-based Theories

Unification-based grammars, such as HPSG or LFG, are uniquely well-suited for modeling agreement, as they provide a means to represent the constraints across various aspects of linguistic knowledge, including phonological, morphological, syntactic, semantic, and pragmatic domain (e.g., Pollard and Sag 1994; Wechsler and Zlatić 2003; Villavicencio et al. 2005; Wechsler 2019).

Within such formalisms, agreement occurs when multiple feature sets arising from two distinct elements of a sentence specify information about a single abstract object, so that the information must be mutually consistent (Kay 1984). Unlike in generative theories, where agreement between controller and target is directional and determined by the c-command relation, agreement in unification-based theories is not directional. The two forms are said to agree when the features supplied by them coincide, otherwise they would result in ungrammaticality.

Another advantage of these formalisms is that they use underspecification to indicate less specified sets of features. An underspecified description always picks out a larger class of feature structure than a fully specified one. For instance, the underspecified NUM feature can pick out both singular and plural elements, while only singular if it is specified for singular.

Two types of agreement features are introduced for agreement firstly in HPSG: CONCORD and INDEX (e.g., Kathol 1999; Wechsler and Zlatić 2003). They are later adopted in LFG (e.g., Dalrymple and Kaplan 2000; King and Dalrymple 2004). CONCORD features are often relevant for noun phrase internal agreement, and INDEX features often relevant outside the noun phrase. Both are syntactic features, but as Wechsler and Zlatić (2003) showed, INDEX features are more closely related to semantic features, while CONCORD features are more closely related to morphological declension. As illustrated in example (34), the verb shows INDEX agreement (plural) while the determiner shows CONCORD agreement (singular).

(34) This [boy and girl] are eating a pizza.

2.3.1.1 Head-Driven Phrase Structure Grammar

In HPSG (e.g., Pollard and Sag 1994), predicate-argument agreement arises directly from the valence saturation, while attributive adjectives agree with nouns directly through the composition of the modifier with the head that it selects via the MOD feature. SLASH and SLASH feature values are distributive, that is to say, the conjuncts should share same SLASH and SLASH feature values.

Phrases are typed: headed-phrases are distinct from unheaded-phrases (to which coordinate-phrases belong (Borsley, 2005)). We assume coordinating conjunctions to be weak heads (Abeillé 2005, Abeillé 2006), inheriting the HEAD and SLASH features from their conjunct complement and contributing a feature CONJ. Disregarding conjunction features, SLASH features are shared between the conjuncts and the coordinate phrase (Abeillé 2005, Mouret 2007) and SLASH features are shared by default (/)(35).

(35) $$\text{Coord-phrase} \Rightarrow \text{unheaded-phrase} \ \& \begin{bmatrix} \text{VAL} & \boxed{1} \\ \text{SLASH} & \boxed{2} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{VAL} \ / \ \boxed{1} \\ \text{SLASH} \ \boxed{2} \end{bmatrix}, \ldots \begin{bmatrix} \text{VAL} \ / \ \boxed{1} \\ \text{SLASH} \ \boxed{2} \end{bmatrix} \right\rangle \end{bmatrix}$$

In HPSG, if CCA is with one of the conjuncts, it violates the locality of agreement; Borsley uses linearization (ordering domains) to give the verb access to the internal structure of the coordination; on the other hand, Villavicencio et al. (2005) formalizes CCA as agreement with the whole coordination phrase, by adding additional features shared with one of the conjuncts. They propose two new features in addition to CONCORD and INDEX: LAGR which is shared with the leftmost conjunct, and RAGR which is shared with the rightmost conjunct (36). CONCORD contains the resolution agreement information (i.e. sg and sg=pl).

(36) noun-coord-phr $\Rightarrow$

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{noun} & \\ \text{CONCORD} & \begin{bmatrix}\text{NUM} & \text{pl}\end{bmatrix} \\ \text{LAGR} & \boxed{1} \\ \text{RAGR} & \boxed{n} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{CONCORD} & \boxed{1} \\ \text{LAGR} & \boxed{1} \\ \text{RAGR} & \boxed{1} \end{bmatrix} \end{bmatrix}, \ldots \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{CONCORD} & \boxed{n} \\ \text{LAGR} & \boxed{n} \\ \text{RAGR} & \boxed{n} \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

In closest conjunct agreement (37), the D agrees with the first *N* via LAGR, while a postnominal adjective may agree with the last N via RAGR.

(37)	o	presidente	e	amigo	comeram	juntos
	DEF.M.SG	president.M.SG	and	friend.M.SG	eat.PST.3PL	together.M.PL

‘the president and (his) friend ate together’ (Villavicencio et al. 2005, p. 436)

A detailed schema for example (37) is illustrated in Figure 2.2. LAGR and RAGR are head features. The value of LAGR of the coordinate structure comes from the LAGR of the leftmost daughter and that of RAGR comes from the RAGR of the rightmost daughter. The CONCORD value, on the other hand, reflects the resolved agreement features of the coordinate structure, with identical values of INDEX (see An and Abeillé 2017 for a detailed analysis of determiner agreement in French and An and Abeillé 2019 for adjective agreement) .

2.3.1.2 Lexical-Functional Grammar

In LFG (Bresnan et al. 1982), two syntactic structures are considered: the constituent structure (c-structure), which represents the tree structure of syntactic constituents and linear precedence; the functional structure (f-structure), which is an attribute-value structure encoding, for instance, syntactic argument structure, grammatical functions, and features such as tense, person, number, gender, and case. Syntactic agreement is in general treated as an f-structure phenomenon. The correspondence between c-structure nodes and

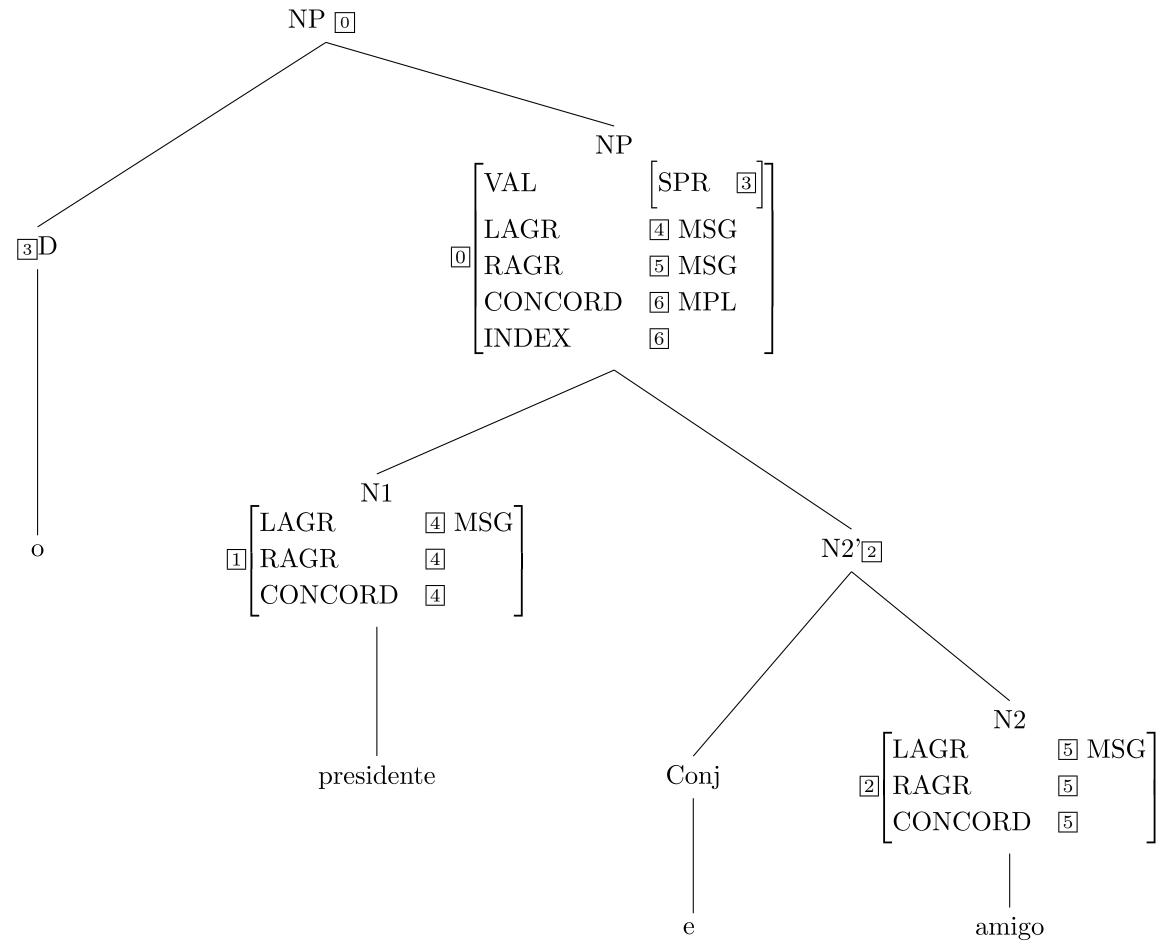


Figure 2.2 – Illustration of CCA in example (37) with HPSG schema

f-structures is indicated by arrows leading from nodes in the c-structure tree to f-structures.

Sadler (1999) was the first to analyse CCA in this framework. In example (38), CCA is obligatory in verb-subject order in Welsh.

(38) Roedd Mair a fi i briodi.
was.3SG Mair and 1.SG to marry
'Mair and I were to marry.' (Sadler 1999, p. 2)

The standard coordination rule in LFG is stated in (39) (e.g., Dalrymple et al. 1995; Dalrymple 2001), with the coordination phrase as a flat structure. The up arrow ↑ refers to the f-structure corresponding to the mother node in the rule, and the down arrow ↓ refers to the f-structure of the daughter node. In the rule (39), the ↑=↓ functional annotations on the conjunction node require the f-structures for the conjunction to be the same as the f-structure for the mother node. The set-membership symbol ∈ is used as an attribute to non-deterministically pick out one of the conjunct members of a coordinate set. It specifies that the f-structure for each daughter node is a member of the set of f-structures associated with the mother node. So, for example, the Conj *and* can contribute a plural feature value, while the conjuncts may be singular, without a unification clash *The boy and the girl are eating a pizza*.

(39) $\begin{array}{llll} \text{NP} \rightarrow & \text{NP} & \text{CONJ} & \text{NP} \\ & \downarrow\in\uparrow & \uparrow=\downarrow & \downarrow\in\uparrow \end{array}$

While conjoined NPs are resolved to plural, King and Dalrymple (2004) find that a singular determiner is required in English with singular conjunct nouns (e.g. *This boy and girl are eating a pizza*). This shows that agreement in the nominal domain is different from agreement in the verbal domain since the verb is plural while the determiner is singular. They follow the distributive/non-distributive distinction in Dalrymple and Kaplan (2000), and propose that CONCORD features are distributive and INDEX features are non-distributive. The coordination phrase has an INDEX feature but not a CONCORD feature. As illustrated by schema (40), the lexical entry for D requires the nouns to have singular CONCORD. The coordination phrase has a plural INDEX, representing the set formed by its conjuncts and triggering plural verb agreement.

(40)

$$\begin{bmatrix} \text{INDEX} & \begin{bmatrix} \text{NUM} & \text{PL} \end{bmatrix} \\ \multicolumn{2}{l}{\left\{ \begin{matrix} \begin{bmatrix} \text{CONCORD} & \begin{bmatrix} \text{NUM} & \text{SG} \end{bmatrix} \\ \text{INDEX} & \begin{bmatrix} \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix} \\ \begin{bmatrix} \text{CONCORD} & \begin{bmatrix} \text{NUM} & \text{SG} \end{bmatrix} \\ \text{INDEX} & \begin{bmatrix} \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix} \end{matrix} \right\}} \end{bmatrix}$$

However, this account cannot explain the agreement patterns where the conjuncts have mismatch of number (or gender) observed in other languages. Thus, Dalrymple and Hristov (2010) distinguish closest conjunct INDEX agreement for the predicate agreement (41-a) and closest conjunct CONCORD agreement for attributive agreement, including determiners or adjectives (41-b).

(41) a. Gwelaist ti a'th frawd eich hunain.
saw.2.SG 2.SG and.2.SG brother 2.PL self
'You and your brother saw yourself.' (Welsh, Kuhn and Sadler 2007)

b. njegove molbe i uveravanja
POSS.F.PL prayer.F.PL and assurance.F.PL
'his prayers and assurances' (Serbian/Croatian/Bosnian, Corbett 1991)

Dalrymple and Hristov (2010) also define "closest-conjunct" agreement which relies on the ordering between the agreement controller (f) and the target ($\downarrow$). The definition given in (42) assumes the closest conjunct is the leftmost one if the controller is on the left, and the rightmost one if the controller is on the right. The symbol $<_f$ denotes the relation of functional precedence, a relation that holds between two f-structures if (roughly) a linear precedence relation holds between the constituent structure nodes that correspond to those f-structures.

(42)

$$
\begin{aligned}
f_c \equiv \{ & f_L : \downarrow <_f f_L \\
& \mid f_R : f_R <_f \downarrow \}
\end{aligned}
$$

In sum, both HPSG and LFG provide elegant solutions for modeling CCA in the grammar, which uses feature-value unification between target and controller. Regarding the four properties of agreement: domain, target, controller and feature, these approaches specify some of their effects, but also face many challenges:

1. HPSG use the valence saturation for predicate-argument agreement and determiner-noun agreement, while the MOD feature selection for attributive adjectives agreement. However, LFG use distributive/non distributive features, CONCORD features are distributive and INDEX features are non-distributive. CONCORD features are often relevant for noun phrase internal agreement (i.e. attributive agreement), and INDEX features often relevant outside the noun phrase (i.e. predicative agreement).

2. CONCORD or INDEX features comprise NUM, GEN, PER value. The approaches presented above distinguish CONCORD and INDEX agreement, and they assume that NUM and GEN agreement can take different values. For instance, agreement occurs in number with the CONCORD value of the coordination and in gender with the LAGR value.

3. The values of agreement features should be mutually consistent. They use linealizations features to distinguish the directionality between controller and target, but cannot explain why cases where the target is before the controller ("de nombreuses filles" some numerous.F.PL girl.F.PL (French)) work in a different way than cases where the target is after the controller ("des filles nombreuses" some girl.F.PL numerous.F.PL (French)).

2.3.2 Minimalist Generative Grammar

In Minimalist Generative Grammar, the coordination phrase is analyzed as a hierarchical structure headed by the conjunction (fig. 2.1b in section 2.2). In minimalism, the operation Agree is a very general feature matching operation between a probe and a commanding target, which is not limited to morphosyntactic agreement but also used for subcategorization.

Closest conjunct agreement as well as its relevance in MGG has been explored recently in great detail. These works provide a different point of view to CCA. Some argue that agreement is an entirely post-syntactic process, while other approaches locate it entirely within the syntactic system. In this section, I will summarize three most representative approaches to CCA in order to give an overview of the generative approaches.

2.3.2.1 One-step Account

Van Koppen (2005, 2006) discusses the first conjunct agreement case in Dutch when the complementizer precedes the verb, as illustrated in example (43). The complementizer, which should agree with the subject, shows the same number as the closest conjunct of the coordination phrase.

(43) Ich dink des doow an ich ôs kenne treffe.
I think that.2SG [2.SG en 1.SG]$_{1PL}$ 1.PL can.PL meet
'I think that you and I can meet.' (Tegelen Dutch, Van Koppen 2006)

Van Koppen argues that the complementizer *de* probes for ϕ-features and hits the conjoined subject located in SpecTP. The specifier of the coordination phrase (the ConjP) and the projection of its head are equally accessible and thus equally suitable targets for agreement (44).

(44) $[C[_{TP}; [_{ConjP}\ NP_1\ [_{Conj'}\ Conj\ NP_2\ ]\ ]\ [_{T'}\ T...$

However, his account can only explain the post-verbal position cases. Bošković (2009) discusses cases of last conjunct agreement (LCA) in preverbal position in Serbo-Croatian. Differing from FCA, the head in LCA probes for ϕ-features induces movement of the subject. As in cases of FCA, the probe finds both the whole ConjP and the first conjunct. In Serbo-Croatian, Coordinate Structure Constraint can be violated in that the first conjunct can be moved out of the conjunction phrase. Hence, both the first conjunct as well as the whole coordination could undergo movement. By reason of the lethal ambiguity (McGinnis 1998), the probe enters into a second cycle of Agree and finds the lower conjunct. Thus, agreement is irrelevant with linearization and only correlates with whether an element has undergone movement or not.

In general, this approach must take into account the specific properties of Serbo-Croatian, such as the violability of the CSC for first but not second conjuncts, as well as the correlation between movement and LCA. However, it does not straightforwardly transfer to other languages.

2.3.2.2 Two-step Account

Marušič et al. (2007, 2015) propose a two-step analysis, including Matching and Valuation to account for Slovenian gender agreement pattern. Matching is always syntactic and it refers to the operation that picks agreement targets based on the ϕ-features that are visible on them. Valuation is the actual transfer of feature values between probes and goals, and it can happen either in the syntax or in the postsyntactic component.

In the Slovenian language, in preverbal position, the verb can agree in gender with either the first conjunct, or the second conjunct or in masculine which is considered as default agreement (45). However, the verb can only agree with the first conjunct or in masculine in post-verbal subject position (46).

(45) [Krave in teleta] so odšla/odšle/odšli na pašo.
cow.F.PL and calf.N.PL AUX.PL go.PST.N.PL/F.PL/M.PL on graze
'Yesterday calves and cows went grazing.'

(46) Včĕraj so *odšla/odšle/odšli [krave in teleta] na pašo.
yesterday AUX.PL go.PST.*N.PL/F.PL/M.PL cow.F.PL and calf.N.PL on graze

'Yesterday cows and calves went grazing.'

The coordination phrase can compute its number feature but not gender feature. There are two principles for the target to obtain its gender value: one is to use the default value for the gender agreement, namely masculine. The second strategy is that syntactic Agree applies in two steps: Match and Valuation, the latter of which can apply at PF. During the valuation of gender feature at PF, the probe can have access to elements inside the ConjP. However, the valuation of the probe can apply either before or after linearization. If it applies before linearization, then the structurally highest (i.e. the first) conjunct provides the missing gender features. When valuation applies after linearization, therefore, the linearly closest conjunct provides features.

This approach predicts the following patterns: if the agreeing head precedes the ConjP (46), then it will either insert default gender features or find the features of the first conjunct as the first conjunct is both the structurally highest and linearly closest conjunct. If the agreeing head however follows the ConjP (45), the speaker will either insert default features, choose the structurally highest conjunct (①) or the linearly closest conjunct (②), as illustrated in (47).

①

(47) $[[_{conjP}$ NP$_1$ $[_{Conj'}$ in NP$_2$$]$ AUX V...

②

Similar with this analysis, Bhatt and Walkow (2013) explain subject-object asymmetry in Hindi-Urdu using two-step account. It will not be detailed here.

This account can cover a wide range of syntactic configuration, predicting that agreement with the lowest conjunct is not possible when the the target is before the controller. However, it remains to be seen whether approaches along these lines can be transferred to languages which have more restrictive patterns, such as word order restrictions or subject-object asymmetries (Nevins and Weisser 2019).

2.3.2.3 Ordering of Primitive Operations

The model proposed in Murphy and Puškar (2018) sets out to cover a similar data set from Serbo-Croatian as the ones discussed in Slovenian (Marušič et al. 2007): first conjunct agreement, last conjunct agreement and default agreement in subject-verb order and only first conjunct agreement and default agreement in verb-subject order. Similar to Bošković (2009), it derives CCA patterns without actually referring to linear representations.

The main idea of this approach is: agreeing elements actually will always target the coordination phrase and never single conjuncts, but the coordination phrase can compute its own gender value in different ways. These different patterns result from the order of application of basic syntactic operations: MERGE, AGR, MOVE, as illustrated in (48). MERGE is simply the familiar operation that checks (c-)selectional features on a given head: if a head bears more than one such feature, they are discharged simultaneously by a single application of MERGE. MOVE corresponds to Internal merge, which can apply freely. Crucially, Agree can apply in two directions: when downward Agree (↓AGR↓) applies, the & probe copies the gender value from the second conjunct (N); upward Agree (↑AGR↑) targets the NP in Spec-&P and copies the gender value of the second noun to the & probe. (see Murphy and Puškar 2018 for a detailed discussion about how these orders are allowed).

(48) a. (MOVE) > MERGE > ↑AGR↑ > ↓AGR↓ → Resolved Agreement

b. (MOVE) > MERGE > ↓AGR↓ > ↑AGR↑ → Resolved Agreement

c. (MOVE) > ↑AGR↑ > MERGE > ↓AGR↓ → LCA

d. (MOVE) > ↓AGR↓ > MERGE > ↑AGR↑ → FCA (postverbal)

e. (MOVE) > ↓AGR↓ > ↑AGR↑ > MERGE → FCA (postverbal)

f. (Move) > ↑Agr↑ > ↓Agr↓ > Merge → FCA (preverbal)

This proposal manages to derive different agreement patterns in Slovenian by means of ordering of operations rather than linearization. It makes interesting predictions that a certain order of operations in a given derivation should interact with all sorts of places in clause-level syntactic phenomena. However, this account makes it difficult to explain the asymmetry between pre- and post-nominal adjective agreement. Along with the analysis of Marušič et al., they assume that the coordination head has a number feature, but does not have a gender feature and is furthermore not able to compute a resolved gender feature on the basis of the respective gender features of its conjunct. However, CCA for gender can be seen in a number of languages. It is not clear that this approach can be extended to number CCA.

Even though the generative grammars and the unification based theory are quite different, they both consider CCA as part of their grammar. The unification-based theory provides extra features to account for CCA. Most approaches in generative grammar locate CCA in their grammar by combining special syntactic properties of coordination phrase and the movement. Table (48) summarizes the main proposals of different theories and their accounts for the syntactic structures of coordination phrase, as well as for the main agreement properties: feature, direction between controller and target and domain.

Table 2.1 – Summary of main accounts for domain, feature and directionality between target and controller in different syntactic theories

Approach		References	Domains	Feature	Directionality
HPSG		Villavicencio et al. 2005	attributive CONCORD predicative INDEX	gender and number can work differently	not taken into account directionality, but features for linearization, like DOM (Borsley, 2009) can be used
LFG		King and Dalrymple 2004; Dalrymple and Hristov 2010	borrow CONCORD and INDEX features from HPSG	gender and number can work differently	$<_f$ denotes the relation of functional precedence
Minimalism	one-step	Van Koppen 2005, 2006	only deals with verbal domain	both gender and number	Van Koppen only deals with preverbal agreement and Bošković (2009) takes into account post-verbal agreement using specific properties of Serbo-Croatian
	two-step	Marušič et al. 2007, 2015	only deals with verbal domain	only gender	ordering between valuation and linearization
	multiple-steps	Murphy and Puškar 2018	only deals with verbal domain	only gender	ordering among Merge, Agree, Move

2.4 Psycholinguistic Models of Agreement

An important volume of work can also be found in psycholinguistics regarding agreement. The psycholinguistic approach to agreement gives prominence to language performance by understanding the factors influencing agreement and how they play a role.

Psycholinguistic theories of agreement are mainly concerned with language production, and specially in attraction errors. In general, there are three main language models for agreement[8]: Marking & Morphing (e.g., Eberhard et al. 2005), Constraint Satisfaction (e.g., Haskell and MacDonald 2003; Thornton and MacDonald 2003) and Working Memory Retrieval (e.g., Badecker and Kuminiak 2007). These models differ from each other in the following ways: some are proposed for language comprehension, while some are for language production. Some are one stage-language model while others are multi-stage models supposing that different levels, or at least lexical and syntactic levels, are functionally distinct in the human language processor. Most of this literature discusses Subject-Verb or pronoun agreement, few discusses agreement in the nominal domain. The languages they study are quite varied, including English, French, Italian, Spanish, Hindi, etc.

2.4.1 Marking and Morphing Account

The Marking and Morphing (or M&M) framework (c.f. Bock et al. 2001, Bock et al. 2004, Eberhard et al. 2005) seeks to account for attraction errors during language production. The general idea of M&M account is that agreement goes through three additional procedures besides the general views of word and sentence production: valuation of notional number, number marking and number morphing.

The valuation of notional number (also called *conceptual number* or *semantic number*) takes place during the preverbal encoding of speaker meaning. The purpose is to distinguish notional singulars from notional plurals in the speaker's referent model. The notional number can be different from the lexical number. For instance, notional plurals include

[8] There is also the Maximalist Hypothesis (e.g., Vigliocco and Franck 1999, 2001; Vigliocco and Hartsuiker 2002; Vigliocco et al. 1999), as it is quite similar to constraint satisfaction model and it is still quite vague, we will not discuss it further.

both lexical plurals (e.g., 'clothes') and lexical singulars (e.g., 'clothing', 'wardrobe').

Marking is the mechanism that transmits a collective number message to the syntax. The value consistent with the notional number of the phrase's referent from the first step will be linguistically interpreted. Its targets are noun phrases, which will be marked with a number consistent with the notional number and from which the number can be transmitted to verbs during the process of morphing.

Morphing is a part of structural integration, in which the lexical and structural forms are bound together. The morphological information realized from marking will be bound to structural positions. Morphing also serves to reconcile number-relevant features from the syntax and lexicon and transmit number features to structurally controlled morphemes (e.g. to verbs). Thus, verbs inherit the number of the subject noun phrase, whereas pronouns get their number in a process of agreement CONCORD, that is to say, pronoun has the same notional number as any nouns phrase with which it is coreferent.

Based on the M&M theory, Eberhard et al. (2005) propose an activation-based probabilistic model to account for number attraction and agreement in sentence production. This pioneering study treats agreement in different domains together, that is to say, the dependency between verb and subject and between personal pronoun and its antecedent. They suppose that pronoun number works in the same way as verb number during valuation, because the number meaning behind the utterance is the same. However, they differ from each other in terms of how they get their number values. Verb number agreement occurs under the control of syntactic processes; pronoun number is inherent in lexical entries, making number part of their semantics.

Their model is illustrated by Figure 2.3. For an utterance, the source of number information is first bound to a temporary structural network, and then its information is transmitted to the structure. The information moves or spreads within the structure according to principles of structural organization, assembly, and dissolution.

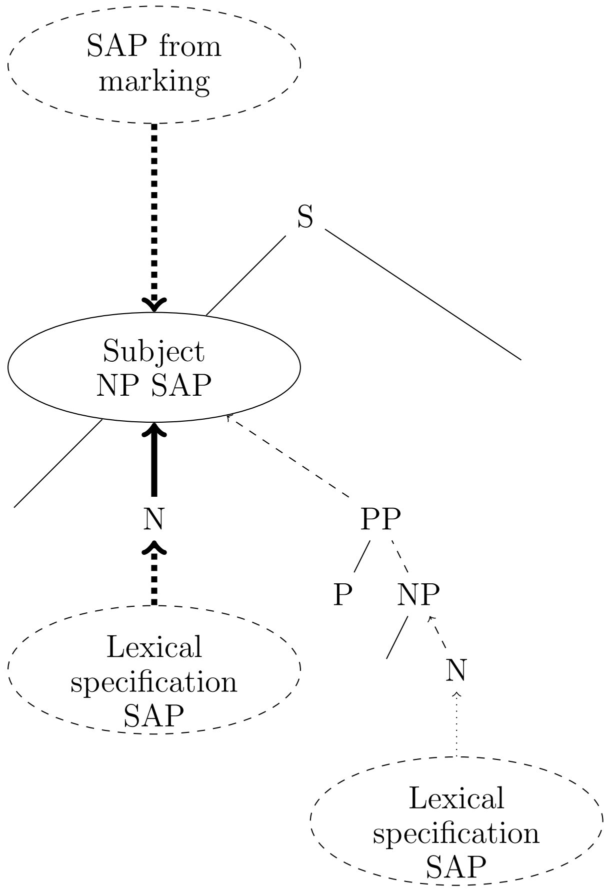


Figure 2.3 – Sources of singular and plural (SAP) accumulating at root of subject NP in basic marking and morphing model. The difference between the solid arrow and dashed arrow reflects the greater weight of the lexical specification SAP from the head noun than from the local noun.

Number information in the model is labelled as SAP (Singular-and-Plural). Negative values are more singular, and positive values are more plural. In the model are two factors contributing to morphing: one is morphological number specifications, the other is links between number controllers and number targets within a structural network.

Number specification is calculated by the SAP values of morphemes, or S(m).

$$S(m) = Specification \times C_{freq} \tag{2.1}$$

First of all, the specification values vary according to the types of noun. It has the maximal value 1 for plural count nouns, invariant plural nouns, and plural pronouns, because they trigger a plural agreement. Singular count nouns, singular pronouns, and mass nouns have specification values of 0, as a result of the weakness of singular attraction to singular local nouns in contrast with plural attraction to plural nouns (Eberhard 1997). The uninflected form of collective nouns had a value of .07, which comes from the corpus study by Bock et al. (2004). The specification values were adjusted by the relative frequencies of the nouns' contrasting singular and plural forms, or C_{freq} in Equation 2.2.

$$C_{freq} = log_{10}(frequency_{singular} + frequency_{plural})/log_{10}(frequency_{plural}) \tag{2.2}$$

S(r) represents the total amount of SAP at the root of the subject noun phrase, which was calculated by adapting a simple formula for spreading activation (Dell 1986), as shown in Equation 2.3:

$$S(r) = S(n) + \sum_{j} w_j \times S(m_j), \tag{2.3}$$

S(n) in the model represents the ambiguous notional number value for subject phrase, with interval (-1, 1). The values are estimated from 17 previous studies (.48 for the best fitting-values). S(m_j) are the lexical specification SAPs of the morphemes bound to the subject noun phrase (e.g., head noun and local noun), and w_j are the weights of the binding sites. The weights of local nouns and head nouns are also estimated from the same previous studies (e.g., w_H, w_L).

The model was fit to the verb-agreement data by transforming S(r) into a probability of plural agreement using the logistic transformation as shown in Equation 2.4. A constant bias (b) is added to S(r) to predispose the model to default to singular (zero plural probability) in the absence of evidence for plurality. The bias is also a free parameter estimated from the previous study (best fitting-value 3.42).

$$1/1 + exp - [S(r) + b], \tag{2.4}$$

The pronoun model is a minimal modification of the verb model, with identical parameters and parameter values. S(r_{PRO}) results from combining three SAP sources: the value of S(n) is equivalent to that for the verb agreement, because the referent of both phrases is the same. S(r), is the total SAP at the root of the antecedent subject noun phrase in the preceding clause (calculated by Equation 2.3). The only difference is that there is an addition S(m_{PRO}), which is the lexical specification of the pronoun morpheme that is selected for binding to its antecedent (1 for plural, 0 for singular). It is modulated by the weight of the branch (w_H) between the pronoun and its antecedent.

$$S(r_{PRO}) = S(n) + S(r) + [w_H \times S(m_{PRO})] \tag{2.5}$$

As in the verb model, S(r_{PRO}) was transformed into a plural probability using the logistic transformation in Equation 2.6, with the same of bias as in Equation 2.4.

$$1/\{1 + exp - [S(r_{PRO}) + b]\} \tag{2.6}$$

However, the model is a strictly feed-forward model and information flow between the levels is unidirectional (Bock and Levelt 1994). It predicts that the semantic factors only play a role in the initial stage. Furthermore, there should be little or no influence of directionality between the target and controller on agreement. Moreover, this model only deals with number, and can hardly be generalized to gender agreement.

2.4.2 Constraint-based Competition Models

On the contrary, constraint-based models are one-step model (e.g., MacDonald 1994; Trueswell and Tanenhaus 1994; McRae et al. 1998; Spivey-Knowlton et al. 1998). In this approach, sentence processing is a continuous process during which a large number of probabilistic constraints are computed in parallel.

Most of the computational models in this framework use a multiple constraints approach with an explicit competition algorithm (e.g., MacWhinney et al. 1984; MacWhinney 1987; Bates et al. 1989). The validity of a cue is a function of two factors: how available it is and how reliable it is. A strength of this approach is that it predicts that information sources can interact. That is, the contribution of a given source of information may depend on other sources of information. For instance, if one or more factors strongly promote singular agreement, then another factor which promotes plural agreement will have little effect.

In this framework, instead of being considered as correct or incorrect, agreement is viewed in terms of a gradient scale, and can be influenced by multiple factors. As a result, not all factors necessarily exert an equal effect, so that more reliable constraints may exert a stronger bias, possibly decreasing the effects of other more subtle ones (e.g., Haskell and MacDonald 2003, Haskell and MacDonald 2005, Thornton and MacDonald 2003)

Haskell and MacDonald (2003) explore the influence of morphological regularity and other conflicting semantic and functional factors on subject-verb agreement. In example (49-a), when the head noun is singular (non-collective), and the local noun is either a regular or irregular plural, no effect of morphological regularity is observed. However, effects of regularity are observed with collective head nouns (49-b). In addition, the items in (49-b) do not contain adjectives between the preposition and the local noun that will increase the memory burden on participants. The effects of morphological regularity would emerge when noun collectivity maximizes its effect (according to Bock et al. (1999), collective head nouns such as *committee*, followed by a plural noun in the post-modifying phrase, elicited 60% plural verbs whereas ordinary singular head nouns elicited 10% plural verbs).

(49) a. The room for the sick children/kids is/are cheerful.
b. The class of children/kids is/are cheerful.

The constraint framework is also proposed to account for closest conjunct agreement. Haskell and MacDonald (2005) showed that linear proximity plays a role in subject-verb agreement when the subject involves a disjunction. They found that a verb that agrees with the nearest noun (P in (50-a), S in (50-b)) is more acceptable than a verb that agrees with the more distant noun (S in (50-a), P in (50-b)).

(50) a. Can you ask Brenda if the boy or the girls is/are going to go first?

b. Can you ask Brenda if the girls or the boy is/are going to go first?

However, in cases of attraction errors, abundant evidence suggests that the linear proximity between the non-controller noun and the verb does not significantly affect the proportions of attraction errors (see Vigliocco and Nicol 1998, Franck et al. 2002). For instance, the verb is closer to the local noun in the declarative clause (51-a) than in the question clause (51-b). If the proximity of the verb to the local noun has an effect, then such errors should be more prevalent in the declarative condition (51-a) than in the question condition (51-a). Vigliocco and Nicol found no evidence for a difference in the rate of agreement errors across the two conditions.

(51) a. The helicopter for the flights was safe?

b. Was the helicopter for the flights safe?

According to Haskell and MacDonald (2005), linear order does play a role in computing number agreement in general, but it is only observable with disjoined subjects because the two nouns are with the same structural proximity to the verb (fig. 2.4) but with one linearly closer than the other (N2). They propose that the influence of syntactic hierarchy is strong (N1 is the head and much higher than N2), making the the effect of linear order difficult to detect.

Advantages of adapting constraint-based framework to model gradient agreement are many: i) it provides an algorithm in which various constraints compete for one outcome;

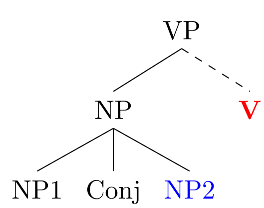


Figure 2.4 – Syntactic structure of CCA in Haskell and MacDonald (2005)

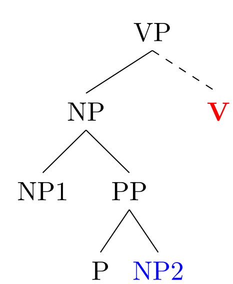


Figure 2.5 – Syntactic structure of attraction error

ii) each constraints has a weights rather than being categorical; iii) the outcome can be in a graded scale. However, the previous studies focuses on one or two constraints playing an role for one particular linguistic phenomenon. In regards to the question of agreement with coordination structures, it is not complete in what constraints come into the competition and how they play a role.

2.4.3 Cue-based Retrieval Models

In the past two decades, cue-based memory models (Lewis and Vasishth 2005) have been widely influential for theories of sentence comprehension, as they provide a general mechanism to account for the processing of a variety of long-distance dependencies, including subject-verb agreement (c.f. Badecker and Kuminiak 2007; Wagers et al. 2009; Schlueter et al. 2018) .

According to Lewis and Vasishth (2005), each chunk that comprehenders encounter is a set of feature-value representations and will be retained in the working memory. Sentence comprehension is procedural which involves incremental structure building. As in linguistic frameworks such as Head Driven Phrase Structure Grammar (Pollard and Sag 1994) and Tree-Adjoining Grammar (c.f. Joshi and Schabes 1991, Schabes et al. 1988), each chunk contains syntactic information, including argument structure, and seeks to combine with other chunks. And later elements in the sentence may need to retrieve information from the previous elements, which involves working memory recall.

Badecker and Kuminiak (2007) explain the attraction asymmetries observed in gender agreement in Slovak using the working memory retrieval account. The general idea is straightforward. For example, if the inflected form of a verb B in a sentence plan depends on the morpho-syntactic features of noun phrase A that occurred earlier, then A must be inspected; and in order to inspect A for these features, A must be retrieved from working memory. In agreement, retrieval cues, such as nominative case and pre-verbal position, can aid in retrieving the correct lexical subject. Agreement attraction occurs when cue-based retrieval nominates the wrong noun to form an agreement relationship with the verb.

Badecker and Kuminiak (2007) use the working memory retrieval to account for the morpho-phonological influences in the production of attraction errors. If nominative case is used as a retrieval cue for the agreement source, then one would expect that nouns that are ambiguous in their case-marking are more likely to be erroneously nominated than nouns that are clearly marked as non-subjects. Their results show that attraction errors arose more frequently when both the head and the local noun were case-ambiguous with respect to the nominative-accusative distinction (52). On the countrary, when the head noun is marked NOMINATIVE and the local noun is either an unambiguously ACCUSATIVE (53-a) or a case ambiguous (53-b), the case-based retrieval cue does not affect selecting an agreement source that might be nominative over one that unambiguously is nominative. The same is for cases when the head noun is ambiguous while the local noun is marked ACCUSATIVE (54-b), as the retrial cue does not choose an accusative noun for agreement source.

(52) Trest$_{\text{M},nom \vee acc}$ za krádež$_{\text{F},nom \vee acc}$ 'The punishment for the theft'

(53) a. Unambiguous mismatch
Sluha$_{\text{M},nom}$ pre hostinu$_{\text{F},acc}$ 'The servant for the feast'
b. Ambiguous mismatch
Sluha$_{\text{M},nom}$ pre domácnost$_{\text{F},nom \vee acc}$ 'The servant for the household'

(54) a. Unambiguous mismatch
Odmena$_{\text{F},nom}$ pre vý hercu$_{\text{M},acc}$ 'The reward for the winner'
b. Ambiguous mismatch
Trest$_{\text{M},nom \vee acc}$ za vraždu$_{\text{F},acc}$ 'The punishment for the murder'

Schlueter et al. (2018) compare the agreement attraction with plurals marked by suffixing (55-b) with attraction from those marked by coordination (55-c). Conjoined singular NPs, which are plural in their syntax and contain only an equivocal morphological signal of plural, namely *and*, caused strong attraction effects in both speeded acceptability rating and self-paced reading experiment. They also detect significantly more attraction from conjoined singular noun phrases than for attractors containing plural -s in the acceptability rating experiment. They suggest that the verb's number retrieval cue does not target just plural -s, but is instead specified in more general terms, including the coordinator *and*.

(55) a. The slogan about the husband was/were designed to get attention.
b. The slogan about the husbands was/were designed to get attention.
c. The slogan about the husband and the wife was/were designed to get attention.

This account could also be supported by other findings, which show that local nouns that are logical subjects of the verb (e.g., "the album by the classical composers were praised") are more likely to cause agreement attraction than local nouns that are not plausible subjects of the verb (e.g.,"the album by the classical composers were played") (Thornton and MacDonald 2003).

However, the memory retrieval model is incomplete in its coverage, as it does not specify how the constraints are mapped into retrieval cues, that is what features associated with a dependency are deployed as retrieval cues. There are few implementations of cue-based retrieval with direct access. The ACT-R implementation is currently the only mathematically precise expression of a content-based retrieval theory to be applied to psycholinguistic data to date (e.g., Vasishth et al. 2008; Dillon et al. 2013, 2014). This represents an important challenge for theory development because it limits the generation and verification of precise quantitative predictions.

Chapter 3

Constraints on Agreement

As illustrated in Chapter 2, agreement with a conjoined NP is extremely variable. CCA is cross-linguistically very pervasive and is more frequent in some contexts than others, for instance, when the target is before the controller (c.f. Corbett 1991; Munn 1999; Grevisse and Goosse 2016). This chapter will spell out these factors: the existing empirical evidence, as well as their implications for linguistic theories. The factors discussed in this chapter are not limited to those that will be included in the model in chapter 8: domain, feature and word order between controller and target, but include others that have been discussed in the literature, such as animacy and semantic interpretation.

3.1 Domain: the Agreement Hierarchy

From a typological perspective, Corbett has proposed the agreement hierarchy, which is a powerful ranking of constraints on agreement options, based on evidence from different languages and different phenomena (c.f. Corbett 1979; Corbett 1983; Corbett 1991; Corbett 2006). For any controller that permits several agreement strategies, as we move rightwards along the agreement hierarchy (1), the likelihood of resolved agreement will increase monotonically (Corbett 1991, p. 182).

(1) attributive > predicate > relative pronoun > personal pronoun

⟵ non-resolution – – resolution ⟶

According to this hierarchy, CCA should be more common for determiner-noun agreement than for subject-verb agreement. Corbett (1991) reports that in Russian, resolution number agreement is about 12% for attributive agreement in their corpus whereas it is about 70% for predicative agreement.

This hierarchy constrains not only agreement with conjoined phrases, but also a wide range of phenomenon, like the English collective nouns ‘committee’, which can trigger both singular and plural agreement (The committee is/are happy.). In the Spoken American Corpus (Longman Spoken American Corpus; 5 million words), the percentage of plural agreement that singular *committee* nouns can trigger represents 9% for verb agreement, whereas the number is 74% for relative pronoun agreement and 94% for personal pronoun agreement (Levin 2001).

A French study by Largy (2001) reveals that French children correctly use verbal agreement (CM1 ‘4th grade’) later than determiner agreement (CE2 ‘3rd grade’), in both production and revision (written) tasks. This asymmetry between nominal and verbal agreement suggests that the agreement hierarchy may be applied to language acquisition as well: the more the agreement is on the rightside of the agreement hierarchy, the later it can be acquired.

Different domains in the agreement hierarchy are accounted for differently by linguistic theories. In unification based theories, two types of agreement features are used: CONCORD and INDEX (e.g., Kathol 1999; Wechsler and Zlatić 2003). CONCORD features are used for morphosyntactic features in the noun phrase, while INDEX features are used for syntactic and semantic features in the verb phrase (e.g. This boy and girl are happy: CONCORD singular for the D, INDEX plural for the verb).

In minimalism (Chomsky et al. 2000), the Agree operation is mainly the ϕ-feature matching between the probe and target, which does not differentiate internal nominal agreement and verbal agreement. However, various debates require that agreement in different domains should be accounted differently (c.f. Frampton et al. 2006; Danon 2011).

This work investigates determiner, attributive adjective, and predicate morpho-syntactic agreement. Determiner and attributive adjective agreement is called 'attributive' agreement, and verb and predicative adjective agreement is called 'predicative' agreement.

French personal pronouns come in strong (*moi*) and weak (*je*, *me*) forms; the weak forms (or clitics) have received an affixal status in the linguistic literature (Miller, 1992). The distinction between agreement markers and pronouns is not simple and this opposition is just a simplification (cf. Bresnan and Mchombo 1987; Corbett 2003). There are more than two possibilities and therefore a complex typology. Pronouns share the morphological behaviour with other inflectional affixes, i.e. vary in gender and number. But attributive and predicative agreement and pronouns are quite different. Attributive and predicative agreement reflects a grammatical matching between two elements in a sentence, while pronoun agreement is subject to grammatical constraints, but also extends beyond the sentence grammar into discourse (e.g. Pollard and Sag 1994; Wechsler and Zlatić 2003). A pronoun bears an anaphoric relation to its antecedent and may be coreferential with it. This study only takes into account attributive and predicative agreement, by supposing that pronoun agreement obey different constraints, which requires further studies.

3.2 Directionality Between Controller and Target

Corbett (1991) also mentions that CCA is more frequent when the agreement target precedes the controller. This is a categorical constraint in some languages (Modern Standard Arabic, Welsh) where CCA is the only agreement strategy (see example (12) in section 2.1) and a tendency in other languages.

This hypothesis has been confirmed by different experimental works: on subject-verb number agreement with *or-coordination* in English (e.g., Morgan 1984, Peterson 1986, Haskell and MacDonald 2005), and on subject-verb gender agreement with *and-coordination* in South Slavic languages (e.g., Willer-Gold et al. 2017). For example, Willer-Gold et al. (2017) show that the proportion of CCA is much higher in verb-subject order (2-a) than in subject-verb order (2-b) in production experiments in Bosnian/Croatian/Serbian.

(2) a. Jučer su odštampane molbe i rješenja
“Yesterday AUX.PL print.PCPT.F.PL requests.F.PL and decisionsN.PL
‘Yesterday, requests and decisions were printed out.’

b. Molbe i rješenja su odštampana jučer.
“Requests.F.PL and decisionsN.PL AUX.PL print.PCPT.N.PL yesterday
‘Requests and decisions were printed out yesterday.’

This effect of structural differences on subject-verb agreement can also be observed in other structures than coordination when there exists different agreement options. In English, especially for the quantifier pseudo-partitive subject, a singular verb is more acceptable in the inversion (3-a) (3.35/5) than in the verb-subject order (3-b) (2.67/5) (Deevy, 1999).

(3) a. Was/were a large number of tourists milling around everywhere?

b. A large number of tourists was/were milling around everywhere.

Willer-Gold et al. (2017) explain that assuming a hierarchical structure of coordination phrase (Kayne, 1994), the closest noun in VS order (N1) is structurally higher than that in SV order (N2) (fig. 3.1). On that account, CCA is more common in VS order since it satisfies simultaneously CCA and Highest Conjunct Agreement (HCA), whereas in SV order the closest conjunct is in a lower hierarchical position.

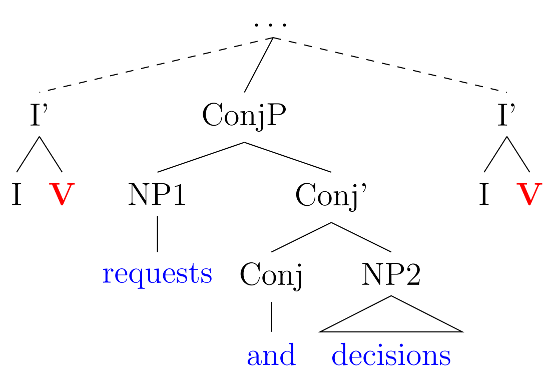


Figure 3.1 – Structures for (2-a) (2-b) with coordination phrases following Kayne (1994)

Furthermore, there exists an auxiliary (‘su’) in the sentence (2-b) which intervenes between the coordination phrase and the agreement target in SV order but not in VS order (2-a).

The analysis of Borsley (2005) with respect to the syntactic structure of coordination structures (fig. 3.2) is also hierarchical but is unheaded. Thus, the account of Borsley (2005) also predicts that NP1 is hierarchically closer to the agreeing participle regardless in SV order or VS order.

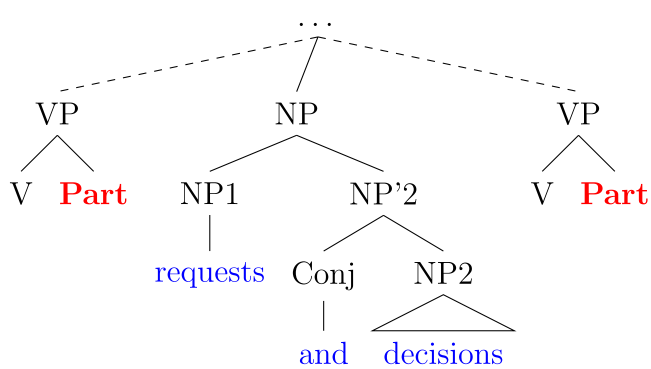


Figure 3.2 – Syntactic structure for (2-a) (2-b) with coordination phrases à la Borsley (2005)

In the approach of King and Dalrymple (2004), the coordination phrase is a flat structure (fig. 3.3). Thus, the closest noun is in identical hierarchical distances with the target when the target precedes or follows the coordination phrase.

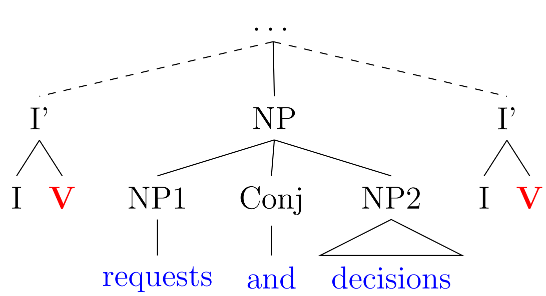


Figure 3.3 – Syntactic structure of coordination phrases by King and Dalrymple (2004)

In unification theories, agreement is achieved when the features are mutually matched. The directionality between the target and the controller does not play a very important role. Some works (cf. Borsley 2009) propose additional features (such as DOM in HPSG) to account for different word orders.

Thus, agreement with coordination structures is such a cross-over in the language that we can observe effects of hierarchical structure, linear order and directionality simultaneously. For Willer-Gold et al. (2017) (as well as Borsley 2005), NP1 is hierarchically closer to V, while structural distance does not play a role and only linear proximity determines agreement in King and Dalrymple (2004). The closest noun is structurally different in different word order SV/VS (N1 in VS and N2 in SV), which causes that agreement behaves differently in different word orders (cf. Willer-Gold et al. 2017)

Meantime, this asymmetry between SV and VS order can also be explained with an incremental processing account (e.g., Tanenhaus et al. 1995; Levy 2008). Only when the controller is before the target, does the speaker know the features of all conjuncts before computing target agreement. When the target is before, the speaker may not know the whole controller, and would thus make agreement with the first noun as soon as possible in order to finish the agreement procedure, a strategy that we may call 'early' or 'greedy' agreement.

3.3 Agreement Features: Number and Gender

Leaving person aside, number and gender are two main agreement features in French. They both occur in the nominal (determiners and attributive adjectives) and the verbal domain (verb, participles and predicative adjectives), but are quite different from one another. First, they differ from one another with respect to their linguistic definitions. Gender is a conceptual characteristic or a formal property of words. It is arbitrary for non-human nouns: the fact that *chaise* is feminine or *livre* is masculine in French is irrelevant of their semantic meanings.

(4) a. la meilleure chaise — DEF.F.SG best.F.SG chair
 b. le meilleur livre — DEF.M.SG best.M.SG book

For human nouns, on the other hand, it correlates with social gender (Gygax et al. 2009;

Bonami and Boyé 2019, Burnett and Bonami 2019). Nouns referring to males are usually masculine, and nouns referring to females are usually feminine. For example, *garçon* 'boy' is masculine and *fille* 'girl' is feminine. Note that for human nouns, especially 'professional nouns', their interpretation involves a social meaning. Masculine is ambiguous between a generic reading (i.e., refer to persons of both sexes, or to persons of indefinite sex or whose sex is irrelevant) and a specific reading (i.e., masculine refers only to men). *les présidents* can be used to pick out either men or women (5-a); however, a noun phrase with feminine grammatical gender, such as *la présidente*, exclusively picks out women (5-b).

(5) a. les présidents
DEF.PL president.M.PL
'the (male or female) presidents' or 'the male presidents'

b. les présidentes
DEF.PL president.F.PL
'the female presidents'

Number, on the other hand, is always considered as a meaningful feature signaling the quantity of the referent, either for non-human nouns (6-a) or for human nouns (6-b), except for intrinsic plurals which refer to a single object (*les ciseaux* 'scissors') ot a single event (*les fiançailles* 'engagement').

(6) a. la chaise/les chaises 'the.F.SG chair.SG / the.PL chair.PL '

b. Le président/les présidents 'the.M.SG president.SG/the.PL president.PL'

Gender and number are marked in different ways for different categories. It is important to distinguish two types of inflections: inherent and contextual inflection (cf. Booij 1996, 2012). "Inherent inflection is the kind of inflection that is not required by the syntactic context, although it may have syntactic relevance. Examples are the category number for nouns, comparative and superlative degree of the adjective, tense and aspects for verbs. Contextual inflection, on the other hand, is that kind of inflection that is dictated in syntax, such as person and number markers on verbs, agree markers for adjectives[...]"

(Booij 1996).

In written French[1], for agreement targets, such as determiners and adjectives, number and gender are contextual inflections. Verb agreement is contextual inflection as well. With respect to agreement controllers, while it is clear that number is an inherent inflection for nouns, gender as inflection has been debated (See Spencer 2002; Bonami and Boyé 2019). For nouns denoting inanimate entities, French has plenty of independent gender-specifc affixes. Such as, affix '-age' is specific for masculine (mari-age 'wedding') while '-ion' is specific for feminine (press-ion 'pressure'). Many affixes are compatible with both genders as well, such as '-oire' (ras-oir.M 'razor', baign-oire.F 'bathtub'). For human nouns, this thesis is in favor of the account that personal nouns were formed by parallel suffixation for masculine/feminine nouns, rather than by derivation of one noun from the other (Bonami and Boyé, 2019). French possesses various pairs of affixes to form masculine/feminine nouns, such as '-eur/-euse' (*chanteur/chanteuse* 'singer.M/singer.F'. Moreover, many personal nouns have a common gender, such as *journaliste*, 'journalist.M/F'.

Gender and number can allow for different agreement strategies. According to Marušič et al. 2007; Bošković 2009; Marušič et al. 2015, in South Slavic languages, CCA only happens with gender, but not number. Their claim is that the coordination phrase has a number feature but not a gender feature, so that the target should take plural number agreement but should look for the gender feature among its conjuncts through some syntactic operations, which allows the possibility of CCA in gender.

But in fact, Nevins (2018) points out that in Bosnian/Croatian/Serbian, when both conjuncts are singular, gender agreement depends on prior number agreement. That is to say, number agreement computes first and restricts gender agreement, which should be consistent. In particular, when a coordination phrase N.SG & N.SG, only M.PL (default) is possible, and the resolution (N.PL) is not an option. Plural is considered as a default agreement in number (dual for the resolution) and gender agreement depends on prior number agreement, thus the resolution agreement in gender is not possible. Nevins (2018) explains this gender and number asymmetry in a feature-geometric account which states

[1] This thesis only discusses the morphology in written French.

that gender is dependent on number.

The empirical evidence on whether gender and number agreement mechanisms are similar in cognitive processing is mixed. In a production study by Vigliocco et al. (1996), the rates of gender and number agreement errors within a language usually differ considerably, being higher for number than for gender. De Vincenzi (1999) examines the use of gender/number information in pronoun resolution mechanisms in Italian using a priming experiment and shows that both number and gender are used to activate an antecedent at the end of a sentence, only number information is available at the initial stage. Barber and Carreiras (2005) carry an ERP study in order to investigate mental representations of gender and number in cases of agreement violations. They show that the amplitude, latency, and distribution for the early effects of gender and number agreement violations are similar, indicating that the detection of gender/number violations involves at least some common process. Nevins et al. (2007) compare the agreement violations on different dimensions (gender, number, gender/number, person/gender) using ERP and behavioral measures for Hindi subject-verb agreement. They do not find amplitude differences among gender, number, and combined gender/number, but a significantly larger P600 effect for the gender/person combination. They suggest that person has a privileged status among agreement features, and a possible difference between number and gender processing, but the effect should be treated with caution since it is not strong.

In spite of the rich body of literature, less is known about the specific processes that lead to number and gender agreement in coordination structures. In particular, coordination, especially *and-coordination*, involves a group meaning in number, which leads to a plural agreement. However, gender is uninterpretable for non-human nouns, without semantic import (e.g., that the fact that 'table' is feminine in French and masculine in South Slavic does not lead to a difference in interpretation in these languages). Masculine agreement in case of gender mismatch is a prescriptive rule stemming from the fact that masculine can have a 'generic' interpretation: the masculine form *les habitants* ('the.PL inhabitant.M.PL') can refer to a mixed group of men and women, whereas *les habitantes* ('the.PL inhabitant.F.PL') would only refer to a female group. When there is a conflict between masculine and feminine, 'masculine wins', according to French prescriptive rules.

3.4 The Role of Animacy

Corbett (1991) notices that non-human nouns favor closest conjunct agreement. In recent experimental studies about CCA, some ignore this effect of animacy (c.f. Keung and Staub 2018; Foppolo and Staub 2020), whilst others only choose non-human nouns (c.f. Willer-Gold et al. 2017).

In the study by Bamyacı et al. (2014) on Turkish, they conduct Magnitude Estimation experiments by testing verb agreement with subject NPs, which belongs to four different animacy categories (a) human, (b) animal, (c) quasi-animate, and (d) inanimate subjects. Each sentences consist of a plural subject noun phrase (NP) followed by a verb.

(7) a. Human: Kinship (e.g., *anne* 'mother'); Profession (e.g., *öğretmen* 'teacher')
b. Animal: High (e.g., *deve* 'camel'); Low (e.g., *örümcek* 'spider')
c. Quasi-animate: Teleologically capable entities (e.g., *uçak* 'plane'); Entities with inherited animacy (e.g., *el* 'hand')
d. Inanimate: Appliance (e.g., *sandalye* 'chair'); Clothes (e.g., *gömlek* 'shirt')

In Turkish, which is a verb final language, plural agreement on the verb is optional with plural subjects. Their results show that the strength of the plural dispreference with plural subjects increases from (7-a) to (7-d), particularly with a striking drop between animal subjects and quasi-animate subjects. Plural agreement with a plural subject is not available when the subject is inanimate, but it is available to a certain degree when the subject is animate. Furthermore, they observe that not all inanimate subjects are alike. Their results confirm the view that linguistic animacy is a continuum rather than a binary distinction: [human > animal] > quasi-animate > inanimate.

In a study of inanimates, Lorimor (2007) points out that conjoined subjects elicit large proportions of singular agreement, especially when the subjects involve deverbal nouns.

Simple mass nouns elicit significantly more singular verbs than simple count nouns and collectives, and deverbal count and mass nouns elicit significantly more singular verbs than all other noun types. Collectives elicit significantly more singular verbs than simple count nouns but significantly less than any of the noun types.

(8) a. Simple Count: 'the name and address'
  b. Collectives: 'the directory and catalog'
  c. Simple Mass: 'the tea and coffee'
  d. Deverbal Count: 'the operation and recovery'
  e. Deverbal Mass: 'the singing and dancing'

Lorimor (2007) points out that the high portion of singular with conjoined mass nouns should be highly susceptible to notional coalescence. For example, "cream and sugar", which describes substances that not only occur in the same contexts (e.g., coffee), but which are also physically stirred together and (relatively) homogenized.

(9) a. Cream and sugar is added at your request.
  b. Cream and sugar is behind you.
  c. Cream and sugar is needed to hide the bitter flavor.

For conjoined deverbal nouns, their abstract quality makes them particularly susceptible to coalescence. A singular notional interpretation should be available when the two nouns denote one complex event, state, or activity.

(10) a. I think drinking and driving is a really bad thing.
  b. The manufacture and distribution of cash is by far the Federal Government's priority.

Note that cross-linguistically, there are several more fine-grained distinctions within the main categories of animacy (cf. Corbett 2000; Haspelmath 2013; Zaenen et al. 2004). In order to simplify, the present thesis distinguishes human and non-human in the experiments in the following chapters. While grammatical gender is related to social gender for human nouns, the relation between biological sex and grammatical gender tends to be looser in the case of animals. In French, for instance, a panda is always *un panda* (masculine) and a whale is always *une baleine* (feminine), regardless of their biological sex. To specify the sex of an animal, a modifier may be added, as in *un panda femelle* ('a female panda') or *une baleine mâle* ('a male whale'). Different nouns for the male and the female of a species are more frequent for common pets or farm animals, e.g. *une vache* ('a cow') and *un taureau* ('a bull').

French possesses various pairs of affixes to form gendered nouns for humans, so that men are male and women are female (*chanteur/ chanteuse* 'singer.M.SG /singer.F.SG). For animals, only those closest to humans (domestic, companion or farm animals) usually have nouns with grammatical gender motivated by their biological gender, for instance, *chien/chienne* ('dog.M.SG/dog.F.SG'), *chat/chatte* ('cat.M.SG/cat.F.SG'), *tigre/tigresse* ('tiger.M.SG/tiger.F.SG'). Gender is not interpretable with the other animals. For inanimates, there may be a partial motivation for grammatical gender, but the nouns do not come in pairs. Thus, the following chapters leave animals aside and only compare human nouns and inanimates regarding gender and number agreement.

3.5 The Role of Semantic Interpretation

Another hypothesis is that agreement may be determined by semantic interpretation. Recall that number agreement with two conjoined nouns depends on the joint/split reading. *Or* does not convey the same information as *and*. Chierchia (2013) points out that *or* has an implicature cancellation/suspension, but not *and*.

Foppolo and Staub (2020) test whether agreement with disjunction may be modulated when the disjunction occurs in the antecedent of a conditional (11-b), or when it is embedded under an attitude verb (11-c), or with or without negation (11-d) (e.g., I think that; I don't think that). These contexts might render a disjunctive subject more felicitous in general, because they are used to express uncertainty and/or speaker's ignorance. However, they do not find any decrease of acceptability of plural agreement in such contexts.

(11) a. Matrix: The lawyer or the accountant is/are coming to the meeting.
b. antecedent: If the lawyer or the accountant is/are coming to the meeting, I won't go.
c. embedded: I think that the lawyer or the accountant is/are coming to the meeting.
d. neg_embedded: I don't think that the lawyer or the accountant is/are coming to the meeting.

Furthermore, they create different contexts in which the predicate either does or does not allow an interpretation on which it is true of both disjuncts; while it is possible for both a lawyer and an accountant to come to a meeting, it is not possible for both to be the next CEO. Their results do not reveal significant differences between these conditions ((12-a) is the repetition of that in (33-a)) and condition ((33-b) is the repetition of that in (12-b)).

(12) a. inclusive: The lawyer or the accountant is/are going to the meeting.
b. exclusive: The lawyer or the accountant is/are going to become the next CEO of the company.

Foppolo and Staub (2020) find that English speakers are highly tolerant of both singular and plural agreement with two disjoined singular noun. The data do not confirm the hypothesis that the interpretation of the disjunction as exclusive or inclusive plays an important role.

Of course, agreement is a very complex language phenomenon, which may be influenced by other lexical factors. For instance, Haskell and MacDonald (2003) compare the proportion of attraction errors for morphologically regular local nouns ('the family for the spotted **rats** are dirty') and irregular local nouns ('the family for the spotted **mice** are dirty') when the head noun is collective and show a clear effect of morphological regularity, which I will not detail here.

To summarize, this chapter spells out the theoretical and experimental basics of the different factors that may favor CCA: domain, feature, word order between controller and target, animacy, and semantic interpretation. The recent experimental results reveal that the semantic context (inclusive/exclusive reading) does not have a measurable effect on the acceptability of singular/plural verb.

In the following chapters we will present new empirical results regarding French agreement, that test precisely these factors: gender agreement vs number agreement; attributive domain vs predicative domain; the target precedes/follows the coordination; human vs non-human nouns; *and-coordination* vs *or-coordination*. Chapter 4 and chapter 5 present agreement in the nominal domain (determiner and attributive adjective), with chapter 4 for number agreement and chapter 5 for gender agreement. Chapter 6 and 7 present agreement in the verbal domain (verb and predicative participle), with chapter 6 for number agreement and chapter 7 for gender agreement.

Chapter 4

Attributive Number Agreement

This chapter presents the results for number agreement in the nominal domain, including one corpus study on determiner agreement (with *et* ‘and’ coordinated nouns) and two acceptability judgment experiments (one on determiner agreement, one on attributive adjective agreement, with both *et* ‘and’ and *ou* ‘or’). For attributive agreement, we tested cases where the determiner or attributive adjective agrees with a bare noun coordination (also called ‘binomials’, Malkiel 1959; Cooper and Ross 1975): D-N1-Conj-N2, N1-Conj-N2-A. In general, bare nouns are not allowed in French, but they become plausible in coordinate constructions (see Le Bruyn and de Swart 2014 for an OT analysis of the article use). Both N1-Conj-N2-A and D-N1-Conj-N2 constructions are restricted to instances of ‘natural coordination’ (Wälchli, 2005), which implies that a close lexico-semantic relationship exists between the coordinands. For instance, *les père et mère* (‘the father and mother’) is felicitous while *les père et fleur* (‘the father and flower’) is not, due to the lack of a natural coordination reading. A natural coordination can give rise to both joint (‘this colleague and friend is travelling to china’) and split reading (‘this boy and girl are eating a pizza’).

This chapter focuses on agreement in such constructions, in particular it examines whether and under which conditions CCA and resolution rules are acceptable. Furthermore, binomial coordination can give rise to either a joint or a split reading, which can lead to different agreement strategies. The current work focuses on agreement of split binomials.

This chapter compares agreement for two word orders: when the target precedes the coordination (determiner agreement) and when the target follows the coordination (post-nominal adjective agreement). In addition, the effects of animacy are examined as well. Part of these results are published in An and Abeillé (2017, 2019).

4.1 Corpus Study of Determiner Number Agreement

4.1.1 General Results

We used the web-based corpus frWaC (1.6 billion words, Baroni et al. 2009) because it is a large corpus of contemporary French, including informal usage, and is annotated for parts of speech. We found 371 000 tokens with the request *D N et N*. In frWaC, words are not tagged for their number and gender information. We firstly extracted all the pairs of binomials. Then, we annotated automatically the number for nouns and determiners with *Lexique* (New et al. 2001), an electrical French dictionary in which several kinds of information including gender, number of French words are provided. Table 4.1 reports the numbers of binomials of different types.[1]

pattern	type	token
Dsg-N1sg-et-N2sg	31412	51711
Dpl-N1sg-et-N2sg	1308	5137
Dsg-N1sg-et-N2pl	5742	9490
Dpl-N1sg-et-N2pl	724	1432
Dpl-N1pl-et-N2sg	7586	13460
Dpl-N1pl-et-N2pl	55269	201503
total	102041	282733

Table 4.1 – Types and tokens of different number patterns for binomials in frWaC

The plural binomials were the most frequent ones. When N1 and N2 were both singular,

[1]These are raw numbers, including duplicates and errors.

the D could be either singular (example (1), (2)) or plural (3). In the Dsg case, the binomial could either have a joint (1) or a split reading (2).

(1) **Le chanteur et poète** québécois Gilles Vigneault publie en
the.M.SG singer.M.SG and poet.SG Quebec.M.SG Gilles Vigneault publish.3.SG in
France un livre d' entretiens.
France a book of interviews
'The Quebec singer and poet, Gilles Vigneault, publishes a book of interviews in France' (frWaC, `republique-des-lettres.fr`)

(2) Présentez-vous à **la date et lieu** indiqué
show.IMP.2.PL-yourself at the.F.SG date.F.SG and place.M.SG indicate.PTCP.M.SG
pour suivre votre formation.
to follow your training.
'Show up at the date and place indicated to follow your training.' (frWaC, `secours57.fr`)

(3) **Les lieu et programme** seront précisés sur le
the.PL place.M.SG and program.M.SG be.FUT.3.PL specify.PTCP.M.PL on the
bulletin.
bulletin
'The place and program will be specified on the bulletin' (frWaC, `rao.free.fr`)

We also found cases where there was a mismatch of number. When N1 was singular and N2 was plural, a Dsg (4-a) was more frequent than a Dpl (4-b), the first could be considered as closest conjunct agreement.

(4) a. L' atelier est fermé **le dimanche** et **jours fériés**.
the workshop is close.PTCP.M.SG the.M.SG Sunday and holiday.PL
'The workshop is closed on Sundays and public holidays.' (frWaC, `fram.fr`)

b. Cette publication comporte **les nom et prénoms**
This.F.SG publication contains the.PL name.M.SG and first name.M.PL
du débiteur.
of.DEF.M.SG debtor
'This publication contains the first and last names of the debtor.' (frWaC, `courdecassation.fr`)

When N1 was plural and N2 was singular, the D was plural (5), which could be considered as a case of closest conjunct agreement or resolution agreement. In frWaC, 88 cases were found for the Dsg-N1pl-et-N2sg pattern, but all involved obvious errors. Thus, they were not listed in the table.

(5) Voici pour **les** **frères** **et** **sœur** des photos
here is for the.PL brother.M.PL and sister.F.SG INDF.PL picture.F.PL
faites tout exprès pour eux.
do.PTCP.F.PL all especially for 3.M.PL
'Here are, for the brothers and sisters, some pictures made especially for them'
(frWaC, `catherine-de-mercueil.over-blog.fr`)

As different agreement strategies can be caused by the ambiguity between joint/split readings, in particular with the D-N1sg-et-N2sg pattern (see Le Bruyn and de Swart 2014), the next section will distinguish the joint/split readings. Then we will examine the agreement strategies with the split reading, testing effects of humanness in section 4.1.3 and the syntactic function in section 4.1.4.

4.1.2 Humanness and Semantic Readings

We extracted binomials combining two Nsg with more than five occurrences (22 600 tokens) and removed the errors (10 640 tokens left). We annotated noun animacy with an external dictionary (Bonami pc.) and the joint or split reading manually. Table 4.2 reports the number tokens of joint/split readings for human and non-human nouns. For human nouns, 97.03% examples had a joint reading (see (1)), while for non-human nouns, only 0.6% examples had (6).

(6) **Le** **restaurant** **et** **bar** Starlight propose un menu
the.M.SG restaurant.M.SG and bar.M.SG Starlight offer.3SG a menu
international.
international
'The restaurant and bar, Starlight, offers an international menu.'
(frWaC, `expedia.fr`)

	joint		*split*		*total*	
	types	tokens	types	tokens	types	tokens
humans	196	2304	6	105	202	2409
non-humans	3	31	492	10535	495	10566
total	199	2335	498	10640	697	12975

Table 4.2 – Types and tokens of different readings of singular binomials in frWaC

For split readings, there were only 6 types for human noun (7), whereas there were 492 types for non-human nouns (8).

(7) **Sa** **femme** **et** **fils** seront tenus de tenir clos
POSS.F.SG wife.SG and son.M.SG be.FUT.3.PL charged.PTCP.M.PL of keep closed
...

'His wife and son will be in charge of keeping closed...' (frWaC, `sorbonne.fr`)

(8) Présentez-vous à **la** **date** **et** **lieu** indiqué
introduce.IMP.2.PL at the.F.SG date.F.SG and place.M.SG indicate.PTCP.M.SG
pour suivre votre formation.
to follow POSS.2.SG training.
'Show up at the date and place indicated to follow your training.' (frWac, `secours57.fr`)

The results illustrated important frequency differences between human and non-human nouns in terms of semantic interpretation. Human nouns yielded a bias for the joint reading while non-human nouns gave a bias for the split reading. As the joint reading could only trigger singular agreement, we hypothesize that singular determiners for human nouns can easily give raise to a joint reading, making the split reading less acceptable in such condition. Thus, plural determiners were more acceptable for human nouns with a split reading. The next section will explore the agreement strategies with a split reading, for human and non-human nouns.

4.1.3 Humanness and Number Agreement

The results (table 4.3) reported more examples with a plural D for human nouns (9), even if both singular and plural D were quite infrequent. However, for non-human nouns, the singular D was more frequent (see (2), (3)).

(9) a. **Les** **mari** **et** **femme** sont d' accord sur le partage
the.PL husband.M.SG and wife.F.SG be.3.PL of agreement on the division
des biens.
of.DEF.PL property.PL
'The husband and wife agree on the division of these properties.' (frWaC, `judiciaire.blog.20minutes.fr`)

b. Elle part loin à la recherche de nourriture pour **son** **mari**
she goes far to the research of food for POSS.M.SG husband.M.SG
et **bébé**.
and baby.M.SG
'She goes far away looking for food for her husband and baby.'
(frWaC, `harunyahya.fr`)

	Dsg		*Dpl*		*total*	
	types	tokens	types	tokens	types	tokens
human	1	6	5	99	6	105
non-human	439	7507	53	2997	492	10535
total	440	7513	58	3096	498	10640

Table 4.3 – Dsg/Dpl with singular split binomials in frWaC

We suppose that this difference can be accounted for by a tendency to avoid ambiguity. For human nouns, the singular D would favor a joint reading, which explains why it was quite rare with a split reading in the corpus. However, for non-human nouns, both the singular and plural D were possible with a split reading, since non-human binomials were not ambiguous (or rarely ambiguous) between a joint and a split reading. The singular D was more frequent, exhibiting closest conjunct agreement.

4.1.4 Humanness and Syntactic Functions

The syntactic position of the binomial may play a role as well. If split binomials are in the subject position, the number of the predicate would no doubt influence that of the determiner as in French the predicate should agree in number with the subject. However, if split binomials are a complement, there will not be such specifications coming from the predicate.

Human nouns tend to be in the subject position more often than inanimate nouns (Clark and Begun, 1971). Previous studies have examples of (human) binomials in only the subject position (c.f. Le Bruyn and de Swart 2014; Heycock and Zamparelli 2005). So perhaps it was the independent tendency for human nouns to be in the subject position that favored the plural D.

Since human nouns had a strong preference for the plural D, we intended to compare number agreement strategies for inanimate nouns in different syntactic positions in frWaC. In order to be able to balance the singular/plural D, we chose two pairs of inanimate nouns which can appear with both singular/plural D: *D nom et prenom* ('D name.M.SG and first name.M.SG') (324 tokens of the Dsg and 513 tokens of the Dpl), *D date et heure* ('D date.F.SG and time.F.SG') (96 tokens of the Dsg and 49 tokens of the Dpl) and annotated manually their syntactic position: (preverbal) subject, inverted-subject, complement.

Table 4.4 shows that there were significantly more examples in the complement position, and the plural determiner was preferred in the subject position. But in the complement position, the difference between singular/plural D was not significant.

	subj	subj- inv	comps	total
Dpl	42	17	503	562
Dsg	6	3	411	420
total	48	20	914	982

Table 4.4 – D agreement and syntactic function of singular split binomials in frWaC

To sum up, the corpus study illustrated that agreement depended on the semantic interpretation: singular agreement was used for joint singular binomials while both singular and plural agreement were found for split ones. For split singular binomials, agreement was also determined by other factors, such as humanness and syntactic function. Human nouns and subject position favored a plural agreement.

Then, we ran two acceptability rating experiments carefully controlling these potential linguistic factors. The experiments investigated effects of humanness and word order between target and controller in both *and-coordination* and *or-coordination*. The experimental items were put in the object position to avoid syntactic function bias. Since the object context was neutral between split and joint reading, we chose human and non human nouns which could not have a joint interpretation (like *les père et mère* ('the father and mother') could not be co-referents).

Furthermore, since we used written corpora, they displayed agreement patterns which were not necessarily observed in spoken French (the distinction between masculine and feminine - *joli/jolie* ('pretty.M.SG/.F.SG') and between singular and plural - *joli/jolis* ('pretty.M.SG/.PL') is not realized in spoken French). This is why in all our experiments we only took agreement targets which are distinct in spoken French (*va/vont* 'aller.3.SG/.3.PL'; *nouveaux/nouvelles* 'new.M.PL/.F.PL').

4.2 Experimental Study on Determiner and Adjective Number Agreement

Since formally collected judgments are more reliable than speakers' intuitions (e.g., Wasow and Arnold 2005; Sprouse and Almeida 2012), and may reveal previously unobserved patterns in the data (e.g., Keller 2000; Hofmeister and Sag 2010), we ran a series of acceptability judgment experiments with the same methods and procedures. The experiments were conducted online using the Ibex Farm platform (Drummond 2013). Note that given the large set of possible values the conjuncts' number could take (i.e. N1sg+N2sg, N1sg+N2pl, N1pl+N2sg, N1pl+N2pl), it was resource-intensive to test all the possible conditions. We only tested certain conditions in particular when the closest noun was singular, where CCA and resolution rules contradicted (i.e. when the closest noun was singular, CCA predicted singular agreement while RA predicted plural agreement).

We ran two acceptability judgment experiments for number agreement in the nominal domain: one for determiner agreement, the other for post-nominal adjective agreement. Their design and procedure were the same. In French, all determiners make a distinction between singular and plural. In order to avoid that the number of the determiner may influence that of the prenominal adjective (in "the.PL new.F.PL student.F.SG and researcher.F.SG", the number of the adjective and the determiner should be consistent), we compared determiner agreement in prenominal position in experiment I and adjective agreement in post-nominal position in experiment II.

4.2.1 Experiment I: Determiner Number Agreement

4.2.1.1 Materials and procedures

We tested cases where the closest noun was singular (N1sg+N2sg, N1sg+N2pl) for determiner number agreement, as illustrated in table 4.5. The coordinators varied between *et* ('and') and *ou* ('or'). Among the 24 experimental items, half were with human items and half with non-human items. Furthermore, the target could be Dsg/Dpl. So there were 16 experimental conditions in total. The coordination phrase could only have a split reading and was put in the object position in order to avoid effects of verb agreement. All nouns were of the same gender (half of the pairs are masculine and half of the pairs are feminine). We also included 12 control items (grammatical and ungrammatical) in order to test the differences between CCA in number and number attraction errors. Half items were associated with a comprehension question (yes/no question), in order to make sure that the participants understood the sentence. (The items are included in Appendices section A.1). 24 filler items from an irrelevant experiment about island constructions were included.

The experiments were conducted as follows: first of all, participants had to fill out a questionnaire composed of a series of questions regarding their age, sex, native language and profession. Then they would be trained with three practice items in order to familiarise them with the acceptability task. In the task, participants were asked to rate the acceptability of the sentence with 11 buttons at the bottom of the sentence indicating 0-10, with 0 representing fully unacceptable and 10 representing fully acceptable. After rating the acceptability of the sentence, half of the sentences were followed by a comprehension question. When the practice items finished, the experiments began. The 24 experimental items, 12 control items as well as 24 fillers were randomized following a Latin square design.

Table 4.5 – Conditions and examples for the prenominal attributive number agreement experiment

Combination [2]	Humanness	Sentences
D-N1sg-et-N2sg	human	Il faudrait pouvoir prévenir le/les **directeur et sous-directeur** de l'établissement. it should be possible to warn the.M.SG/PL director and assistant director of the establishment
	non-human	Vous verrez votre/vos **nom et prénom** à l'écran. you will see your.SG/PL name and first name on the screen
D-N1sg-ou-N2sg	human	Il faudrait pouvoir prévenir le/les **directeur ou sous-directeur** de l'établissement. it should be possible to warn the.M.SG/PL director or assistant director of the establishment
	non-human	Vous verrez votre/vos **nom ou prénom** à l'écran. you will see your.SG/PL name or first name on the screen
D-N1sg-et-N2pl	human	Il faudrait pouvoir prévenir le/les **directeur et sous-directeurs** de l'établissement. it should be possible to warn the.M.SG/PL director and assistant directors of the establishment
	non-human	Vous verrez votre/vos **nom et prénoms** à l'écran. you will see your.SG/PL name and first names on the screen
D-N1sg-ou-N2pl	human	Il faudrait pouvoir prévenir le/les **directeur ou sous-directeurs** de l'établissement. it should be possible to warn the.M.SG/PL director or assistant directors of the establishment
	non-human	Vous verrez votre/vos **nom ou prénoms** à l'écran. you will see your.SG/PL name or first names on the screen
control	grammatical	**La mère** des enfants ira à l'école demain. the.F.SG mother of.PL children will go.SG to the school tomorrow
	ungrammatical	**La mère** des enfants iront à l'école demain.

the.F.SG mother of.PL children will go.PL to the school tomorrow

---

4.2.1.2 Results

We recruited 99 participants on the platform `http://crowdpanel.io/`. The experiment lasted 15 minutes and each participant received 4 euros after participation. We removed participants with comprehension accuracy below 75% (7 participants removed). In addition, 11 participants were removed since their averaged median score for ungrammatical sentences was equal or higher than that for grammatical sentences. This criterion was chosen since the experiment was conducted over the Internet: it was impossible to check whether the participants pay attention or not. If one participant rated ungrammatical sentences with an obvious grammatical error higher than grammatical sentences, they must not have been reading the sentences carefully, resulting in unusable data (I reported the results before removing such participants in appendices). After removal of problematic participants, 81 monolingual native French speakers were left in the experiment for determiner agreement (age ranges from 18 to 67, median=42, 46 female, 35 male).

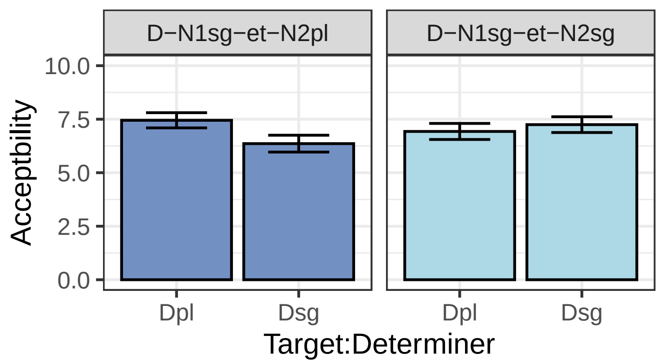
The results are reported in fig. 4.1. Error bars in all figures of this thesis correspond to 95 percent confidence intervals. In general, the experimental items were rated higher than the ungrammatical controls ($mean = 3.16$) but lower than the grammatical controls ($mean = 9.19$). For *and-coordination*, when the N2 was plural (the D-N1sg-et-N2pl combination), the plural determiner ($mean = 7.45$) was largely preferred to the singular ($mean = 6.36$). On the contrary, the singular determiner was preferred when the N2 was singular (the D-N1sg-et-N2sg combination) ($mean = 6.93$ for the Dpl vs $mean = 7.25$ for the Dsg). For *or-coordination*, a plural determiner was also more acceptable when the N2 was plural in the D-N1sg-ou-N2pl combination ($mean = 6.43$ for the Dsg, $mean = 6.96$ for the Dpl), but this difference between Dsg/Dpl was smaller than that in *and-coordination*. A Dsg was preferred in the D-N1sg-ou-N2sg combination ($mean = 7.8$

[2] In this thesis, we use the term COMBINATION to refer to a combined target and the coordination controller with the specification of the number/gender of conjuncts. For instance, the D-N1sg-et-N2sg denotes a determiner agreement with two singular nouns.

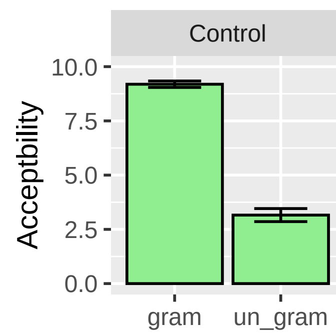
for the Dsg, $mean = 6.98$ for the Dpl).

Figure 4.1 – Results of the prenominal attributive number agreement experiment, with *and-coordination* on the top left, *or-coordination* on the bottom and control items on the top right. Bar colors represent the different combinations: darker blue when N2 is plural and lighter blue when N2 is singular; green represents control combinations.

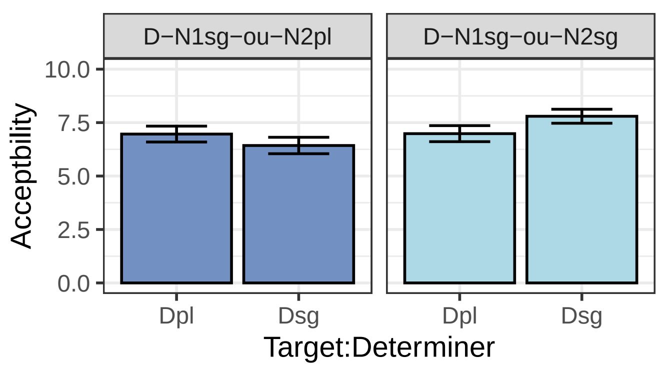
(a) and-coordination



(b) Control



(c) or-coordination



Effects of N2 First of all, we analysed whether the singularity of N2 played a role in determiner agreement. Since the combination D-N1sg-et-N2sg differed from the combination D-N1sg-et-N2pl only by the number of the second noun, their differences in acceptability should stem from the effect of the N2 (the farthest noun rather than the closest noun). First, for *and-coordination*, we fitted a mixed-effects ordinal regression model using the *clmm()* function in the ordinal R package (Christensen 2018). This is an appropriate statistical model for ratings that cannot be assumed to represent an interval scale, i.e., the values may not represent equally spaced points in subjects' subjective acceptability space. The same model was used in the following experiments. Fixed effects for this experiment were D (Dsg vs. Dpl) * N2 (N2sg vs. N2pl). We also included random intercepts, as well as maximal random slopes (D * N2) for items and subjects (Barr et al., 2013).

For *and-coordination*, there was a significant effect of determiner number ($p < 0.001$), as well as the interaction between D and N2 ($p < 0.001$) (see details in Appendices table A.1). Overall, the plural determiner was more acceptable. We were especially interested in the interaction between D and N2. This significant effect illustrated that Dsg/Dpl were rated differently when the N2 was singular than when the N2 was plural. In comparison to the singular N2, a plural N2 would favor a plural determiner and make the singular determiner less acceptable.

We fitted an equivalent ordinal model for *or-coordination*. We also found significant main effects of D and the interaction between D and N2 (see details of the model in Appendices table A.1). But this time, a Dpl was less acceptable when the N2 was plural than when the N2 was singular. The rating for the Dpl was unchanged regardless of the number of the N2.

This is puzzling since the N2 was not the closest conjunct (the closest Noun is always N1 and is singular), nor highest conjunct (the N1 is also the highest), but it was the farthest noun. Notice also that this was contradicted by our corpus results in Table 4.1, we had much more examples for the pattern Dsg-N1sg-et-N2pl (5742 types/ 9490 tokens) than the pattern Dpl-N1sg-et-N2pl (724/1432). We did not test number mismatch with the combination D-N1pl-et-N2sg, but maybe the mere presence of a plural (in an acceptability judgement task) yielded a plural preference (see below a similar result for verb number agreement,chapter 6). More work is needed on this subject.

Effects of Coordinator In order to compare *and-coordination* and *or-coordination*, we fitted an ordinal regression model separately for the D-N1sg-Conj-N2sg combinations and the D-N1sg-Conj-N2pl combinations, with two main factors: D (Dsg vs Dpl) * Conj (*et* ('and') vs *ou* ('or')) (Details of the model are in Appendices table A.2). We included random intercepts and maximal random slopes (D*Conj) for items and subjects for both models except excluding the interaction between D and Conj for items in the D-N1sg-Conj-N2sg combinations as this was the maximal model that converged.

For the D-N1sg-Conj-N2sg combinations, the main effects of D and Conj alone were not significant. That is to say, in general, Dsg and Dpl were equally acceptable and there were no differences between *et* and *ou* as well. On the other hand, the interaction between D and Conj was significant ($p = 0.04$). The difference between *et* and *ou* could be seen only with the Dsg. A singular determiner was more acceptable for *ou* than for *et*.

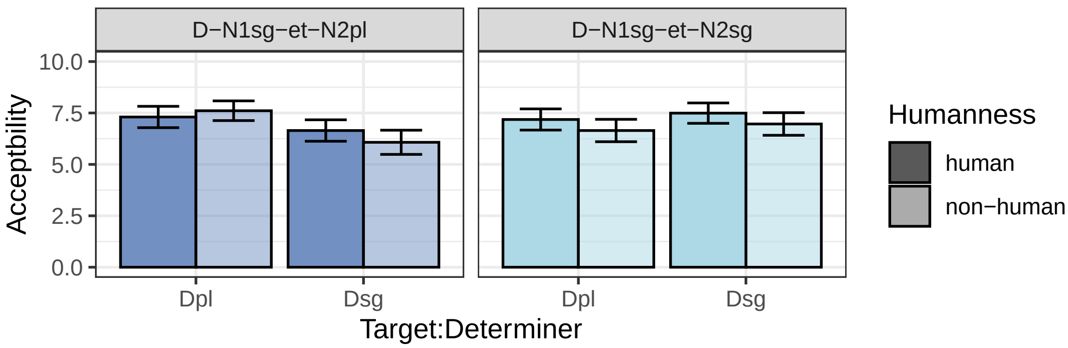
Regarding the D-N1sg-Conj-N2pl combinations, there was a significant effect of D ($p < 0.001$), Conj ($p = 0.04$) and the interaction between D and Conj ($p = 0.05$). When the N2 was plural, the plural determiner was preferred. *and-coordination* was more acceptable than *or-coordination*. Meanwhile, there was a significant interaction between Conj and D. As a singular determiner was equally acceptable for *et* and *ou*, a plural determiner was more acceptable for *et* than for *ou*.

Effects of Humanness Next, we examined the effects of humanness for each combination. Figure 4.2 compares human nouns and non-human nouns in each combination, with human nouns in a more saturated color and non-human nouns in a less saturated color. In each combination, we fitted a maximal mixed-effects ordinal regression model with fixed-effects (D*Humanness), as well as random intercepts for subjects and items, D as a random slope for items and D*Humanness as random slopes for subjects (see details of the model in Appendices table A.3). No significant interactions were found in any of these four combinations. Humanness was not a significant factor that influences determiner number agreement.

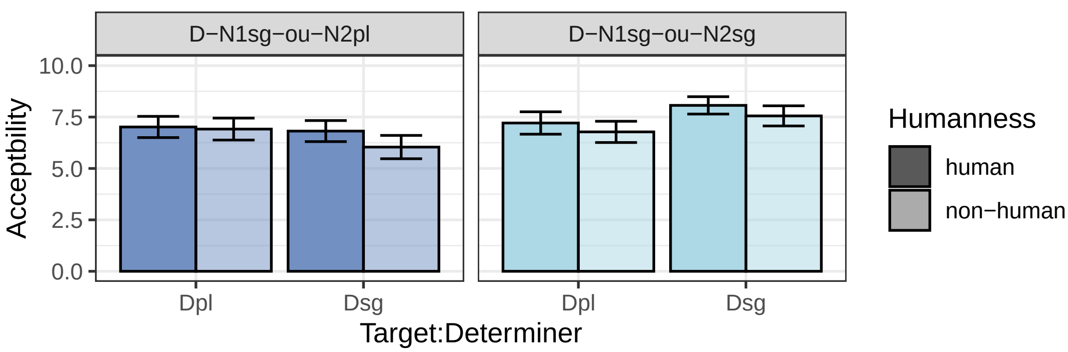
In summary, this experiment compared *and-coordination* with *or-coordination* in determiner number agreement, revealing differences between *et* and *ou* regarding agreement in both D-N1sg-Conj-N2pl and D-N1sg-Conj-N2sg combinations. When the closest noun was singular and the farthest noun was plural, the Dpl was more acceptable in *and-coordination* than in *or-coordination*, whereas the Dsg was equally rated regardless of the conjunction.

Figure 4.2 – Effects of humanness in prenominal attributive number agreement experiment

(a) and-coordination



(b) or-coordination



On the contrary, when both nouns were singular, the Dsg was more acceptable with *ou* and the Dpl sentences were equally rated with *et* and *ou*.

This experiment also compared the effects of N2sg/N2pl on agreement (i.e. when the closest noun was the same, the farthest noun was different), we found a significant interaction between N2 and D for both *and-coordination* and *or-coordination*. When the N2 was plural, the plural determiner was more acceptable and the singular determiner was less acceptable for *and-coordination*, whereas for *or-coordination*, a plural N2 only decreased the acceptability of the Dsg.

However, no significant effects of humanness were found in any of the combinations.

4.2.2 Experiment II: Post-nominal Adjective Number Agreement

In post-nominal position, we tested adjective agreement with combinations N1sg-Conj-N2sg-A, while the conjunctions varied between *et* ('and') and *ou* ('or') . The items (table 4.6) included 12 human nouns and 12 non-human nouns, which were similar to those in the determiner experiment in section 4.2.1, except that we made slight changes to certain items so that they were plausible in the context. We included the same 12 control items, as well as 24 fillers from another experiment about island constructions. The procedure was the same as the one described in section 4.2.1.

We had 64 participants recruited on the site `http://crowdpanel.io/`. The experiment lasted 15 minutes and each participant received 4 euros after participation. We removed 6 participants with comprehension accuracy below 75% and 4 participants whose averaged median rating for ungrammatical sentences was higher than that for grammatical sentences. The results of 53 monolingual native French speakers were kept for final analysis (age ranges from 23 to 78, median age=36; 35 female, 18 male).

4.2.2.1 Results

First, in order to examine whether the conjunctions *et/ou* played a role, we fitted a maximal mixed-effect ordinal regression model, with fixed factors (A (Asg vs Apl) *Conj (*et* vs *ou*), as well as random intercepts and A*Conj as random slopes for items and subjects. No significant effects were observed (details are in Appendices table A.4). Both singular and plural were acceptable for *and-coordination* ($mean = 8.21$ for the Asg, $mean = 8.19$ for the Apl) and *or-coordination* ($mean = 8.35$ for the Asg, $mean = 8.37$ for the Apl), compared to the grammatical controls ($mean = 9.07$ for the gram, $mean = 2.62$ for the un-gram).

Next, we tested effects of humanness for *and-coordination* in the N1sg-et-N2sg-A combination and for *or-coordination* in the N1sg-ou-N2sg-A combination. We fitted separately a mixed-effects ordinal regression model for each combination. Fixed effects were A*Humanness and random slopes for items was A and for subjects was A*Humanness (see details in Appendices table A.5). Again, no significant interactions were found. However,

Table 4.6 – Conditions and examples for post-nominal adjective number agreement experiment

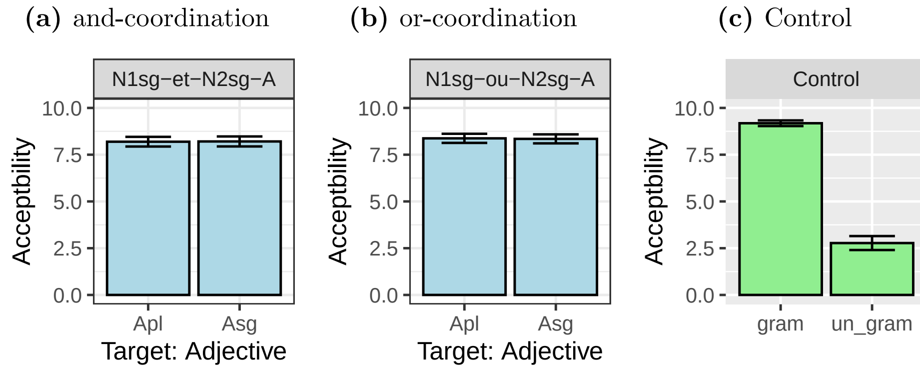
Combination	Humanness	Sentences
N1sg-et-N2sg-A	human	Cette formation gratuite vous prépare au mieux à la fonction de **directeur et sous-directeur** administratif/administratifs. this free training prepares you at best for the position of director and assistant director administrative.M.SG/PL
	non-human	L'intégration est toujours plus difficile pour un élève avec **nom et prénom** étranger/étrangères. the integration is always more difficult for a student with name and first name foreign.M.SG/PL
N1sg-ou-N2sg-A	human	Cette formation gratuite vous prépare au mieux à la fonction de **directeur ou sous-directeur** administratif/administratifs. this free training prepares you at best for the position of director or assistant director administrative.M.SG/PL
	non-human	L'intégration est toujours plus difficile pour un élève avec **nom ou prénom** étranger/étrangers. the integration is always more difficult for a student with name or first name foreign.M.SG/PL
control	grammatical	**La mère** des enfants ira à l'école demain. the.F.SG mother of.DEF.PL children go.FUT.SG to the school tomorrow
	ungrammatical	**La mère** des enfants iront à l'école demain. the.F.SG mother of.DEF.PL children go.FUT.PL to the school tomorrow

humanness played a significant role. Human nouns were more acceptable than non-human nouns in both *and-coordination* and *or-coordination*.

4.3 Discussions on Attributive Number Agreement

Our experimental data showed that number agreement with the closest noun was different from attraction errors and that its effect on the acceptability of sentences was gradient. In attributive position, number agreement with a conjoined NP depended on various factors: conjunction, the number value of the conjuncts and directionality.

Figure 4.3 – Results of post-nominal adjective number agreement experiment



4.3.1 Number Agreement and Conjunction

Our results showed that when both N1 and N2 were singular, only in prenominal position, the Dsg was more acceptable in *and-coordination* (D-N1sg-et-N2sg) than in *or-coordination* (D-N1sg-ou-N2sg). We did not find significant differences between *et* and *ou* in post-nominal position (N1sg-et/ou-N2sg-A). This result is surprising, since the semantic differences between the conjunction *et* and the disjunction *ou* predicts that their agreement strategies are different (see Chapter 2). However, speakers seem to use some similar number agreement strategies regardless of the conjunction when both nouns are singular.

However, when the second noun was plural, the differences between *et* and *ou* disappeared: in prenominal position, a singular determiner was equally acceptable for *et* and *ou*, whereas a plural determiner was more acceptable for *et* than for *ou*.

4.3.2 Agreement and Directionality

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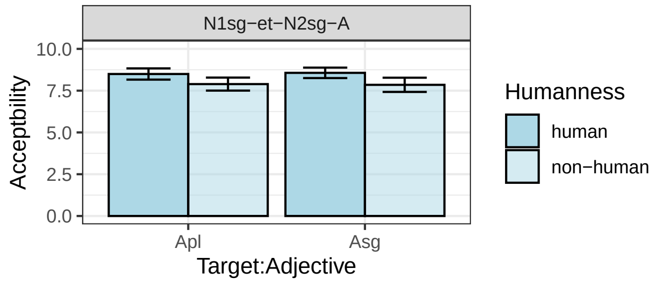
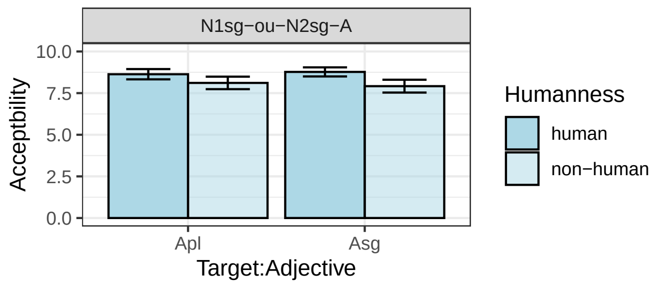
In order to examine the effects of directionality, we compared determiner agreement when the target preceded the controller with post-nominal adjective agreement when the controller followed the target. For *and-coordination*, plural agreement was less acceptable when the target preceded the controller in the D-N1sg-et-N2sg combination ($mean = 6.93$) than in the N1sg-et-N2sg-A combination ($mean = 8.19$). This difference remained for

Figure 4.4 – Humanness and post-nominal adjective number agreement experiment

(a) and-coordination



(b) or-coordination



singular agreement ($mean$ = 7.25 for the determiner, $mean$ = 8.21 for the post-nominal adjective *et*).

As for *or-coordination*, we also observed that plural agreement became more acceptable in post-nominal position than in prenominal position ($mean$ = 6.98 for the Dpl vs $mean$ = 8.37 for the Apl), but the difference for singular agreement was small ($mean$ = 7.8 for the Dsg vs $mean$ = 8.35 for the Asg).

For *or-coordination*, when the target was before the controller, plural agreement which violated CCA had a larger negative impact on the acceptability than when the target was after the controller (see section 3.2 above). Directionality played a role. However, singular agreement which violated the resolution rule was also less acceptable in prenominal position, but this difference of acceptability (about 0.5) was less important than that of plural agreement (about 1.5). We suppose this effect for singular agreement may be due to the fact that the N-Conj-N-A construction is generally more acceptable than the D-N-Conj-N construction.

However, both Dsg and Dpl were less acceptable in prenominal position. Effects of directionality predict that a Dpl which violates CCA in prenominal position is less acceptable. We suggest that the degradation of the Dsg in prenominal position may be due to the semantic ambiguity between joint/split readings. A singular D favors a joint reading, whereas the binomials can not refer to one person in the context (*le maire et adjoint* 'the mayor and deputy'). For this reason, the acceptability for the Dsg is degraded, whereas a Dpl cannot allow a joint reading as plausible in the context.

4.3.3 Attributive Number Agreement and Humanness

In attributive number agreement, we did not find effects of humanness in the experimental data. In the corpus study in section 4.1, singular agreement was more frequent with non-human nouns while plural agreement was more frequent with human nouns. However, this difference of frequency did not show in the sentences' acceptability.

The effects of humanness may result from the way we distinguished nouns. Lorimor 2007 finds effects of noun classes on verb agreement with conjoined NPs, but she divides nouns into five categories: simple count, simple mass, collectives, deverbal mass, deverbal count. In this study, we distinguished nouns into human and non-human in order to make the classification compatible with gender agreement. All our human nouns were count nouns, all the non-human nouns in our experimental items were also count nouns, which may explain the fact that no effects of humanness on number agreement was observed.

4.3.4 Number Agreement and the Syntax of Binomial Constructions

Le Bruyn and de Swart (2014) develop an optimality-theoretic analysis (see section 8.1.1 below for a detail illustration of this framework) that suggests a different syntactic structure depending on the meaning.

In this framework, the grammar is made of a set of constraints which can be violated, and which may be ranked differently from one language to another. In contrast to many other approaches to linguistics, the constraints are hierarchical, differ in strength, and crucially, the strongest constraint has absolute dominance over all weaker, i.e. lower ranked, constraints. There are two basic types of constraints: faithfulness constraints require identity between input and output forms; markedness constraints impose requirements on the structural well-formedness of the output, which motivate changes from the underlying form.

Using bidirectional Optimality Theory (Hendriks et al. 2010), Le Bruyn and de Swart (2014) propose a ranking of constraints in languages like English (10-a), based on de Swart and Zwarts (2008) and de Swart and Zwarts (2010)'s typology. The ranking of a specific markedness constraint for coordination (*FunctSCoordP) with respect to a more general markedness constraint (*FunctN) and three faithfulness constraints (10-d)-(10-f) determine the article use with split and joint coordination readings.

(10) a. {FPl, *FunctSCoordP} >> {FDr, FDef} >> *FunctN.
b. *FunctN: avoid functional structure in the nominal domain
c. *FunctNSCoordP: avoid functional structure (D) on top of a split coordination
d. FPl: reference to a plurality of individuals must be reflected in the form
e. FDr: the presence of a discourse referent in the semantics corresponds to an expression that carries discourse referential force
f. FDef: reference to discourse-unique individuals requires the use of an expression of definiteness

The markedness constraint *FunctSCoordP ranks above the faithfulness constraint FDr and FDef implies that split coordination lifts the normal requirement on definite and indefinite article use. The high-ranking of *FunctSCoordP with regard to *Funct predicts that split binomials will behave differently from joint binomials and standard arguments in allowing for bare nominals.

The ranking of constraints may vary cross-linguistically. In languages like English or French, *FunctN is ranked low with respect to the faithfulness constraints governing article use and *FunctNSCoordP is ranked high. Thus, Split Coordination Phrases behave differently from Joint Coordination Phrases.

In some languages, like Mandarin Chinese and Russian, *FunctN is ranked higher than the faithfulness constraints governing article use, thus rendering *FunctNSCoordP obsolete. Therefore Split Coordination Phrases behaves in the same way as Joint Coordination Phrases. In (11-a) and (11-b), coordination phrases involving bare nominals in Mandarin Chinese and Russian allow both for a split and a joint reading.

(11) a. Nàtiān yǐhòu, tā yǒu le gēge hé péngyou
that.day after, he has ASP brother and friend
(i) 'After that day he had a person who was both a friend and a brother.'

(ii) 'After that day he had (found back) the (his) brother and the (his) friend.'

(Mandarin, Le Bruyn and de Swart 2014, p.1230)

b. Na vstreču prišel drug i kollega
to meeting come.PST.M.SG friend.NOM.M.SG and colleague.NOM.M.SG
Maši.
Maša.GEN.F.SG
'A friend and (a) colleague of Macha's came to the meeting.' (Russian, Le Bruyn and de Swart 2014, p.1230)

Le Bruyn and de Swart (2014) propose that in English-like languages (French, Spanish) there is a DP projection above the coordination for joint readings. In addition, for the split reading (12-a), the first noun is combined with the D to form a DP, which is then combined with the second noun (12-b).

(12) a. $[_{DP}$ D $[_{CoordP}$NP and$_{joint}$ NP]]

b. $[_{CoordP}[_{DP}$ D NP] and$_{split}$ $[_{NP}$ NP]]

This analysis predicts that for the joint reading, the number value of the determiner should be the same as that of its conjuncts. For split readings, the number value of the determiner is determined by the closest noun. That is why a plural determiner is not grammatical in (13-b) .

(13) a. Ce poète et écrivain est célèbre.
DEM.M.SG poet.M.SG and writer.M.SG is famous
'This poet and writer is famous.'

b. *Ces marin et soldat sont souvent ensemble.
DEM.PL sailor.M.SG and soldier.M.SG be.PRS.3.PL often together
'This sailor and soldier are often together.' (Heycock and Zamparelli, 2005)

Le Bruyn and de Swart (2014) find some examples where the plural determiner is acceptable (14). They note that these cases are extremely rare and are taken as outliers that are to be explained by the sloppy writing style of blogs or an unnatural bureaucratic writing style.

(14) a. mes frère et soeur
my.PL brother.M.SG and sister.F.SG
my brother and sister

b. les date et signature
the.PL date.F.SG and signature.F.SG
the date and signature

In Russian-like languages, the D ranges over the whole CoordP in split reading. Thus only a plural determiner is felicitous.

(15) èti mužčina i ženščina
DEM.PL man.M.SG and woman.F.SG
these man and woman (King and Dalrymple, 2004)

Le Bruyn and de Swart (2014)'s analysis relies on linguistic intuitions about human binomials, and only deals with *and-coordination*. It is based on the assumption that only one output is possible in a given language, which is incompatible with our results. Our empirical results suggest that number agreement for the joint reading is categorical, since only a singular D is allowed. However, both singular and plural D are allowed for the split reading, and which one is used is rather a matter of preference (cf. Bresnan and Nikitina 2003). Furthermore, this analysis can only take into account the role of the semantic interpretation (joint/split reading) on number agreement and cannot be generalized to other agreement patterns, such as gender agreement or predicative agreement.

In conclusion, this chapter investigated number agreement in the nominal domain. Both corpus data and experimental data confirmed that CCA exists in French and is even preferred under certain conditions. The corpus data focused on *and-coordination*, showing that humanness had an effect on the joint/split reading choice: human nouns were more frequent with a joint reading, whereas non-human nouns were more frequent with a split reading. Also, both preverbal subject and inverted subject positions favored plural agreement for a split reading, compared to the object position.

By controlling semantic readings and syntactic positions, we ran two experiments: one deals with determiner agreement and the other with attributive adjective agreement. Our experimental results showed that the violation of CCA had a larger negative effect on the acceptability when the target was before the coordination phrase. We did not find effects of humanness in the the acceptability judgment experiments. Importantly, no differences between *et/ou* were found when both conjuncts were singular, but plural became preferred for *et* when the second conjunct was plural.

Table 4.7 – Summary of experimental results for attributive number agreement

	combination	target	mean	standard deviation (stdev)	standard error (se)
1	D-N1sg-et-N2pl	Dpl	7.45	2.82	0.18
2	D-N1sg-et-N2pl	Dsg	6.36	3.12	0.20
3	D-N1sg-et-N2sg	Dpl	6.93	3.02	0.19
4	D-N1sg-et-N2sg	Dsg	7.25	2.94	0.19
5	D-N1sg-ou-N2pl	Dpl	6.96	2.98	0.19
6	D-N1sg-ou-N2pl	Dsg	6.43	3.11	0.20
7	D-N1sg-ou-N2sg	Dpl	6.98	2.97	0.19
8	D-N1sg-ou-N2sg	Dsg	7.80	2.65	0.17
1	gram		9.19	1.69	0.08
2	un-gram		3.16	3.40	0.15
1	N1sg-et-N2sg-A	Apl	8.19	2.36	0.13
2	N1sg-et-N2sg-A	Asg	8.21	2.43	0.14
3	N1sg-ou-N2sg-A	Apl	8.37	2.22	0.12
4	N1sg-ou-N2sg-A	Asg	8.35	2.19	0.12
1	gram		9.07	1.56	0.09
2	un-gram		2.62	3.28	0.18

Chapter 5

Attributive Gender Agreement

This chapter considers gender agreement in the nominal domain. We conducted two corpus studies, one about determiner agreement, the other about attributive adjective agreement. We ran four acceptability judgment experiments: one regarding adjective agreement in pre/post-nominal positions, two regarding determiner agreement with *certains/certaines* (some.M.PL/.F.PL), and one comparing gender and number determiner agreement; as well as one self-paced reading experiment that replicated the last acceptability experiment.

As it has been discussed in the previous chapter, agreement with coordinate structures in the nominal domain happens with the binomial constructions, such as D(A)-N1-Conj-N2 or N1-Conj-N2-A. For gender agreement, most plural articles and possessives in French are gender non-distinguishing (i.e. have the same form for masculine and feminine, for instance *les* 'the.PL', *nos*, 'our.PL'...). Furthermore, adjectives in French can be prenominal and post-nominal. Thus we can compare adjectives in prenominal position (with a gender non-distinguishing determiner to avoid effects of determiners) and post-nominal position. We also test determiner gender agreement manifested on one particular determiner *certains/certaines* 'some.M.PL/F.PL', one of the rare determiners whose plural form varies in gender. Part of the results are published in Abeillé, An, and Shiraïshi (2018).

5.1 New Corpus Data on Attributive Gender Agreement

5.1.1 Determiner Agreement

When two singular nouns are coordinated, the determiner can be either singular or plural. However, most plural articles and possessives are gender non-distinguishing, which makes it impossible to distinguish CCA and RA (1).

(1) [...] avec **mes** **frère** **et** **soeur** nous écrivions des
[...] with my.PL brother.M.SG and sister.F.SG we write.PST.1.PL INDF.PL
cartes de voeux à ceux qu' on connaissait.
cards of greetings to those that one knows
'with my brother and sister, we wrote some greeting cards to those that we knew.'
(frWaC, `forum.elle.fr`)

We will discuss two cases in this section: a singular determiner with two singular conjuncts and a plural determiner *certains/certaines* ('some.M.PL/F.PL') with two plural conjuncts.

5.1.1.1 Coordination of Two Singular Nouns

We used the same data set extracted from frWaC as in Chapter 4 and annotated automatically the gender and the number of determiners and conjuncts using *Lexique* (New et al., 2001). This section investigates gender mismatch cases in the pattern Dsg-N1sg-et-N2sg (including Dsg-N1fsg-et-N2msg and Dsg-N1msg-et-N2fsg) taking into account only cases with at least five tokens in the corpus (table 5.1). We observe that when the first noun is feminine, only 17.6% of the articles are gender non-distinguishing (3-a). But when the first noun is masculine, only 28.9% of the articles are gender non-distinguishing (3-b). The other cases showed closest conjunct agreement: Dfsg-N1fsg-et-N2msg (4-a) or Dmsg-N1msg-et-N2fsg (4-b).[1]

[1]The 10 cases in frWaC that contradicted CCA (Dmsg-Nfsg-et-Nmsg, Dfsg-Nmsg-et-Nfsg) could be considered irrelevant. They could be analysed as NPs without a head noun (*une assurance Vieillissement et longévité* in (2-a), *le secteur logistique et transport* in (2-b)) or as proper names.

(3) a. Pour **votre sécurité et confort**, notre garage est accessible
for your.SG safety.F.SG and comfort.M.SG, our garage is accessible
directement depuis la réception et salles de réunion.
directly from the.F.SG reception.F.SG and room.F.PL of meeting.
'For your safety and comfort, our garage is accessible directly from the reception and meeting rooms.' (frWaC, `bestwestern.fr`)

b. Je félicite pas mal de mes concitoyens pour **leur talent et capacité** de se souvenir d' événements passés de notre histoire.
I congratulate a lot of my fellow citizens for their.SG talent.M.SG and ability.F.SG to REFL remember events past of our history.
'I congratulate a lot of my fellow citizens on their talent and ability to remember past events in our history.' (frWaC, `voila.fr`)

(4) a. Présentez-vous à **la date et lieu indiqué**
present.IMP.2.PL at the.F.SG date.F.SG and place.M.SG indicate.PTCP.M.SG
pour suivre votre formation.
to follow your training.
'Present your-self at the date and place indicated to follow your training.' (frWaC, `secours57.fr`)

b. **le lieu et date** de rédaction/publication
the.M.SG place.M.SG and date.F.SG of writing/publication
'the place and date of writing/publication' (frWaC, `gfii.asso.fr`)

	gender non-distinguishing D	Dfsg	Dmsg	total
Dsg-N1fsg-et-N2msg	992	4612	5	5639
Dsg-N1msg-et-N2fsg	862	5	2075	3007
total	1854	4617	2080	8646

Table 5.1 – Tokens of D gender agreement with two Nsg in frWaC

(2) a. ... demander **une Vieillissement et longévité**.
... ask a.F.SG aging.M.SG and longevity.F.SG
'ask one assurance 'Aging and longevity'' (frWaC, `stoody.fr`)

b. Possédant une bonne expérience dans **le logistique et transport** ...
having a good experience in the.M.SG logistics.F.SG and transport.M.SG
'having good experiences in the logistics and transport' (`centraljob.fr`)

5.1.1.2 Coordination of Two Plural Nouns: *certains/certaines*

The only plural determiner that varies in gender in French is *certains/certaines* ('certain') (Schnedecker, 2005). This section examines the agreement strategies used in binomials with *certains*. In frWaC, we found 2511 tokens for the pattern *certains*-N1-et-N2, and 1328 tokens for the pattern *certaines*-N1-et-N2. The gender and number of nouns were annotated with *Lexique* (New et al., 2001). The results for plural binomials that have nouns with different genders are reported in table 5.2.

	N1mpl et N2fpl	N1fpl et N2mpl
certains	460	9
certaines	0	178
Total	460	187

Table 5.2 – Tokens of *certains/certaines* with plural binomials of different genders

The results showed that in case of gender discordance, the determiner agreed mostly with the first noun, even exclusively in feminine (*certaines*-N1fpl-et-N2mpl). For the masculine determiner (*certains*-N1mpl-et-N2fpl), it was difficult to distinguish whether the preference for masculine *certains* was the result of the resolution rule or closest conjunct agreement.

There were very few examples that showed resolution agreement and contradicted closest conjunct agreement (*certains*-N1fpl-et-N2mpl), as in (5).

(5) a. Ces mausolées existent encore aujourd'hui au niveau de
these mausoleums exist still today at.DEF.SG level of
certains villes et villages de la Mitidja.
certain.M.PL town.F.PL and village.M.PL of the.F.SG Mitidja.
'These mausoleums still exist today in certain towns and village in the Mitidja.'

(frWaC, `tipaza.blogs.seniorplanet.fr`)

b. Nous lui avons communiqué les adresses de
we DAT.SG AUX.1.PL communicate.PTCP.M.SG the addresses of
certains consœurs et confrères concernés par ces langues.
some.M.PL colleague.F.PL and colleague.M.PL affected by these languages

'We have communicated to him the addresses of certain female and male colleagues concerned by these languages' (frWaC, `sft.fr`)

5.1.2 Adjective Agreement

We also examined adjective gender agreement in frWaC. In this corpus, we found 32 769 tokens for the pattern D-A-N1-et-N2 and 59 818 tokens for the pattern D-N1-et-N2-A. We randomly created a subset of 2 500 items for each structure and annotated the gender of nouns and adjectives with *Lexique* (New et al. 2001). We selected only plural nouns (among the two sets of 2 500, it turned out that 1 081 were plural prenominal adjectives and 1 000 were plural post-nominal adjectives). We left out coordinations that have nouns with the same gender and looked only at items with different genders. We then checked each item manually and removed the examples where the adjective noun combination was a compound and when the A had scope over only one conjunct (6-a) [2] or had a syncretic form (6-b).

(6) a. les **grandes écoles** et laboratoires
the.PL big.F.PL school.F.PL and laboratory.M.PL
'the Grandes Ecoles and laboratories.'

b. les outils et procédures **nécessaires**
the tool.M.PL and procedure.F.PL necessary.PL
'the necessary tools and procedures.'

We thus obtained 290 tokens for the pattern D-A-N1-et-N2 and 370 for the D-N1-et-N2-A. Table 5.3 reports the occurrences of masc/fem adjectives with the two plural nouns of different genders.

In both prenominal and post-nominal positions, when the closest noun was masculine, we could not determine whether the masculine agreement was triggered by resolution rules

[2] *Grandes Écoles* is a collocation which refers to some selective French higher education establishments which are different from the Universities.

	Am	Af	Total	% CCA	% RA
A-N1f-et-N2m	5	88	93	94.62	4.38
A-N1m-et-N2f	197	0	197	100	100
N1m-et-N2f-A	79	65	144	55.86	44.14
N1f-et-N2m-A	226	0	226	100	100

Table 5.3 – Adjective agreement with plural Nouns of different genders in frWac

or by CCA. The adjectives were always masculine in these cases (7-a), (7-b).[3]

(7) a. les **différents** pays et organisations
the.PL different.M.PL country.M.PL and organization.F.PL
'different countries and organizations'

b. les régions et pays **voisins**
the.PL region.F.PL and country.M.PL neighboring.M.PL
'neighboring regions and countries'

In patterns like D-A-N1f-et-N2m and D-N1m-et-N2f-A, we found two possibilities for attributive adjective agreement: RA (8-a), (8-b) or CCA (8-c), (8-d). However, we found a higher portion of CCA when the target preceded the coordination (A-N1f-et-N2m) than when the target followed the coordination (N1m-et-N2f-A).

(8) a. les **différents** ressources et services
the.PL different.M.PL resource.F.PL and service.M.PL
'the different resources and services.' (frWac, `ac-orleans-tours.fr`)

b. leurs droits et obligations **respectifs**
their.PL right.M.PL and obligation.F.PL respective.M.PL
'their respective rights and obligations.' (frWaC, `rhonealpes.fr`)

c. les **différentes** villes et pays
the.PL different.F.PL city.F.PL and country.M.PL
'the different cities and countries.' (frWaC, `leava.fr`)

d. les objectifs et caractéristiques **essentielles**
the.PL objective.M.PL and characteristic.F.PL essential.F.PL
'the essential objectives and characteristics.' (frWaC, `gouv.fr`)

[3] We took out the only example with a feminine A, which was not an example of modern French: *le haute rendement et impedence* (the.M.SG high.F.SG efficiency.M.SG and impedance.F.SG).

In sum, the corpus data showed that when the target preceded the coordination, i.e. in determiner or prenominal adjective agreement, CCA in gender was almost the only strategy. However, resolution agreement became more frequent when the target followed the coordination, such as in the post-nominal position.

However, corpus data may be sparse or have confounds, and they displayed agreement patterns which are not necessarily observed in spoken French (for instance, the distinction between masculine and feminine - *joli/jolie* ('pretty.M.SG/.F.SG' is not realized in spoken French). In order to test the acceptability of such corpus data, we ran three acceptability rating experiments to see whether the corpus frequencies correspond to speaker's preferences. We wanted to compare CCA and attraction errors (Bock and Miller 1991). We also tested the difference between human and non-human nouns.[4]

5.2 Experiments: Attributive Gender Agreement

We ran a series of three acceptability judgment experiments with the same design and procedure as shown in Chapter 4: two for determiner agreement with *certains/certaines* (one for the combination D-N1m-et-N2f, the other for the D-N1f-et-N2m) and one for adjective agreement. The latter tested both prenominal and post-nominal positions and the closest noun was always feminine. All these experiments tested *and-coordination* and the conjuncts were plural to avoid number agreement.

5.2.1 Experiment I: Determiners *certains/certaines*

5.2.1.1 Acceptability Judgement with *certains/certaines*

Here we present two experiments: one for the D-N1f-et-D2m combination and the other for the D-N1m-et-D2f combination. Determiners were always *certains/certaines* ('some. M.SG/F.SG). Nouns and determiners were all plural in order to avoid effects of number

[4]Our corpus data did not provide enough examples with human nouns for a statistical study since most of the examples involve inanimates.

agreement. The items were exactly the same in the two experiments, only differing in their word order. In each experiment, there were 24 experimental items. Half of the experimental items were non-human and half human nouns, with both conjuncts either human or non-human. We draw on the corpus data to build the experimental items. We also included 24 fillers from an independent experiment. In these experiments, the binomials were in the subject position and verbs were plural without gender markings (no past participle or adjective attribute). There were also 6 control items: each control item came in an ungrammatical version with an agreement error and a parallel grammatical version.[5]

Combination	Humanness	Sentences
D-N1f-et-N2m	human	Certains/Certaines **étudiantes et étudiants** sont déjà en stage. some.M.PL/F.PL student.F.PL and student.M.PL are already in internship
	non-human	Certains/Certaines **interactions et comportements** des molécules ont surpris les chercheurs. some.M.PL/F.PL interaction.F.PL and behavior.M.PL of.PL molecules have surprised the researchers
D-N1m-et-N2f	human	Certains/Certaines **étudiants et étudiantes** sont déjà en stage. some.M.PL/F.PL student.M.PL and student.F.PL are already in internship
	non-human	Certains/Certaines **comportements et interactions** des molécules ont surpris les chercheurs. some.M.PL/F.PL behavior.M.PL and interaction.F.PL of.PL molecules have surprised the researchers
control	gram_A	Les annonces dans les **journaux** demeurent un moyen répandu pour annoncer les possibilités de marché. the ads in the.PL newspaper.PL remain a means popular to announce the opportunities of market
	un-gram_A	Les annonces dans le **journaux** demeurent un moyen répandu pour annoncer les possibilités de marché. the ads in the.SG newspaper.PL remain a means popular to announce the opportunities of market

Table 5.4 – Conditions and examples for determiner gender agreement. Double lines separate the conditions that appear in different experiments

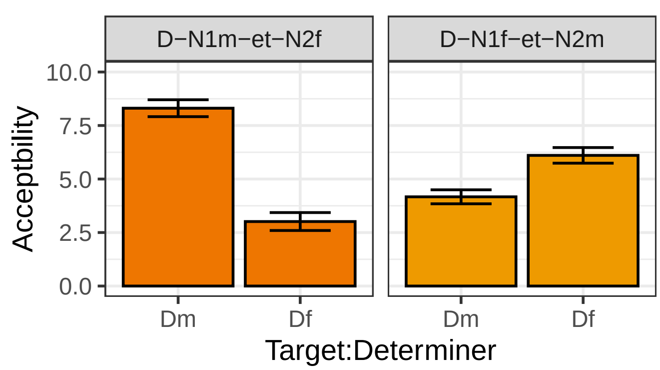
[5]These were the first experiments that we ran in this series of experiments presented in the present thesis. The agreement error involved a simple mismatch between the determiner and the noun. There were no comprehension questions.

39 native French speakers, recruited on the RISC website for the D-N1f-et-N2m experiment (`http://www.risc.cnrs.fr/`), participated voluntarily. We removed 11 participants who rated the ungrammatical controls higher than the grammatical controls, so that 28 participants were kept for analysis. 21 native French speakers were recruited for the D-N1m-et-N2f experiment, of which three participants who rated the ungrammatical controls higher than the grammatical controls were removed (leaving 18 for analyses). They were asked to rate the sentences on a scale from 1 (unacceptable) to 10 (perfect).

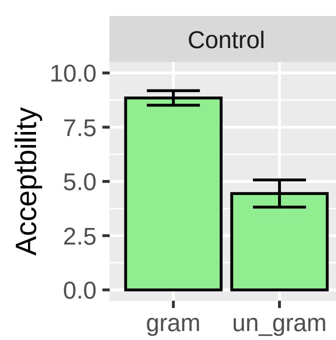
Results are shown in fig. 5.1. When the closest noun was feminine (D-N1f-et-N2m), *certaines* was more acceptable (mean score: 6.11) than *certains* (average score: 4.17), *certains* thus receiving similar average rating as the ungrammatical controls (mean score: 4.03). Closest conjunct agreement (*certaines*, mean score: 6.11) was less acceptable than the grammatical controls (mean score 8.72). When the closest noun was masculine, masculine agreement (mean score: 8.31) was rated slightly less acceptable than the grammatical controls ($mean = 8.77$), whereas feminine agreement which violated both CCA and resolution rules, was not acceptable (mean score 3.01) with average ratings even lower than the mean score for the ungrammatical controls (3.84). [6]

Figure 5.1 – Results of determiner agreement experiments. The control condition is the mean of the two experiments.

(a) and-coordination



(b) Control



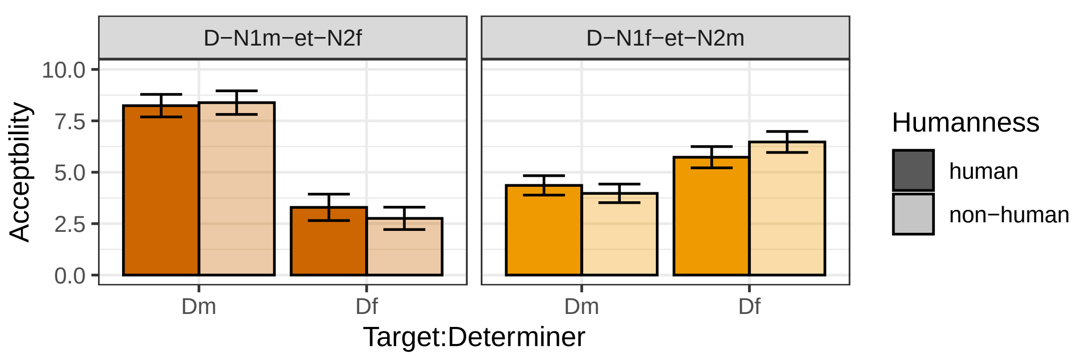
[6]The ungrammatical sentences were rated relatively high in these experiments. It may be caused by the fact that the sentences were usually very long and the mismatch between determiner and noun did not cause comprehension problems.

Effects of Humanness: The acceptability for both human and non-human nouns are reported in fig. 5.2. We fitted a mixed-effects ordinal model for each combination. The fixed effects were D*Humanness with D as a random slope for items. For the D-N1f-et-N2m combination, random slopes for subjects were maximal: D*Humanness, but without the interaction between D and Humanness for the D-N1m-et-N2f combination as models with larger random effect structures would not converge (see details of the results in table B.1 in annexes).

Regarding the combination D-N1f-et-N2m, we found a significant main effect for D ($p = 0.03$), *certaines* was more acceptable than *certains* (table B.1 in appendices). The main effect of humanness was also significant ($p = 0.003$): non-human nouns were more acceptable than human nouns. This difference was particularly caused by the fact that in the combination D-N1f-et-N2m, non-human nouns were rated higher than human nouns for Df. There was a significant interaction between gender and humanness ($p < 0.001$): *certains* was more acceptable with human nouns, while *certaines* was more acceptable with non-human nouns.

For the combination D-N1m-et-N2f, there was only a significant main effect of D (see details of the results in table B.1 in appendices): *certains* was rated higher than *certaines*. The main effect of humanness and the interaction between D and humanness were not significant.

Figure 5.2 – Humanness and determiner gender agreement experiments



With the results of frWaC as well as two acceptability judgement experiments, we can now conclude that for gender agreement, when there was a conflict between resolution rules and closest conjunct agreement, the closest conjunct agreement was privileged: *certaines*-N1fpl-et-N2mpl were frequent and acceptable. In these cases, the resolution agreement (with the benefit for the masculine) is not acceptable.

5.2.2 Experiment II: Adjectives

Attributive adjectives in French can be in pre or post-nominal position, depending on their semantic class (cf., Wilmet, 1981; Bouchard, 1998; Thuilier et al., 2012). For example, indefinites and cardinals are only found in prenominal position (9-a)-(9-b), while size, color or relational adjectives occur postnominally (9-c)(9-d).[7]

(9) a. ces quelques fleurs / *ces fleurs quelques
   DEM.PL some.PL flower.F.PL
   'these few flowers'

b. mes trois amis / *mes amis trois
   my.PL three friend.M.PL
   'my three friends'

c. un repas italien / #un italien repas
   a.M.SG Italian.M.SG meal.M.SG
   'an Italian meal'

d. une pièce ronde / #une ronde pièce
   a.F.SG round.F.SG room.F.SG
   'a round room'

Many evaluative adjectives like *agréable* 'pleasant' (10) can alternate between pre and post-nominal positions with roughly the same meaning (Abeillé and Godard 1999; Thuilier et al. 2012).

(10) a. une agréable soirée (prenominal)
   a.F.SG nice.SG evening.F.SG

[7]As in English, all adjectives must occur after the noun when they have a phrasal dependent: *un bon repas* 'a good meal'/ *un repas bon pour moi* / **un bon pour moi repas* 'a meal good for me', hence the Weight constraint proposed by (Abeillé and Godard 1999) or the [LEX +] constraint by (Sadler and Arnold 1994) for prenominal adjectives.

b. une soirée agréable (post-nominal)
a.F.SG evening.F.SG nice.SG
'a nice evening'

This experiment compares agreement of such attributive adjectives which can be in both prenominal and post-nominal position.

5.2.2.1 Materials

We constructed 24 experimental items, 12 human plural binominals and 12 non-human ones.[8] The items were slightly different from those in the determiner agreement experiments in order to be plausible with pre/post-nominal adjectives. Our adjectives could appear in both pre and post-nominal positions with roughly the same meaning, and they could have scope over the coordination in both positions. We chose human nouns with distinct masculine and feminine forms, to avoid the interference from implicit expectations about social gender bias. We tested the A-N1f-et-N2m combination for prenominal adjective and the N1m-et-N2f-A combination for post-nominal adjective. Only *and-coordination* was tested. We changed the order of binominals so that the closest conjunct was always feminine in order to distinguish CCA from RA. Thus, masculine adjectives corresponded to RA and feminine adjectives corresponded to CCA. With prenominal adjectives, the determiner was *de* in order to force the adjective to have a wide scope (plural *de* was a variant of indefinite *des* only with a prenominal adjective (Milner, 1978)).

We also included 12 control items, with one grammatical version and one version with an agreement error, in order to test the differences between closest conjunct agreement and attraction errors. The ungrammatical version included a closest feminine noun complement.

[8] One non-human item was removed because of a manipulation error. This left us with 11 items with non-human nouns.

Table 5.5 – Conditions and examples for the attributive adjective gender agreement experiment

Condition	Humanness	Sentences
A-N1f-et-N2m	human	De nouvelles/nouveaux **étudiantes et étudiants** sont déjà en stage. INDF.PL new.F.PL/M.PL student.F.PL and student.M.PL are already in internship.
	non-human	De nombreux/nombreuses **nuits et jours** seront nécessaires pour finir ce travail. INDF.PL numerous.M.PL/F.PL night.F.PL and day.M.PL will be necessary to finish this work
N1m-et-N2f-A	human	Des **étudiants et étudiantes** nouvelles/nouveaux sont déjà en stage. INDF.PL student.M.PL and student.F.PL new.F.PL/M.PL are already in internship.
	non-human	Des **jours et nuits** nombreux/nombreuses seront nécessaires pour finir ce travail. INDF.PL day.M.PL and night.F.PL numerous.M.PL/F.PL will be necessary to finish this work
control	gram	Le **fils** de la voisine est content d'aller à l'école. the.M.SG son.M.SG of the.F.SG neighbor.F.SG is happy.M.SG of go to the school
	un-gram	Le **fils** de la voisine est contente d'aller à l'école. the.M.SG son.M.SG of the.F.SG neighbor.F.SG is happy.F.SG of go to the school

5.2.2.2 Participants and Procedures

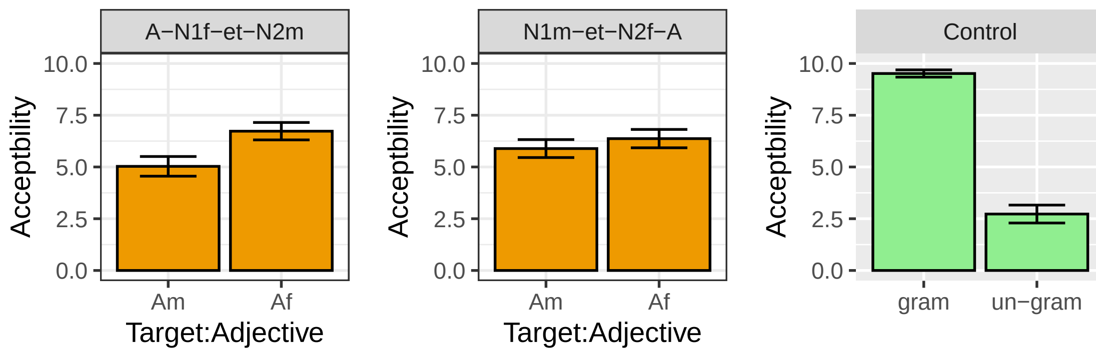
The procedure of the experiment was the same as that in the previous chapter. There were 24 experimental items, 12 controls, 20 distractors (from an unrelated experiment) and 3 practice items in total. Each item rating was followed by a comprehension question (yes/no question).

43 native speakers of French (21 to 82 years old, median = 34, 26 female, 10 male, 3 did not report their gender), recruited on the RISC website (`http://www.risc.cnrs.fr/`) volunteered to participate in the experiment. 3 participants were removed because their accuracy for comprehension questions was less than 75% and one was removed because he/she rated the ungrammatical controls higher than the grammatical controls.

5.2.2.3 Results

The results are shown in fig. 5.3. In general, the experimental items were judged better than the attraction errors (*mean* = 2.73), but worse than the grammatical controls (*mean* = 9.52). Feminine adjectives (*mean* = 6.73 in prenominal position, *mean* = 6.37 in post-nominal position) were also preferred over masculine adjectives (*mean* = 5.03 in prenominal position, *mean* = 5.89 in post-nominal position), and this preference was stronger in prenominal position.

Figure 5.3 – Results of the adjective gender agreement experiment

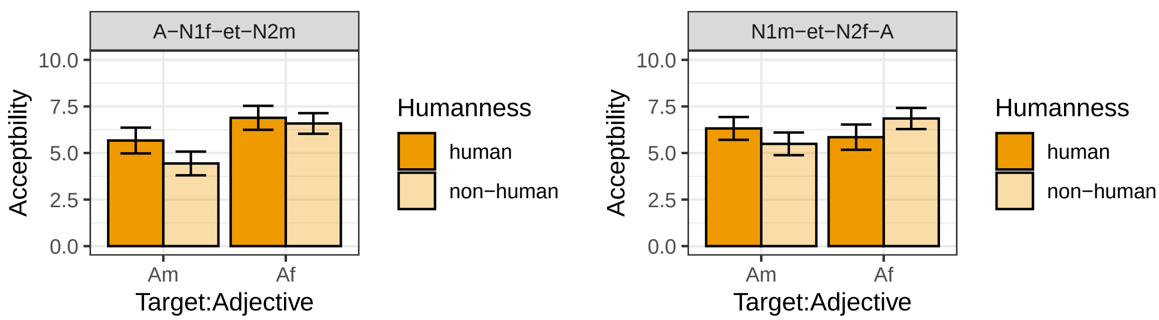


Effects of Directionality: We analysed the data with a mixed-effects ordinal regression model using the *clmm()* function as in the previous analysis. Fixed effects in this model were position (prenominal vs. post-nominal) * We also included maximal random effects (random intercepts and random slopes) for items and subjects. The coefficient of random and fixed effects are presented in Appendices table B.2.

There were no significant main effects of gender and position. But the interaction between gender and position was significant ($p = 0.006$). CCA was particularly preferred in prenominal position, which is consistent with our corpus data (section 5.1.2) and with the typological discovery by Corbett (1991) that CCA is more acceptable when the target precedes the controller.

Effects of Humanness In the A-N1f-et-N2m combination, we ran a similar mixed-effect ordinal regression model as for the previous experiments, with A*Humanness as fixed effects and random slopes for subjects and A as random slopes for items. The results (Appendices table B.3 for more details) showed a significant effect of A gender ($p = 0.01$). As shown in fig. 5.4, in prenominal position, feminine adjectives were preferred with both human nouns and non-human nouns. The theoretical interest lied in the interaction between Humanness and A gender – the difference between Am/Af with non-human nouns was bigger than the one with human nouns, but this interaction was not significant ($p = 0.24$).

Figure 5.4 – Humanness and adjective gender agreement experiments



However, in post-nominal position, masculine adjectives were preferred with human nouns, and feminine adjectives were preferred with non-human nouns. This interaction was significant ($p = 0.004$) in the mixed-effect ordinal regression model. We did not find significant main effects for A gender ($p = 0.59$). Across humanness conditions, masculine and feminine adjectives were equally acceptable. The main effect of Humanness is marginal ($p = 0.07$).

To sum up, CCA was preferred with prenominal adjectives compared to post-nominal adjectives. If we zoom in on the data, the interaction between gender agreement and humanness was significant only in post-nominal position. Masculine (resolution) agreement was more acceptable with human nouns, while feminine agreement (CCA) with non-human nouns (compared with non-human nouns)

5.3 Discussion on Attributive Gender Agreement

5.3.1 Agreement and Directionality

Both our experimental data and corpus data showed an effect of adjective position on gender agreement with coordinate structures. CCA was the only strategy in prenominal position, including determiners and prenominal attributive adjectives, whereas both CCA and resolution agreement were acceptable in post-nominal position. This was the pattern observed in the corpus data and acceptability judgement experiments.

This result consistent with the observation in Corbett 1991 that CCA is preferred when the target precedes the controller. It can be explained by incremental language processing: when the target follows the coordination, speakers process the agreement after seeing the whole coordination; whereas when the target precedes the coordination, speakers see the target first and precipitate in completing the coordination agreement after seeing the first conjunct. We call agreement with the closest conjunct whenever the target precedes the coordination EARLY AGREEMENT (see Chapter 8 for further discussions).

Some accounts take structural proximity into account (Willer-Gold et al., 2017): in head-initial languages, like English and French, the closest conjunct is the highest one (and is structurally closest to the target counting the number of intervening nodes) when the target precedes the controller (prenominal adjectives or postverbal subjects). But this proposal is built primarily on a hierarchical structure of coordination structures (see section 3.2 above).

5.3.2 Agreement and Humanness

Our acceptability rating experiments showed that the preference for CCA was sensitive to humanness. However, the effect of humanness was only significant in some combinations: D-N1f-et-N2m and N1m-et-N2f-A.

But the interaction between agreement and humanness was not significant in D-N1m-et-N2f and A-N1f-et-N2m combinations. We suppose that the lack of a significant effect of humanness may be due to the low number of participants in these experiments, and thus a lack of statistical power.

Table 5.6 – Summary of experimental results for attributive gender agreement

	combination	target	mean	standard deviation (stdev)	standard error (se)
1	D-N1f-et-N2m	Df	6.11	3.14	0.19
2	D-N1f-et-N2m	Dm	4.17	2.84	0.17
3	un-gram_A		4.03	3.48	0.41
4	gram_A		8.72	2.18	0.26
1	D-N1mp-et-N2fp	Dfp	3.01	2.62	0.21
2	D-N1mp-et-N2fp	Dmp	8.31	2.57	0.20
3	un-gram_A		3.84	3.42	0.32
4	gram_A		8.77	2.07	0.20
1	N1m-et-N2f-A	Af	6.37	3.26	0.23
2	N1m-et-N2f-A	Am	5.89	3.20	0.22
3	A-N1f-et-N2m	Af	6.73	3.11	0.21
4	A-N1f-et-N2m	Am	5.03	3.45	0.24
5	gram		9.52	1.31	0.09
6	un-gram		2.73	3.27	0.22

5.4 Gender Agreement and Number Agreement

Comparing the results in this chapter regarding gender attributive agreement with that regarding number attributive agreement in the previous chapter, we observed that in prenominal position, only CCA was acceptable for gender agreement (*certaines/*certains régions et départements* 'some.F.PL/M.PL region.F.PL and department.M.PL), while both CCA and RA were acceptable for number agreement in French (*vos/votre nom et prénom*, 'your.PL/SG name.M.PL and first name.M.PL'). This difference between gender and number in binomial coordination agreement is robust and observed not only in French, but also in other languages. In the corpus study by Villavicencio et al. (2005) in Portuguese, the authors show that prenominal gender agreement only involves CCA, but determiner-noun agreement can involve resolved number, closely tied to the semantics (a singular determiner is only possible with a coordinate structure which denotes a singular entity). In

South Slavic languages, CCA is only observed for gender agreement but not for number agreement in predicative agreement (cf. Marušič et al. 2007; Nevins and Weisser 2019).

The reason why gender agreement is more sensitive to linear proximity is interesting and mysterious. Gender agreement is arbitrary for non-humans, but number agreement is closely related to the meaning. Split binomials referring to a plural entity trigger plural agreement. However, the resolution rule that masculine and feminine are resolved to masculine is a prescriptive rule and begins to be criticized by feminists (cf. Viennot et al. 2018).

So far, we tested gender and number agreement independently, i.e. an experiment tested either gender agreement or number agreement. In order to better understand the differences between number and gender agreement, we ran two experiments comparing number and gender agreement in prenominal position: one acceptability judgment and one self-paced reading. The aim of these experiments was to find on the one hand whether CCA causes processing difficulties; and on the other hand whether the difficulties for gender and number agreement are the same and occur at the same time.

5.4.1 An Acceptability Rating Experiment

The experiment was a 2 (agreement: CCA/RA) $\times$ 2 (feature: gender/number) design (table 5.7). We chose two combinations: D-N1f-et-N2m for gender agreement and D-N1sg-et-N2sg for number agreement, because in these two combinations CCA was different from the resolution rule. All the nouns were human. The closest N1 had the same lemma in both conditions: it was feminine singular in the condition **CCA/RA number** but feminine plural in the condition **CCA/RA gender**. N2 also had the same lemma in both conditions: it was in the feminine singular form in the condition **CCA/RA number** and the feminine plural form in the condition **CCA/RA gender**. That is to say, each noun must have a distinct masculine and feminine form, as well as a singular and plural form. As a result, the sentence involved either number or gender agreement, rather than both. In the condition **CCA/RA number**, the Dsg showed CCA in number while the Dpl showed resolution agreement. In the condition **CCA/RA gender**, the Df showed CCA in gender while the Dm showed resolution agreement. Moreover, N1 and N2 could not refer to the same person to avoid coreference.

Table 5.7 – Conditions and examples for the number/gender acceptability experiment

Condition	Examples
CCA/RA number	L'entretien ennuie la/les candidate et recruteuse malgré les pauses. The interview bores the.F.SG/PL candidate.F.SG and recruiter.F.SG notwithstanding the breaks.
CCA/RA gender	L'entretien ennuie certains/certaines candidates et recruteurs malgré les pauses. The interview bores some.M.PL/F.PL candidate.F.PL and recruiter.M.PL notwithstanding the breaks.

5.4.1.1 Participants and Procedures

The procedures were the same as in the previous chapter. There were 24 experimental items, 20 distractors (from an unrelated experiment) and 3 practice items in total. One third of the items were associated with a comprehension question in order to check whether the participants were paying attention.

38 native speakers of French were recruited on the RISC website (`http://www.risc.cnrs.fr/`) and volunteered to participate in the experiment. 3 participants were removed because their accuracy for comprehension questions was less than 75%. One participant was removed because he/she did not report his/her mother language and one participant was removed because he/she was younger than 18. So the results of 33 participants were kept for the final analysis (18 to 75 years old, median age = 28, 23 female, 10 male),

5.4.1.2 Results

The results are shown in fig. 5.5. The preference of CCA/RA corresponds to the findings in the previous experiments. CCA was preferred for gender ($mean = 7.37$ for CCA and $mean = 6.45$ for RA), while CCA and RA were equally acceptable for number ($mean = 7.02$ for CCA and $mean = 6.91$ for RA).

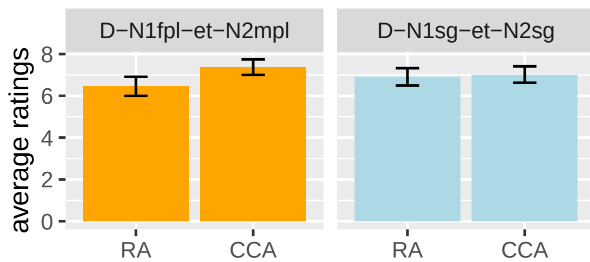


Figure 5.5 – Results of acceptability rating experiments comparing gender and number agreement

The averaged ratings in this experiment were higher than that in the previous ones because we did not include the grammatical controls. The criteria that the averaged median for grammatical sentences must be bigger than for ungrammatical sentences could not be applied to check whether participants paid attention during the experiment. This criteria usually resulted in a lower acceptability rating in general (see a comparison of the results before and after removing such participants of other experiments in Appendices).

We analysed the data with a mixed-effects ordinal regression model using the *clmm()* function as usual. The fixed effects in this model were agreement (CCA vs. RA) * feature (gender vs. number). We also included maximal random effects (random intercepts and random slopes) for items and subjects (the coefficients of the fixed effects are presented in the Appendices table B.4). No significant effects were found. A lack of effects may due to a lack of participants, hence a lack of statistical power.

5.4.2 A Self-paced Reading Experiment

We used a self-paced reading paradigm (firstly introduced by Just et al. 1982), in which sentences are presented region-by-region (one region can be one or multiple words). Participants could see only one region in the window, they should push the mouse button in order to move to another window (fig. 5.6). We recorded the reading time for each window. This paradigm allows readers to use button presses to control the exposure duration for each region of a text they read. The latencies of the button presses depend on the properties of the words being read and correlate with the time course of the cognitive processes during reading and text comprehension.

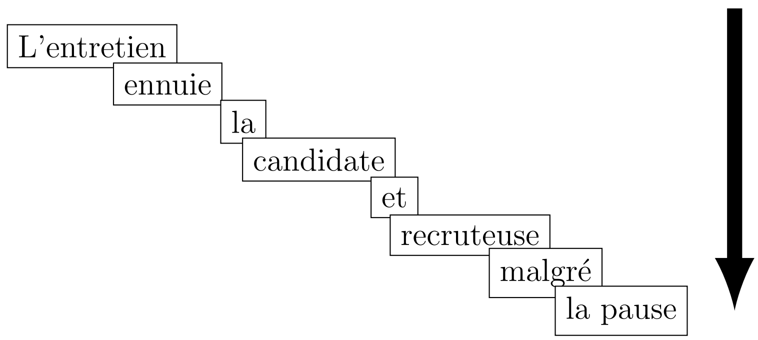


Figure 5.6 – Illustration of self-paced reading experiment. In order to move from one window to another, participants should press the moose button.

The materials were exactly the same as in the acceptability rating experiment. Each sentence was presented with 8 regions (separated by | in section 5.4.2). The critical region should be N1, et, N2, and N2+1. One third of the sentences were followed by a comprehension question. There were 24 experimental items [9] and 24 fillers from another irrelevant experiment about island structures. All the items were randomized with Latin square. Each participant could see a set of 48 sentences.

5.4.2.1 Procedures and participants

The experiment was carried out on a Windows XP computer running the E-Prime experimental software (Psychology Software Tools, Pittsburgh, PA), in a normally illuminated room, with the participant sitting a natural distance from the keyboard and monitor.

At the beginning, the participants should fill a questionnaire asking information of gender, age, mother languages, etc. After that, the trial would begin. There was first a practice phase with three sentences and associated comprehension questions, and then the actual experiment. Participants should use the mouse button to move through the

[9] One item was removed because a manipulation error. Thus there were 23 items kept for the final analysis.

Table 5.8 – Conditions and examples for the number/gender self-paced reading experiment

Condition	Examples				
CCA/RA number	**Subj** | L'entretien | The interview	**Verb** | ennuie | bores	**D** | la/les | the.F.SG/PL	**N1** | candidate | candidate.F.SG	**et** | et | and
	N2 | recruteuse | recruiter.F.SG	**N2+1** | malgré | notwithstanding	**N2+2** les pauses. the breaks.		
CCA/RA gender	**Subj** | L'entretien | The interview	**Verb** | ennuie | bores	**D** | certains/certaines | some.M.PL/F.PL	**N1** | candidates | candidate.F.PL	**et** | et | and
	N2 | recruteurs | recruiter.M.PL	**N2+1** | malgré | notwithstanding	**N2+2** les pauses. the breaks.		

sentence, and press Y or N to answer the comprehension questions.

44 participants were recruited to participate the experiments and they received 5 euros after finishing the experiment. The results of 40 participants were kept with comprehension accuracy >75%. Responses that were shorter than 200 ms or longer than 4000 ms were excluded from analysis, eliminating 0.1% of the experimental trials (8 out of 7912).

5.4.2.2 Results

In fig. 5.7 we report the total reading time for the ease of presentation. The four conditions differed from each other in the regions N1, N2 and N2+1. The differences in the region D were the result of word length (*certaines/certains* was much longer than *le/la*, thus caused longer reading time).

For each region, we only report residual reading times, which take into account the effects of word length (number of characters). This effectively reduced variability due to individual differences in reading times.

The analyses of each factor were carried out using linear mixed-effects regression models with the *lme4* R package (Bates et al., 2015). Participants and items were crossed random effects, and the two experimental factors (agreement, feature) were crossed fixed effects in

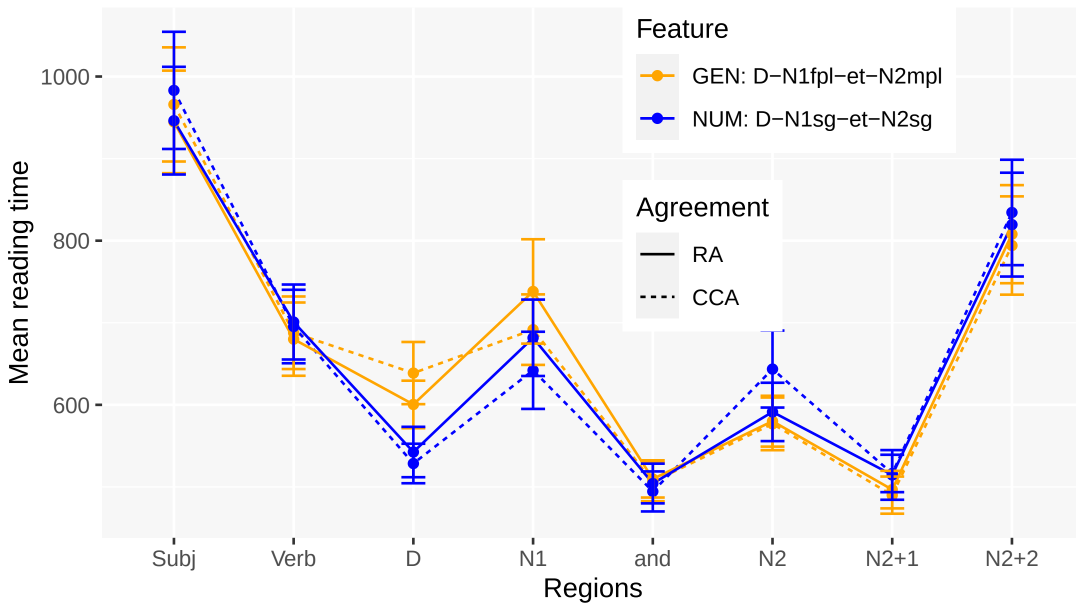


Figure 5.7 – Total reading time for each condition and for each region

each model analysis (detailed results in appendices table B.5).

Beginning at the N1 region, Figure 5.8 shows that the CCA was read faster than the resolution agreement. In the model analysis, we started with a model that included all random slopes, but due to a failure to converge, the random effects structure was simplified until the largest converging model was achieved. The random slope for subjects was feature and agreement without interactions while the random slopes for items was feature. No significant effects were found for any factors.

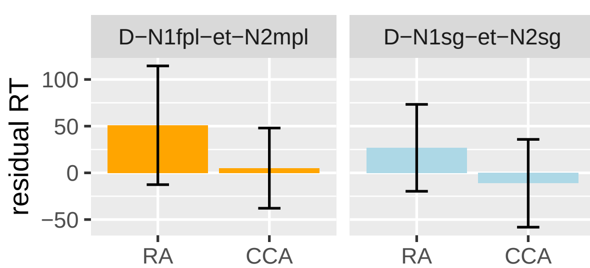


Figure 5.8 – Residual reading time of region N1

In the N2 region, there was a clear difference between number and gender, especially because the CCA in number was read slower (fig. 5.9). We analysed the result with a maximal-mixed effects model. There were significant effects of feature ($p = 0.02$). The interaction between feature and agreement was marginal ($p = 0.09$). This result highlights that the difference between the features arises in the N2 region after the participants had seen the whole coordination phrase. Both RA and CCA caused processing difficulties, but the CCA was especially slow. However, surprisingly, neither CCA nor RA caused processing difficulties for gender agreement.

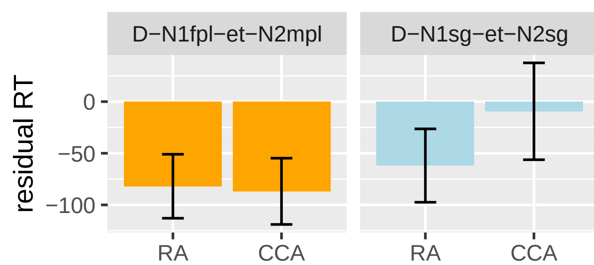


Figure 5.9 – Residual reading time of region N2

We tested whether there was a spillover effect — continuous effects even after the eyes have left the word (Mitchell, 1984; Rayner, 1998) — in the N2+1 region (fig. 5.10). We analysed the results with a maximal mixed-effects model and found no significant effects.

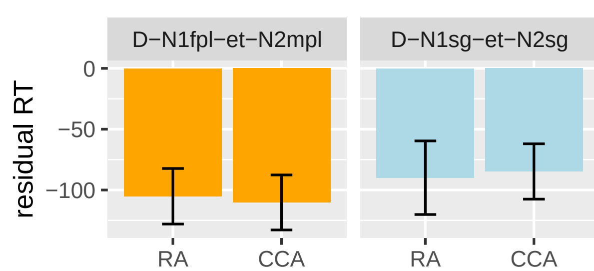


Figure 5.10 – Residual reading time of region N2+1

In conclusion, we found differences between gender and number in the N2 region. Number agreement was processed much slower than gender agreement at the last conjunct of the coordination phrase. Neither CCA nor RA in gender caused processing difficulties, while CCA in number caused a long latency. This may illustrate why CCA is acceptable for gender, but not for number. We speculate that speakers disliked mismatch between the D and the N1 and considered it as an error at the first glance, RA for gender was not acceptable. This mismatch difficulty may be compensated by a meaning interpretation for number (only plural noun is compatible with the context) but not for gender.

Chapter 6

Predicative Number Agreement

In order to examine whether the pattern that we observed in the nominal domain remains the same in the verbal domain, this chapter and the following chapter focus on verbal agreement. This chapter studies (predicative) number agreement, and the next one will present data on (predicative) gender agreement.

In French, the verb is morphologically marked for subject number ((1-a) and (1-b)). However, the main verb is not marked for gender ((1-a) and (1-c)), but the predicative adjective is (2). This thesis compares number agreement of the main verb on the one hand, with gender agreement of the predicative adjective on the other hand.

(1) a. L' **infirmier** **viendra**.
the.SG nurse.M.SG come.FUT.3.SG

b. Les **infirmiers** **viendront**.
the.PL nurse.M.PL come.FUT.3.PL

c. L' **infirmière** **viendra**.
the.SG nurse.F.SG come.FUT.3.SG

(2) a. L' **infirmier** est **satisfait**.
the nurse.M.SG is satisfy.M.SG

b. L' **infirmière** est **satisfaite**
the nurse.F.SG is satisfy.F.SG

Furthermore, French is often described as a language with a basic subject-verb word order (SV), but in some contexts, the subject can follow the verb (VS) (Kayne and Pollock, 1978).

(3) L' homme avec lequel est sortie Marie s'appelle Jacques.
the man with whom has gone out Marie is named Jacques.
'The man who Marie has gone out with is named Jacques.' (Kayne and Pollock, 1978: 595–598)

Leaving aside the clitic inversion (*Vient-il?* 'comes-he?'), which is a suffixation compatible with a preverbal subject (*Paul vient-il?* 'Paul comes-he?') (Huot, 1986; Miller, 1992). Marandin (2011) distinguishes three kinds of NP subject inversion in French: i) inversion in extraction contexts (4-a); ii) inversion via permutation only for heavy subjects (4-b); and iii) presentative inversion (4-c), which can only apply to unaccusative verbs for which postverbal NPs are analysed as objects.

(4) a. Ma voiture, qu' a soigneusement révisée mon copain Pierre, devrait passer le test pollution sans problème.
My car, which has carefully overhauled my friend Pierre, should pass the pollution test without problem.
'My car my pal Pierre has carefully overhauled should pass the pollution test easily'

b. Ne sont pas des pièces d'identité les cartes de crédit et le permis de conduire
NEG are not the IDs the cards of credit and the driving license
'The credit cards and the driving license are not IDs'

c. Alors entrèrent deux soldats.
Then entered two soldiers entered
'Then two soldiers entered'

In what follows we only test the inversion in extraction contexts, which is the more common case in French. This inversion is not constrained by the characteristics of verbs or subjects.

As has been discussed in section 2.1.2, French descriptive sources allow both singular and plural agreement with *or-coordination*, but prescribes a resolution rule for *and-coordination*. This chapter will present the empirical data about predicative number agreement, regarding *and-coordination* and *or-coordination*, with both SV order and VS order.

6.1 FTB Agreement Patterns

First of all, we searched the French Treebank (Abeillé et al., 2019) for number predicative agreement patterns with *et* (and) and *ou* (or). The French Treebank is a sizable resource based on newspaper text (LeMonde) annotated for syntactic relations (`http://ftb.linguist.paris-univ-diderot.fr`). We searched for subject coordinate NPs and filtered out the results [1]. We present statistics for subject number agreement patterns in the French Treebank (FTB) in table 6.1.

Condition	Vsg	Vpl	total
NP1pl-et-NP2pl	1	116	116
NP1sg-et-NP2pl	0	50	50
NP1pl-et-NP2sg	0	30	30
NP1sg-et-NP2sg	5	288	293
NP1pl-ou-NP2pl	0	14	14
NP1sg-ou-NP2pl	0	0	0
NP1pl-ou-NP2sg	0	1	1
NP1sg-ou-NP2sg	5	8	13

Table 6.1 – Verb Number agreement patterns in the FTB

In most cases, plural agreement was used for both *and-coordination* (5-a) and *or-coordination* (5-b). However, singular agreement was found when two singular nouns were involved, especially with *or-coordination* (38.5% for *or-coordination* (6-b),(6-c), 1.6% for *and-coordination* (6-a)).

[1] I would like to thank Merit Kudlepp for her the help; she was an intern at LLF in June 2019

(5) a. ...la rentabilité ou la non-rentabilité **dépendent**
the.F.SG profitability or the.F.SG non-profitability depend.PRS.3.PL
du marché
of.DEF.M.SG market
'the profitability or the non-profitability depends on the market'

b. La France et l' Allemagne **occupent** une place prédominante ...
the France and the Germany occupy.PRS.3.PL a place predominant...
'France and Germany occupy a predominant place'

(6) a. Ce glissement progressif de la terre vers l' océan, et l' isolement
this shift gradual from the land to the ocean, and the isolation
qui en découle, **offre** des avantages appréciables
which GEN.3.SG results, offer.PRS.3.SG INDF.PL benefits significant
'The gradual shift of the land into the Ocean, and the isolation which results from it, offers some significant benefits'

b. ... chaque gradé ou gendarme d' active **recevra** une liste
each officer or policeman of activity receive.FUT.3.SG a list
des candidats correspondant à son grade
of.DEF.PL candidates corresponding to his grade
'each active officer or policeman will receive a list of candidates corresponding to his grade'

c. Quand un bateau de plaisance ou un scooter **heurte** un baigneur ...
when a boat of pleasure or a scooter hits a bather
'when a recreational boat or a scooter hit.PRS.3.PL a swimmer'

When the verb was singular, sometimes the coordinate subject shared a common determiner (6-b), but most of the cases were NP coordinations (6-a),(6-c). In cases of disjunctions *X or Y*, X and Y were usually semantically disjoint. However, disjunctions of terms can express 'lexical uncertainty' (cf. Potts and Levy 2015). This was the case of (6-b): 'gradé' ('officier') and gendarme ('policeman') stand in an entailment relation (*gradé* entails *gendarme*). The use of disjunction was 'part of a speaker strategy to manage lexical uncertainty surrounding the two terms, or block unwanted implicatures that the listener might draw from the general term alone' (Potts and Levy 2015).

There were relatively few examples for *and-coordination* with a Vsg (6-a). In absolute numbers there were 5 cases altogether in both environments (a Vsg with *and* and *or*), but a Vpl was more frequent with *and-coordination*. In (6-a), there was a comma and the second NP could be analysed as an incidental adjunct (Abeillé, 2005).

6.2 Experimental data

To test number agreement, we chose singular nouns with the same gender in order to avoid interactions with gender agreement. For attributive agreement we tested noun coordination (with a common D), while for predicative agreement we tested NP coordination (with a D preceding each N). Coordinate nouns with a common D were possible as subjects, but determiner agreement would interact with predicate agreement ((7-a) and (7-b)). So we chose full NP subjects (7-c) in order to only test predicate agreement.

(7) a. Vos nom et prénom seront écrits à l'encre
your.PL surname.M.SG and name.M.SG be.FUT.3.PL written.PL in ink
noire.
black

b. Votre nom ou prénom sera écrit à l'encre
your.SG surname.M.SG and name.M.SG be.FUT.3.SG written.SG in ink
noire.
black

c. Votre nom et votre prénom sera/seront écrit/écrits à
your.SG surname.M.SG and your.SG name.M.SG be.FUT.3.PL written.PL in
l'encre noire.
ink black
'Your name and surname will be written in black ink.'

Furthermore, we tested embedded subjects in predicate agreement (8) rather than matrix subjects as in the attributive agreement experiments (9). The indirect questions (and intransitive verbs) were natural contexts for the subject inversion (Marandin, 2011; Bonami and Godard, 2001), so that the coordination could be plausible with both SV and VS orders. With the VS order, there was also an intervening determiner between the target and the closest noun.

We slightly changed the coordinated nouns from the attributive agreement experiments so that they were plausible in the predicate agreement condition.

(8) a. Je me demande quand le maire et l' adjoint viendra/viendront.
I wonder when the mayor.SG and the deputy.SG comeFUT.SG/PL

b. Je me demande quand viendra/viendront le maire et l' adjoint.
I wonder when comeFUT.SG/PL the mayor.M.SG and the deputy.M.SG
'I wonder when the mayor and the deputy will come.'

(9) a. Il faudrait aller voir le/les maire et adjoint à la mairie.
It should go see the.M.SG/PL mayor.SG and deputy.SG in the town hall
'You should go see the mayor and assistant to the town hall.'

b. Il faut beaucoup d' énergie pour obtenir la position de maire et adjoint titulaire/titulaires.
It should a lot of energy to obtain the position of mayor.SG and deputy.SG titular.SG/PL.
'It takes a lot of energy to get the position of mayor and deputy titular.'

6.2.1 Materials and procedures

For predicative number agreement, we ran three acceptability rating experiments for *or-coordination*: one for NP1sg-ou-NP2sg-V and V-NP1sg-ou-NP2sg combinations (we call it "NP1sg-ou-NP2sg experiment"), one for NP1sg-or-NP2pl-V and V-NP1sg-or-NP2pl combinations (we call it "NP1sg-ou-NP2pl experiment"), and one for NP1pl-ou-NP2sg-V and V-NP1pl-ou-NP2sg combinations (we call it "NP1pl-ou-NP2sg experiment"). Two word orders were tested: subject-verb, verb-subject (Table 6.2). As in the previous experiments, half of the experimental items were with human nouns and half with non-human nouns. Thus there were eight conditions in each experiment, for instance NP1sg-ou-NP2sg-Vsg/pl +/-human, Vsg/pl-NP1sg-ou-NP2sg +/-human. All the experimental items were followed by a comprehension question. 12 control items with attraction errors were the same as in the attributive number agreement[2], and 20 fillers from another independent experiment were included. [3]

We ran one experiment for *and-coordination*, only testing SV order since agreement with *and-coordination* was very strongly expected to be plural (see the materials in Appendix section C.1).

The procedures were the same as in the previous experiments. There were 56 participants recruited for the NP1sg-ou-NP2sg experiment (48 participants kept after removing participants whose comprehension accuracy was lower than 75% and the averaged median of the grammatical controls is higher than the ungrammatical controls, median age=32, 33 women, 14 men, 1 non reported), 48 participants for the NP1pl-ou-NP2sg experiment (39 participants kept after removing participants using the same criteria above, median age=23, 31 women, 8 men), 54 participants for the NP1sg-ou-NP2pl experiment (50 kept after removing participants using the same criteria, median age= 27.5, 33 women, 17 men). 26 participants for *and-coordination* (22 kept after removing participants using the same criteria, median age= 22.5, 18 women, 4 men). Participants were recruited on the French RISC site for volunteers and their participation in the experiments was voluntary.

Table 6.2 – Conditions and examples in predicative number agreement experiments. Different experiments are separated by the double lines

Combination	Humanness	Sentences
NP1sg-ou-NP2sg-V	human	Je me demande où **le maire ou l'adjoint** va/vont aller. I wonder where the mayor and the deputy FUT.SG/PL go
	non-human	J'ignore à quel point **le livre ou le film** va/vont m'intéresser. I do not know to which point the book or the movie FUT.SG/PL ACC.1.SG interest
V-NP1sg-ou-NP2sg	human	Je me demande où va/vont aller **le maire ou l'adjoint**. I wonder where FUT.SG/PL go the mayor or the deputy
	non-human	J'ignore à quel point va/vont m'intéresser **le livre ou le film**. I do not know to which point FUT.SG/PL ACC.1.SG interest the book or the movie
NP1sg-ou-NP2pl-V	human	Je me demande où **le maire ou les adjoints** va/vont aller. I wonder where the mayor and the deputies FUT.SG/PL go

[2]In *or-coordination* experiments, the control items were the same as in attributive number agreement, there were no control items in the *and-coordination* experiment.

[3]The fillers were not the same in the three experiments, but they were all from a series of experiments about subject island constructions.

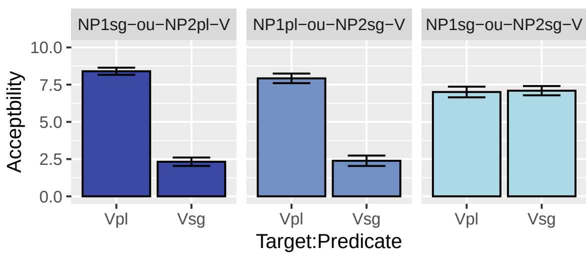
	non-human	J'ignore à quel point **le film ou les livres** va/vont m'intéresser. I do not know to which point the movie or the books FUT.SG/PL ACC.1.SG interest
V-NP1sg-ou-NP2pl	human	Je me demande où va/vont aller **le maire ou les adjoints**. I wonder where FUT.SG/PL go the mayor or the deputies
	non-human	J'ignore à quel point va/vont m'intéresser **le film ou les livres**. I do not know to which point FUT.SG/PL ACC.1.SG interest the movie or the books
NP1pl-ou-NP2sg-V	human	Je me demande où **les adjoints ou le maire** va/vont aller. I wonder where the deputies and the mayor FUT.SG/PL go
	non-human	J'ignore à quel point **les livres ou le film** va/vont m'intéresser. I do not know to which point the books or the movie FUT.SG/PL ACC.1.SG interest
V-NP1pl-ou-NP2sg	human	Je me demande où va/vont aller **les adjoints ou le maire**. I wonder where FUT.SG/PL go the deputies or the mayor
	non-human	J'ignore à quel point va/vont m'intéresser **les livres ou le film**. I do not know to which point FUT.SG/PL ACC.1.SG interest the books or the movie
NP1sg-et-NP2sg-V	human	Je me demande où **le maire et l'adjoint** va/vont aller. I wonder where the mayor and the deputy FUT.SG/PL go
	non-human	J'ignore à quel point **le livre et le film** va/vont m'intéresser. I do not know to which point the book and the movie FUT.SG/PL ACC.1.SG interest
NP1pl-et-NP2sg-V	human	Je me demande où **les adjoints et le maire** va/vont aller. I wonder where the deputies and the mayor FUT.SG/PL go
	non-human	J'ignore à quel point **les livres ou le film** va/vont m'intéresser. I do not know to which point the books or the movie FUT.SG/PL ACC.1.SG interest
NP1sg-et-NP2pl-V	human	Je me demande où **le maire et les adjoints** va/vont aller. I wonder where the mayor and the deputies FUT.SG/PL go
	non-human	J'ignore à quel point **le film et les livres** va/vont m'intéresser. I do not know to which point the movie and the books FUT.SG/PL interest me
midrule NP1pl-et-NP2pl-V	human	Je me demande où **les maires et les adjoints** va/vont aller. I wonder where the mayors and the deputies FUT.SG/PL go
	non-human	J'ignore à quel point **les films et les livres** va/vont m'intéresser. I do not know to which point the movies and the books FUT.SG/PL interest me
control	grammatical	**La mère** des enfants ira à l'école demain. the.F.SG mother of.DEF.PL children go.FUT.SG to the school tomorrow
	ungrammatical	**La mère** des enfants iront à l'école demain. the.F.SG mother of.DEF.PL children go.FUT.PL to the school tomorrow

6.2.2 Results

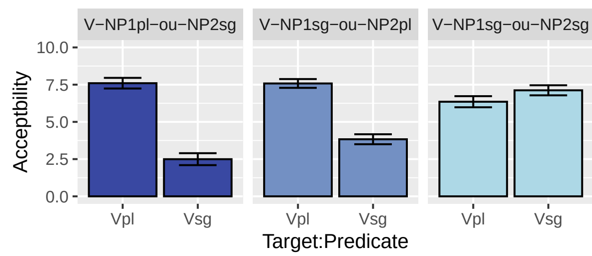
In order to be able to compare results across conditions, the results of all the experiments are illustrated in fig. 6.1 with *or-coordination* on the top and *and-coordination* on the bottom, SV order on the left and VS order on the right. The means presented for the control conditions are averaged across the three *or-coordination* experiments.[4]

Figure 6.1 – Results of predicative number agreement experiments

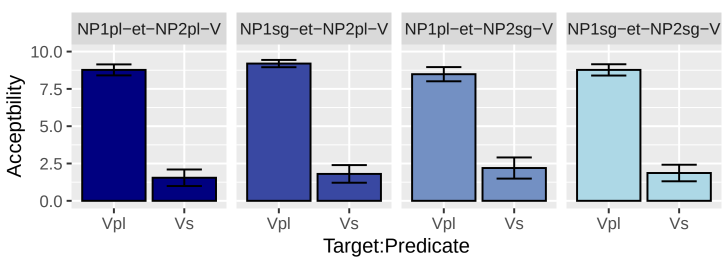
(a) *or-coordination*-SV order



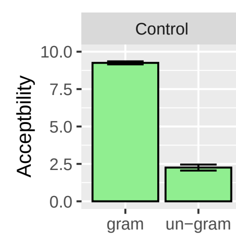
(b) *or-coordination*-VS order



(c) *and-coordination*-SV order



(d) Control



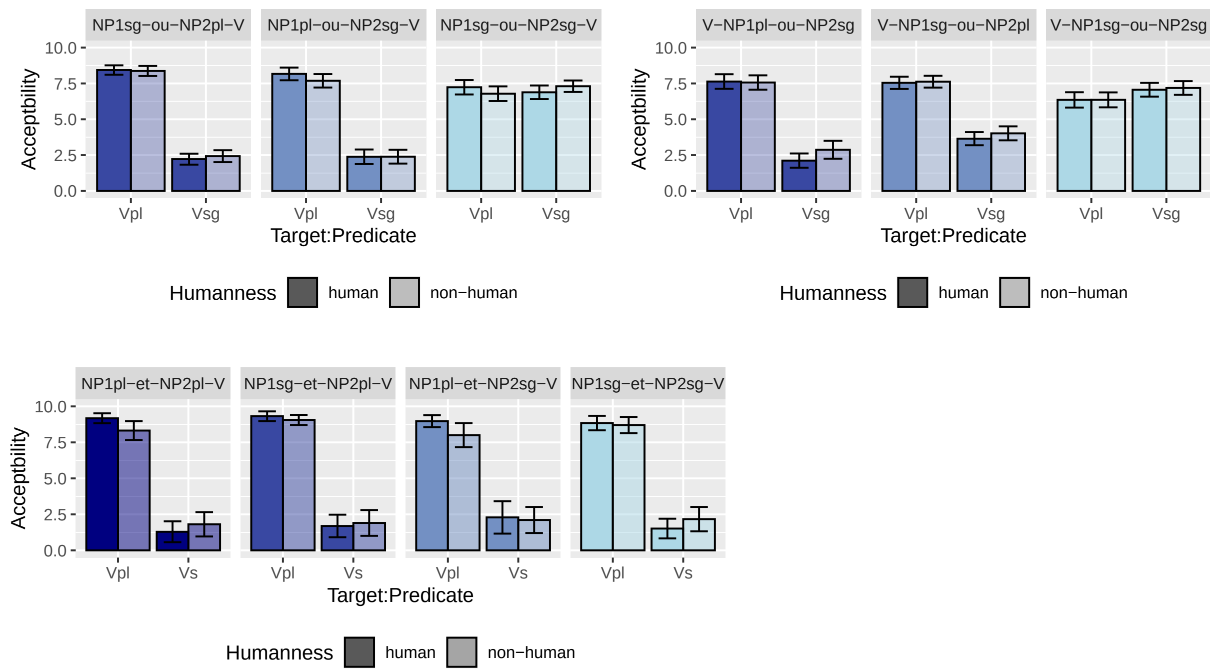
The distinction between human nouns and non-human nouns in the different experimental conditions is illustrated in fig. 6.2. Darker shades in each sub-figure correspond to human, lighter shades to non-human conditions.

For *and-coordination*, there was a clear distinction between the Vsg and the Vpl. Only the Vpl was acceptable regardless of the number of the conjuncts, as expected. The following sections concentrate on different combinations of *or-coordination*.

[4]The control items were rated as 9.22 (gram)/1.44 (un-gram) in NP1pl-conj-NP2sg experiment, 9.21 (gram)/ 1.74 (un-gram) in NP1sg-conj-NP2pl experiment, 9.30 (gram)/3.66 (un-gram) in NP1sg-conj-NP2sg experiment

Figure 6.2 – Effects of humanness in predicative number agreement experiments

(a) SV order **(b)** VS order



6.2.2.1 *or-coordination*: with two singular Nouns

For *or-coordination*, with two singular disjunct NPs (the lightblue bars on the top of fig. 6.1), both singular and plural verbs were acceptable, with both VS ($mean$ = 7.12 for the Vsg, 6.35 for the Vpl) and SV orders ($mean$ = 7.09 for the Vsg, 7.01 for the Vpl).

Effects of Directionality: In order to test the effects of the directionality on number agreement, we fitted a maximal mixed-effect ordinal model, with word order (VS vs. SV) and verb number (Vpl vs. Vsg) and their interaction as fixed effects. We also included random intercepts and word order * V as random slopes for items and for subjects. There was a significant interaction between number agreement and word order ($p = 0.03$) (see Appendix table C.1 for details). This effect was mainly caused by plural verbs, which were rated lower in the V-NP1sg-ou-NP2sg combination (when the target preceded the coordination) than in the NP1sg-ou-NP2sg-V combination (when the target followed the coordination). Directionality had a little effect on singular verbs ($mean$ = 7.12 with the

VS order and 7.01 with the SV order).

In addition, there was a significant main effect of word order ($p = 0.02$): the SV order was more acceptable than the VS order. No significant effect of agreement was found ($p = 0.17$): singular and plural verbs were equally acceptable.

Effects of Humanness: We fitted an ordinal regression model for each combination: V-NP1sg-ou-NP2sg, NP1sg-ou-NP2sg-V, with the fixed effects V * Humanness, as well as V as random slopes for items and V * Humanness as random slopes for subjects for the SV order combination and without the interaction for the VS order combination (see Appendices table C.2) [5]. The only environment in which the interaction between verb agreement and Humanness was significant was NP1sg-ou-NP2sg-V ($p = 0.04$): a Vpl was more acceptable for human nouns while a Vsg was more acceptable for non-human nouns. However, this interaction was not significant when the target preceded the coordination ($p = 0.7$). There was no main effects of humanness and verb number in either of the combinations – human nouns and non-human nouns were equally acceptable, and singular and plural verbs were also equally acceptable.

6.2.2.2 *or-coordination*: when the closest conjunct is singular

When there was at least one plural conjunct, the distinction between Vsg and Vpl was nearly categorical, only the Vpl was acceptable even when the closest noun was singular.

Effects of Directionality: If we compare SV and VS orders when the closest noun was singular (NP1pl-ou-NP2sg-V vs. V-NP1sg-ou-NP2pl), plural verbs, which violated CCA, were rated slightly lower with the VS order ($mean = 7.58$) than with the SV order ($mean = 7.92$). However, singular verbs rated higher with the VS order ($mean = 3.83$) than with the SV order ($mean = 2.39$).

We fitted an ordinal regression model similar to the one employed for two disjunct singular nouns except that we included only V as random slope for subjects since the two

[5] We did not analyze effects of humanness with *and-coordination* as there were not enough participants

different word orders were tested in two different experiments. There was a significant interaction between verb number and word order ($p < 0.001$) (see Appendix table C.3 for details). Singular verbs were more acceptable with the VS order than with the SV order, whereas plural verbs were less acceptable with the VS order. The effect of verb number was also significant ($p < 0.001$): plural verbs were more acceptable than singular verbs. Word order was not significant ($p = 0.33$)

Effects of Humanness: We fitted an ordinal regression model separately for combinations V-NP1sg-ou-NP2pl and NP1pl-ou-NP2sg-V, with the same main factors as for two singular disjunct nouns and including maximal random effects (see Appendices table C.4 for details). A marginal interaction between V and Humanness was found for the NP1pl-ou-NP2sg-V condition ($p = 0.07$). Plural verbs were more acceptable for human nouns, while singular verbs were more acceptable for non-human nouns. The interaction was not significant when the target preceded the controller (V-NP1pl-ou-NP2sg) ($p = 0.66$). Verb number was significant in both conditions, plural verbs were more acceptable than singular verbs. The main effect of Humanness was not significant.

6.2.2.3 *or-coordination*: when the closest conjunct is plural

When the closest noun was plural (NP1sg-ou-NP2pl-V vs. V-NP1pl-ou-NP2sg), plural verbs were also rated lower with the VS order ($mean = 7.6$) than with the SV order ($mean = 8.40$), whereas singular verbs were rated similarly with both SV order ($mean = 2.5$) and VS order ($mean = 2.59$)

Effects of Directionality: In order to test the effects of directionality, we fitted an ordinal model with the same factors as employed for items where the closest noun was singular (see Appendix table C.5 for details). The effects of word order and verb number were also significant for these conditions ($p < 0.001$), the SV order was more acceptable than the VS order, and plural verbs were more acceptable than singular verbs. The interaction between V and position was significant ($p = 0.003$): plural verbs were more acceptable with the SV than with the VS order.

Effects of Humanness: We tested the effect of Humanness with an ordinal regression model for each combination: NP1sg-ou-NP2pl-V and V-NP1pl-ou-NP2sg, with the same factors as for singular closest conjuncts (see details in Appendix table C.6). No interaction between Humanness and verb agreement was found in any of the conditions ($p = 0.19$ for the V-NP1pl-ou-NP2sg while $p = 0.55$ for the NP1sg-ou-NP2pl-V). The main effect of Humanness was not significant either. But verb agreement was significant: plural verbs were more acceptable than singular verbs.

6.3 Discussion

6.3.1 Subject-Predicate Inversion

The effects of directionality on number agreement were consistent across all the *or-coordination* experiments. This effect was robust for plural agreement when the closest noun was singular. Violation of CCA (Vpl) when the closest noun was singular showed a bigger penalty when the target was before the controller. However, when the closest noun was plural, singular agreement which violated CCA was as unacceptable with the SV order as with the VS order. One hypothesis for a lack of effects of directionality in such cases can be that singular verbs were already unacceptable with the SV order (mean around 2.5). The violation of CCA did not cause any more degradation when the target preceded the coordination. [6]

To explain these differences in predicative position, we must also take into account the properties that characterize the subject-predicate inversion in French. Inverted subjects have different properties from preverbal subjects. For instance, French allows subject-predicate inversion within a clause introduced by a *wh-word* (10-a) but embedded "yes-no"

[6]Furthermore, we also found that the singular verbs were more acceptable in the Vsg-NP1sg-or-NP2pl than in the NP1pl-or-NP2sg-Vsg condition, and plural verbs were more acceptable in the NP1sg-or-NP2pl-Vpl than in the Vpl-NP1pl-or-NP2sg condition as well. This is puzzling since such results are not covered by the hypothesis that when the target precedes the controller, the violation of CCA has a bigger penality on acceptability. Since SV and VS orders were tested in two different experiments, participants may use different scales for their responses. The reasons for such effects are unclear.

questions cannot trigger subject-predicate inversion (10-b) (Kayne and Pollock, 1978).

(10) a. Je me demande quand partira ton ami.
I wonder when will leave your friend
'I wonder when your friend will leave.' (Kayne and Pollock 1978, p.595)

b. *Je me demande si partira ton ami.
I wonder if will leave your friend
'I wonder if your friend will leave.' (Kayne and Pollock 1978, p.596)

The inverted subject has some complement-like properties, such as allowing for nouns preceded by *de*, which are not possible for preverbal subjects.

(11) a. *un lac où d' enfants ne se baignent pas
a lake where INDF.PL children NEG bathe NEG

b. un lac où ne se baignent pas d' enfants
a lake where NEG bathe NEG INDF.PL children

c. un lac où je ne vois pas d' enfants
a lake where je NEG see NEG INDF.PL children

Bonami and Godard (2001) argue that the inverted subjects do not carry nominative case like preverbal subjects, but a particular inverted case value, which has an intermediate status between nominative and accusative.

Abeillé (1996) and Marandin (1997) show that agreement differentiates inverted subjects from complements and preverbal subjects, since inverted subjects agree in number, but not in person with the verb, which must be 3rd person. [7]

(12) a. L' appartement que Claire et Marie repeignent/*repeint
the apartment that Claire and Marie repaint.PL/*repaint.SG

b. L' appartement que repeignent/*repeint Claire et Marie
the apartment that repaint.PL/*repaint.SG Claire and Marie

[7] Bonami and Godard (2001) distinguish 'elaborative' inversion which is reserved for long subjects and is compatible with a direct object (*Recevront leur diplome les étudians suivants:...* Receive.FUT.3.PL their diploma the students following...), from other types of inversion. In this series of experiments, we use subject inversion in relative clauses and wh- interrogatives with an intransitive verb, which is not a case of elaborative inversion.

(13) a.

L'	appartement	que	Claire	et	toi	habitiez	à l'époque
the	apartment	that	Claire	and	you	live.IMP.2PL	at the time

b.

L'	appartement	qu'	habitaient/*habitiez	Claire	et	toi	à	l'	époque
the	apartment	that	live.IMP.3PL/*live.2PL	Claire	and	you	at	the	time

(Marandin 1997)

We do not consider person agreement in this thesis. The results of our experiments show that verbs agree in number with inverted subjects, but not exactly in the same way as with preverbal subjects. The violation of CCA, which is determined by the linear proximity shows a clear penalty on the acceptability with inverted subjects.

6.3.2 Effects of Humanness

The effects of humanness on agreement were not consistent across all conditions. With VS order, there was no interaction between agreement and humanness. This interaction was significant only with the SV order and when both the nouns were singular, in the N1sg-ou-NP2sg-V combination.

This may be due to the way we classed nouns (human/non-human) as discussed in Chapter 4 for attributive number agreement, where the effect of humanness on agreement was not significant either. Number agreement was less sensitive to humanness, and more to the countable/non-countable distinction (see Lorimor 2007 for English coordination agreement).

6.3.3 Differences between *et* and *ou*

With SV order, if we compare *and-coordination* and *or-coordination*, singular and plural verbs were rated in a similar way in NP1pl-Conj-NP2sg-V and NP1sg-Conj-NP2pl-V combinations: when there was at least one plural conjunct, plural agreement was preferred, even when the plural conjunct was not the closest.

This result is unexpected, since in other languages, as English, it seems that the closest conjunct determines agreement with *or-coordination*. In a production experiment by

Haskell and MacDonald (2005) (repeated examples of Chapter 2 (50-a), (50-b)), plural agreement is produced around 95% when the closest noun is plural (14-a), but only around 25% when the closest noun is singular (14-b).

(14) a. SP: Can you ask Brenda if the boy or the girls is/are going to go first?

b. PS Can you ask Brenda if the girls or the boy is/are going to go first?

Differences between *and* and *or* were found with two singular nouns in French. For *and-coordination*, only plural agreement was highly acceptable, while singular and plural agreement were equally acceptable for *or-coordination*.

Looking at English, the prescriptive style guides (e.g. Fowler and Aaron 2001) enforce the rule that if the subject is preverbal, the verb should agree in number with the second noun. Foppolo and Staub (2020) find, however, that plural agreement only slightly reduces acceptability in a rating study in English, and the prescriptive rule for singular *or-agreement* may thus be weaker.

In the Italian grammar book *Grande grammatica italiana di consultazione*, Scorretti said *quando si hanno in una frase duo o più sogetti disgiunti, l'accordo del verbo è di norma con uno solo dei coordinati* ('when a sentence has two or more disjunct subjects, the agreement by the norm is with only one of the coordinates') (15-a), he adds that the verb can also be in the plural' (15-b).

(15) a. Mario o Gino potrebbe scrivergli
Mario or Gino can.COND.3.SG write.DAT.3.SG

b. Mario o Gino potrebbero scrivergli
Mario or Gino can.COND.3.PL write.DAT.3.PL
'Mario or Gino could write to him.' (Scorretti 1988, p274)

Foppolo and Staub (2020) show that in Italian, singular and plural agreement do not differ in acceptability in a rating experiment (with two singular preverbal subjects), as in French.

In conclusion, in predicative number agreement, only plural agreement is acceptable for *and-coordination*. This is different from attributive agreement since a Dsg is acceptable in both determiner agreement (D-N1sg-et-N2sg, D-N1sg-et-N2pl) and post-nominal adjective agreement (N1sg-et-N2sg-A).

Regarding *or-coordination*, with two singular disjoined NPs, both singular and plural verbs are acceptable. But their acceptability is degraded compared to the grammatical control items. When there is at least one plural conjunct, *or-coordination* behaves in a similar way as *and-coordination*, the Vpl is strongly preferred. Compared to attributive number agreement, the Dsg (Asg) is preferred with two singular disjoined NPs, whereas the Dpl is preferred when one of the conjuncts is plural even when it is the farthest one.

In both attributive and predicate agreement, the effects of humanness are not consistent. They only show up in one combination: NP1sg-or-NP2sg-V. But the effects of directionality are consistent and robust: plural agreement is less acceptable with the VS order when the closest noun is singular.

Table 6.3 – Summary of experimental results of number predicative experiments

	combination	target	mean	standard deviation (stdev)	standard error (se)
1	NP1pl-ou-NP2sg-V	Vpl	7.92	2.52	0.16
2	NP1pl-ou-NP2sg-V	Vsg	2.39	2.72	0.18
3	V-NP1pl-ou-NP2sg	Vpl	7.60	2.79	0.18
4	V-NP1pl-ou-NP2sg	Vsg	2.50	3.13	0.20
5	un-gram		1.43	2.47	0.16
6	gram		9.28	1.44	0.09
1	NP1sg-ou-NP2pl-V	Vpl	8.40	2.12	0.12
2	NP1sg-ou-NP2pl-V	Vsg	2.32	2.49	0.14
3	V-NP1sg-ou-NP2pl	Vpl	7.58	2.61	0.15
4	V-NP1sg-ou-NP2pl	Vsg	3.83	2.96	0.17
5	un-gram		1.74	2.59	0.15
6	gram		9.21	1.63	0.09
1	V-NP1sg-ou-NP2sg	Vpl	6.35	3.18	0.19
2	V-NP1sg-ou-NP2sg	Vsg	7.12	2.86	0.17
3	NP1sg-ou-NP2sg-V	Vpl	7.01	3.04	0.18
4	NP1sg-ou-NP2sg-V	Vsg	7.09	2.63	0.16
5	un-gram		3.52	3.20	0.19
6	gram		9.28	1.24	0.07
1	NP1pl-et-NP2pl-V	Vpl	8.77	1.53	0.19
2	NP1pl-et-NP2pl-V	Vsg	1.55	2.30	0.28
3	NP1pl-et-NP2sg-V	Vpl	8.48	1.97	0.24
4	NP1pl-et-NP2sg- V	Vsg	2.20	2.94	0.36
5	NP1sg-et-NP2pl-V	Vpl	9.20	1.01	0.12
6	NP1sg-et-NP2pl-V	Vsg	1.80	2.45	0.30
7	NP1sg-et-NP2sg-V	Vpl	8.77	1.57	0.19
8	NP1sg-et-NP2sg-V	Vsg	1.86	2.30	0.28

Chapter 7

Predicative Gender Agreement

Lastly, we examine predicate gender agreement. In French, only predicative adjectives and past/passive participles agree in gender in the verbal domain. The empirical data in this section include a corpus search (French Treebank) as well as two acceptability judgment experiments investigating gender agreement manifested by predicative participles.

7.1 Corpus data

In the French Treebank (Abeillé et al., 2019), there were few examples of predicative gender agreement, as it only manifested itself on predicative adjectives or past/passive participles. We filtered a subset of the results obtained when searching for coordinate subjects (see chapter 6 section 6.1). Table 7.1 shows the frequency of each gender agreement pattern.

The agreement strategy was simple when both conjuncts were of the same gender (either masculine or feminine, see example (1)): the predicate agreed with both of them by taking on the same gender value. However, it became complicated when there was a mismatch of gender (see example (2)). The corpus data showed that the masculine predicate was used, both with *et* and for *ou*.

(1) le Chili et l' Argentine seraient les premiers **intéressés**. (Le Monde, FTB)
the Chile and the Argentina would be the first interested
'Chile and Argentina would be the first to be interested'

Condition	Am	Af	total
NP1m-et-NP2m	38	0	38
NP1m-et-NP2f	10	1	11
NP1f-et-NP2m	9	0	9
NP1f-et-NP2f	0	16	16
NP1m-ou-NP2m	1	0	1
NP1m-ou-NP2f	0	0	0
NP1f-ou-NP2m	1	0	1
NP1f-ou-NP2f	0	1	1

Table 7.1 – Predicative gender agreement patterns in FTB.

(2) La réussite ou l' échec ne pourront être **constatés** qu' après une quinzaine
the success or the failure can be seen only after a fifteen
de jours (Le Monde, FTB)
of days
'Success or failure can only be seen after two weeks'

7.2 Experimental data

We ran two experiments, one for *and-coordination* and one for *or-coordination*. In both experiments on gender agreement, we chose plural nouns with different genders, in order to avoid interactions with number agreement. Contrary to attributive agreement experiments which tested noun coordination (with plural nouns and a common D), predicative agreement experiments tested NP coordination (with plural nouns) (3-a), to avoid that one controller will trigger two different agreement targets (3-b).

(3) a. les étudiants et les étudiantes seront responsables
the.PL student.M.PL and the.PL student.F.PL be.FUT.3.PL responsible.PL

b. les étudiants et étudiantes seront responsables
the.PL student.M.PL and student.F.PL be.FUT.3.PL responsible.PL

The noun pairs tested in predicative agreement experiments were slightly different from those in attributive agreement experiments. As experiments in Chapter 6, we took indirect questions, which were natural contexts for the subject inversion (see Chapter 6 above). With the VS order there was also an intervening D between the target and the closest noun. Another difference with attributive agreement experiments was that we tested passive participles for predicative agreement, but determiner and adjectives for attributive agreement. Passive participles were used because the subject inversion was more natural with participles than with adjectives (4).

(4) a. Je me demande quand les étudiants seront contents/inscrits
I REFL wonder when the students be.FUT.3.PL happy.PL/enrolled.PL

b. Je me demande quand seront ?contents/inscrits les étudiants
I REFL wonder when be.FUT.3.PL happy.PL/enrolled.PL the students

7.2.1 Materials and procedures

We tested coordinations with gender mismatch (NP1f-et/ou-NP2m and N1m-et/ou-NP2f) for *and-coordination* and *or-coordination*, with both SV order and VS order, and also varying +/- humanness. As a result, there were 16 item conditions in total (Table 7.2). Conditions for *and-coordination* and those for *or-coordination* were tested in two separate experiments. Each experiment included 24 experimental items, 12 control items which were the same as for attributive gender agreement, as well as 24 fillers from an independent experiment about island structure. Half of the sentences were followed by a comprehension question in order to check whether the participants paid enough attention. 127 participants completed the *and-coordination* sub-experiment. We kept for analysis only the participants whose comprehension accuracy was higher than 75% and the averaged median for the grammatical items was higher than the ungrammatical items, as in earlier experiments we considered high ratings for the ungrammatical controls as evidence that the participants did not pay enough attention. As a result, 79 participants were kept (median age= 41, 42 women, 36 men, 1 unknown) [1]. In the *or-coordination* sub-experiment, 128 participants completed the experiment with 84 participants left with comprehension accuracy higher than 75% and the averaged median for grammatical items higher than ungrammatical

[1] 4 participants participated twice in *and-coordination* experiment, two participants in *or-coordination* experiment, we only kept their first attempt.

items (median age=42, 45 women, 38 men, 1 unknown).

The participants were recruited from the platform `http://crowdpanel.io/` and received 4 euros after completing the experiment [2]. The procedures were the same as in the previous experiments.

Table 7.2 – Conditions and examples of predicative gender agreement, which are tested in two different experiments, one for *and-coordination* another for *or-coordination*. Different experiments are separated by double lines

Condition	Humanness	Sentences
NP1f-et-NP2m-V	human	Je me demande où **les étudiantes et les étudiants** seront conduits/conduites. I REFL wonder where the student.F.PL and the student.M.PL be.FUT.3.PL take.PTCP.F.PL/M.PL
	non-human	Il se demande par qui **les notes et les résultats** seront remis/remises. He REFL wonders by whom the grade.F.PL and the result.M.PL be.FUT.3.PL deliver.PTCP.F.PL/M.PL
NP1m-et-NP2f-V	human	Je me demande où **les étudiants et les étudiantes** seront conduits/conduites. I REFL wonder where the student.M.PL and the student.F.PL be.FUT.3.PL take.PTCP.F.PL/M.PL
	non-human	Il se demande par qui **les résultats et les notes** seront remis/remises. He REFL wonders by who the result.M.PL and the grade.F.PL be.FUT.3.PL deliver.PTCP.F.PL/M.PL
V-NP1f-et-NP2m	human	Je me demande où seront conduits/conduites **les étudiantes et les étudiants**. I REFL wonder where be.FUT.3.PL take.PTCP.F.PL/M.PL the student.F.PL and the student.M.PL
	non-human	Il se demande par qui seront remis/remises **les notes et les résultats**. He REFL wonders by who be.FUT.3.PL deliver.PTCP.F.PL/M.PL the grade.F.PL and the result.M.PL
V-NP1m-et-NP2f	human	Je me demande où seront conduits/conduites **les étudiants et les étudiantes**. I REFL wonder where be.FUT.3.PL take.PTCP.F.PL/M.PL the student.M.PL and the student.F.PL
	non-human	Il se demande par qui seront remis/remises **les résultats et les notes**. He REFL wonders by who be.FUT.3.PL deliver.PTCP.F.PL/M.PL the result.M.PL and the grade.F.PL
NP1f-ou-NP2m-V	human	Je me demande où **les étudiantes ou les étudiants** seront conduits/conduites. I REFL wonder where the student.F.PL or the student.M.PL be.FUT.3.PL take.PTCP.F.PL/M.PL

[2] In this thesis, the participants of some experiments were recruited on the RISC, a free CNRS platform where the participants volunteered to complete experiments. However, the amount of volunteers on this platform was limited. This is why, in some experiments, the participants were recruited from another platform `http://crowdpanel.io/`. There were more participants available and they were paid 0.27€/min. However, participants recruited on this platform were largely less attentive as can be seen by the high number of exclusions.

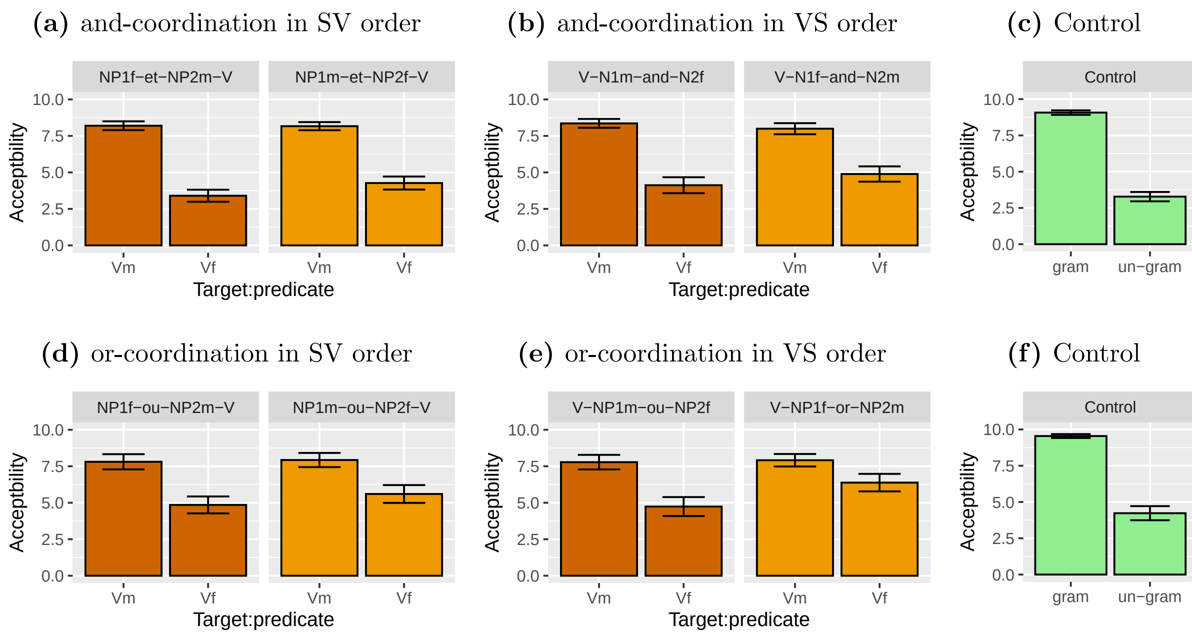
	non-human	Il se demande par qui **les notes ou les résultats** seront remis/remises. He REFL wonders by who the grade.F.PL or the result.M.PL be.FUT.3.PL deliver.PTCP.F.PL/M.PL
NP1m-ou-NP2f-V	human	Je me demande où **les étudiants ou les étudiantes** seront conduits/conduites. I REFL wonder where the student.M.PL or the student.F.PL be.FUT.3.PL take.PTCP.F.PL/M.PL
	non-human	Il se demande par qui **les résultats ou les notes** seront remis/remises. He REFL wonders by who the result.M.PL or the grade.F.PL be.FUT.3.PL deliver.PTCP.F.PL/M.PL
V-NP1f-ou-NP2m	human	Je me demande où seront conduits/conduites **les étudiantes ou les étudiants**. I REFL wonder where be.FUT.3.PL take.PTCP.F.PL/M.PL the student.F.PL or the student.M.PL
	non-human	Il se demande par qui seront remis/remises **les notes ou les résultats**. He REFL wonders by who be.FUT.3.PL deliver.PTCP.F.PL/M.PL the grade.F.PL or the result.M.PL
V-NP1m-ou-NP2f	human	Je me demande où seront conduits/conduites **les étudiants ou les étudiantes**. I REFL wonder where be.FUT.3.PL take.PTCP.F.PL/M.PL the student.M.PL or the student.F.PL
	non-human	Il se demande par qui seront remis/remises **les résultats ou les notes**. He wonders by who be.FUT.3.PL deliver.PTCP.F.PL/M.PL the result.M.PL and the grade.F.PL
control	grammatical	Le **fils** de la voisine est content d'aller à l'école. the.M.SG son.M.SG of the.F.SG neighbor.F.SG is happy.M.SG to go to the school
	ungrammatical	Le **fils** de la voisine est contente d'aller à l'école. the.M.SG son.M.SG of the.F.SG neighbor.F.SG is happy.F.SG to go to the school

7.2.2 Results

The results are reported in fig. 7.1. In general, masculine agreement was rated better than feminine agreement, regardless of the gender of conjuncts and word order; ratings for both gender agreements lied between the grammatical controls (9.07 in *and-coordination*, 9.23 in *or-coordination* experiment) and the ungrammatical controls (3.28 in *and-coordination* experiment, 3.46 in *or-coordination* experiment).

Masculine predicate agreement was rated similarly across all conditions (with ratings around 8). On the other hand, feminine agreement was rated better when the closest noun was feminine than when the closest noun was masculine in both *and-coordination*

Figure 7.1 – Results of predicative gender agreement experiments



(*mean* = 4.27 for the NP1m-et-NP2f-Vf vs. *mean* = 3.40 for the NP1f-et-NP2m-Vf; *mean* = 4.16 for the Vf-NP1f-et-NP2m vs. *mean* = 3.47 for the Vf-NP1m-et-NP2f) and in *or-coordination* (*mean* = 5.25 for the NP1m-ou-NP2f-Vf vs. *mean* = 4.44 for the NP1f-ou-NP2m-Vf; *mean* = 5.34 for the Vf-NP1f-ou-NP2m vs. *mean* = 3.79 for the Vf-NP1m-ou-NP2f). These results illustrated that the gender of the closest noun played a role in predicative gender agreement.

In what follows, we examined the effects of coordinator *et/ou*, directionality, as well as humanness separately.

Effects of *et(and)/ou(or)* With respect to the distinction between *et* and *ou*, across all conditions, the mean ratings for masculine agreement were similar. However, feminine agreement was rated better in *or-coordination* than in *and-coordination*, both when the closest noun was masculine and when it was feminine.

Effects of directionality: Regarding *and-coordination*, when the closest noun was feminine, feminine predicates (CCA) were rated slightly higher with the VS order than with the SV order, whereas masculine predicates (RA) were rated lower with the VS order (with the SV order NP1m-et-NP2f-V, $mean = 3.4/8.2$ for Vf/Vm; with the VS order V-NP1f-et-NP2m, $mean = 4.16/7.8$ for Vf/Vm). And this effect of directionality remained of similar significance when the closest noun was masculine: a Vf which violated both CCA and RA was rated lower with the VS order (with the SV order NP1f-et-NP2m-Vf, $mean = 4.27/8.17$ for Vf/Vm; with the VS order V-NP1m-et-NP2f, $mean = 3.47/8.28$ for Vf/Vm).

The same tendency was observed for *or-coordination*, either when the closest noun was feminine (with the SV order NP1m-ou-NP2f-V, $mean = 5.25/7.81$ for Vf/Vm; with the VS order V-NP1f-ou-NP2m, $mean = 5.34/7.58$ for Vf/Vm), or when the closest noun was masculine (with the SV order NP1f-ou-NP2m-V, $mean = 4.44/8$ for Vf/Vm; with the VS order V-NP1m-ou-NP2f, $mean = 3.79/8.02$ for Vf/Vm). But these numeric differences between SV and VS orders were very small.

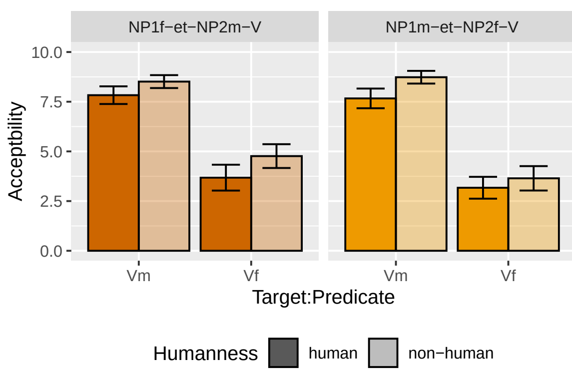
To test whether these differences between SV and VS orders were statistically significant, we submitted the data to ordinal regression models. In *and-coordination*, we fitted one maximal ordinal regression model, comparing two combinations when the closest noun was masculine (V-NP1m-et-NP2f and NP1f-et-NP2m-V). We fitted another maximal ordinal regression model comparing two combinations when the closest noun was feminine (V-NP1f-et-NP2m and NP1m-et-NP2f-V) (see detail in appendices table D.1). Fixed effects were position (SV/VS) * gender(Vm/Vf), with random intercepts and maximal random slopes (position * gender) for both subjects and items. In both models, the only significant effect was that of predicate gender ($p < 0.001$), masculine agreement was more acceptable than feminine agreement. But no interactions between predicate gender and position were found. That is to say, the predicate agreement did not seem to depend on the verb position.

We fitted the same models for *or-coordination*. Once again, no significant interactions between gender and position were found, neither in the combinations when the closest noun was masculine nor in the combinations when the closest noun was feminine (see details in Appendices table D.3).

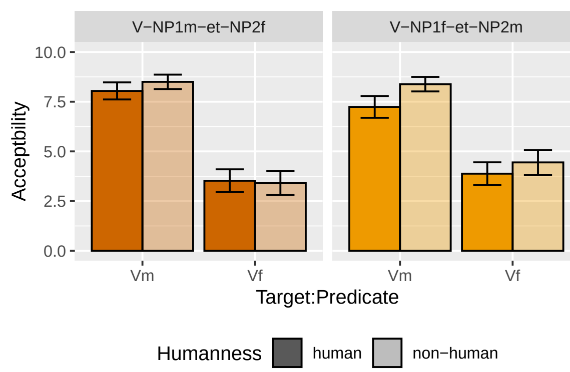
Effect of humanness The details of results for human and non-human nouns are reported in fig. 7.2. We fitted a maximal ordinal regression model for each combination, with Humanness and Gender as well as their interaction as fixed effects (Humanness * gender). We also included random intercepts for both subjects and items, and gender of predicate as random slope for items and Humanness * gender as random slopes for subjects. Surprisingly, there was only a significant interaction between humanness and predicate gender in the V-NP1m-ou-NP2m combination (see details in Appendices tables D.2 and D.4).

Figure 7.2 – Results of predicative gender agreement experiments

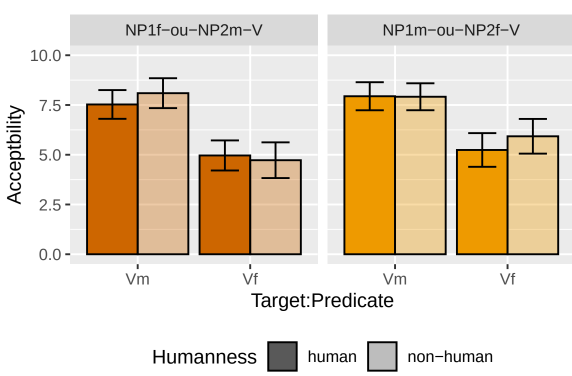
(a) and-coordination in SV order



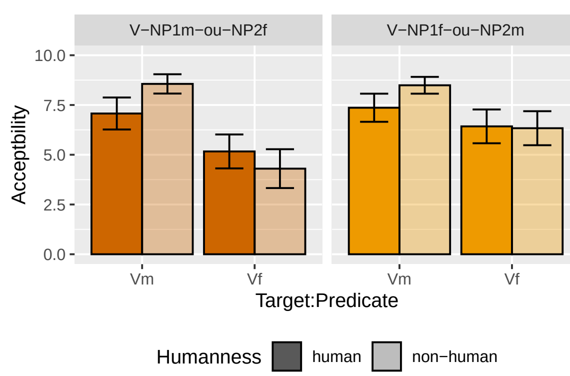
(b) and-coordination in VS order



(c) or-coordination in SV order



(d) or-coordination in VS order



7.3 Discussion

This chapter presents empirical evidence on predicate gender agreement. Predicate gender agreement is less frequent than predicate number agreement as it only manifests itself on predicative adjectives or past/passive participles. When both conjuncts are of the same gender, the target should agree with both conjuncts. When the gender of conjuncts is mismatched, we found that masculine was preferred for both *and-coordination* and *or-coordination*. There was only one counterexample in the corpus data. The acceptability rating experiments suggested that masculine agreement was rated higher than feminine in both *and-coordination* and *or-coordination*, but feminine agreement was rated slightly better for *or-coordination* than *and-coordination*, but it was never preferred to masculine.

There is no robust effect of directionality, which is different from that in attributive agreement. However, attributive and predicate agreement are distinct from each other with respect to their syntactic structure.

Figures 7.3 and 7.4 compare the tree structure of attributive and predicate agreement. In terms of linear distance, the target is linearly adjacent to the first conjunct in both structures when the target precedes the coordination. However, when the target follows the coordination, there is an intervening copula in predicate agreement. Thus the post-nominal target is linearily closer to the last conjunct in attributive adjective agreement than in predicative adjective agreement.

In terms of structural distance, it is greater for predicative adjectives (in both orders) than for an attributive adjectives. There is the S and VP node between the passive participle and the NP, whereas the A and bare noun coordination are in the same NP in attributive agreement [3]

[3] In a minimalist account, there is a similar difference (more distance with predicative agreement, since there is an intervening IP).

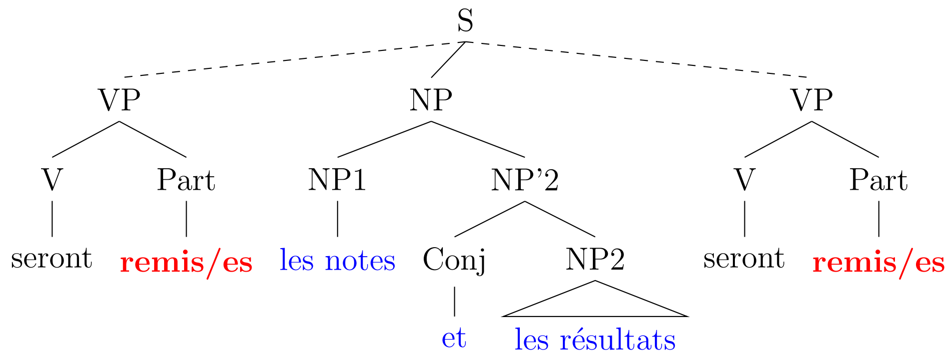


Figure 7.3 – Syntactic structure for predicate agreement with coordination phrases in the account of Borsley (2005)

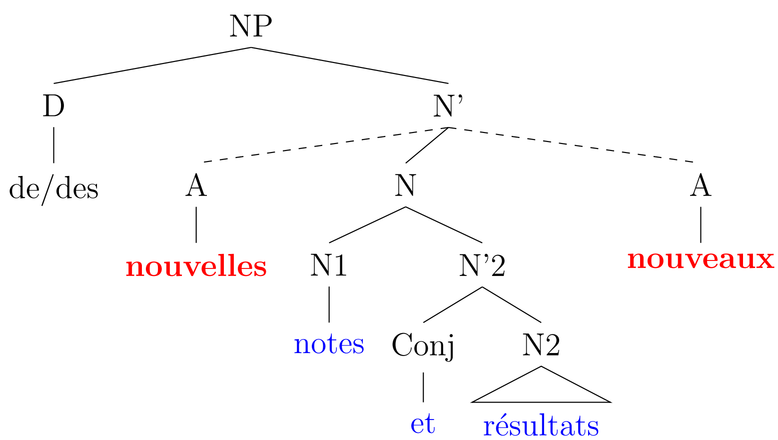


Figure 7.4 – Syntactic structure for attributive agreement with coordination phrases in the account of Borsley (2005)

Another difference between attributive and predicative agreement may come from our choice of items. Attributive agreement involves noun coordination while predicative agreement involves NP coordination. Thus, in target-coordination order there is also an intervening D between the target and the closest noun for predicate agreement. Furthermore, passive participles are used for predicative agreement while we had determiners and adjectives for attributive agreement.

	combination	target	mean	standard deviation (stdev)	standard error (se)
1	V-NP1f-et-NP2m	Vf	4.16	3.37	0.22
2	NP1f-et-NP2m-V	Vf	3.40	3.16	0.21
3	V-NP1f-et-NP2m	Vm	7.80	2.66	0.17
4	NP1f-et-NP2m-V	Vm	8.20	2.36	0.15
5	V-NP1m-et-NP2f	Vf	3.47	3.28	0.21
6	NP1m-et-NP2f-V	Vf	4.27	3.47	0.23
7	V-NP1m-et-NP2f	Vm	8.28	2.22	0.14
8	NP1m-et-NP2f-V	Vm	8.17	2.22	0.14
1	gram		9.07	1.75	0.08
2	un-gram		3.28	3.53	0.16
1	V-NP1f-ou-NP2m	Vf	5.34	3.57	0.22
2	NP1f-ou-NP2m-V	Vf	4.44	3.38	0.21
3	V-NP1f-ou-NP2m	Vm	7.58	2.76	0.17
4	NP1f-ou-NP2m-V	Vm	8.00	2.55	0.16
5	V-NP1m-ou-NP2f	Vf	3.79	3.36	0.21
6	NP1m-ou-NP2f-V	Vf	5.25	3.47	0.22
7	V-NP1m-ou-NP2f	Vm	8.02	2.45	0.15
8	NP1m-ou-NP2f-V	Vm	7.81	2.62	0.16
1	gram		9.23	1.65	0.07
2	un-gram		3.46	3.48	0.15

Chapter 8

Computational Models

Chapters 4-7 present corpus and experimental data in attributive/predicative position regarding gender/number agreement in French, revealing that CCA behaves differently with different types of agreement. For instance, both CCA and the resolution rule are acceptable for attributive agreement in number when the target precedes the controller (i.e. determiner or prenominal Adjective agreement), whereas only CCA is acceptable for attributive agreement in gender under such conditions. However, considering the multiple coordination patterns raised by domain, feature, coordinator (and/or), directionality between controller and target combinations, the corpus and experimental data presented above only deal with a subset of all possible patterns.

Formal linguistic theories, such as HPSG, LFG and Minimalism, have shown their limits when it comes to accounting for the wide range of agreement properties (see Chapter 2 above). A growing number of experimental studies begin to explore this question, but they only rely on one feature/domain combination, for instance, gender in the verbal domain (Willer-Gold et al., 2017) or number in the verbal domain (Foppolo and Staub, 2020). In this chapter, we propose a quantitative model, which links the qualitative theoretical observations and patterns (e.g., Nevins and Weisser 2019; Corbett 1991) to quantitative predictions about acceptability. Such a model should be able capture the generalizations underlying the experimental results of tested conditions on the one hand, and make predictions about unseen patterns on the other hand.

Furthermore, neural language models trained with large corpus have achieved state-of-the-art performances on many NLP tasks, and recently have been shown to learn a number of hierarchically-sensitive syntactic dependencies between individual words (Linzen et al., 2016; Gulordava et al., 2018). However, An, Qian, Wilcox, and Levy (2019) assess whether different neural language models trained on English and French can predict correctly agreement with coordination structures. Our results suggest that models are far from achieving human-performance. They use a native linear combination of NP constituent number/gender to drive CoordNP/verb number/gender agreement. What's more, the neural networks are like a 'black box' and give no insights on what linguistic generalizations they use to predict agreement with coordination structures.

The model proposed here makes three main contributions. First of all, it provides a detailed comparison of multiple human acceptability experiments, using cross-validated/held-out train/test methodology. The experimental data obtained from human experiments is extremely sparse and its collection is expensive, as each condition requires a minimum number of items and participants. We use machine-learning methods (by adding penalized regularization path and using high dimensional regression) to deal with this problem and to avoid the possible overfitting entailed by the small dataset.

Secondly, it unifies constraints from four main parameters of agreement: domain, feature, controller and target, in order to cover a large set of agreement patterns. This model is trained on French data, but can be generalized to other languages, as these four parameters of agreement are universal. In addition, the model is trained with experimental data of *and-coordination*. As a second step, it is generalized to *or-coordination* in an attempt to discover what is the same and what is different between *and* and *or*.

Last but not least, this model captures typological tendencies into a quantitative predictive framework. Our results confirm the agreement hierarchy proposed by Corbett (1991) regarding the agreement domain: CCA is less acceptable for predicative agreement than for attributive agreement. Both gender and number agreement follow this hierarchy. Moreover, our model reveals that gender and number behaves differently in agreement with coordination structures. We propose that CCA is more acceptable with a less interpretable feature (gender) than with a more interpretable feature (number).

This chapter starts with a summary of two previous models of gradient grammaticality: optimality theory and harmonic grammar, from which our model is inspired.

8.1 Previous Models of Gradient Grammaticality

Optimization-based grammars, such as harmonic grammar (Legendre et al. 1990) or optimality theory (Smolensky and Prince 1993), offer ways to capture intermediate grammaticality. In such grammars, each possible symbolic linguistic structure is evaluated by a set of well-formedness constraints, taking into account the different strengths or proprieties of constraints. The well-formed or grammatical structures are the ones that optimally satisfy the constraints. But the two frameworks differ from each other primarily in how the constraints are ranked.

8.1.1 Optimality Theory

Standard optimality theory (OT) (Smolensky and Prince 1993) is not a probabilistic framework, but it is a useful in-between point as we proceed from categorical to probabilistic grammars. In OT, universal grammar is an optimizing system of UNIVERSAL, VIOLABLE, RANKED well-formedness constraints on linguistic forms.

In the OT framework, the constraints are UNIVERSAL. The true prediction of an OT analysis is typological and not the data of one language (Harmonic mind, p527). The constraints are general since they are supposed to be present in all grammars. A constraint cannot hold in one language and simply disappear in another. But the constraints are VIOLABLE, e.g., a constraint may be violated in one context but remain unviolated in another. The effect of a given constraint is relative to its RANKING, which is determined on a language-particular basis. For a given input, the grammar generates and evaluates a potentially infinite set of output candidates, which consists of all alternative structural realizations of that input. A grammar for a particular language results from imposing a strict domination ranking on the entire universal set. The grammars of different languages differ in how the constraints are ranked.

The ranking of constraints in standard OT is hierarchical, therefore no particular numerical strengths are necessary. For any two constraints C1 and C2, either C1 outranks C2 or C2 outranks C1. The violation of any higher-ranked constraint takes absolute priority over any lower-ranked constraint (i.e. a single violation of a higher-ranked constraint is always worse than any number of violations of any number of lower-ranked constraints). Violation of higher-ranked constraints cannot be compensated for by satisfaction of lower-ranked constraints. Thus, there are no trade-offs in OT.

For a particular input, alternative structural realizations compete for the status of being the optimal output. The most harmonic output – the one which best satisfies, or minimally violates, the full set of ranked constraints in a given language – is the optimal one. Only the optimal structure is grammatical. See a detailed application of OT for article use and agreement in joint/split binomials in section 4.3.4.

A problem with standard OT is that it predicts that there should always be a unique output for every input, which is determined by the highest ranked differentiating constraint. This is tenable in some areas of linguistics, but it is at odds with gradient acceptability. There are variations of standard optimality theory trying to work with variable outputs (Nagy and Reynolds 1997, Anttila 2001, Boersma 1997, Pesetsky 1998, Müller 1999). For the particular case here, I will explain the linear optimality theory (LOT) proposed by Keller (2000, 2006).

The core assumption in LOT is that linguistic constraints are annotated with numeric weights and they are cumulative. The grammaticality of a structure is determined by the weighted sum of its constraint violations. A grammar signature is a pair $\langle \mathbf{C}, w \rangle$, in which $\mathbf{C} = \{C_1, C_2 \ldots C_m\}$ is the constraint set, and w is a function that associates a constraint $C_i \in \mathbf{C}$ with its constraint weight w_i.

For any structure $s_k \in S$, $C_i(s_k)$ is a function that maps structure s_k with the constraint $C_i \in \mathbf{C}$. In general, $C_i(s_k)$ returns 1 if the constraint C_i is violated and 0 otherwise. The harmony $h(s_k)$ of a structure s_k is the negation of weighted sum of all the constraints that the structure s_k violates, given in Equation 8.1

$$h(s_k) = -\sum_{i=1}^{m} w_i C_i(s_k) \quad \text{for} \quad s_k \in S \tag{8.1}$$

Keller (2000, 2006) use Gaussian Elimination and Least Square Estimation algorithms for parameter estimation – determining the constraint weights of a grammar. But LSE is more applicable to experimental data because Gaussian Elimination gives an exact solution to a system of linear equations – it cannot converge if there is no set of weights that satisfy all the ranking arguments exactly – which is not the case in experimental data. On the contrary, LSE can find an approximate set of constraints fitting the data.

Note that LOT only deals with acceptability differences, not with absolute acceptability values. Acceptability differences are computed in terms of the relative harmony of candidates in the same candidate set. Let S1, S2 and S3 be candidate structures in the candidate set S. The coefficient w is computed according to the relative harmony between S1, S2, S3 (h(S1)-h(S2), h(S2)-h(S3), h(S1)-h(S3)) through the method of Least Square Estimation.

Keller also mentions the fact that the Standard Optimality theory does not allow for "ganging up", where the violation of multiple low ranked constraints makes the output worse than the violation of a single high ranked constraint. However, as constraint violations in LOT are cumulative, they can gang up. For example, assuming that the weight of the constraint C_1 is twice that of the constraint C_2, in LOT a structure that violates C_1 once will be as ungrammatical as one that violates C_2 twice, i.e., C_2 gangs up against C_1. Such a ganging up of constraint violations should be impossible under strict domination in Standard OT. For discussion of ganging up, both empirical and theoretical, see Jäger and Rosenbach (2006); Keller (2000, 2006); McClelland and Vander Wyk (2006); Pater et al. (2007).

8.1.2 Harmonic Grammar

Harmonic grammar (Legendre et al. 1990; Smolensky et al. 1992) is a predecessor of OT that builds on the assumption that constraints are annotated with numeric weights (rather than being rank-ordered as in Standard OT). Smolensky and Prince (1993, p.200) point out that "Optimality Theory [...] represents a very specialized kind of Harmonic Grammar, with exponential weighting of the constraints". Harmonic grammar (HG) has been implemented in a multi-layer connectionist symbolic network architecture and has been applied successfully to gradient syntactic data by Legendre et al. (1990). The parameters in Legendre et al. 1990 are learned through back propagation (Rumelhart et al. 1988).

Another variant of harmonic grammar is the maximal entropy model, in which the probability of a candidate winning depends on its harmony. The maximum entropy (MaxEnt) model was in widespread use in computational linguistics in the 1990s, some example applications include part-of-speech (POS) tagging (Ratnaparkhi 1996), parsing (Johnson et al. 1999), language modelling (Rosenfeld 1996), and text categorisation (Nigam et al. 1999).

In phonology and phonetics, the MaxEnt phonotactic learning model was proposed by Hayes and Wilson (2008) to handle phonetic well-formedness, which leads to a fundamental rethinking of the domain. Their model uses weighted constraints to define a probability distribution over the space of possible word forms, thus creating a phonotactic grammar formalizing knowledge of the relative probabilities of word forms.

Similar to "linear OT", they use a harmony score $h(s_k)$ for any $s_k \in S$ to represent the weighted sum of the form's constraint violations.

$$h(s_k) = \sum_{i=1}^{m} w_i C_i(s_k) \tag{8.2}$$

The probabilities of forms are calculated from their constraint violations and the weights. Considering the principle of maximum entropy (Jaynes, 1957), the probability distribution which best represents the current state of knowledge is the distribution that, given any features, has maximum entropy. That is to say, with a discrete observation s_k in the sample space S, the maximum entropy probability distribution $P(s_k)$ given a set of constraints $C = \{C_1, C_2, \ldots, C_m\}$ is stated in equation 8.3 (see a proof in Della Pietra et al. 1997)

$$P(s_k) = \frac{1}{Z} \exp\left(-\sum_{i=1}^{m} w_i C_i(s_k)\right) \quad \forall\ s_k \in S \tag{8.3}$$

Here Z is just a normalization constant – the total maximum entropy values of all possible forms in S. C_i is an indicator function and the weight w_i associates with the function C_i.

Logistic regression is also intimately related to maximum-entropy modeling. If we take the log of both sides on eq. (8.3), we have the linear model (eq. (8.4)). The log of the probability of an output is straightforwardly related to the sum of the weights for the features that are violated, as log $Z(i)$ is a constant.

$$log\ P(s_k) = -\sum_{i=1}^{m} w_i C_i(s_k) - log\ Z \tag{8.4}$$

Logistic regression is used when a response variable is binary while the MaxEnt generalizes the same principle for multinomial cases. An example in linguistic literature using a logistic regression model is for ordering binomials (e.g., *rose and flower* vs *flower and rose*) (Benor and Levy 2006). Binomial ordering is a noncategorical phenomenon involving contraint conflicts such as a short word preceding a longer word; less marked item (i.e. have a broader, more general meaning) in the first place. Benor and Levy (2006) investigate three violable-constraints frameworks: optimality theory, stochastic optimality theory, and logistic regression. All of these frameworks are able to handle the interaction of conflicting constraints in binomial ordering, with OT being the most restrictive, and StOT more restrictive than logistic regression. Logistic regression was able to achieve a better fit to their corpus than both hand-constructed OT and automatically learned StOT models.

Likewise, in the MaxEnt grammar and logistic regression, constraints can gang up: two weaker constraints can combine to overcome a single stronger constraint.

In sum, this section discusses models that handle gradience: optimality theory (Smolensky and Prince, 1993) and harmonic grammar (Legendre et al., 1990), as well as their variations, such as linear OT (Keller, 2000, 2006) and the maximal entropy model (Hayes and Wilson, 2008). They are similar but also differ in several respects: i) constraint ranking (Standard OT uses categorical constraint ranking, while others like Linear OT, MaxEnt, HG use numeric weights) ii) constraint violations (OT and MaxEnt only model constraint violation while HG models both satisfaction and violation) iii) parameter estimation (these models have been implemented with different parameter estimation methods: standard OT uses manually ranking, in HG the parameters are estimated with backpropagation, LOT is trained with least square estimation and the MaxEnt model uses conjugate gradient descent). iv) ganging up (some models enable a "ganging up" effect, like Linear OT, MaxEntn and HG, while others not, like Standard OT).

	ranking	Constraint violation	Parameter Estimation	ganging up
Standard OT	categorical	violation	manually ranking	No
Linear OT	weighted	violation	Least Square	Yes
Maximal entropy	weighted	violation	gradient descent	Yes
Harmonic Grammar	weighted	violation and satisfaction	backpropagation	Yes

Table 8.1 – Summary of properties of different models

8.2 A Harmonic Model for Agreement with Coordination Structures

Taking inspiration from the previous models, we propose a harmonic model to account for agreement with coordination structures within the violable-constraints frameworks. The well-formedness of a structure is the result of interacting violable constraints combining agreement target, controller, domain and feature.

8.2.1 Definitions

In the model, candidates are pairs ⟨In, Out⟩ consisting of an input structure s_k and an output of structure's well-formedness $y(s_k)$.

Each input STRUCTURE consists of an agreement with a coordination structure, with the specification of four agreement parameters pointed out by Corbett (2006): feature, domain, controller, target, as well as coordinator (*and/or*) and the related directionality between controller and target. For instance, NP1sg-et-NP2sg-Vsg is an input which indicates that agreement domain is verbal, agreement feature is number, controller includes two singular nouns and target is singular. In addition, the structure contains an *and-coordination* and the target follows the controller.

The WELL-FORMEDNESS or GRAMMATICALITY of a structure is a numeric score (0,10) which is approximated by the mean of acceptability of such condition in the previous psycholinguistic experiments.

We use the term CONSTRAINT to refer to the agreement strategy that a structure violates under various conditions (e.g. domain (attributive or predicative), feature (number or gender), directionality, coordinator) that may degrade its well-formedness. For instance, NP1pl-et-NP2sg-Vsg violates the resolution number agreement in the predicative domain (the constraint is defined as 'RA [Pred][Num]' in the following section, for a detailed discussion of the constraint set, see section 8.2.6). A given structure may violate more than one constraint, for instance NP1sg-et-NP2pl-Vsg violates both RA [Pred][Num] and CCA [Pred][Num].

The scope of this model is as follows: in *and-coordination*, the conjoined NPs are put in a context where they must refer to two distinct entities, like *Le maire et l'adjoint va/vont venir ensemble* ("the mayor.SG and the deputy.SG will.SG/PL come together"). As shown above, an *and-coordination* phrase can refer to a single entity, especially for role names, mass nouns and deverbal nouns. For instance, *salt and pepper* may refer to a spice that contains both salt and pepper; if so, *salt and pepper* should be considered as notional singular. Notional number has a significant effect on number agreement choice (Lorimor

2007) and coreferent coordinated nouns (*my friend and colleague*) always trigger singular agreement (Heycock and Zamparelli, 2005; Le Bruyn and de Swart, 2014). There is no doubt that it affects acceptability judgments, but it is not in the scope of this study. The primary goal of our model is to understand the constraints that decrease acceptability judgments as a consequence of structural mismatch between the controller and target. We lay to one side cases of joint readings. We balance human and non-human nouns in our experimental sets in order to neutralize the effect of noun type.

Since interpretation (exclusive or inclusive) may also play a role in *or-coordination*, the *or-coordination* phrase was embedded in a felicitous context which expresses speaker's uncertainty (such as *Je me demande quand va/vont venir le maire ou l'adjoint*, "I'm wondering when will.SG/.PL come the mayor.SG and the deputy.SG"), allowing for both inclusive and exclusive reading.

8.2.2 Model Architecture

Our approach remains similar to the harmonic grammar. The sentences' acceptability is supposed to be a normal distribution. Provided the constraint set is an adequate one, the well-formedness of a sentence s_k (denoted as $y(s_k)$) is determined by the sum of the violation of constraints of a structure s_k (eq. (8.5)).

$$h(s_k) = w_0 + \sum_{i=1}^{m} w_i C_i(s_k) \tag{8.5}$$

The model (see fig. 8.1 for an illustration) presumes that the sentences are well-formed without the agreement issues. w_0 denotes the well-formedness of the structure without any constraints violated. The function C_i matches a structure s_k with the constraint i and returns -1 if s_k violates the constraint and 0 otherwise.

Each constraint function C_i has a non-negative weight w_i. Constraints with higher weights have a more powerful effect in lowering the well-formedness of the form that violates them. We restrict weights to be positive. While there is no technical problem with allowing a mix of negative and positive weights, the consequences for linguistic analysis would be serious. Negative weight would turn a penalty (violation count) into a benefit, i.e. it would suggest there is a constraint that should be violated to improve grammaticality.

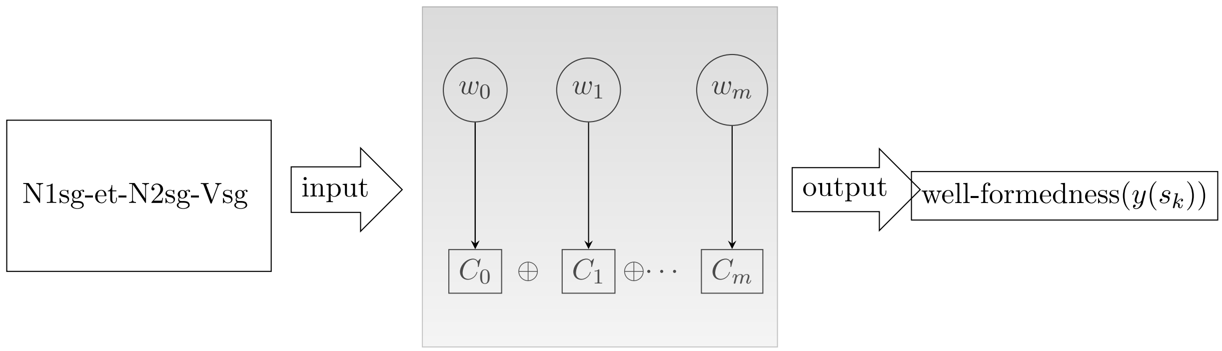


Figure 8.1 – Illustration of the model's architecture. The model's input s_k is a structure involving an agreement with a coordination phrase. The model will assign a well-formedness score $y(s_k)$ to the structure s_k. The model includes a linear combination of constraints $C_i, i \in (1, m)$. Each constraint function C_i is associated with a numeric weight w_i. C_0 is a bias(intercept) denoting the structure's well-formedness without any constraint violation.

The constraints are cumulative, allowing ganging up effects. Lower-valued constraint violations can gang up to overcome the higher weighted one. Contrary to OT, which aims at choosing the best outcome in a candidate set, this model simply imposes a numerical cut-off on degree of violation. The lower bound on the output (the acceptability of a structure) is 0 – any amount of violations within this range will be tolerated if the structure violates multiple constraints.

8.2.3 Penalized Regularization

Now let's turn to estimating the weight w_i associated with each constraint i. So far, the question turns out to be a regular linear regression model question. The major goal is to approximate the response variable $y(s_k)$ using a linear combination of the predictors.

$$y(s_k) = w_0 + \sum_{i=1}^{m} w_i C_i(s_k), \quad s_k \in S \tag{8.6}$$

The model is parameterized by a m-dimensional vector of regression weights $w = (w_1, \ldots, w_m) \in \mathbb{R}^m$ and an intercept (or "bias") term $w_0 \in \mathbb{R}$. We use a common practice "least squares", looking for the parameter values (w_0, w) that minimize the squared-error loss. The objective function becomes:

$$\underset{w_0,w}{\text{minimize}} \left\{ \frac{1}{2K} \sum_{k=1}^{K} (y_k - w_0 - \sum_{i=1}^{m} w_i C_i(s_k))^2 \right\} \tag{8.7}$$

However, this function may face two serious problems: i) the coefficients can explode. The model will predict a very big intercept w_0 and coefficients w. ii) the coefficients are likely to have a very high variance due to overfitting. As a result, such models perform very well on training data but have high error rates on test data.

The prediction accuracy can sometimes be improved by shrinking the values of the regression coefficients, or setting some coefficients to zero. By doing so, we introduce some regularization paths, which is a common practice in machine learning to solve such problems. The aim of the regularization path is to reduce the variance of the predicted values, and hence it may improve the overall prediction accuracy (as measured in terms of the mean-squared error on a test set). The second reason is for the purposes of interpretation. The regularization path allows us to penalize the coefficients of predictors with small effects to near zero. Thus it helps to identify a smaller subset of these predictors that exhibit the strongest effects.

There are two main kinds of regularization: Lasso and Ridge. On the basis of eq. (8.7), Lasso penalizes the sum of the absolute values of the coefficients (ℓ_1 penalty).

$$\min_{(w_0,w)\in\mathbb{R}^{n+1}} \frac{1}{2K} \sum_{k=1}^{K} (y_k - w_0 - \sum_{i=1}^{m} w_i C_i(s_k))^2 + \lambda ||W||_1, \tag{8.8}$$

Note that , $\|\cdot\|_1$ denotes the ℓ_1 norm of its argument, which is the sum of the absolute value of its components in a vector space. The bound λ is a kind of "budget": it limits the sum of the absolute values of the parameter estimates. As a result, for high values of λ, the coefficients becomes very small. There is no penalty when λ equals to 0. The value of λ must be specified by an external procedure such as cross-validation, which we discuss later in the chapter.

Ridge regularization is very similar to Lasso, but takes the ℓ_2 norm instead of the ℓ_1 norm. ℓ_2 norms are also known as Euclidean norm of the vector space.

$$\min_{(w_0,W)\in\mathbb{R}^{n+1}} \frac{1}{2K}\sum_{k=1}^{K}(y_k - w_0 - \sum_{i=1}^{m} w_i C_i(s_k))^2 + \lambda||W||_2^2/2, \tag{8.9}$$

The regularization model chosen in the present work is elasticnet. The penalty regularization is a combination of Ridge and Lasso penalties discussed above. Our objective function thus becomes the following: (implemented in the R package *glmnet* by Feldman et al. 2009):

$$\min_{(w_0,w)\in\mathbb{R}^{n+1}} \frac{1}{2K}\sum_{k=1}^{K}(y_k - w_0 - \sum_{i=1}^{m} w_i C_i(s_k))^2 + \lambda\left[(1-\alpha)||W||_2^2/2 + \alpha||W||_1\right], \tag{8.10}$$

where $\lambda \geq 0$ is a complexity parameter which decides how seriously the coefficients are penalized and $0 \leq \alpha \leq 1$ is a compromise between Ridge ($\alpha = 0$) and Lasso ($\alpha = 1$) penalties.

8.2.4 High-Dimensional Regression Linear Model

We use a high-dimensional regression over subgroups of observations. The approach is to treat gender and number as related problem instances and jointly estimate subgroup-specific regression coefficients. Accordingly, the penalty encourages the coefficient vectors from different subgroups to be close to each other. The model resolves problems where subgroup-specific models may be expected to be similar but not necessarily identical.

In our model, gender and number are considered as two subgroups rather than putting all the constraints for both in the same pool. Theoretically, gender and number are not two independent features, i.e. an agreement may violate simultaneously gender and number agreement. It is not clear whether the violation of gender and number is a simple sum of the penalty for gender and that for number (see Fuchs et al. 2015; Lorimor et al. 2016). In a simple pooling approach, the violation of gender and number agreement should be a sum of violation of both.

This is not the case for agreement domain. A specific agreement can involve only one domain (either attributive or predictive, or others). As a result, number and gender are considered as two subgroups, but not agreement domains.

Another advantage is that unlike simple pooling, our approach allows subgroups to have different sparsity patterns and regression coefficients, but it takes advantage of similarities between subgroups (see details below).

There are J subgroups ($J = 2$ in our case: one for number and one for gender) and each subgroup $j \in \{1 \dots J\}$ has the same set of m features. We present in fig. 8.2 the constraints organized in J sub-groups. In total, the constraints size is $J \times m$. C_i^j denotes the i^{th} constraint in the j group. Correspondingly, w_i^j denotes the coefficient for the i^{th} feature in subgroup j.

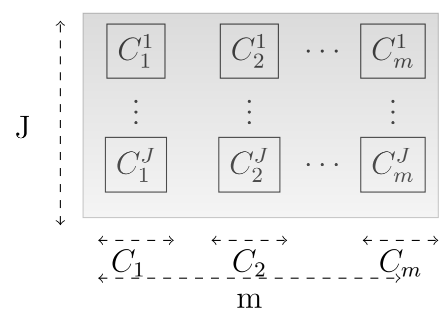


Figure 8.2 – Grid showing the constraint set in our model. The constraint size is $m \times J$. Each subgroup $j \in \{1 \dots J\}$ has the same set of m features.

For each subgroup j, the dimension of feature matrix is $K_j \times m(8.1)$. m is the constraint number and K_j is the sample size of subgroup j. Accordingly, the response vector of subgroup j is of size $K_j \times 1$.

We use an already implemented R package: *fuser*. On the basis of the elasticnet regularization (eq. (8.10)), the *fuser* package adds an additional penalty path to approximate the coefficients in different subgroups. The role of the last term is to encourage similarity between subgroup-specific regression coefficients.

$$\underset{[K_j \times m]}{C^j} = \begin{pmatrix} C_1^j(s_1) & C_2^j(s_1) & \dots & C_m^j(s_1) \\ \vdots & \vdots & \ddots & \vdots \\ C_1^j(s_K) & C_2^j(s_K) & \dots & C_m^j(s_K) \end{pmatrix} \tag{8.11}$$

8.1 – Feature matrix of subgroup $j \in \{1 \dots J\}$. Each row represents the constraint violations of an observation s_k. $C_i^j(s_k)$ returns -1 or 0 depending on whether the constraint C_i is violated or not by structure s_k.

$$\hat{W_{matrix}} = \underset{W_{matrix}=[w^1 \dots w^J]}{\text{argmin}} \sum_{j=1}^{J} \{ \frac{1}{n_j} || \frac{1}{2K} \sum_{k=1}^{K} (y_k - w_0^j - \sum_{i=1}^{m} w_i^j C_i(s_k))^2 || + \\ \lambda \left[(1-\alpha)||w^j||_2^2/2 + \alpha ||w^j||_1 \right] + \gamma \sum_{j'>j}^{J} \tau_{j,j'} ||w^j - w^{j'}||_2^2 \} \tag{8.12}$$

Where λ is a sparsity penalty hyperparameter and γ is a fusion penalty hyperparameter. High λ value will penalize all the coefficients to very small values while high γ value will make the coefficients in different subgroups very close. $\tau_{j,j'}$ gives the possibility of controlling the extent of fusion between specific subgroups. The idea is to allow more fusion between some subgroups than others. By default all τ's are set to unity, but they can also be set to specific values. In our case, since there are only two subgroups, they are set to unity. We use cross-validation to estimate the parameters λ, γ.

8.2.5 Cross-Validation

The common practice in machine learning or computational linguistics to estimate the best value for λ, γ is to use cross-validation, in which we can create training and test sets (or held-out sets) by splitting up the given dataset at random. The training set is used to estimate the parameters of the model, and the test set is used to test the model.

Two common types of cross-validation can be distinguished: k-fold cross-validation and leave-one-out cross-validation.

1. **k-fold Cross-validation** This approach involves randomly splitting the data set into k subsets. The model is tested on one of these subsets, after having been trained on the remaining $k-1$ subsets. This procedure is repeated k times such that each of the subset serves once as test set and $k-1$ times as part of the training set.

2. **Leave-one-out Cross-validation**: This method is an instance of k-fold crossvalidation where k is set to the size of the data set. This means that we train on all items of the training set, leaving out only one item, on which the model is then tested. This procedure is then repeated k times and the average model fit is computed. The advantage of leave one out is that it is even more suitable for small data sets than standard k-fold cross-validation. An obvious disadvantage is that a large number of training and test runs have to be carried out

Given the small size of our dataset, we use leave-one-out cross-validation. We first randomly divide the full dataset of size K into groups K . We fix one group as the test set, and designate the remaining $K-1$ groups as the training set. We then apply the high dimensional regression model to the training data for a range of different λ, γ values, and we use each fitted model to predict the response in the test set, recording the mean-squared prediction errors for each value of λ and γ.

This process is repeated a total of K times, with each of the K groups getting the chance to play the role of the test data, with the remaining $K-1$ groups used as training data. In this way, we obtain K different estimates of the prediction error over a range of values of λ, γ.

The test error is calculated as the squared error (MSE_i) between the one leftover response in the test dataset y_i, and the prediction on the test observation using the model trained with the $K-1$ training observations ($\hat{y}_i$).

$$MSE_i = (y_i - \hat{y}_i)^2 \tag{8.13}$$

For an dataset of K size, this process should be repeated K times. Thus, the cross-validation error $LOOCV_K$ takes an average of the K times test error.

$$LOOCV_{(K)} = \frac{1}{K}\sum_{i=1}^{K} MSE_i \tag{8.14}$$

Leave-one-out cross-validation is a very useful tool to estimate the λ, γ values. Moreover, the hold-out training/test method can test the model's ability to predict new data that was not used in estimating it, in order to flag problems like overfitting or selection bias. It also gives an insights on the regularity the model is not able to capture by comparing the test error in each iteration.

8.2.6 Constraint Inventory

For each subgroup j, the constraint is built up with one agreement strategy (CCA/RA/Early Agreement (EA)), one value that specifies the domain value (Att/ Pred), and the other that specifies the feature value (Num/Gen), thus resulting in 6 possible constraints for each subgroup (fig. 8.3).

$$C^1 \begin{bmatrix} RA & [Att][Num] \\ RA & [Pred][Num] \\ EA & [Att][Num] \\ EA & [Pred][Num] \\ CCA & [Att][Num] \\ CCA & [Pred][Num] \end{bmatrix} \qquad C^2 \begin{bmatrix} RA & [Att][Gen] \\ RA & [Pred][Gen] \\ EA & [Att][Gen] \\ EA & [Pred][Gen] \\ CCA & [Att][Gen] \\ CCA & [Pred][Gen] \end{bmatrix}$$

Figure 8.3 – Representation of the constraint set. There are two subgroups, C^1 for number agreement and C^2 for gender agreement. Within a subgroup j, each constraint C_i^j consists of one element of agreement strategy, one element that specifies the agreement domain value and another specifies the group value.

The three agreement strategies for *and-coordination*: RA, CCA, EA are defined as follows:

CCA: Agreement with the linearly closest conjunct.

RA: The resolution rule means plural agreement for number and masculine agreement when there is at least one masculine conjunct, feminine agreement when both nouns are feminine.

EA: Agreement with the first conjunct when the target precedes the controller. Notice that EA violation only counts when the target is before the controller. If the target is after the controller, even if it does not agree with the first conjunct, it doesn't violate EA.

As shown in section 3.2 above, multiple pieces of evidence indicate that CCA is preferred when the target precedes the controller. Some works (see Willer-Gold et al. 2017) interpret this effect as agreement occurs not only with the linearly closest but also with the structurally closest i.e HIGHEST CONJUNCT AGREEMENT (c.f. Marušič et al. 2015). For them, the coordination structure is hierarchical (Kayne 1994) and the first conjunct is the highest. We propose the term EARLY AGREEMENT in this paper in terms of language processing by not necessarily supposing a hierarchical structure for the coordination phrase, but denoting the fact that when the target precedes the coordination phrase, the speaker urges to perform the agreement when seeing the first NP (ignoring a second conjunct follows), whereas when the target is after the coordination, the speaker computes the agreement after seeing the whole coordination phrase.

In sum, given the constraint C_i and an input s_k, $C_i(s_k)$ acts as a function, returning whether the input structure s_k violates the i^{th} constraint. Table 8.2 illustrates the functionality of $C_i(s_k)$ with regard to number agreement. The ones for gender should work in the same way by simply replacing number by gender.

Table 8.2 – Definition of function $C_i(s_k)$ for number agreement

Constraint C_i	$C_i(s_k)$
CCA [Pred][Num]	$C_i(S) = \begin{cases} -1, & \text{if S involves predicative number agreement, the predicate doesn't agree with the closest conjunct} \\ 0, & \text{otherwise .} \end{cases}$
RA [Pred][Num]	$C_i(s_k) = \begin{cases} -1, & \text{if S involves predicative number agreement, the predicate obeys resolution Rule} \\ 0, & \text{otherwise .} \end{cases}$
EA [Pred][Num]	$C_i(s_k) = \begin{cases} -1, & \text{if S involves predicative number agreement and the target precedes the coordination, the predicate doesn't agree with the first conjunct} \\ 0, & \text{otherwise.} \end{cases}$
CCA [Att][Num]	$C_i(s_k) = \begin{cases} -1, & \text{if S involves attributive number agreement, the attribute doesn't agree with the closest conjunct} \\ 0, & \text{otherwise.} \end{cases}$
RA [Att][Num]	$C_i(s_k) = \begin{cases} -1, & \text{if S involves attributive number agreement, the attribute obeys resolution Rule} \\ 0, & \text{otherwise.} \end{cases}$
EA [Att][Num]	$C_i(s_k) = \begin{cases} -1, & \text{if S involves attributive number agreement and the target precedes the coordination, the attribute doesn't agree with the first conjunct} \\ 0, & \text{otherwise.} \end{cases}$

Table 8.3 exhibits how to match the input structure with the constraints, by taking some examples of subject-verb number agreement. Given a structure s_k and the constraint C_i, each cell gives the results of $C_i(s_k)$. Notice that the table only lists the constraints containing [Pred] and [Num], since other constraints which contain [Att] or [Gen] are not related and should be zero.

Table 8.3 – A representation of constraint violations in different subject-verb agreement structure.

Structure	CCA [Pred][Num]	RA [Pred][Num]	EA [Pred][Num]
NP1sg-et-NP2sg-Vsg	0	-1	0
NP1sg-et-NP2sg-Vpl	-1	0	0
NP1sg-et-NP2pl-Vsg	-1	-1	-1
NP1sg-et-NP2pl-Vpl	0	0	0
Vsg-NP1pl-et-NP2sg	-1	-1	-1
Vpl-NP1pl-et-NP2sg	0	0	0
Vsg-NP1sg-et-NP2sg	0	-1	0
Vpl-NP1sg-et-NP2sg	-1	0	-1

8.3 Theoretical Foundations: Different Strategies

This model presumes that agreement with coordination structures allows at least three agreement strategies: CCA, RA, EA. The violation of each agreement strategy will lead to a penalty on the well-formedness of the structure. Nonetheless, this penalty is not categorical but depends on various factors, for example, domain or feature.

8.3.1 Different Agreement Strategies

The idea that different agreement strategies play a role in agreement with coordination structures and can generalize from patterns to patterns dates back to Reis (1974); Peterson (1986). They consider that agreement with a disjoint NP in English is a "patch up" strategy: the core rules of the syntax do not provide principles for verb agreement with disjoint subjects, and the speaker should resort to various strategies: 'First Conj', 'Plural

Wins', 'Proximity'. These strategies are not ad hoc, but generalized strategies. That is to say, these strategies can be generalized to various patterns, with different strength from construction to construction, from speaker to speaker. However, the proposals of Peterson (1986) are limited to *or-coordination* and do not generalize to *and-coordination*.

The different agreement strategies stem from different fundamental properties of human languages. Resolution rule is a feature computation rule at the constituent level. Human languages are characterized by constituency, that is sentences and phrases are formed by attaching constituents to each other in a hierarchical construct. While some NPs have a clear head which determines the agreement ('the key to the cabinets'), the coordination phrase has to compute its agreement features at the constituent level, based on the conjuncts (Sag et al., 1985; Dalrymple and Kaplan, 2000).

CCA is determined by linear proximity. While CCA has been argued to be a pure performance factor (Berwick et al., 2013), external to grammar, we have shown that it was very different from attraction errors (cf. Keung and Staub 2018).

EA (early agreement) resembles what has been called First Conjunct Agreement (or Highest Conjunct Agreement) (Willer-Gold et al., 2017) and has been viewed by some authors as capturing structural proximity. However it is somewhat different since in our model it also captures directionality: it refers to agreement with the first conjunct when the target precedes the coordination.

Therefore, agreement with coordination structures may be constrained by constituency, linear order as well as directionality and follow contradictory strategies. A well-formed structure should satisfy the requirements of CCA, EA and RA. The violation of any of these strategies will cause some degradations of the structure's well-formedness. We can find similar claims in the literature, for instance Fowler and Aaron (2001) recommends that *when one part of the subject is singular and the other plural, avoid awkwardness by placing the plural part closer to the verb so that the verb is plural.* In (1-a), the verb cannot satisfy at the same time the requirement of linear proximity and resolution rule. As a result, the construction is not perfectly well-formed. However, in (1-b) when the closest noun is plural, the plural verb satisfies both the requirements from the closest conjunct and resolution rule, thus it is well-formed (see the discussion by Zwicky 2009).

(1) a. awkward: The cats or the dog have eaten all the daisies.

b. revised: The dog or the cats have eaten all the daisies.

A similar claim can also be found in the French literature. Curat (1999) proposes that when the prenominal adjective agrees with binomials with gender mismatch, the masculine noun should be placed before the feminine noun in order to have CCA and RA coincide (repetition of example (26) in chapter 2 above).

(2) a. *les nouveaux étudiantes et étudiants
the.PL new.M.PL student.F.PL and student.M.PL

b. ?les nouvelles étudiantes et étudiants
the.PL new.F.PL student.F.PL and student.M.PL

c. les nouveaux étudiants et étudiantes
the.PL new.M.PL student.M.PL and student.F.PL
'the new students' (Curat 1999, p. 61)

The claim that the well-formedness of agreement with disjoined NPs is determined simultaneously by three different agreement strategies is proposed by Peterson (1986) using an informal questionnaire study in English from the 1980s. But he only examines number agreement in *or-coordination*, and assumes that the different strategies are a "patch up" device and sensitive to the semantic interpretation (inclusive/exclusive). The preference can be different from one speaker to another.

With the fast evolution of experimental methods and statistical power, Willer-Gold et al. (2017) investigates the gender agreement strategies with *and-coordination* in 6 western South Slavic language varieties. South Slavic languages possess three gender: masculine, feminine, neuter. The verb agreement possesses three options: either with the first conjunct, or with the second conjunct or in masculine which is considered as default agreement (3-a). They test the production ration of each agreement strategy with elicited production experiments and acceptability rating with acceptability rating experiments in both VS word order (3-a) and SV order (3-b).

(3) a. pečatom su ovjeren-i/-a/-e molbe i rješenja.
yesterday were printed.M.PL/N.PL/F.PL request.F.PL and decision.N.PL
'Yesterday, requests and decisions were printed out.'

b. Molbe i rješenja su ovjeren-i/-a/-e pečatom.
request.F.PL and decision.N.PL were printed.M.PL/N.PL/F.PL yesterday
' Requests and decisions were printed out yesterday.'

Willer-Gold et al. (2017) show that linearly based agreement proved the most common, the most readily available, and the highest-rated agreement pattern. In preverbal position (3-b), CCA (.N.PL) trumps first conjunct agreement (F.PL) at least three times to one, across all six sites. Default agreement (M.PL) is produced significantly more often in SV structures than it is in VS structures (41% vs. 5%).

However, their experimental investigation is limited to AND in one domain and one feature, i.e. predicate gender agreement. Their proposal that 'linear order can prevail structural distance' is a qualitative one rather than giving a quantitative weight for the effects of linear proximity or structural distances.

8.3.2 Different Strategies: Grammatical Knowledge or "lacuna of the grammar"

Another debate is whether the different agreement strategies are part of speakers' grammatical knowledge. Reis (1974); Peterson (1986) consider that it is not a core rule of syntax but a matter of speakers' preferences. Foppolo and Staub (2020) develop this theory and propose that agreement with disjunction is a grammatical 'lacuna', that is to say, the grammar provides no means of valuing the verb's number feature when the subject is a disjunction of singulars. While there are no resolution rules, both singular and plural verbs are acceptable.

We consider that the different strategies are part of the speakers' grammatical knowledge. First of all, the argument of Peterson (1986) that the different strategies are extra-grammatical devices is based on explanations by Bresnan et al. (1985) in the framework of Lexical-Functional Grammar, that the coordinated NP has no syntactic head and no number value assigned by the grammar, thus both singular and plural can be freely selected. However, in further LFG work, King and Dalrymple (2004) propose that the conjoined phrase has a plural CONCORD value. Both CCA and RA are considered as part of the grammar, as well as in HPSG (cf. Kathol 1999; Villavicencio et al. 2005). Other linguistic theories, such as minimalist generative grammar, also include CCA in *and-coordination*, as part of their grammar (see Nevins and Weisser 2019 for an overview).

Secondly, Foppolo and Staub (2020) argue that agreement with disjoined singular NP is a "lacuna of the grammmar", in the sense that speakers' grammar simply does not prescribe a verb number following a disjunctive subject. As a result, either verb form may be acceptable, because neither contradicts any established grammatical principle. However, we will illustrate in the following sections that the idea that agreement with coordination structure is a 'result of three different agreement strategies'. It is not only valid for disjoined singular NP, but also for *and-coordination* where there is an explicit resolution rule. We propose that agreement with coordination structures is a joint interaction of three agreement strategies: CCA, RA, EA, which can be generalized across different patterns, from *and-coordination* to *or-coordination*, from number to gender, from attributive domain to predicative domain.

Thirdly, from a typological point of view, Corbett has proposed the agreement hierarchy (see above section 3.1 for a detailed discussion), not only based on agreement with conjoined NPs but also on a wide range of phenomena cross-linguistically, such as agreement with collective nouns such as "commitee" ('the committee has/have decided'). Thus if these constraints on agreement strategies can generalize across languages and across phenomena, they must be part of the speakers' grammatical knowledge.

8.4 Model Fitting: *and-coordination*

8.4.1 Dataset

We trained the model with 28 observations ($K = 28$) of *and-coordination* obtained from the previous experiments, in which 14 were for number agreement and 14 for gender agreement (table 8.4). We used the mean of acceptability rating of each condition as the response variable. All conditions were annotated with the constraints defined in section 8.2.6 (see all the data annotation in appendices section E.1.1).

Table 8.4 – Summary of the experimental results in *and-coordination*

	Condition	Mean
1	NP1sg-et-NP2pl-Vpl	9.10
2	NP1sg-et-NP2pl-Vsg	1.78
3	NP1sg-et-NP2sg-Vpl	8.68
4	NP1sg-et-NP2sg-Vsg	1.99
5	NP1pl-et-NP2sg-Vpl	8.48
6	NP1pl-et-NP2sg-Vsg	2.25
7	NP1pl-et-NP2pl-Vpl	8.74
8	NP1pl-et-NP2pl-Vsg	1.99
9	NP1sg-and-NP2sg-Asg	8.21
10	NP1sg-and-NP2sg-Apl	8.19
11	Dpl-N1sg-and-N2pl	7.45
12	Dsg-N1sg-and-N2pl	6.36
13	Dpl-N1sg-and-N2sg	6.93
14	Dsg-N1sg-and-N2sg	7.25
15	NP1f-and-NP2m-Vf	3.40
16	NP1f-and-NP2m-Vm	8.20
17	NP1m-and-NP2f-Vf	4.27
18	NP1m-and-NP2f-Vm	8.17
19	Vf-NP1f-and-NP2m	4.16
20	Vm-NP1f-and-NP2m	7.80
21	Vf-NP1m-and-NP2f	3.47
22	Vm-NP1m-and-NP2f	8.28
23	N1m-et-N2f-Af	6.37
24	N1m-et-N2f-Am	5.89
25	D(A)m-N1f-et-N2m	4.57
26	D(A)f-N1f-et-N2m	6.42
27	D(A)m-N1m-et-N2f	8.31
28	D(A)f-N1m-et-N2f	3.01

8.4.2 Parameter Estimation

In order to evaluate the value of λ or γ, we did leave-one-out cross validation: we trained the model by leaving one condition out, then made predictions on this leftover condition using the trained model.

When $\lambda = 0.0000004$, $\gamma = 0.0000004$, the cross-validation error $\mathrm{LOOCV}_{(K)}$ was minimal (0.24). Table 8.5 shows the coefficients of each constraint in the model with the minimal cross-validation error. See fig. 8.4 for a comparison of the coefficients for gender and number.

	[Num]	[Gen]
Intercept	8.89	8.32
CCA [Att]	0.70	2.42
CCA [Pred]	0.29	0.40
RA [Att]	1.62	1.85
RA [Pred]	6.74	4.25
EA [Att]	1.00	1.18
EA [Pred]	0.00	0.15

Table 8.5 – Coefficients learned by Model *fuser* with minimal cross-validation error

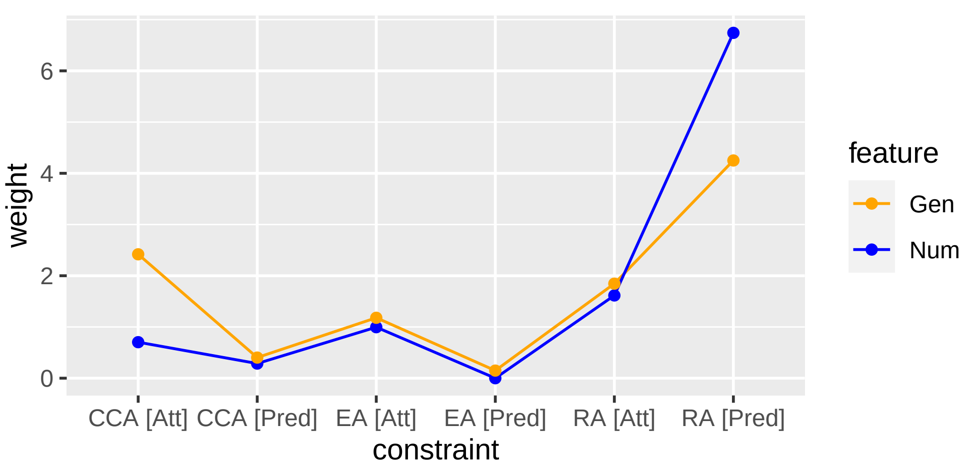


Figure 8.4 – Comparison of coefficients in gender and number agreement

First of all, we contrast number and gender agreement. Their coefficients differ in particular in two conditions: CCA [Att] and RA [Pred]. In attributive agreement, the coefficient of the constraint CCA [Att] is bigger for gender than for number. The violation of

CCA has a bigger penalty on gender agreement than on number agreement. This difference predicts for instance that the structure Dpl-N1sg-et-N2sg should be more acceptable than the structure Dm-N1f-et-N2m. In the verbal domain, the coefficient of the constraint RA [Pred] is bigger for number. That is to say, the violation of RA has a higher penalty on number agreement than on gender agreement, which implies for instance the structure NP1sg-et-NP2sg-Vsg is less acceptable than the structure NP1m-et-NP2f-Vf. This result confirms that gender and number do not go through the same processes. In the nominal domain, gender is more sensitive to the linear proximity than number agreement. Moreover, in the verbal domain, number is more sensitive to the resolution rule.

Secondly, we compare the coefficients in different domains. The coefficient of the constraint CCA [Att] is bigger than that of the CCA [Pred] for both gender and number agreement. Regarding RA, the coefficient of the constraint RA [Pred] is much bigger than that of the RA [Att]. The results confirm the agreement hierarchy proposed by Corbett (1991): the likelihood of CCA decreases from attributive to predicative agreement while the likelihood of RA increases. This hierarchy is true for both gender and number agreement. That is to say, the violation of CCA degrades much more the acceptability in attributive agreement than in predicative agreement. Moreover, the violation of RA has a smaller penalty on the acceptability in the nominal domain.

There is also an effect of directionality, which is demonstrated by the coefficient of the constraints EA [Att] and EA [Pred]. Notice that the coefficient for the EA [Att] is much bigger than for the EA [Pred] – when the target is before the controller, the violation of EA has a bigger negative effect on the acceptability in the attributive position than in the predicative position.

8.4.3 Cross-validation

Next, we zoom in on the results of leave-one-out cross-validation by examining the MSE between the prediction of the model and human acceptability during each cross-validation iteration.

Figure 8.5 illustrates how the prediction of the model correlates with the human acceptability data for each condition (The detailed results are showed in Appendices section E.1.2). y axis of each point in the fig. 8.5 represents the prediction of the model trained without this condition (with the parameters defined above $\lambda = 0.0000004$, $\gamma = 0.0000004$). x axis represents the human acceptability obtained in the previous experiments. If the model works perfectly, all the points should be on the black dotted line $y = x$. The farther the data point is from the line, the less the model can predict reality.

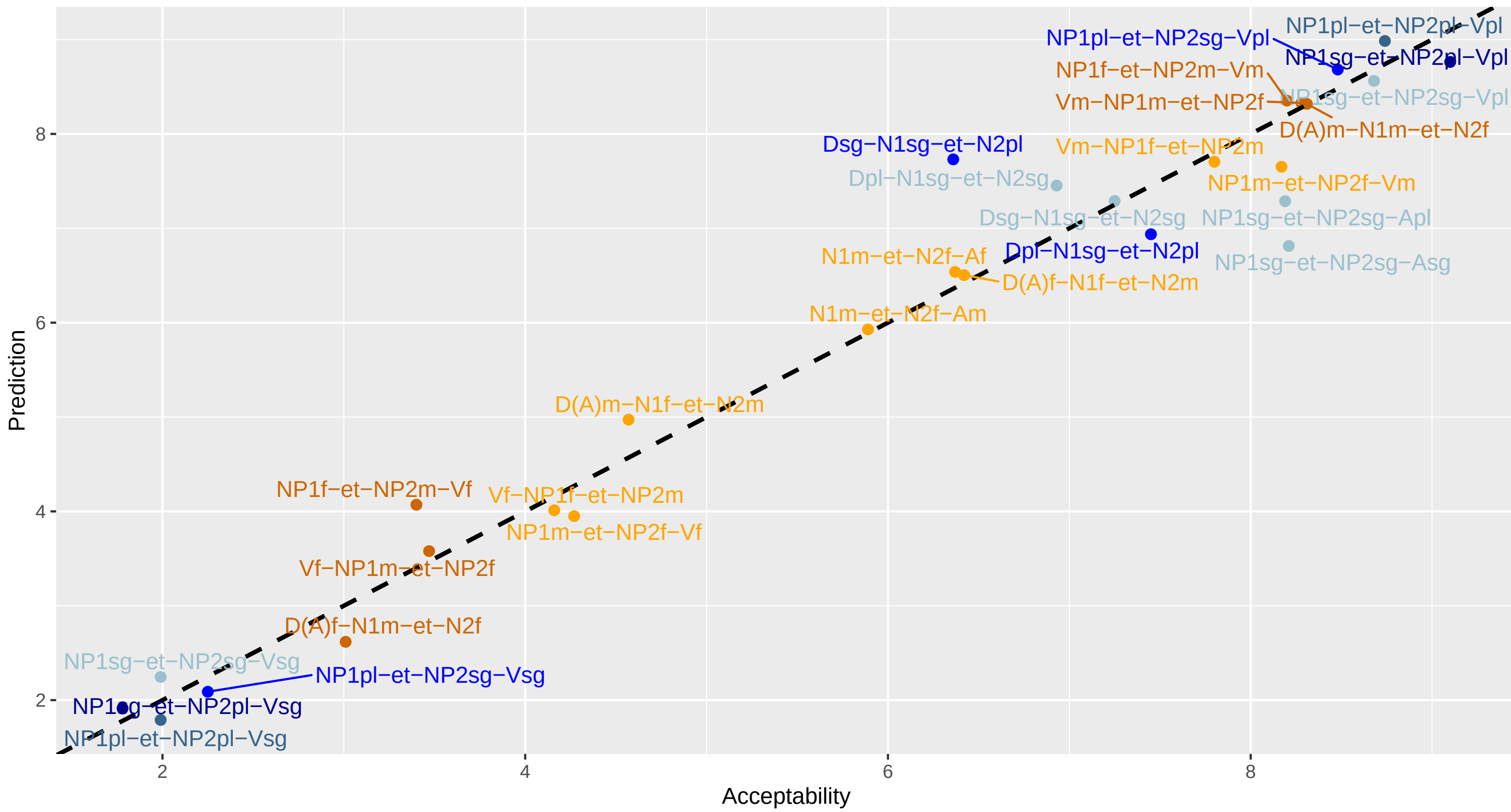


Figure 8.5 – Leave one out cross-validation for each condition in *and-coordination*

The cross-validation results report that this model can capture most of the linguistic generalizations underlying these *and-coordination* experimental data. All the data are distributed along the line $y = x$. Among the 26 conditions, two have the predicted squared error more than 1: Dsg-N1sg-et-N2pl, NP1sg-et-NP2sg-Asg. Note that all these conditions occur in the attributive domain, which can be interpreted by the point that agreement patterns in the attributive domain are more complicated and there are some generalizations that the current model can not capture.

Zooming in on these two conditions, we go back to the experimental findings. Regarding the conditions Dsg/pl-N1sg-et-N2pl, in comparison with the conditions Dsg/pl-N1sg-et-N2sg, the N2pl make a Dpl more acceptable than the N2sg, and makes a Dsg less acceptable (see Chapter 3 for a detailed discussions). However, in our model, the farthest noun (N2) is not taken into account.

The model also works imperfectly for the post-nominal adjectives in number agreement. Singular agreement (in the condition N1sg-et-N2sg-Asg) is rated much higher than predicted. This may stem from the fact that post-nominal adjectives are rated higher than in prenominal position in our experiments. I speculate that this result may come from a structural bias: when the D precedes a singular binomial, there is a strong bias to co-references ('the colleague and friend'), resulting that a singular prenominal determiner is not favored.

8.5 Model Generalisation: Resolution Rule with Disjoined NPs

Or-coordination differs from *and-coordination* by not having an explicit prescriptive grammatical rule. French grammar books (e.g. *Le bon usage*, Grevisse and Goosse 2016) recommend that agreement is usually made with the whole coordination phrase, whereas agreement with the closest conjunct is also very frequent (see section 2.1.2 above).

The model above only discusses *and-coordination* which has a clear resolution rule.

Regarding *or-coordination*, the experimental results exhibited in the previous chapters illustrate that both singular and plural verbs are acceptable with two singular disjoined NP. The same patterns are also observed in English and Italian by Foppolo and Staub (2020).

The explanation of Foppolo and Staub (2020) follows the line of Reis (1974); Peterson (1986), assuming that "agreement with disjoined NP is a 'patch up' strategy: the standard rules do not tell the speaker what to do; unless he escapes into an innocuous paraphrase, he will have to patch up the holes left by his core grammar" (Reis 1974, p166). In their approaches, there should be no resolution rules. Thus neither singular nor plural verb violates it.

On the contrary, this thesis assumes that agreement with disjoined NPs is not a simple 'lacuna of grammar'. In other words: there must be to some extent a resolution rule with *or-coordination* in speakers' grammatical knowledge. Otherwise, only singular agreement will be allowed (as it is the closest). Speakers approximate *or-coordination* to *and-coordination*, by employing to a certain degree the resolution rule found in *and-coordination*, but the strength of the resolution rule is less important than in *and-coordination*. On the other hand, the linear proximity exhibited in CCA, and the directionality exhibited in EA are generalizable from *and-coordination* to *or-coordination*.

This section will compare these two hypotheses by ways of cross-validated/held-out train/test methodology using the acceptability rating data obtained from the previous experiments. We assume the constraint set for *or-coordination* are as same as that for *and-coordination*, but they differ in ways of the definition of resolution rules and their weights. For the 'grammatical lacuna' hypothesis, we suppose that there is no resolution rules so that neither singular target nor plural target violates it. For the second hypothesis that agreement with disjoined NP is part of speakers' grammatical knowledge, we assume that the weight related to CCA and EA in *or-coordination* remains as same as that in *and-coordination*. Singular target violates the resolution rule (plural), but the weight associated with this constraint violation is less important than that in *and-coordination*. We evaluate these two models by test errors in cross-validation as defined in the section 8.2.5.

In addition, we add a baseline model which supposes that speakers use the same strategy for *and-coordination* and *or-coordination* in order to see whether there are some similarities between agreement with *and-coordination* and *or-coordination*.

8.5.1 Baseline model: Prediction with the model trained with *and-coordination*

The *or-coordination* data set includes 26 observations obtained in the experiments in the previous chapters, in which 18 are for number agreement and 8 for gender agreement (table 8.6).

The first model aims to estimate whether the model trained with *and-coordination* can capture some generalizations of *or-coordination*. First of all, all the observations were annotated with the constraint set defined above in section 8.2.6 (see appendices section E.2.1.1 for the constraint annotation). We supposed that there were same resolution rules for *or-coordination* as that for *and-coordination*. Thus the singular (feminine) target violated the resolution rules. The constraint set and its annotation were exactly the same as that in *and-coordination* (see an illustration of constraint annotation in table 8.7).

Figure 8.6 reports the correlation between human acceptability for the *or-coordination* conditions and the prediction on these conditions using the model trained with *and-coordination* data (with the parameters defined above $\lambda = 0.0000004$, $\gamma = 0.0000004$). Very surprisingly, the points are not distributed randomly along the line $y = x$. That is to say, the model trained with *and-coordination* can capture some generalizations underlying *or-coordination*. The mean squared error (MSE) between the predictions of the model and the human acceptability is 2.69. Among these 26 points, two conditions NP1sg-ou-NP2sg-Vsg/pl are very far from the line $y = x$, meaning that some special properties of two disjoined singular NPs cannot be captured by this model. The inverted singular disjunction (Vsg/pl-NP1sg-ou-NP2sg) also have big prediction errors, as well as postnominal adjectives: N1sg-ou-N2sg-Asg. This result points out that the resolution rule for disjoined singular NPs does not play the same role as that for *and-coordination*.

Table 8.6 – Summary of experimental results in *or-coordination*

	Condition	Mean
1	Vsg-NP1sg-ou-NP2sg	7.12
2	Vpl-NP1sg-ou-NP2sg	6.35
3	NP1sg-ou-NP2sg-Vpl	7.01
4	NP1sg-ou-NP2sg-Vsg	7.09
5	N1sg-ou-N2sg-Asg	8.35
6	N1sg-ou-N2sg-Apl	8.37
7	Dpl-N1sg-ou-N2sg	6.98
8	Dsg-N1sg-ou-N2sg	7.80
9	NP1sg-ou-NP2pl-Vpl	8.40
10	NP1sg-ou-NP2pl-Vsg	2.32
11	Vpl-NP1sg-ou-NP2pl	7.58
12	Vsg-NP1sg-ou-NP2pl	3.83
13	NP1pl-ou-NP2sg-Vpl	7.92
14	NP1pl-ou-NP2sg-Vsg	2.39
15	Vpl-NP1pl-ou-NP2sg	7.60
16	Vsg-NP1pl-ou-NP2sg	2.50
17	Dpl-N1sg-ou-N2pl	6.96
18	Dsg-N1sg-ou-N2pl	6.43
19	NP1f-ou-NP2m-Vf	4.44
20	NP1f-ou-NP2m-Vm	8.00
21	NP1m-ou-NP2f-Vf	5.25
22	NP1m-ou-NP2f-Vm	7.81
23	Vf-NP1f-ou-NP2m	5.34
24	Vm-NP1f-ou-NP2m	7.58
25	Vf-NP1m-ou-NP2f	3.79
26	Vm-NP1m-ou-NP2f	8.02

There are three other conditions of number agreement with MSE bigger than 1: Vsg/pl-NP1sg-ou-NP2pl, Vpl-NP1pl-ou-NP2sg. The singular verb is predicted lower in the Vsg-NP1sg-ou-NP2pl condition than human acceptability since the resolution rule may have a less important weight in *or* condition than in *and*. Thus using the weight obtained from *and-coordination* to predict *or-coordination* may result in a prediction lower than reality. However, the condition Vpl-NP1pl-ou-NP2sg which does not violate any constraints has a human acceptability lower than the prediction. In the meantime, the Vpl-NP1sg-ou-NP2pl condition is also predicted higher than the actually value. This effects is mysterious and

	CCA [Pred]	RA [Pred]	EA [Pred]
Vsg-NP1sg-ou-NP2sg	0	**-1**	0
Vpl-NP1sg-ou-NP2sg	-1	**0**	-1
Vsg-NP1pl-ou-NP2sg	-1	-1	-1
Vpl-NP1pl-ou-NP2sg	0	0	0
Vsg-NP1sg-ou-NP2pl	0	-1	0
Vpl-NP1sg-ou-NP2pl	-1	0	-1

Table 8.7 – An illustration of constraint annotations of number agreement with disjoned NPs in Model I

requires more investigation. We speculate that this degradation may due to a word order constraint that VS order is less acceptable.

Two conditions of gender agreement also has MSE bigger than 1: Vf-NP1f-ou-NP2m, NP1m-ou-NP2f-Vf, among which the targets are all feminine. In the experimental results in chapter 7, masculine predicates in *or-coordination* were rated as high as that in *and-coordination*, but feminine predicates which violated resolution rules were rated higher in *or-coordination* than in *and-coordination*. This result highlights the fact that the resolution rule for *or-coordination* does not play exactly the same role as for *and-coordination*.

In sum, remarkably, the model trained by *and-coordination* can capture some generalizations of *or-coordination*. But it fails to predict the conditions in particular where the two disjoined nouns are singular. Furthermore, regarding gender agreement, this model has a lower prediction of the feminine target. This result suggests that the resolution rule for gender agreement is less important in *or-coordination* than that in *and-coordination*.

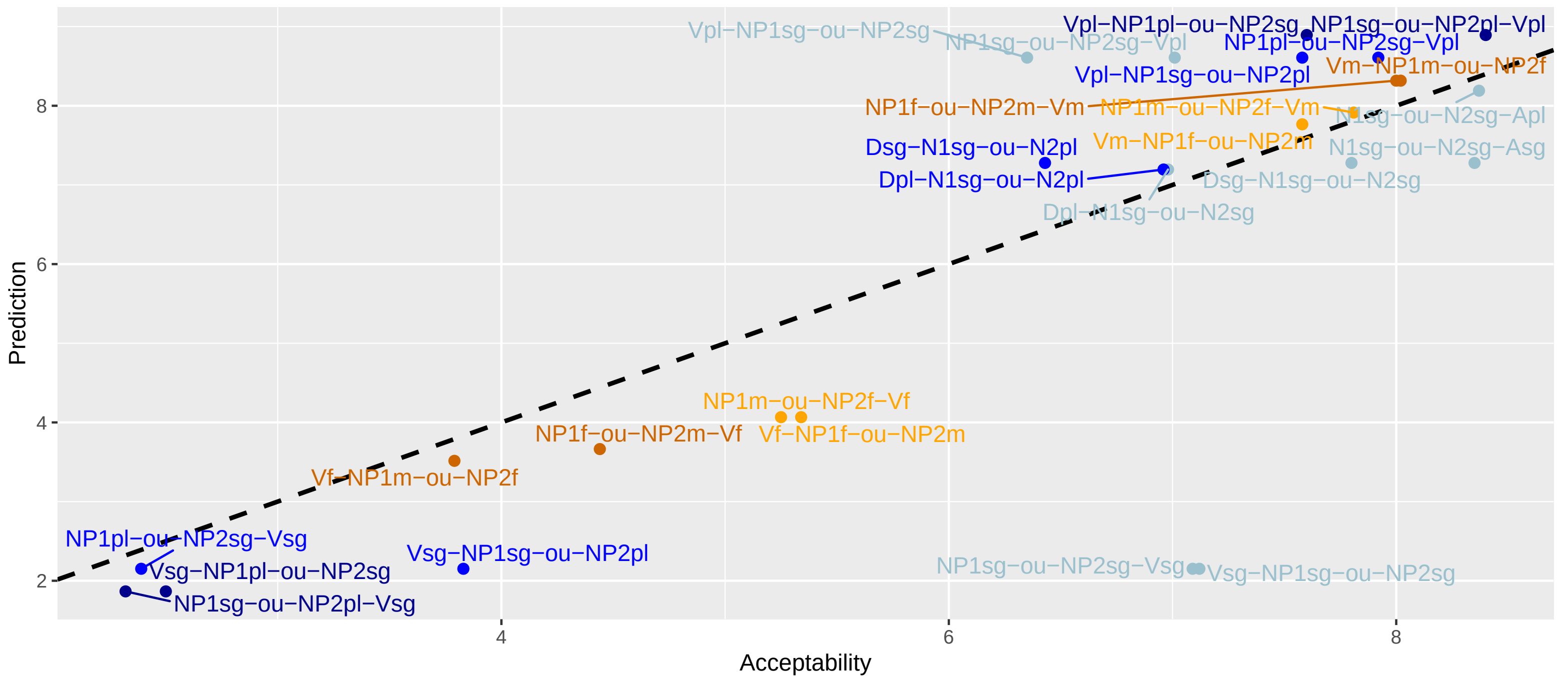


Figure 8.6 – Model I: Prediction on *or-coordination* conditions using weight obtained from *and-coordination*

8.5.2 Model II: Agreement with disjoined NP is a 'grammatical lacuna'

The hypothesis that agreement with two disjoined singular NP is a 'grammatical lacuna' assumes that there is no resolution rules, thus speakers can use both singular and plural agreement. This claim can be incorporated in our model by assuming that with two disjoined singular NPs, neither singular nor plural target violates constraints related to RA since there is no resolution rules under such condition (table 8.8).

On the other hand, in the verbal domain, singular verb was not acceptable when there was at least a plural conjunct regardless of the number of closest noun, for instance in the combination NP1sg-ou-NP2sg-V (see details in Chapter 6). Hence, we assume that there is a resolution rule when there is at least a plural conjunct, which cause the degradation of acceptability of the singular verb.

	CCA [Pred]	RA [Pred]	EA [Pred]
Vsg-NP1sg-ou-NP2sg	0	**0**	0
Vpl-NP1sg-ou-NP2sg	-1	**0**	-1
Vsg-NP1pl-ou-NP2sg	-1	-1	-1
Vpl-NP1pl-ou-NP2sg	0	0	0
Vsg-NP1sg-ou-NP2pl	0	-1	0
Vpl-NP1sg-ou-NP2pl	-1	0	-1

Table 8.8 – An illustration of constraint annotations of number agreement with disjoned NPs in Model II

The prescriptive grammar does not dictate a resolution rule for gender agreement, neither. Henceforth, if there is a disjunction of masculine and feminine, neither masculine nor feminine target violates constraints related to RA (table 8.9).

There are very few data in the nominal domain. We assume the definition of resolution rules is as same as that in the verbal domain (see a total of annotation of constraints in Appendices section E.2.2.1).

In order to test this hypothesis that agreement with disjoined singular NPs is a 'grammatical lacuna', we trained a model using the 26 observations of *or-coordination* with the

	CCA [Pred]	RA [Pred]	EA [Pred]
Vf-NP1m-ou-NP2f	-1	0	-1
Vm-NP1m-ou-NP2f	0	0	0
Vf-NP1f-ou-NP2m	0	0	0
Vm-NP1f-ou-NP2m	-1	0	-1

Table 8.9 – An illustration of constraint annotations of gender agreement with disjoined NPs in Model II

same architecture as that for *and-coordination* defined in section 8.2.2. This model differed from the model for *and-coordination* in the ways of defining resolution rules. There was no resolution rules for two singular disjoined NPs, nor was there any for a disjunction of a masculine noun and a feminine noun. On the contrary, there was a resolution rule to plural when there was at least a plural conjunct as our experimental results highlighted that a singular target was not acceptable regardless of the number of closest noun (see Appendices for a detailed annotation of of the dataset).

The parameters λ, γ were estimated using leave-one-out cross-validation as was done for *and-coordination*. We obtained $\lambda = 5e - 05$, $\gamma = 1e - 04$ when the test error was minimal (LOOCV$_k$= 1.86). The coefficients are showed in table 8.10:

	[Num]	[Gen]
Intercept	7.46	6.65
CCA [Att]	0.00	0.00
CCA [Pred]	0.27	0.51
RA [Att]	0.29	0.00
RA [Pred]	4.27	3.85
EA [Att]	0.17	0.00
EA [Pred]	0.19	0.38

Table 8.10 – The coefficients of constraints in *or-coordination* in Model II

If we compare the coefficients in *or-coordination* with that in *and-coordination* (fig. 8.7), we observe the coefficients of all the constraints in the nominal domain become smaller, which may due to a lack of data. The coefficient for the constraint RA [Pred] also becomes smaller, but only for number agreement.

The result of leave-one-out cross validation for each condition is illustrated in fig. 8.8

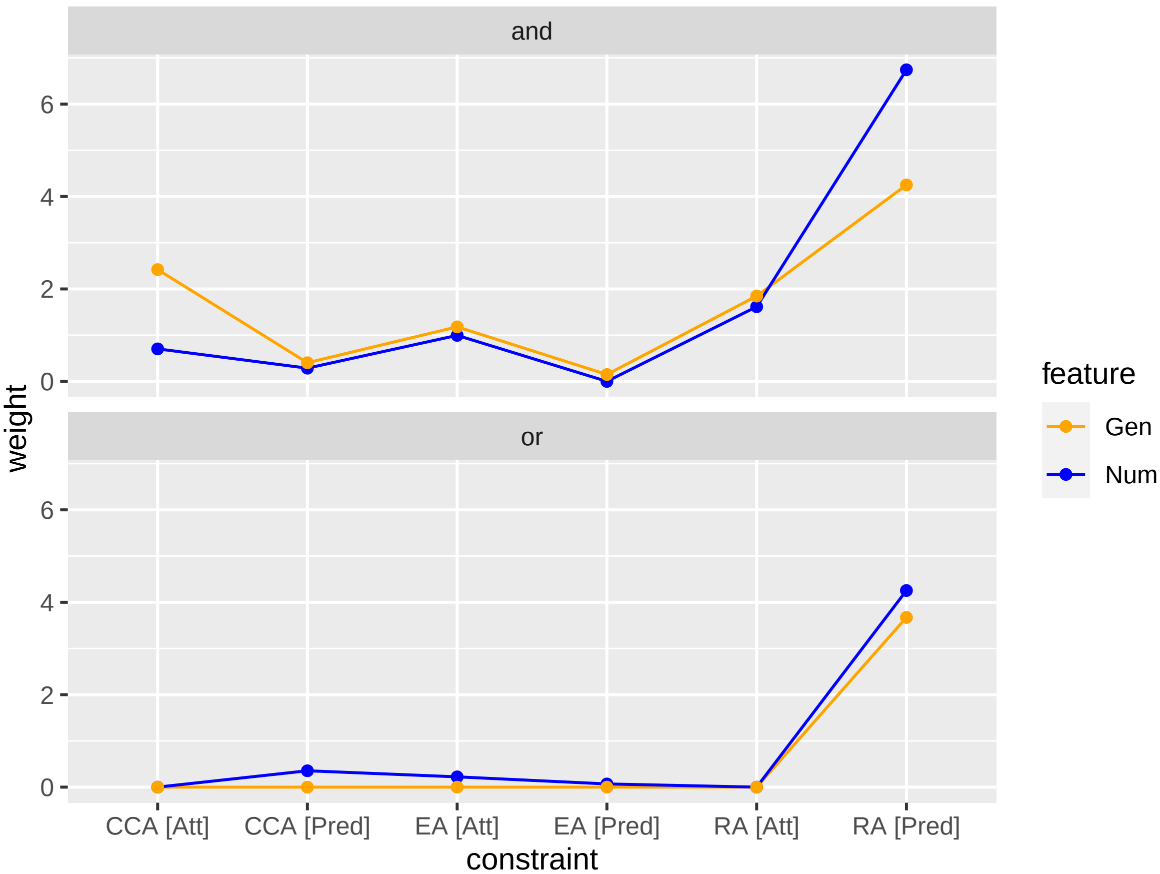


Figure 8.7 – Comparisons of constraints' weight for *and-coordination* and *or-coordination* in Model II

(see details in Appendices section E.2.2.2). This model makes more reasonable predictions for the NP1sg-ou-NP2sg-V conditions than the first model. 12 conditions have a MSE bigger than 1: N1sg-ou-N2sg-Apl, NP1sg-ou-NP2pl-Vpl, NP1pl-ou-NP2sg-Vsg, Dsg-N1sg-ou-N2pl, NP1f-ou-NP2m-Vf/Vm, Nm-ou-Nf-Vf/Vm, Vm/Vf-Nf-ou-Nm, Vm-NP1m-ou-NP2f. However, 8 of them are for gender agreement, that is to say, simply supposing that there is no resolution rules for a disjunction of masculine and feminine is far from capturing the true human generalisation.

Four conditions of number agreement are distributed away from the line $y = x$ (MSE>1): N1sg-ou-N2sg-Apl, NP1sg-ou-NP2pl-Vpl, NP1pl-ou-NP2sg-Vsg, Dsg-N1sg-ou-N2pl. Among these four conditions, three relate to conditions with disjoined singular and plural nouns, which suggests that we can not simply assume that there is a same resolution rule for a disjunction of a singular and plural noun as that in *and-coordination*.

In sum, under the hypothesis that agreement with disjoined NP is a ‘grammatical lacuna’, Model II is far from achieving human performance in predicting the acceptability of agreement with disjoined NPs. This model assumes that there is no resolution rules neither for two disjoined singular NPs, nor for a disjunction of masculine and feminine. On the contrary, there is a resolution rule when there is at least a plural conjunct since the French data showed that a singular verb was not acceptable in such conditions regardless of the closest noun being singular or plural. The model trained under such hypothesis has a relatively high cross-validation error.

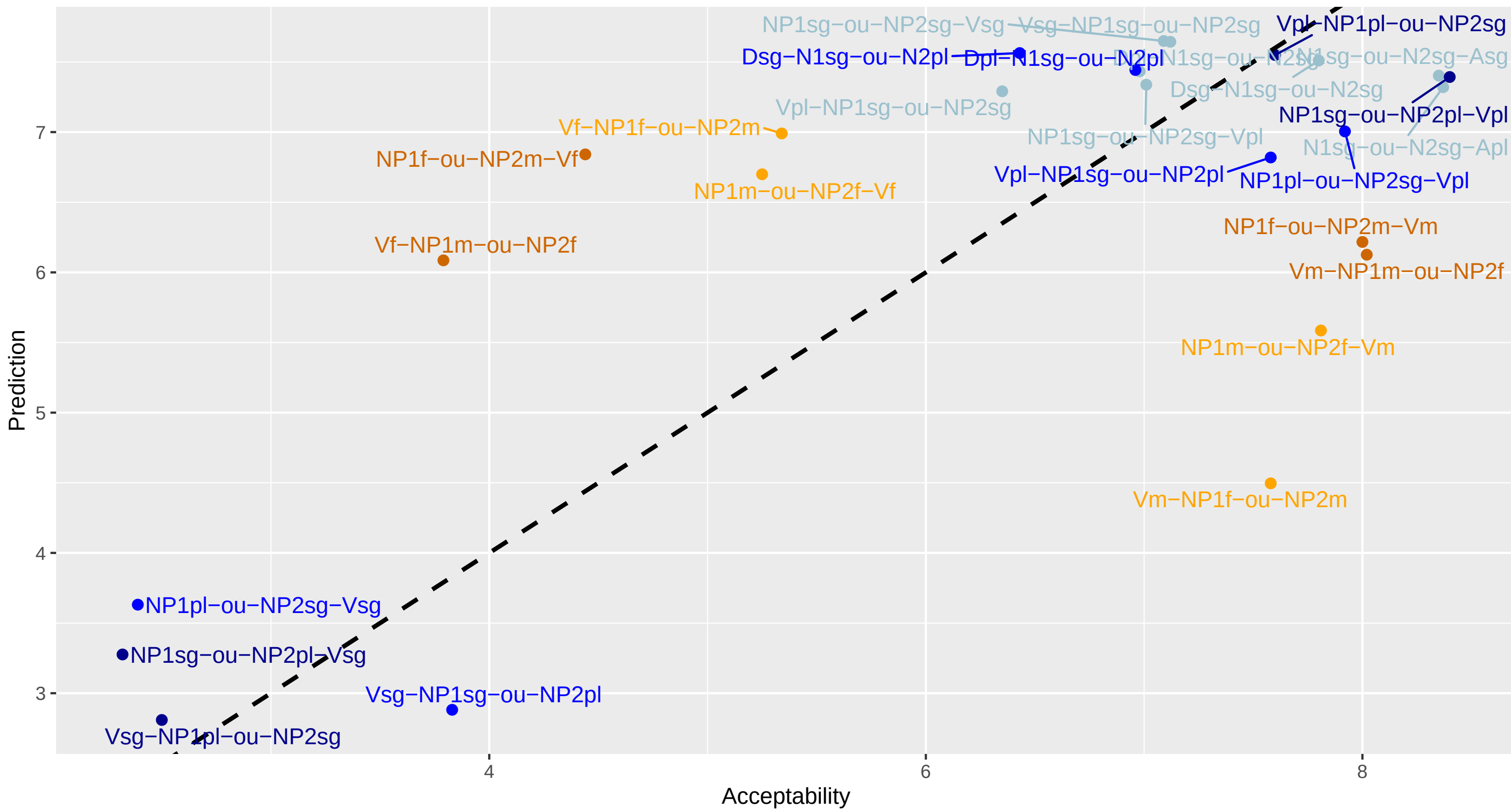


Figure 8.8 – Leave-one-out cross validation for each condition in *or-coordination* in Model II

8.5.3 Model III: implicit resolution rules for *or-coordination*

Model III tests the hypothesis that there is an implicit resolution rule to plural (masculine) with the disjunction. But intuitively the resolution rule plays a less important role than that in *and-coordination*. This model estimates the relative weight related to resolution rules in *or-coordination*, assuming that *and-coordination* and *or-coordination* share the same weight for the constraints related to CCA and EA, and the only difference is that the coefficient for the resolution rules changes, which becomes lower for *or-coordination*.

In order to estimate the relative weight of RA for disjunction, we suppose that the weight of RA for two disjoined singular NPs (the N1sg-ou-N2sg conditions) is distinguished from that for a disjunction of a singular and a plural (the N1sg-ou-N2pl conditions or the N2sg-ou-N1pl conditions), as the plural conjunct in the N1sg-ou-N2pl conditions will favor RA. We suppose that the weight of RA for the N1sg-ou-N2pl conditions is as same as that for the N1pl-ou-N2sg conditions as the lexical plurality is the same and the difference can be accounted for by the linear order.

The 28 observations of *or-coordination* were annotated with the constraints defined in the section 8.2.6 (table 8.11, see appendices section E.2.3.1 for details). The singular/feminine target violated RA. The constraint annotation was the same as that in model I. The difference between these two models was the strength of constraints involving RA.

	CCA [Pred]	RA [Pred]	EA [Pred]
Vsg-NP1sg-ou-NP2sg	0	**-1**	0
Vpl-NP1sg-ou-NP2sg	-1	**0**	-1
Vsg-NP1pl-ou-NP2sg	-1	-1	-1
Vpl-NP1pl-ou-NP2sg	0	0	0
Vsg-NP1sg-ou-NP2pl	0	-1	0
Vpl-NP1sg-ou-NP2pl	-1	0	-1

Table 8.11 – An illustration of constraint annotations of number agreement with disjoned NPs in Model III

The relative weight of resolution rules was estimated in the follow steps: first of all, for conditions with two singular NPs, the strength of RA [Pred/Att][Num] in *or-coordination* was n times (n_1 for Predicative and n_2 for Attributive) that in *and* $n \in (0, 1)$, while for a disjunction of a singular noun/NP and a plural noun/NP, the strength of RA [Att/Pred][Num] in *or-coordination* was j times (j_1 for predicative and j_2 for attributive) that in *and* $j \in (0, 1)$. Secondly, we used the model to predict on the 18 conditions of number *or-coordination* with [i, j] range from 0 to 1 with an interval of 0.1. Then we compared the sum of square errors between the prediction of the model and human acceptability on the set of 18 conditions.

When the mean of the squared error between the prediction and real acceptability data was minimal (0.73), for the N1sg-ou-N1sg conditions, $i_1 = 0.3$, $i_2 = 0.5$, the weight of the constraint RA [Pred][Num] is 2.02, while for the RA [Att][Num] it is 0.81. For the N1sg-ou-N2pl (and N1pl-ou-N2sg) conditions, we obtain $j_1 = 1$, $j_2 = 0.9$. The weight for the constraint RA [Pred][Num] is 6.74 and for RA [Att][Num] is 1.46, which is almost the same as *and-coordination*. If we look at the experimental results in chapter 3 and chapter 5, *or-coordination* had very similar results to *and-coordination* in the N1sg-Conj-N2pl combinations.

Figure 8.9 compares the coefficient of constraints in *or-coordination*, including two singular disjoined NPs and a disjunction of a singular and a plural, with that in *and-coordination*.

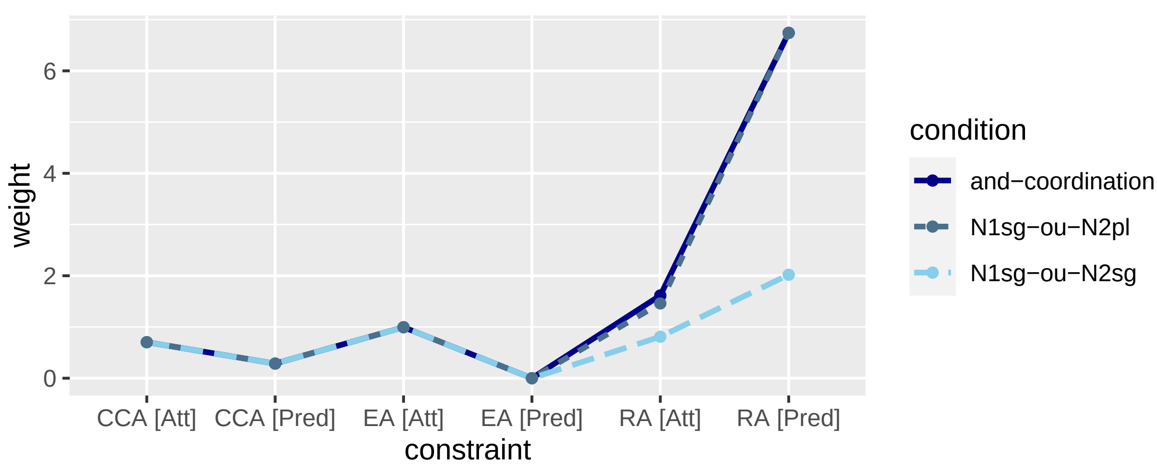


Figure 8.9 – Comparisons of number constraints' weight in *and-coordination* and *or-coordination* in Model III

We also approximated the weight of the constraints of resolution rules for gender agreement when there was a mismatch of masculine and feminine especially in predicate position, since there were no experimental results for attributive agreement. The procedure was the same as that for number agreement. We found that the weight of resolution rules in *or-coordination* is about 80% of that in *and-coordination* – the coefficient of the constraint RA [Pred][Gen] was 3.41. The mean squared error was 0.12.

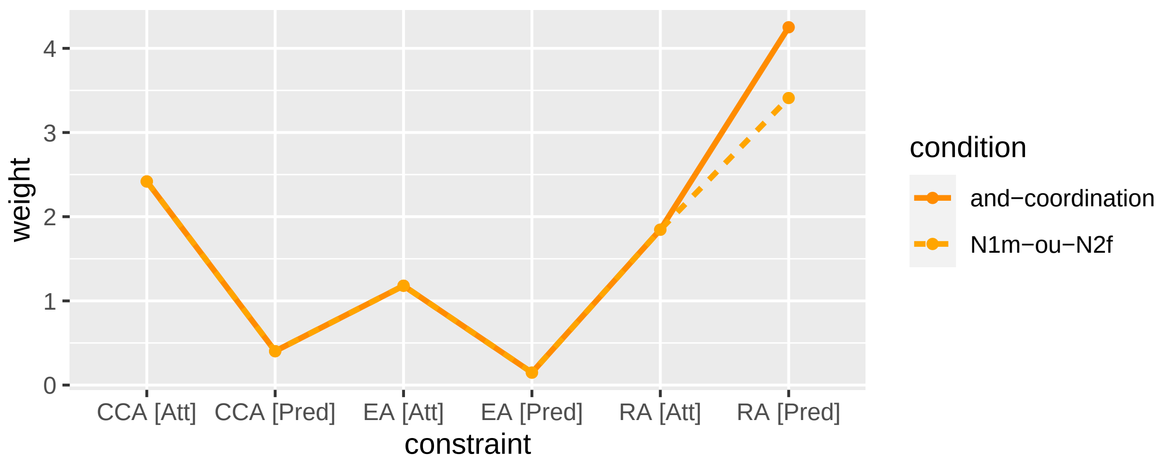


Figure 8.10 – Comparisons of gender constraints' weight in *and-coordination* and *or-coordination* in Model III

Finally, we do leave-one-out cross validation for Model III (fig. 8.11): the weight for the constraints related to EA and CCA are the same as in Model I (in *and-coordination*). The weights for the constraints related to RA were evaluated above (see figs. 8.9 and 8.10). The $\mathrm{LOOCV}_K = 0.52$, the smallest among these three models. Only three conditions fall out of the line of 1: Vpl-NP1sg-ou-NP2sg, NP1pl-ou-NP2sg-Vsg, Dsg-N1sg-ou-N2pl. But they are all below 3. The reason remains mysterious. In these three conditions, the prediction of the model is higher than the actual human acceptability ratings. We assume that these effects may be due to the fact that the mismatch of conjuncts' number (a singular noun and a plural noun) may degrade the acceptability. Otherwise the VS word order may also degrade the acceptability.

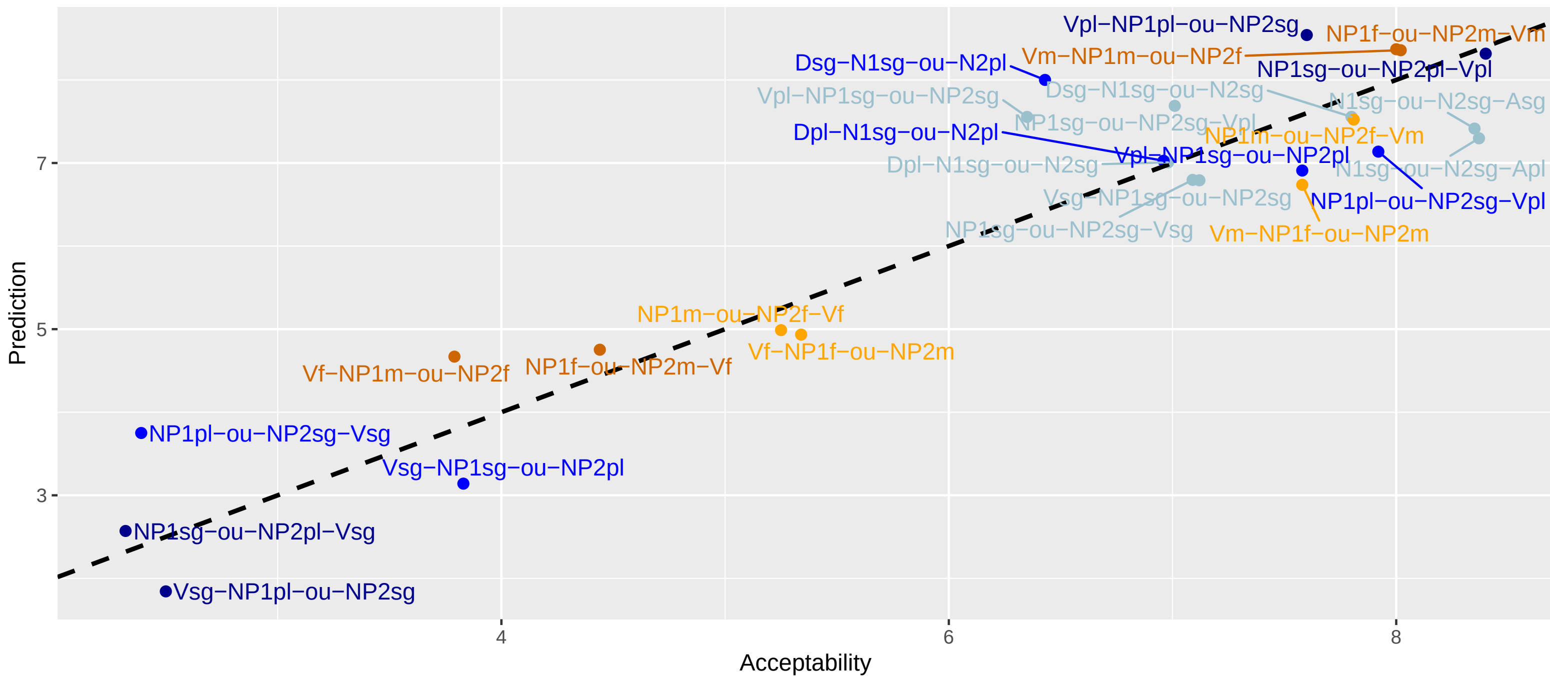


Figure 8.11 – Leave one out cross-validation for each condition in *or-coordination* in Model III

In sum, model III which supposes that there is a resolution rule for *or-coordination*, has the smallest test error among the three models. In this model, we approximate the relative strength of resolution rules by assuming that the strength of constraints related CCA and RA remains the same in *and-coordination* and *or-coordination*. For two singular disjoined NPs, the resolution rule has 30% the strength of that in *and-coordination* in predicate agreement and 50 % in attributive agreement. For a disjunction of a masculine and a feminine noun, the strength of the resolution rule is about 80% of that in *and-coordination* in predicate agreement.

8.6 Discussion

This current framework is different from standard OT (Smolensky and Prince, 1993) which allows only one optimal output. It is also different from linear optimality theory (Keller, 2000, 2006) since LOT only deals with acceptability differences of candidates in the same candidate set. Human acceptability data are characterized by their gradience, which can easily be handled in our model. Furthermore, our model uses train/cross-validation methods and is able to estimate the parameters across different candidate sets and different experiments.

This current model is similar to harmonic grammar as it defines a harmonic score denoting the sum of constraint violation, but it differs in the way the parameter is evaluated: this model uses "least square" by adding regularization paths whereas the common practice in harmonic grammar is backpropagation.

In this model, gang-up of constraints is allowed. Due to the nature of agreement with coordination phrases, each violation could result in a penalty to the acceptability and different violations are cumulative.

Moreover, this model uses high-dimensional penalized regression across heterogeneous subgroups, which allows sharing information about the linear parameters across subgroups. In our case, number and gender are not two independent features as an agreement may involve simultaneously gender and number agreement. Thus such a model considers that number and gender, although related, may differ with respect to their underlying agreement strategies and therefore assign different weights to the constraint violations. This approach gives solutions to the issues of i) sparse data ii) information-sharing between the subgroups.

Hence, such a model architecture allows to unify various aspects of agreement: controller, target, domain, feature, directionality, and conjunctions. The information about controller, target and directionality are encoded in agreement (CCA/RA/EA), which in the constraint set is combined with the values for domain (Pred/Att). Such a unified model not only enables to link the qualitative universal typology (the agreement hierarchy) to a predictive framework; secondly, this unified model also treats *and-coordination* and *or-coordination* together and distinguishes the properties that are shared between these two kinds of agreement as well as the differences among them.

8.6.1 Linking universal typologies to a quantitative/predictive framework

8.6.1.1 Agreement Hierarchy

Our model incorporates the agreement hierarchy into a predictive framework. According to the agreement hierarchy (see Corbett 1991), the likelihood of RA increases from the attributive domain to the predicative domain while the likelihood of CCA decreases. In such a way, the agreement hierarchy predicts on the one hand that the violation of CCA in the attributive domain has a more important penalty on the structure's well-formedness than in the predicative domain. Our model confirms this hierarchy in a quantitative way, revealing that the coeffecient of the constraint CCA [Att] is bigger than the constraint CCA [Pred] . This tendency is true for both number and gender agreement.

In addition to the violation of CCA, the agreement hierarchy predicts on the other hand that the violation of RA should have more effect on the well-formedness in predicative domain. Our model's results are in line with this prediction: the coefficient of the constraint RA [Pred] is bigger than that of the constraint RA [Att]. Once again, this is true for both gender and number agreement.

Concerning EA which is relevant to the effects of directionality, the model's results reveal that the coefficient of constraints related to EA in attributive domain is bigger than that in predicative domain. These effects highlight that the directionality has more important effects in the attributive domain than in the predicative domain.

These differences across domains are observed for both number and gender agreement, which indicate that gender and number agreement share some common properties. But the effects of domain are distinct in some ways for gender and number, which will be discussed in the following section.

8.6.1.2 Gender vs. Number

The results in the section 8.4.2 illustrated an asymmetry between gender and number agreement even though we used a penalized method to approximate the coefficient for gender and number. This asymmetry between gender and number is apparent in two ways: on the one hand, violation of CCA in gender has a greater penalty on the structure's well-formedness than that in number in the attributive domain; on the other hand, in the verbal domain, violation of RA has a greater penalty for number than for gender.

Our results show that French number and gender reveal different patterns with respect to agreement with coordination structures. Linear proximity play a more important role for gender agreement. Furthermore, the self-paced reading experiment in chapter 5 highlighted that CCA in gender does not cause any processing difficulty, but CCA in number was read slowly.

This tendency is observed in Romance languages. In the corpus study by Villavicencio et al. (2005) on Portuguese, they show that in prenominal attributive adjective agreement, CCA is the only choice for number but both CCA and resolution rules are possible for gender agreement in *and-coordination*.

Moreover, in South Slavic languages, Nevins and Weisser (2019) suggests that CCA can only occur with gender agreement but not number in *and-coordination* based on native speakers' intuition.

Based on these evidence, we propose a feature hierarchy regarding agreement with coordination phrases:

CCA is more acceptable for gender agreement than for number agreement.

This hierarchy predicts that the likelihood of CCA increases from number agreement to gender agreement; while the likelihood of RA decreases from number agreement to gender agreement. Of course, this hierarchy is not in conflict with the agreement hierarchy which predicts that CCA is more acceptable in the attributive domain than in the predicative domain, for both gender and number agreement.

One explanation for this difference between gender and number can be that number is an interpretable feature whereas only for animate nouns where gender is interpretable. CCA is not be compatible with the plurality that a *and-coordination* phrase denotes. As a result, we suggest that CCA is less acceptable for the interpretable feature.

Another assumption can be that gender and number are morpho-syntactically marked in different ways. Gender is lexically specified; a given noun belongs to gender X regardless of its syntactic position. Nouns' gender is an inherent property, and this gender persists throughout its use and is manifested through the element that agrees with it. For instance, through *la chaise* ("the.F.SG chair.F.SG"), we know that the noun *chaise* is feminine since the determiner is feminine. Here gender stands apart from number, which is specified within a given utterance. Number is clearly an inflectional morpheme, the number feature of a noun depends on its intended referent in a given use.

Another speculation is that the sensibility of linear proximity may be subsumed under the rubric of feature geometry. According to Greenberg (1963); Harley and Ritter (2002a,b), gender and number are typologically organized in a hierarchical structure. Greenberg (1963) observes a number of crosslinguistic generalizations concerning the clustering of features, describing, e.g., the dependence of gender on number

Universal 36 : if a language has the category of gender, it always has the category of number.

On the basis of the Universal by Greenberg (1963), Harley and Ritter (2002a,b) develop a feature geometry including person, number, gender and case. The relationship between gender and number can be described as: number dominates gender. This feature geometry contributes restrictions about possible and necessary contrasts within a given system, as well as predictions about what constitutes a natural grouping of features. If a language has a feature in the lower position, it must have the feature in the higher position. We can speculate that the lower a feature in a geometry space, the more it is sensitive to the linear proximity. But this thesis only deals gender and number agreement, more evidences about other features like person are needed to be able to conclude.

It should be noted that in this thesis, we tested agreement either in number or in gender, but not both. Nevins (2018) point out that in Bosnian/Croatian/ Serbian, Slovenian, when the verb agrees with a coordinate subject, gender agreement depends on prior number agreement. That is to say, gender agreement should be consistent with number agreement. But less is known in French. Further studies are needed to include violation of number and gender in our framework.

8.6.2 *and-coordination* agreement and *or-coordination* agreement

In most previous studies, *and-coordination* and *or-coordination* are studied separately and are believed to trigger different agreement strategies. However, we discover that even though *et* and *ou* are not exactly the same, they share some common ground: if we make predictions on *or-coordination* conditions with the model trained on *and-coordination*, it can cover a wide range of conditions. Meanwhile, the *and-coordination* model fails to predict some *or-coordination* conditions, in particular for two singular disjoined nouns or a disjunction of a masculine and feminine.

We used our model to test the hypothesis that agreement with a disjoined NP is a ‘grammatical lacuna’ (Peterson, 1986; Foppolo and Staub, 2020) by encoding that in such a case there was no resolution rule violations for a disjunction of two singular NPs or for a disjunction of a masculine and a feminine nouns. However, such a model failed to cover many coordination patterns and had more prediction errors than Model III. Foppolo and Staub (2020) has shown that in English, agreement with singular disjoined NPs is not based on semantics (i.e. singular for exclusive reading of 'or', plural for inclusive reading). If the agreement is not based on semantics, it may be based on the default feature value (i.e. if there is no prescribed agreement strategy, the speakers' last rescue). However, the definition of the default feature value is not clear. For *or-coordination* in English, many theories assume that singular is the default (no agreement) and plural is CCA (Haskell and MacDonald, 2003; Keung and Staub, 2018). It is not always easy to tease apart RA, CCA and the default agreement: one may interpret singular as CCA (with two singular Ns) but it can also be default; or interpret masculine as RA (with mixed genders) but it can also be default. This thesis is not aimed to tease apart the default agreement strategy and resolution rules, but suppose that plural (masculine) is the resolution rule for both *et* and *ou*.

In model III, we hypothesize that the constraints' weight related to EA and RA can be generalized from *et* to *ou*. The weight related to resolution rules is smaller in *or-coordination* with two disjoined NPs and a disjunction of a singular and a plural, and a masculine and a feminine, which are evaluated with the experimental results. Our model shows that for a disjunction of masculine and feminine, the weight of the resolution rule is about 80% of that in *and-coordination* in predicate position. Regarding the N1sg-ou-N2sg conditions, the resolution rule is about 30% of that in *and-coordination* in predicate position, whereas it is 50% of that in attributive position. When there is a plural conjunct, the resolution rule has a very strong effect and behaves the same as in *and-coordination* in attributive agreement, and 90% of the weights in *and-coordination* in predicate position.

8.7 Conclusions

This chapter provides a new framework to predict the grammaticality of agreement with coordination structures. The model was trained with a very small dataset obtained from human experiments, but achieved very high accuracy in held-out cross-validation. This suggests that this model can be generalized to new patterns. Moreover, the constrained sets are built with universal properties of agreement: agreement, domain, directionality, feature, and can easily be generalized from one language to another. Languages may differ from each other with respect to the constraints' weight.

An, Qian, Wilcox, and Levy (2019) evaluate the agreement strategies used by neural language models, such as LSTM, RNNG by deviating the surprisal (Hale 2003; Levy 2008) differences between singular and plural verb when the subject is a coordination phrase in English (*The boy(s) and/or the girl(s) is/are coming*) and French, based on very large corpora. They find that such models are using a simple "bag of features" strategy by simply combining the number/gender of the first noun and the second noun, as well as the conjunct, predicting similar results for *and-coordination* and *or-coordination*.

This work is not designed to train language models to predict the gradient grammaticality of sentences. We have tried to show that an adequate simple linear model with linguistic features can achieve much more human-like behavior.

The sum-weighted model of gradient grammaticality is also compatible with the constraint-based approach in sentence processing in assuming that language consists of a set of constraints (see section 2.4.2 above). The constraint-based approach to grammaticality supposes a set of grammatical constraints compete for the sentences' well-formedness, the constraint violations are cumulative. With respect to constraint-based approach to sentence processing, most of the works use an explicit competition algorithm (e.g., MacWhinney et al. 1984; MacWhinney 1987; Bates et al. 1989): various constraint compete for one optimal output. However, the sentence processing is different from grammaticality in that only one solution is possible during comprehension while grammaticality is a gradient intuition.

Chapter 9

Conclusions

This chapter summarizes the main findings of this thesis and outlines some issues for further research raised by these findings.

9.1 Main Findings

This thesis investigated agreement with coordination structures. The results of this investigation provided a series of experimental, theoretical, and methodological contributions towards the understanding of grammaticality gradience, as well as morphosyntactic agreement in general. The following is a summary of the central findings:

1. We examined large written corpora (frWaC for attributive agreement and French Treebank for predicative agreement) for agreement in number and in gender with coordination structures. The results showed that in French the agreement strategy with such structures is not limited to resolution rule, and closest conjunct agreement is very common. The frequency of CCA may be sensitive to animacy, semantic interpretation and various factors.

2. We conducted a series of experiments, including acceptability judgement and self-paced reading, that tested different parameters impacting agreement with coordination structures: domain (Noun/Verb), directionality (before/after coordination),

feature (gender/number), conjunction (*ou/et*). These experiments showed that the acceptability of agreement with coordination structures is gradient. The gradient experimental data can yield insights that are not readily available from intuitive, informal linguistic judgments.

3. The empirical results contradicted the prescriptive rule and most linguistic literature that French only permits resolution rule with *et* (masculine and plural) (Corbett, 1991). Our results showed that CCA is pervasive in French, like in other Romance languages, for instance, Spanish (Demonte and Perez-Jimenez, 2012) and Portuguese (Villavicencio et al., 2005). They also showed that CCA is quite different from attraction errors (Bock and Miller, 1991; Fayol and Largy, 1992).

4. The corpus and experimental findings also support the claim that there are three agreement strategies in French: closest conjunct agreement (CCA), resolution agreement (RA), early agreement (EA). These strategies are sensitive to several factors: CCA is more acceptable for gender than for number agreement; in the nominal domain (Det and attributive A) than in the predicative domain (Verb or participle); for *et* than for *ou*.

5. To account for the gradience of our experimental results, we proposed a weighted framework/model that reconciles availability of multiple agreement strategies in one language (French) and across languages. The weighted model is inspired from harmonic grammar (Legendre et al., 1990) and linear OT (Keller, 2000). It learns from a limited set of experimental data, given a predefined set of constraints and assigns different penalties to each constraint violation. We provided a detailed comparison of a rich set of human acceptability judgments, using cross-validated/held-out train/test methodology

6. This model unifies constraints from different agreement parameters: domain, features. And it captures typological tendencies (i.e. agreement hierarchy by Corbett (1991)) into a quantitative predictive framework. We showed that number and gen-

der follow the same agreement hierarchy. In both cases, attributive agreement favors CCA.

7. We proposed a feature hierarchy so that a more interpretable feature (number) is less sensitive to linear proximity than a less interpretable feature (gender); it remains to be tested for person.

8. The model also unified *and-coordination* and *or-coordination*, revealing what is the same, what is different. The model was trained with *and-coordination*, then generalized to *or-coordination*. The results contradicts the assumption that there is no resolution rule for *ou*, so that both singular and plural verb are acceptable. We proposed that there is a (plural/masculine) resolution rule for *or-coordination* in the speakers' grammar, but its weight is weaker than in *and-coordination*. Other conjunctions remain to be tested (for example *ni..ni* see An and Abeillé Amlap 2019)

9.2 Issues for Further Research

In this section, we provide a brief discussion of a number of issues for further research that follow from the findings reported in this thesis.

9.2.1 Extending the Model to Other Languages

This thesis presents data from French, a language whose morphology distinguishes two numbers (singular/plural) and two genders (masculine/feminine). As discussed in section 2.1.1.1. This model can be extended to these morphology rich languages (e.g. three-gender languages, such as South Slavic languages), by providing a flexible framework to reconsider the different agreement strategies, as well as their related weights .

As have been discussed insection 2.1.2, English grammar dictates that agreement with disjoined singular nouns are singular. Most forced-choice experimental studies also show that when the closest noun is singular and the furtherest noun is plural (NP1pl-or-NP2sg-V), singular noun is preferred. This preference is different from that in French, where only the plural verb is acceptable. One hypothesis can be that the weight of resolution rule with disjoined NP can be different across languages.

9.2.2 Extending the Model to Other Language Phenomena

Further modeling studies should be carried out to back up the claim that the weighted model offers a suitable framework for accounting for gradient linguistic data. In particular, it should be demonstrated in more detail that the model can deal with a large variety of phenomenon.

Another obvious starting point for a further investigation can be island constructions. A series of experimental studies have shown that the acceptability of island construction are sensitive to various constraints: specificity (Kluender and Kutas, 1993; Hofmeister and Sag, 2010; Hofmeister et al., 2013), intervention effects (Friedmann et al., 2009), prosody and relevance (Chaves, 2013; Chaves and Dery, 2014), discourse functions (Ambridge and Goldberg, 2008; Abeillé et al., 2020)

Such a weighted model that we design for agreement with coordination structures could be expanded to island constructions. The challenge is to develop a constraint set that is universal for all of these languages.

9.2.3 Gradient Grammaticality and Deep Neural Networks

With the fast development of computational linguistics, researchers begin to explore the correlation between the sentences' gradient grammaticality and the probability assigned to the sentences by the language models. Lau et al. 2017 use a set of language modeling of large corpus: such as N-gram models, Hidden Markov Models, recurrent neural network model, PCFG parses to predict the probability of a sentence (quantitative likelihood that a sentence occurs under the model). They correlate the acceptability prediction from language models output using one of several metrics with human acceptability and achieve an encouraging degree of accuracy. Warstadt et al. 2019a discuss several pre-trained transformer models applied to classifying sentences in their Corpus of Linguistic Acceptability

(CoLA, Warstadt et al. 2019b) as acceptable or not. These models exhibit levels of accuracy that vary widely relative to the types of syntactic and morphological patterns that appear in CoLA. Their result outperforms other available models, but remains far from human performances.

Compared to human, the performance of language models of gradient grammaticality is underwhelmed. Several studies (Linzen et al. 2016; Gulordava et al. 2018; An et al. 2019) begin to evaluate what syntactic generalisation these models can learn using psycholinguistic paradigms. Gulordava et al. (2018) reveal that these language models can learn some hierarchical representation by evaluating subject-verb agreement with attractions ('the key to the cabinet is/are'). But An et al. (2019) shows that the neaural network models fail to predict agreement with coordination structures.

In the future, we can train deep neural network models with small data set (our experimental data set) in order to assess the possibility to use deep learning algorithms to predict grammaticality through a limited acceptability dataset and a particular phenomenon.

9.2.4 Linear Proximity and Language Evolution

As a matter of fact, CCA is also observed in Latin ((1-a) in Gildersleeve and Lodge 1948, p.184, as cited in Corbett 1991, p.179; (1-b) was cited in Johnson 2013, p.6) . In (1-a), the verb agrees in person and number with the closest conjunct and in (1-b) the attributive adjective agrees in number and gender with the closest noun.

(1) a. et ego et Cicero meus flagitabit
and I and Cicero my will-demand.3.SG
'both my Cicero and I will demand it'

b. eadem alacritate ac studio
same.F.SG.ABL ardor.F.SG.ABL and zeal.N.SG.ABL
'with the same ardor and zeal' (Caesar BG. 4.24)

Some French feminists (Viennot et al., 2018) have claimed that modern French has lost

CCA in gender which was more common in classical French (2), due to the enforcement of a male dominant norm.

(2)	Armez-vous	d' un	courage	et	d' une	foi	nouvelle
	Arm-yourself	of a.M.SG	courage.M.SG	and	of a.F.SG	faith.F.SG	new.F.SG

'Arm yourself with new courage and faith' (Racine, Athalie, 1691)

Diachronic studies still have to be done, but we have shown that modern French still has vivid CCA for gender and for number. We do not know whether recent feminist manifesto is a factor that will promote CCA in the next steps of language evolution.

Furthermore, agreement with coordination structures sees a conflict between constituency, linear proximity. Another hypothesis is that the effects of linear proximity becomes less stronger given the pressure of constituency. Studying how the effects of linear proximity change over time and across different geographical areas will give insights to how human syntax evaluates, and advance our understanding of human language.

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Appendices

Appendix A

Attributive Number Agreement

A.1 Attributive Number Agreement: Determiner

A.1.1 Materials

experimental items

1. **D-N1sg-et-N2sg**:

   Il faudrait pouvoir prévenir le/les directeur et sous-directeur de l'établissement.

   D-N1sg-et-N2pl:

   Il faudrait pouvoir prévenir le/les directeur et sous-directeurs de l'établissement.

   D-N1sg-ou-N2sg:

   Il faudrait pouvoir prévenir le/les directeur ou sous-directeur de l'établissement.

   D-N1sg-ou-N2pl:

   Il faudrait pouvoir prévenir le/les directeur ou sous-directeurs de l'établissement.

   Q: Le directeur est-il prévenu? A: Non

2. Il faudrait aller voir le maire et adjoint à la mairie.

3. L'interne devrait assister le médecin et infirmier des urgences.

   Q: Y-a-t-il des internes à l'hôpital? A: Oui

4. La directrice de l'école recevra la mère et grand-mère de Nicolas dans son bureau.
   Q: Nicolas va-t-il à l'école? A: Oui

5. J'aimerais accompagner ma sœur et cousine à la kermesse.
   Q: Est-ce qu'il s'agit d'aller au cinéma ? A: Non

6. J'inviterai mon père et grand-père pour la fête des pères.
   Q: Est-ce que la femme de ménage informe le locataire en cas d'urgences? A: Non

7. Le procès mobilisera un juge et avocat pendant plusieurs semaines.

8. Le médecin rencontrera le donneur et receveur au sujet de la transplantation.

9. Le secrétaire s'engagera à en informer le client et partenaire sans délai.
   Q: Est-ce que le patron va contacter le client? A: Non

10. Le gardien pourra contacter le propriétaire et locataire de l'appartement du sixième en cas d'urgence.
    Q: Le loyer va-t-il changer?

11. C'est au conseil de nommer le président et vice-président de chaque secteur.

12. Le président de l'université convoquera la directrice et doctorante au sujet de la soutenance de mardi prochain.

13. Le propriétaire augmentera le loyer et supplément dès la semaine prochaine.

14. Il est possible d'insérer une image et figure dans le corps de l'article.

15. Le retard de l'avion nous oblige à prendre le car et train jusqu'en Allemagne.
    Q: L'avion est-il en retard? A: Oui

16. Vous verrez votre nom et prénom à l'écran.

17. La mairie fermera le parc et musée en hiver.

18. Chaque participant devra lire la question et réponse sur son papier.

    Q: Est-ce que la question est affichée sur l'écran? A: Non

19. Je donnerai à mon neveu un livre et cahier pour son anniversaire.

20. Tu devrais acheter un canapé et fauteuil pour le nouveau salon.

    Q: Est-ce que'il est question d'acheter des meubles? A: Oui

21. Je cherche une robe et ceinture pour le mariage.

    Q: Est-ce qu'il s'agit d'un mariage? A: Oui

22. Vous recevrez un courrier et email quand votre dossier sera traité.

23. La clé empêche le voleur de retirer la porte et fenêtre de l'encadrement.

    Q: Est-ce que le voleur parvient à sortir par la porte? A: Non

24. Je garderai cette vidéo et photo en souvenir de nos vacances.

control items

1. **gram**: La mère des enfants ira à l'école demain.

   un_gram: La mère des enfants iront à l'école demain.

   Q: La dame a-t-elle des enfants ? A: Oui

2. Le chef des Indiens a fait des signaux de fumée.

3. Le dernier des pharaons a été enterré au XIe siècle.

   Q: La phrase parle-t-elle de l'Egypte ? A: Oui

4. Le navire des pirates a causé de nombreux dommages aux ennemis.

   Q: Les pirates avaient-ils des ennemis ? A: Oui

5. Le commandant des armées a attaqué la Biélorussie.

6. Le délégué des élèves finit les cours à 15h.

   Q: Le délégué finit-il les cours le matin ? A: Non

7. Les tables de la cuisine sont trop petites pour manger.

8. Les livres de ma bibliothèque ont très mal vieilli.

9. Les cousins de mon père partent en vacances demain.

10. Les chats de mon frère sont allergiques au poisson.

    Q: Sait-on si ma sœur a des chats ? A: Non

11. Les boutons de ma chemise ont craqué quand je me suis levé.

12. Les ministres du gouvernement ont pris de mauvaises décisions.

    Q:La phrase parle-t-elle d'astronomie ? A: Non

A.1.2 Results

A.1.2.1 Mean of acceptability ratings for all conditions before removing participants whose averaged median of ungrammatical items larger than that of grammatical items

	type	D	Humanness	mean	standard deviation	standard error
1	N1sg-et-N2pl	Dpl	human	7.44	2.91	0.24
2	N1sg-et-N2pl	Dpl	non-human	7.69	2.60	0.23
3	N1sg-et-N2pl	Dsg	human	6.84	2.87	0.24
4	N1sg-et-N2pl	Dsg	non-human	6.29	3.33	0.29
5	N1sg-et-N2sg	Dpl	human	7.24	2.95	0.24
6	N1sg-et-N2sg	Dpl	non-human	6.78	2.99	0.26
7	N1sg-et-N2sg	Dsg	human	7.54	2.84	0.23
8	N1sg-et-N2sg	Dsg	non-human	7.10	2.93	0.26
9	N1sg-ou-N2pl	Dpl	human	7.18	2.78	0.24
10	N1sg-ou-N2pl	Dpl	non-human	7.05	3.05	0.25
11	N2sg-ou-N2pl	Dsg	human	7.04	2.87	0.24
12	N1sg-ou-N2pl	Dsg	non-human	6.31	3.21	0.27
13	N1sg-ou-N2sg	Dpl	human	7.33	2.92	0.26
14	N1sg-ou-N2sg	Dpl	non-human	6.94	2.95	0.25
15	N1sg-ou-N2sg	Dsg	human	8.13	2.31	0.20
16	N1sg-ou-N2sg	Dsg	non-human	7.68	2.80	0.23

A.1.2.2 Mean of acceptability ratings for all conditions after removing participants whose averaged median of ungrammatical items larger than that of grammatical items (kept for model analysis)

	type	D	Humanness	mean	standard deviation	standard error
1	N1sg-et-N2pl	Dpl	human	7.30	3.00	0.26
2	N1sg-et-N2pl	Dpl	non-human	7.61	2.62	0.24
3	N1sg-et-N2pl	Dsg	human	6.65	2.90	0.27
4	N1sg-et-N2pl	Dsg	non-human	6.07	3.30	0.30
5	N1sg-et-N2sg	Dpl	human	7.18	3.01	0.26
6	N1sg-et-N2sg	Dpl	non-human	6.65	3.03	0.28
7	N1sg-et-N2sg	Dsg	human	7.49	2.88	0.25
8	N1sg-et-N2sg	Dsg	non-human	6.96	3.00	0.28
9	N1sg-ou-N2pl	Dpl	human	7.02	2.85	0.26
10	N1sg-ou-N2pl	Dpl	non-human	6.92	3.10	0.27
11	N1sg-ou-N2pl	Dsg	human	6.82	2.93	0.26
12	N1sg-ou-N2pl	Dsg	non-human	6.04	3.25	0.29
13	N1sg-ou-N2sg	Dpl	human	7.21	2.97	0.28
14	N1sg-ou-N2sg	Dpl	non-human	6.78	2.96	0.26
15	N1sg-ou-N2sg	Dsg	human	8.07	2.35	0.22
16	N1sg-ou-N2sg	Dsg	non-human	7.56	2.88	0.25

A.1.3 Model Analysis

A.1.3.1 Effects of N2:

These two models compare the effects of N2 in *and-coordination* and *or-coordination* separately.

For *and-coordination* (comparing the combination D-N1sg-et-N2sg and the combination D-N1sg-et-N2pl), the fixed effects were D (Dsg/Dpl) and N2 (N2sg/N2pl). We also included random intercept and maximal random slop for items and subjects.

For *or-coordination* (comparing the combination D-N1sg-ou-N2sg and the combination D-N1sg-ou-N2pl), the fixed effects were D (Dsg/Dpl) and N2 (N2sg/N2pl). We also included random intercept and maximal random slop for items and subjects.

Model formula: model< −clmm(Note∼ D*N2+(1+ D*N2|subject)+ (1+D*N2 | Item), threshold ='symmetric', data=data)

		and-coordination	*or-coordination*
DDsg	(Estimate)	-0.88^{***}	-0.47^{*}
	(Std. Error)	(0.22)	(0.21)
N2Nsg		-0.33	-0.01
		(0.21)	(0.18)
DDsg:N2Nsg		1.07^{***}	1.20^{***}
		(0.30)	(0.32)
central.1		-2.23^{***}	-1.97^{***}
		(0.27)	(0.29)
central.2		-1.60^{***}	-1.36^{***}
		(0.26)	(0.28)
spacing.1		0.44^{***}	0.51^{***}
		(0.04)	(0.05)
spacing.2		0.99^{***}	1.02^{***}
		(0.06)	(0.06)
spacing.3		1.74^{***}	1.89^{***}
		(0.08)	(0.09)
spacing.4		2.59^{***}	2.97^{***}
		(0.11)	(0.12)
Log Likelihood		-1969.80	-1949.87
AIC		3997.60	3957.73
BIC		4139.25	4099.80
Num. obs.		977	991
Groups (subject)		81	81
Groups (item)		24	24
Variance: subject: (Intercept)		1.91	3.28
Variance: subject: DDsg		0.34	0.97
Variance: subject: N2Nsg		0.17	0.02
Variance: subject: DDsg:N2Nsg		1.64	1.06
Variance: item: (Intercept)		0.62	0.52
Variance: item: DDsg		0.31	0.11
Variance: item: N2Nsg		0.22	0.03
Variance: item: DDsg:N2Nsg		0.12	0.68

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.1 – Results of mixed-effects ordinal regression models testing effects of N2 in *and-coordination* and *or-coordination* respectively

A.1.3.2 Effect of coordinator:

In order to test the effects of *and* and *or*. We fitted two mixed-effects ordinal regression models.

One is for combinations D-N1sg-Conj-N2sg (including D-N1sg-et-N2sg and D-N1sg-ou-N2sg). The fixed effects of the model was D*Conj. We also included random intercept, as well as D*Conj as random slopes for subjects, but without the interaction between D and Conj for items. The models used the following formula:

model< −clmm(Note∼ D*Conj+ (1+ D*Conj|subject) + (1+ D+Conj|Item), threshold = 'symmetric', data=data)

The other was for combinations D-N1sg-Conj-N2pl (including D-N1sg-et-N2pl and D-N1sg-ou-N2pl). The fixed effects of the model were D*Conj. We also included random intercept, as well as D*Conj as random slopes for both items and subjects. The models used the following formula:

model< −clmm(Note_factor∼ D*conj+ (1+ D*conj|subject) + (1+ D*conj|Item), threshold = 'symmetric', data=data)

	D-N1sg-Conj-N2sg	D-N1sg-Conj-N2pl
DDsg	(Estimate) 0.22	-0.93^{***}
	(Std. Error) (0.25)	(0.24)
conjou	-0.14	-0.44^{*}
	(0.18)	(0.21)
DDsg:Conjou	0.55^{*}	0.51^{*}
	(0.26)	(0.26)
central.1	-1.97^{***}	-2.34^{***}
	(0.29)	(0.28)
central.2	-1.39^{***}	-1.68^{***}
	(0.28)	(0.27)
spacing.1	0.44^{***}	0.50^{***}
	(0.04)	(0.04)
spacing.2	0.99^{***}	1.01^{***}
	(0.06)	(0.06)
spacing.3	1.77^{***}	1.85^{***}
	(0.09)	(0.08)
spacing.4	2.76^{***}	2.77^{***}
	(0.11)	(0.11)
Log Likelihood	-1919.48	-1999.91
AIC	3888.96	4057.81
BIC	4011.30	4199.61
Num. obs.	986	982
Groups (subject)	81	81
Groups (item)	24	24
Variance: subject: (Intercept)	3.26	1.99
Variance: subject: DDsg	1.76	0.66
Variance: subject: Conjou	0.02	0.06
Variance: subject: DDsg:Conjou	0.51	0.11
Variance: item: (Intercept)	0.49	0.73
Variance: item: DDsg	0.14	0.44
Variance: item: conjou	0.06	0.33
Variance: item: DDsg:Conjou		0.16

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.2 – Results of mixed-effects of ordinal regression model testing effects of Conj in the D-N1sg-conj-N2sg combinations and the D-N1sg-conj-N2pl combinations

A.1.3.3 Effect of Humanness:

Then we test the effect of humanness in each combination. We fitted four ordinal regression models, one for the combination D-N1sg-et-N2sg, one for the D-N1sg-et-N2pl, one for the D-N1sg-ou-N2sg, one for the D-N1sg-ou-N2pl. The fixed effects are Humanness (human/non-human) *D (Dsg/Dpl), the random slopes for subjects were Humanness*D and for items were D.

The four model used a same formula:

model< −clmm(Note∼ D*Humanness+(1+ D*Humanness|subject)+ (1+D | Item), threshold =‘symmetric’, data=data)

	D-N1sg-et-N2sg	D-N1sg-et-N2pl	D-N1sg-ou-N2sg	D-N1sg-ou-N2pl
DDsg	0.27	-0.66^{*}	0.58	-0.08
	(0.29)	(0.31)	(0.31)	(0.27)
Humannessnon-human	-0.45	0.22	-0.49	0.08
	(0.36)	(0.44)	(0.33)	(0.37)
DDsg:Humannessnon-human	-0.13	-0.67	0.38	-0.67
	(0.40)	(0.43)	(0.45)	(0.37)
central.1	-2.09^{***}	-2.24^{***}	-2.23^{***}	-1.89^{***}
	(0.33)	(0.38)	(0.35)	(0.33)
central.2	-1.43^{***}	-1.64^{***}	-1.74^{***}	-1.19^{***}
	(0.31)	(0.36)	(0.33)	(0.32)
spacing.1	0.41^{***}	0.48^{***}	0.50^{***}	0.52^{***}
	(0.06)	(0.06)	(0.07)	(0.06)
spacing.2	0.94^{***}	1.06^{***}	1.08^{***}	0.96^{***}
	(0.09)	(0.10)	(0.10)	(0.09)
spacing.3	1.59^{***}	1.96^{***}	2.03^{***}	1.74^{***}
	(0.12)	(0.15)	(0.15)	(0.12)
spacing.4	2.44^{***}	2.82^{***}	3.19^{***}	2.74^{***}
	(0.17)	(0.19)	(0.21)	(0.16)
Log Likelihood	-1013.56	-992.92	-943.28	-1048.15
AIC	2071.12	2029.83	1930.56	2140.31
BIC	2163.58	2121.79	2022.93	2232.98
Num. obs.	494	483	492	499
Groups (subject)	81	81	81	81
Groups (item)	24	24	24	24
Variance: subject: (Intercept)	2.38	2.56	3.55	2.22
Variance: subject: DDsg	1.51	0.99	0.76	0.51
Variance: subject: Humannessnon-human	0.05	0.70	0.36	0.04
Variance: subject: DDsg:Humannessnon-human	2.50	1.52	3.37	0.03
Variance: item: (Intercept)	0.37	0.69	0.23	0.43
Variance: item: DDsg	0.01	0.24	0.18	0.12

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.3 – Results of four mixed-effects of ordinal regression models testing effects of humanness in the combinations: D-N1sg-et-N2sg, D-N1sg-et-N2pl D-N1sg-ou-N2sg, D-N1sg-ou-N2pl

A.2 Attributive Number Agreement: Adjectives

A.2.1 Materials

1. **Dsg-et-Dsg-A**: Cette formation gratuite vous prépare au mieux à la fonction de directeur et sous-directeur administratif/administratifs.

   Dsg-ou-Dsg-A: Cette formation gratuite vous prépare au mieux à la fonction de directeur ou sous-directeur administratif/administratifs.

   Q: La formation est-elle gratuite? A: Oui

2. Il faut beaucoup d'énergie pour obtenir la position de maire et adjoint titulaires.

   Q: Est-ce que c'est facile de devenir maire titulaire? A: Non

3. Cette nouvelle loi favorisera l'embauche de médecin et infirmier qualifiés.

4. La nouvelle loi va définir le statut de tuteur et curateur indivuels.

5. Le styliste fabriquera une robe pour fille et femme handicapées.

   Q: Est-ce qu'il fabriquera une robe ? A: Oui

6. Ce dispositif modifiera en profondeur le rôle de père et grand-père actifs.

7. Cette réforme va profondément accroître le pouvoir de magistrat et juge délégués.

   Q: S'agit-il d'une nouvelle réforme ? A: Oui

8. Il convient de supprimer les termes de donneur et receveur universels.

9. La start-up est toujours à la recherche de client et partenaire potentiels.

   Q: La phrase parle-t-elle d'un start-up ? A: Oui

10. Il a été question de mettre en vente un ticket à prix réduit pour étudiant et chômeur parisiens.

    Q: S'agit-il un ticket normal? A: Non

11. Ce parcours de formation est indispensable pour le diplôme de pharmacien et diététicien agréés.

12. Cette mère recherche un livre pour enfant et adolesent surdoués.

13. Il faudrait nous signaler en cas de date et heure incorrectes.

14. Voici le formulaire de demande de remboursement pour votre hostipalisation en hôpital et centre spécialisés.
    Q:La phrase parle-elle du remboursement de l'hospitalisation? A: Oui

15. Le patient a pris un médicament pour douleur et rougeur oculaires.
    Q: Le patient a-il pris un médicament ? A: Oui

16. L'intégration est toujours plus difficile pour un élève avec nom et prénom étrangers.
    Q: L'intégration est-elle facile pour tout le monde? A: Non

17. Le manuel devra de plus fournir un descriptif avec image et figure explicatives.

18. Le site vous conseille de bloquer le message en cas de question et réponse problématiques.

19. On m'a proposé un catalogue de formations avec perspective et débouché surprenantes.

20. Chaque randonnée avec ce guide a été une excursion avec météo et destination idéales.
    Q: Le guide est-il compétent? A: Oui

21. Ce site de vente en ligne de tissus vous contactera en cas de dimension et quantité manquantes.

22. Il est fortement déconseillé d'user de titre et sous-titre longs.
    Q: Les titres longs sont-ils recommandés? A: Non

23. Ce magasin propose un agrandisseur de chaussure à longueur et largeur ajustable.
    Q: La taille de l'agrandisseur est-elle fixée ? A: Non

24. Cette formation vous orientera vers les métiers en association et organisation gouvernementales.

control items

1. **gram**: La mère des enfants ira à l'école demain.
   un_gram: La mère des enfants iront à l'école demain.
   Q: La dame a-t-elle des enfants ? A: Oui

2. Le chef des Indiens a fait des signaux de fumée.

3. Le dernier des pharaons a été enterré au XIe siècle.
   Q: La phrase parle-t-elle de l'Egypte ? A: Oui

4. Le navire des pirates a causé de nombreux dommages aux ennemis.
   Q: Les pirates avaient-ils des ennemis ? A: Oui

5. Le commandant des armées a attaqué la Biélorussie.

6. Le délégué des élèves finit les cours à 15h.
   Q: Le délégué finit-il les cours le matin ? A: Non

7. Les tables de la cuisine sont trop petites pour manger.

8. Les livres de ma bibliothèque ont très mal vieilli.

9. Les cousins de mon père partent en vacances demain.

10. Les chats de mon frère sont allergiques au poisson.
    Q: Sait-on si ma sœur a des chats ? A: Non

11. Les boutons de ma chemise ont craqué quand je me suis levé.

12. Les ministres du gouvernement ont pris de mauvaises décisions.
    Q:La phrase parle-t-elle d'astronomie ? A: Non

A.2.2 Results

A.2.2.1 Mean of acceptability ratings for all conditions before removing participants whose averaged median of ungrammatical items larger than that of grammatical items

	combination	A	Humanness	mean	stdev	se
1	N1sg-et-N2sg-A	Apl	human	8.56	2.10	0.16
2	N1sg-et-N2sg-A	Apl	non-human	7.95	2.46	0.19
3	N1sg-et-N2sg-A	Asg	human	8.55	2.03	0.15
4	N1sg-et-N2sg-A	Asg	non-human	7.97	2.67	0.20
5	N1sg-ou-N2sg-A	Apl	human	8.63	1.96	0.15
6	N1sg-ou-N2sg-A	Apl	non-human	8.16	2.36	0.18
7	N1sg-ou-N2sg-A	Asg	human	8.79	1.74	0.13
8	N1sg-ou-N2sg-A	Asg	non-human	7.98	2.41	0.18

A.2.2.2 Mean of acceptability ratings for all conditions after removing participants whose averaged median of ungrammatical items larger than that of grammatical items (kept for model analysis)

	combination	A	Humanness	mean	stdev	se
1	N1sg-et-N2sg-A	Apl	human	8.50	2.16	0.17
2	N1sg-et-N2sg-A	Apl	non-human	7.89	2.51	0.20
3	N1sg-et-N2sg-A	Asg	human	8.57	2.01	0.16
4	N1sg-et-N2sg-A	Asg	non-human	7.85	2.74	0.22
5	N1sg-ou-N2sg-A	Apl	human	8.64	1.98	0.16
6	N1sg-ou-N2sg-A	Apl	non-human	8.11	2.42	0.19
7	N1sg-ou-N2sg-A	Asg	human	8.77	1.76	0.14
8	N1sg-ou-N2sg-A	Asg	non-human	7.92	2.48	0.20

A.2.3 Model Analysis

A.2.3.1 Effects of conjunction

This ordinal regression model compares the combinations N1sg-et-N2sg-A and N1sg-ou-N2sg-A, testing effects of conjunctions *et/ou* on the agreement. The fixed effects of the model were A (Asg/Apl) * Conj (and/or), the random slopes for subjects and items were maximal: A*Conj.

formula: model$< -$clmm(Note$\sim$ A*Conj+ (1+ A*Conj|subject) + (1+ A*Conj|Item), threshold = 'symmetric', data=data)

	Model 1
AAsg	0.18
	(0.20)
Conjou	0.27
	(0.19)
AAsg:Conjou	-0.28
	(0.29)
central.1	-3.78^{***}
	(0.34)
central.2	-3.19^{***}
	(0.33)
spacing.1	0.55^{***}
	(0.05)
spacing.2	1.34^{***}
	(0.08)
spacing.3	2.20^{***}
	(0.10)
spacing.4	3.58^{***}
	(0.13)
Log Likelihood	-1853.38
AIC	3764.76
BIC	3914.06
Num. obs.	1272
Groups (subject)	53
Groups (Item)	24
Variance: subject: (Intercept)	3.82
Variance: subject: AAsg	0.12
Variance: subject: Conjou	0.11
Variance: subject: AAsg:Conjou	0.22
Variance: Item: (Intercept)	0.23
Variance: Item: AAsg	0.02
Variance: Item: Conjou	0.00
Variance: Item: AAsg:Conjou	0.12

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.4 – Results of the mixed-effects ordinal regression model testing effects of conjunctions in the N1sg-Conj-N2sg-A combinations

A.2.3.2 Effects of humanness

We test the effect of humanness in each combination with an ordinal regression model, one for the N1sg-et-N2sg-A combination, one for the N1sg-ou-N2sg-A combination. The fixed effects were Humanness (human/non-human) *A (Dsg/Dpl), random slopes for subjects were Humanness*A and for items was A.

formula: model< −clmm(Note∼ A*Humanness+(1+ A*Humanness|subject)+ (1+A | Item), threshold =‘symmetric’, data=data)

	N1sg-et-N2sg-A	N1sg-ou-N2sg-A
AAsg	0.02	0.15
	(0.29)	(0.30)
Humannessnon-human	-0.80^{**}	-0.87^{*}
	(0.28)	(0.34)
AAsg:Humannessnon-human	0.20	−0.52
	(0.39)	(0.38)
central.1	-3.89^{***}	-4.94^{***}
	(0.38)	(0.50)
central.2	-3.30^{***}	-4.31^{***}
	(0.37)	(0.49)
spacing.1	0.46^{***}	0.67^{***}
	(0.07)	(0.09)
spacing.2	1.23^{***}	1.51^{***}
	(0.11)	(0.13)
spacing.3	1.99^{***}	2.49^{***}
	(0.13)	(0.17)
spacing.4	3.18^{***}	4.12^{***}
	(0.17)	(0.21)
Log Likelihood	−992.55	−902.73
AIC	2029.10	1841.46
BIC	2127.11	1921.66
Num. obs.	636	636
Groups (subject)	53	53
Groups (Item)	24	24
Variance: subject: (Intercept)	3.97	7.13
Variance: subject: AAsg	0.01	0.01
Variance: subject: Humannessnon-human	0.15	0.15
Variance: subject: AAsg:Humannessnon-human	0.18	
Variance: Item: (Intercept)	0.06	0.26
Variance: Item: AAsg	0.04	0.16

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.5 – Results of the mixed-effects ordinal regression model testing effects of humanness in the combination N1sg-et-N2sg-A and the N1sg-ou-N2sg-A

Appendix B

Attributive Gender Agreement

B.1 Attributive Gender Agreement: Determiners

B.1.1 Materials

1. **D-N1f-et-N2m:** Certaines/certains interactions et comportements des molécules ont surpris les chercheurs.

   D-N1m-et-N2f: Certaines/certains comportements et interactions des molécules ont surpris les chercheurs.

2. Certaines dialogues et scènes du texte sont difficilement prononçables.

3. Certaines questionnements et analyses légitimes n'ont pas encore reçu de réponse satisfaisante.

4. Certaines départements et régions vont recevoir de nouveaux noms.

5. Certaines talents et activités précoces sont propres aux enfants.

6. Certaines comportements et propriétés sont caractéristiques des êtres vivants.

7. Certaines ouvrages et revues de cette époque atteignent des prix élevés.

8. Certaines évènements et dates semblent porter malheur.

9. Certaines immeubles et maisons doivent faire l'objet d'une rénovation.

10. Certaines pays et îles vont subir les conséquences de la montée des eaux.

11. Certaines quartiers et banlieues souffrent de problèmes de transports.

12. Certaines usages et règles doivent s'enseigner très tôt.

13. Certaines animateurs et célébrités de la télévision ont des salaires beaucoup trop élevés.

14. Certaines élus et personnalités sont sur toutes les chaines.

15. Certaines papillons et abeilles sont en voie de disparition.

16. Certaines chirurgiens et infirmières supportent mal les nuits de garde.

17. Certaines instituteurs et institutrices se plaignent de leurs rémunérations.

18. Certaines directeurs et secrétaires ont plaisir à se retrouver au pot de fin d'année.

19. ertaines amis et personnes changent beaucoup au moment de la retraite.

20. Certaines enseignants et enseignantes sont encore en grève.

21. Certaines électeurs et électrices attendraient le dernier moment pour décider de leur vote.

22. Certaines travailleurs et travailleuses se plaignent de formes de discrimination.

23. ertaines avocats et avocates ne prennent pas de clients de l'aide juridictionnelle.

24. Certaines étudiants et étudiantes sont encore en stage.

Control

1. **un_gram**: Les annonces dans le journaux demeurent un moyen répandu pour annoncer le décès.

   gram: Les annonces dans le journaux demeurent un moyen répandu pour annoncer le décès.

2. Cela dure depuis de nombreuses années, mais le monde ferme le yeux.

3. Le chevaux étaient utilisés pour tirer le bois dans des endroits peu accessibles comme la forêt.

4. C'est pourquoi j'ai suivi avec une attention particulière les travail qui ont débouché sur le rapport à l'examen.

5. Les bijou de couleur peuvent donner force, courage et invincibilité.

6. La tête sur les genou, je dormirai peut-être deux heures.

B.1.2 Results

B.1.2.1 Mean of acceptability ratings for all conditions before removing participants whose averaged median of ungrammatical items larger than that of grammatical items

	Combination	D	Humanness	mean	stdev	se
1	D-N1f-et-N2m	Df	human	6.13	3.14	0.21
2	D-N1f-et-N2m	Df	non-human	6.91	3.06	0.20
3	D-N1f-et-N2m	Dm	human	4.92	3.25	0.21
4	D-N1f-et-N2m	Dm	non-human	4.40	3.17	0.21
5	D-N1m-et-N2f	Df	human	3.29	2.78	0.33
6	D-N1m-et-N2f	Df	non-human	2.76	2.45	0.28
7	D-N1m-et-N2f	Dm	human	8.24	2.56	0.28
8	D-N1m-et-N2f	Dm	non-human	8.38	2.58	0.29

B.1.2.2 Mean of acceptability ratings for all conditions after removing participants whose averaged median of ungrammatical items larger than that of grammatical items (kept for model analysis)

	Combination	D	Humanness	mean	stdev	se
1	D-N1f-et-N2m	Df	human	5.73	3.13	0.26
2	D-N1f-et-N2m	Df	non-human	6.47	3.12	0.26
3	D-N1f-et-N2m	Dm	human	4.36	2.92	0.24
4	D-N1f-et-N2m	Dm	non-human	3.97	2.76	0.23
5	D-N1m-et-N2f	Df	human	3.29	2.78	0.33
6	D-N1m-et-N2f	Df	non-human	2.76	2.45	0.28
7	D-N1m-et-N2f	Dm	human	8.24	2.56	0.28
8	D-N1m-et-N2f	Dm	non-human	8.38	2.58	0.29

B.1.3 Model Analysis

We fitted two ordinal regression models, one for the combination D-N1f-et-N2m and one for the D-N1m-et-N2f, with fixed effects Humanness (human/non-human) *D (Dm/Df). The random slopes for items were D, for subjects were Humanness*D for the D-N1f-et-N2m combination but without the interaction for the D-N1m-et-N2f combination.

formular for the D-N1f-et-N2m combination:

model< −clmm(Note∼ D*Humanness+(1+ D*Humanness|subject)+ (1+D | Item), threshold =‘symmetric’, data=data)

formular for the D-N1m-et-N2f combination:

model< −clmm(Note∼ D*Humanness+(1+ D+Humanness|subject)+ (1+D | Item), threshold =‘symmetric’, data=data)

	D-N1f-et-N2m	D-N1m-et-N2f
DDm	-1.15^{*}	4.73^{***}
	(0.54)	(0.78)
Humannessnonhuman	0.76^{**}	-0.52
	(0.26)	(0.36)
DDm :Humannessnonhuman	-1.11^{***}	0.82
	(0.32)	(0.55)
central	-0.05	1.91^{***}
	(0.59)	(0.53)
spacing.1	0.65^{***}	0.59^{***}
	(0.06)	(0.10)
spacing.2	1.30^{***}	0.96^{***}
	(0.09)	(0.12)
spacing.3	2.27^{***}	1.59^{***}
	(0.12)	(0.15)
spacing.4	3.54^{***}	2.51^{***}
	(0.17)	(0.19)
Log Likelihood	-1068.63	-474.86
AIC	2179.26	983.71
BIC	2270.74	1047.34
Num. obs.	576	312
Groups (subject)	24	
Groups (Item)	24	24
Variance: Item: (Intercept)	7.72	0.02
Variance: Item: DDm	5.70	0.30
Variance: Item: Humannessnonhuman	0.43	
Variance: Item: DDm:Humannessnonhuman	0.04	
Variance: subject: (Intercept)	0.00	
Variance: subject:DDm	0.00	
Groups (subject)		13
Variance: subject: (Intercept)		2.62
Variance: subject: DDm		5.62
Variance: subject: Humannessnonhuman		0.21

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.1 – Results of the mixed-effects ordinal regression model testing effects of humanness in the combination D-Nf-et-Nm and the D-N1m-et-N2f

B.2 Attributive Gender Agreement: Adjectives

B.2.1 Materials

1. **N1m-et-N2f-A:** Des agissements et interactions surprenants/surprenantes risquent d'étonner les chercheurs.

   A-N1f-et-N2m: Des surprenants/surprenantes interactions et agissements risquent d'étonner les chercheurs.

   Q: Les scientifiques vont-ils sans doute être surpris? A: Oui

2. Des procédés et solutions astucieuses permettront de résoudre ce problème.

   Q: Le problème est-il résolu? A: Non

3. Des départements et régions anciennes vont recevoir de nouveaux noms.

   Q: Les régions vont-elles être renommées? A: Oui

4. Des comportements et propriétés fabuleuses sont caractéristiques des êtres vivants.

   Q: Les êtres vivants ont-ils des spécificités? A: Oui

5. Des événements et activités intéressantes ont lieu dans cette enceinte.

   Q: Y a-t-il une femme enceinte? A: Non

6. Des ananas et cerises délicieuses sont disponibles au marché.

   Q: Y a-t-il des fruits sur le marché? A: Oui

7. Des appareils et technologies étonnantes verront le jour dans les années à venir.

   Q: La phrase parle-t-elle de littérature ? A: Non

8. Des jours et nuits nombreuses seront nécessaires pour finir ce travail.

   Q: Ce travail est-il facile? A: Non

9. Des mensonges et vérités criantes sortent de la bouche de ces gens.

   Q: Ces gens sont-ils toujours honnêtes? A: Non

10. Des immeubles et maisons nouvelles vont déjà faire l'objet de rénovations.

    Q: La phrase parle-t-elle de mode? A: Non

11. Des tissus et matières délicates composent ces robes.

    Q: Ces robes sont-t-elles délicates? A: Oui

12. Des usages et règles importantes doivent s'enseigner très tôt.

    Q: La phrase parle-t-elle de livre? A: Non

13. Des donateurs et donatrices généreuses ont fait cadeau de leurs vêtements.

    Q: Ces gens sont-ils radins? A: Non

14. Des étudiants et étudiantes nouvelles sont déjà en stage.

    Q: Les étudiants travaillent-ils en ce moment? A: Oui

15. Des citoyens et citoyennes nombreuses attendent le dernier moment pour voter.

    Q: Les électeurs sont-ils indécis? A: Oui

16. Des animateurs et célébrités anciennes se retrouvent au gala de fin d'année.

    Q: Le gala se passe-t-il en janvier? A: Non

17. Des infirmiers et chirurgiennes courageuses effectuent des nuits de garde.

    Q: Le personnel hospitalier travaille-t-il parfois la nuit? A: Oui

18. Des copains et copines gentilles me donneront leurs cadeaux.

    Q: Vais-je recevoir des cadeaux? A: Oui

19. Des comédiens et comédiennes surprenantes rendent cette pièce incroyable.

    Q: Les acteurs sont-ils doués? A: Oui

20. Des adolescents et adolescentes joyeuses révisaient sur les pelouses.

    Q: La scène se passait-elle dans une crèche? A: Non

21. Des spectateurs et spectatrices ravissantes se pressaient à la fin de la pièce.

    Q: La phrase parle-t-elle de spectacle ? A: Oui

22. Des acteurs et actrices élégantes ont fait leur entrée au festival de Cannes.

    Q: Le festival de Cannes a-t-il commencé ? A: Oui

23. Des chefs d'Etat et personnalités importantes ont commencé les négociations.

    Q: Les négociations sont-elles terminées? A: Non

24. Des bijoutiers et créatrices fameuses présenteront leurs œuvres.

    Q: La phrase parle-t-elle de cuisine ? A: Non

control items

1. Le fils de la voisine est content d'aller à l'école.

   Q: Le fils est-il scolarisé ? A: Oui

2. Le four de la cuisine est trop crasseux pour faire à manger.

   Q: Le four est-il propre ? A: Non

3. Le mari de ma sœur est acteur à Hollywood.

   Q: Le mari travaille-t-il en France ? A: Non

4. L'amant de ma femme a été pris la main dans le sac.

   Q: Ma femme est-elle fidèle ? A: Non

5. Le fourgon de la police sera vert dorénavant.

   Q: Les agents ont-ils un véhicule ? A: Oui

6. Le rire de ma mère devient de plus en plus agaçant.

   Q: Ma mère rit-elle? A: Oui

7. L'entrée du palais est vraiment somptueuse.

   Q: La phrase parle-t-elle d'architecture ? A: Oui

8. La venue du roi paraît assez effrayante.

   Q: Est-ce une monarchie ? A: Oui

9. La cousine de mon père est dessinatrice pour enfants.

   Q: Est-ce qu'un de mes parents a une cousine ? A: Oui

10. La vitrine du magasin semble ancienne et délabrée.

    Q: La vitrine est-elle neuve ? A: Non

11. La place du village est déserte depuis des années.

    Q: La place est-elle inhabitée ? A: Oui

12. La lumière du soleil devient plus chaude après 14h.

    Q: ait-il plus chaud le matin ? A: Non

B.2.2 Results

B.2.2.1 Mean of acceptability ratings for all conditions before removing participants whose averaged median of ungrammatical items larger than that of grammatical items

	combination	A	Humanness	mean	stdev.r	se.r
1	N1m-et-N2f-A	Af	human	6.22	3.48	0.33
2	N1m-et-N2f-A	Af	non-human	7.05	2.99	0.27
3	N1m-et-N2f-A	Am	human	6.65	3.15	0.30
4	N1m-et-N2f-A	Am	non-human	5.89	3.32	0.30
5	A-N1f-et-N2m	Af	human	7.05	3.29	0.32
6	A-N1f-et-N2m	Af	non-human	6.87	3.00	0.27
7	A-N1f-et-N2m	Am	human	6.14	3.54	0.34
8	A-N1f-et-N2m	Am	non-human	4.92	3.50	0.32

	combination	A	Humanness	mean	stdev.r	se.r
1	N1m-et-N2f-A	Af	human	5.85	3.46	0.35
2	N1m-et-N2f-A	Af	non-human	6.85	3.01	0.29
3	N1m-et-N2f-A	Am	human	6.32	3.12	0.31
4	N1m-et-N2f-A	Am	non-human	5.49	3.23	0.31
5	A-N1f-et-N2m	Af	human	6.89	3.27	0.33
6	A-N1f-et-N2m	Af	non-human	6.59	2.97	0.28
7	A-N1f-et-N2m	Am	human	5.67	3.48	0.35
8	A-N1f-et-N2m	Am	non-human	4.44	3.33	0.33

B.2.2.2 Mean of acceptability ratings for all conditions after removing participants whose averaged median of ungrammatical items larger than that of grammatical items (kept for model analysis)

B.2.3 Model analysis

B.2.3.1 Effects of position

This regression test the effects of adjectives' position on gender agreement, with fixed effects A (Am/Af)*position (pre/post). There were also random intercepts, as well as A*position as random slopes for subjects and items.

formula: model< −clmm(Note∼ A*position+(1+ A*position|subject)+ (1+A*position | Item), threshold =‘symmetric’, data=data)

	Model 1
AAm	-0.64
	(0.47)
positionpre	0.39
	(0.34)
AAm:positionpre	-0.94^{**}
	(0.34)
central.1	-1.67^{***}
	(0.43)
central.2	-0.94^{*}
	(0.42)
spacing.1	0.56^{***}
	(0.05)
spacing.2	1.22^{***}
	(0.07)
spacing.3	1.93^{***}
	(0.09)
spacing.4	2.60^{***}
	(0.11)
Log Likelihood	-1674.62
AIC	3407.24
BIC	3544.09
Num. obs.	828
Groups (subject)	36
Groups (Item)	23
Variance: subject: (Intercept)	4.81
Variance: subject: AAm	5.68
Variance: subject: positionpre	0.93
Variance: subject: AAm:positionpre	0.82
Variance: Item: (Intercept)	0.43
Variance: Item: AAm	0.55
Variance: Item: positionpre	0.91
Variance: Item: AAm:positionpre	0.29

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.2 – Results of the mixed-effects ordinal regression model testing effects of adjective’s position

Effects of humanness We fitted an ordinal regression for each condition: A-N1f-et-N2f, N1m-et-N2f-A, with fixed effects Humanness (human/non-human) *A (Asg/Apl), random intercept and Humanness*A as random slopes for subjects and A for items.

formula: model< −clmm(Note ∼ D*Human+(1+ A*Human|subject)+ (1+A |Item), threshold =‘symmetric’, data=data)

	A-N1f-et-N2m	N1m-et-N2f-A
Humannessnon-human	-0.62	0.72
	(0.37)	(0.40)
AAm	-1.41^{*}	0.30
	(0.58)	(0.56)
Humannessnon-human:AAm	-0.50	-1.62^{**}
	(0.43)	(0.57)
central.1	-2.39^{***}	-1.31^{*}
	(0.59)	(0.53)
central.2	-1.62^{**}	-0.54
	(0.59)	(0.53)
spacing.1	0.54^{***}	0.63^{***}
	(0.07)	(0.07)
spacing.2	1.27^{***}	1.29^{***}
	(0.11)	(0.11)
spacing.3	2.11^{***}	1.96^{***}
	(0.15)	(0.14)
spacing.4	2.79^{***}	2.72^{***}
	(0.19)	(0.18)
Log Likelihood	-832.93	-863.31
AIC	1709.86	1770.62
BIC	1798.33	1859.29
Num. obs.	412	416
Groups (subject)	36	36
Groups (Item)	23	23
Variance: subject: (Intercept)	9.43	7.42
Variance: subject: Humannessnon-human	1.18	1.12
Variance: subject: AAm	7.94	7.88
Variance: subject: Humannessnon-human:AAm	0.04	5.86
Variance: Item: (Intercept)	0.10	0.26
Variance: Item: AAm	0.11	0.01

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.3 – Results of the mixed-effects ordinal regression model testing effects of humanness in the combination A-N1f-et-N2m and the N11m-et-N2f-A

B.3 Gender vs Number Agreement

B.3.1 Materials

1. **D-N1sg-et-N2sg:** L'entraîneur de l'équipe réprimande la/les gardienne et remplaçante depuis 5 minutes.

   D-N1f-et-N2m: L'entraîneur de l'équipe réprimande certaines/certains gardiennes et remplaçants depuis 5 minutes.

2. Le parti a désigné la déléguée et suppléante après le vote.

3. L'entretien ennuie la candidate et recruteuse malgré les pauses.

   Q: L'entretien est-il intéressant ? A: Non

4. La direction a convoqué la surveillante et lycéenne suite à un incident.

5. Les informations télévisées évoquent la prisonnière et policière depuis une semaine.

6. Le compromis engage la vendeuse et distributrice sur le plan juridique.

   Q: Y a-t-il un compromis ? A: Oui

7. Il fallait regrouper la paysanne et marchande dans le jeu.

8. L'assemblée générale a réuni la conseillère et trésorière à propos de l'échéance de la dette.

9. L'acteur a remercié la maquilleuse et réalisatrice pour la réussite du tournage.

   Q: Le tournage a-t-il échoué ? A: Non

10. Le président de l'Université a convoqué la doctorante et directrice au sujet de la soutenance.

11. L'agent de sécurité a arrêté la caissière et cliente après l'affrontement.

12. Le guide Michelin félicite la cuisinière et maraîchère pour la qualité des repas.

    Q: Les repas sont-ils mauvais ? A: Non

13. Le livre fait coexister le mécanicien et chevalier d'une façon amusante.

14. La pièce de Marivaux représente le maître et valet dans des situations singulières.

15. Le médecin a rencontré le donneur et receveur au sujet de la transplantation.

    Q: La scène a-t-elle lieu dans un cadre médical ? A: Oui

16. Le ministre a félicité le rédacteur et rapporteur pour le nouveau code.

17. Le journaliste a interrogé le pharmacien et diététicien pour son prochain article.

18. Le contrat concernera le producteur et consommateur à partir de demain.

19. Mon père appellera son neveu et cousin ce soir.

20. Le voleur a trompé le policier et douanier à l'aéroport.

21. Le juge a critiqué le plaignant et témoin pour leur comportement.

    Q: Y a-t-il eu un comportement répréhensible ? A: Oui

22. Le document informe le chirurgien et patient sur le déroulement de l'opération.

23. Le procès mobilisera un avocat et préfet pendant plusieurs semaines.

24. La chaleur affecte le conducteur et passager dans l'embouteillage de 18h.

    Q: Y a-t-il un embouteillage ? A: Oui

B.3.2 Results for Acceptability Rating Experiment

B.3.2.1 Mean of acceptability ratings for all conditions

	combination	feature	Agreement	mean	stdev	se
1	D-N1f-et-N2m	gender	CCA	7.37	2.66	0.19
2	D-N1f-et-N2m	gender	RA	6.45	3.28	0.23
3	D-N1sg-et-N2sg	number	CCA	7.02	2.82	0.20
4	D-N1sg-et-N2sg	number	RA	6.91	2.99	0.21

B.3.3 Model Analysis

This mixed-effects ordinal regression model analyse the effects of feature and agreement. The mixed effects were feature (gender/number) * agreement (CCA/RA). The randoms slopes were maximal: feature*agreement.

formula: model$<-$clmm(Note $\sim$ feature*agreement+(1+ feature*agreement|subject)+ (1+feature*agreement |Item), threshold ='symmetric', data=data)

	Model 1
featurenum	-0.38
	(0.37)
agreementRA	-0.81^{*}
	(0.39)
featurenum:agreementRA	0.88
	(0.54)
central.1	-2.84^{***}
	(0.49)
central.2	-1.99^{***}
	(0.48)
spacing.1	0.60^{***}
	(0.06)
spacing.2	1.38^{***}
	(0.09)
spacing.3	2.23^{***}
	(0.12)
spacing.4	3.53^{***}
	(0.16)
Log Likelihood	-1460.09
AIC	2978.17
BIC	3113.74
Num. obs.	792
Groups (subject)	33
Groups (Item)	24
Variance: subject: (Intercept)	4.96
Variance: subject: feature	0.73
Variance: subject: agreementRA	2.16
Variance: subject: feature:agreementRA	1.54
Variance: Item: (Intercept)	0.07
Variance: Item: featurenum	0.14
Variance: Item: agreementRA	0.06
Variance: Item: featurenum:agreementRA	0.03

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.4 – Results of the mixed-effects ordinal regression model testing the difference between gender and number agreement

B.3.4 Results for Self-paced Reading Experiment

division of regions

(1) Subj Verb D N1 et N2 N2+1
L'entraîneur de l'équipe réprimande la/les gardienne et remplaçante depuis
N2+2
5 minutes.

The following mixed-effects linear regression models test effects of feature and agreement in the critical regions: N1, et, N2, N2+1, N2+2. Each model tests one region. In these five models, the response variable was the residual reading time, taking into account the word length. The fixed-effects were feature (gender/number)* agreement (CCA/RA). For the Region N1, random slopes for subjects was feature and agreement without interactions and only feature for item as this was the maximal model that converged.

formula: m4 < −lmer(lreds ∼ feature*agreement + (1+feature+agreement|subject)+ (1+feature|Item), data=Reg4, REML=F,lmerControl(optimizer="bobyqa"))

For the rest regions, the random effects for subjects and items were maximal: feature *agreement, using the formula:

m5 < −lmer(lreds ∼ feature*agreement + (1+feature*agreement|subject)+ (1+ feature *agreement|Item), data=Reg5, REML=F,lmerControl(optimizer="bobyqa"))

	N1	et	N2	N2+1	N2+2
(Intercept)	9.87	4.48	−84.43**	−108.55***	15.68
	(43.08)	(20.36)	(27.53)	(19.36)	(49.51)
featurenum	−17.29	−13.23	80.76*	25.25	34.34
	(32.94)	(16.52)	(33.64)	(15.58)	(39.38)
agreementRA	46.90	2.33	2.85	4.93	9.36
	(30.82)	(17.68)	(22.85)	(15.81)	(39.04)
featurenum:agreementRA	−6.98	7.36	−57.85	−7.67	−15.56
	(41.94)	(25.26)	(33.92)	(23.29)	(62.84)
AIC	14414.58	13082.59	13723.77	13041.94	14749.24
BIC	14483.13	13205.00	13846.18	13164.33	14871.60
Log Likelihood	−7193.29	−6516.29	−6836.88	−6495.97	−7349.62
Num. obs.	989	989	989	988	987
Num. groups: Subject	40	40	40	40	40
Num. groups: Item	23	23	23	23	23
Var: Subject (Intercept)	53197.89	9956.17	21968.58	9505.05	69205.65
Var: Subject featurenum	1574.84	188.54	19055.05	177.14	9270.89
Var: Subject agreementRA	2802.57	2603.32	4547.93	92.05	8927.98
Cov: Subject (Intercept) featurenum	−9153.04	−1320.80	10522.11	−675.83	−4029.30
Cov: Subject (Intercept) agreementRA	12210.28	−4191.66	−2223.18	−65.72	4138.35
Cov: Subject featurenum agreementRA	−2100.86	661.76	−1661.77	−104.07	8615.67
Var: Item (Intercept)	1946.60	1182.31	156.95	680.88	2572.43
Var: Item featurenum	3814.37	955.10	5645.92	539.34	2093.62
Cov: Item (Intercept) featurenum	−2724.90	−1062.65	−121.41	289.96	1263.23
Var: Residual	108467.61	27921.09	49437.88	26420.93	149531.01
Var: Subject featurenum:agreementRA		2781.21	9018.51	1794.48	44900.48
Cov: Subject (Intercept) featurenum:agreementRA		4991.19	−1954.33	3844.78	13782.07
Cov: Subject featurenum featurenum:agreementRA		−723.10	−9617.32	−97.63	−20319.91
Cov: Subject agreementRA featurenum:agreementRA		−2585.08	−3292.67	−174.62	−18305.27
Var: Item agreementRA		454.65	79.06	769.71	1885.84
Var: Item featurenum:agreementRA		2649.45	2583.58	1567.34	8227.96
Cov: Item (Intercept) agreementRA		−733.17	50.34	102.17	−476.88
Cov: Item (Intercept) featurenum:agreementRA		1769.88	396.18	−939.44	−845.06
Cov: Item featurenum agreementRA		658.96	552.08	603.61	1393.13
Cov: Item featurenum featurenum:agreementRA		−1590.75	−3271.58	−735.88	−3837.44
Cov: Item agreementRA featurenum:agreementRA		−1097.53	−188.57	−593.25	−3623.59

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.5 – Results of mixed-effects linear regression model in the self-paced reading experiment testing effects of agreement and feature

Appendix C

Predicative Number Agreement

C.1 Materials

1. - **NP1sg-ou-NP2sg-V**: Je me demande où le maire ou l'adjoint va/vont aller.
   - **V-NP1sg-ou-NP2sg**: Je me demande où va/vont le maire ou l'adjoint aller.
   - **NP1sg-ou-NP2pl-V**: Je me demande où le maire ou les adjoints va/vont aller.
   - **V-NP1sg-ou-NP2pl**: Je me demande où va/vont le maire ou les adjoints aller.
   - **NP1pl-ou-NP2sg-V**: Je me demande où les adjoints ou le maire va/vont aller.
   - **V-NP1pl-ou-NP2sg**: Je me demande où va/vont les adjoints ou le maire aller.
   - **NP1sg-et-NP2sg-V**: Je me demande où le maire et l'adjoint va/vont aller.
   - **NP1sg-et-NP2pl-V**: Je me demande où le maire et les adjoints va/vont aller.
   - **NP1pl-et-NP2sg-V**: Je me demande où les adjoints et le maire va/vont aller.

   Je me demande où le maire ou l'adjoint va aller.

   Q: Est-ce que je sais où va le maire ? A: Non

2. Je ne sais plus à quelle heure le plombier ou l'électricien va arriver.

   Q: Est-ce qu'un garagiste doit venir chez moi? A: Non

3. Je me demande quel jour le gouverneur ou le préfet va céder.

   Q: La phrase parle-t-elle de politique? A: Oui

4. Je ne sais pas ce que le bébé ou son cousin va manger.

   Q: Est-ce que je parle de mon grand-père? A: Non

5. Je ne sais pas à quel moment mon père ou mon frère va m'appeler.

   Q: Est-ce que j'attends un coup de fil ? A: Oui

6. J'ignore quel jour le médecin ou l'infirmier va venir.

   Q: Est-ce que j'attends un plombier? A: Non

7. Je n'ai pas noté quand l'agent ou l'huissier va passer.

   Q: Est-ce qu'un représentant de la justice risque de venir chez moi ? A: oui

8. Je me demande comment mon patron ou mon collègue va réagir.

   Q: Est-ce que je travaille dans une boîte ? A: oui

9. J'attends de voir combien le directeur ou l'employé va toucher.

   Q: Est-ce qu'il s'agit d'argent ? A: oui

10. Je verrais comment l'entraîneur ou le joueur va intervenir.

    Q: La phrase parle-t-elle de sport ? A: oui

11. J'aimerais savoir ce que le président ou le ministre va dire.

    Q: Est-ce que ce sont les députés qui vont faire un discours ? A: non

12. Je veux savoir ce que l'invité ou l'hôte va boire.

    Q: : La scène se passe-t-elle chez moi ? A: non

13. Je ne sais pas quel jour le métro ou le bus va marcher.

    Q: : Est-ce qu'il s'agit d'un trajet en vélo? A: non

14. Je me demande pendant quelles semaines le parc ou le musée va fermer.

    Q: Les parcs sont-ils fermés en ce moment ? A: non

15. Je doute de l'heure à laquelle le meeting ou le discours va commencer.

    Q: Quelqu'un va-t-il parler devant le public ? A: oui

16. Je rêve de l'endroit où le train ou l'avion va m'amener.

    Q: Est-ce que je prévois de prendre le car? A: non

17. J'ignore combien le gaz ou le loyer va coûter.

    Q: Suis-je locataire ? A: oui

18. Je veux savoir quand le vinyle ou le CD va sortir.

    Q: Est-ce que j'attends la sortie d'un film ? A: non

19. J'ignore dans quelles rues le parti ou le syndicat va manifester.

    Q: Y aura-t-il une manifestation ? A: oui

20. Je me demande quand le gazole ou le sans-plomb va baisser.

    Q: Est-ce qu'il s'agit d'essence ? A: oui

21. Je ne sais pas comment le pantalon ou le T-shirt va m'aller.

    Q: Vais-je avoir de nouveaux vêtements ? A: oui

22. J'attends de voir ce que le spectacle ou le sketch va donner.

    Q: Ai-je déjà vu ce spectacle ? A: Non

23. J'ignore à quel point le livre ou le film va m'intéresser.

    Q: Ai-je lu ce livre auparavant ? A: Non

24. J'aimerais savoir ce que l'arbre ou le poteau va toucher, en tombant

    Q: Y a-t-il quelque chose sous l'arbre et le poteau ? A: oui

control items

1. **gram**: La mère des enfants ira à l'école demain.

   un_gram: La mère des enfants iront à l'école demain.

   Q: La dame a-t-elle des enfants ? A: Oui

2. Le chef des Indiens a fait des signaux de fumée.

   Q: La scène se déroule-t-elle en Amérique ? A: Non

3. Le dernier des pharaons a été enterré au XIe siècle.

   Q: La phrase parle-t-elle de l'Egypte ? A: Oui

4. Le navire des pirates a causé de nombreux dommages aux ennemis.

   Q: Les pirates avaient-ils des ennemis ? A: Oui

5. Le commandant des armées a attaqué la Biélorussie.

   Q: La Biélorussie a-t-elle été en guerre ? A: Oui

6. Le délégué des élèves finit les cours à 15h.

   Q: Le délégué finit-il les cours le matin ? A: Non

7. Les tables de la cuisine sont trop petites pour manger.

   Q: Mange-t-on dans la cuisine ? A: Non

8. Les livres de ma bibliothèque ont très mal vieilli.

   Q: Ai-je plusieurs bibliothèques ? A: Non

9. Les cousins de mon père partent en vacances demain.

   Q: on père part-il en vacances ? A: Non

10. Les chats de mon frère sont allergiques au poisson.

    Q: Sait-on si ma sœur a des chats ? A: Non

11. Les boutons de ma chemise ont craqué quand je me suis levé.

    Q: Suis-je resté assis tout le temps ? A:Non

12. Les ministres du gouvernement ont pris de mauvaises décisions.

    Q:La phrase parle-t-elle d'astronomie ? A: Non

C.2 Results

C.2.1 Mean of acceptability ratings for all conditions before removing participants whose averaged median of ungrammatical items larger than that of grammatical items

	combination	V	Humanness	m.r	stdev.r	se.r
1	NP1pl-ou-NP2sg-V	Vpl	human	8.16	2.44	0.23
2	NP1pl-ou-NP2sg-V	Vpl	non-human	7.68	2.59	0.24
3	NP1pl-ou-NP2sg-V	Vsg	human	2.38	2.81	0.26
4	NP1pl-ou-NP2sg-V	Vsg	non-human	2.39	2.65	0.24
5	V-NP1pl-ou-NP2sg	Vpl	human	7.63	2.81	0.26
6	V-NP1pl-ou-NP2sg	Vpl	non-human	7.56	2.77	0.26
7	V-NP1pl-ou-NP2sg	Vsg	human	2.12	2.75	0.25
8	V-NP1pl-ou-NP2sg	Vsg	non-human	2.87	3.45	0.32
9	NP1sg-ou-NP2pl-V	Vpl	human	8.43	2.06	0.17
10	NP1sg-ou-NP2pl-V	Vpl	non-human	8.37	2.19	0.18
11	NP1sg-ou-NP2pl-V	Vsg	human	2.22	2.39	0.19
12	NP1sg-ou-NP2pl-V	Vsg	non-human	2.43	2.60	0.21
13	V-NP1sg-ou-NP2pl	Vpl	human	7.54	2.67	0.22
14	V-NP1sg-ou-NP2pl	Vpl	non-human	7.62	2.56	0.21
15	V-NP1sg-ou-NP2pl	Vsg	human	3.65	2.86	0.23
16	V-NP1sg-ou-NP2pl	Vsg	non-human	4.02	3.04	0.25
17	V-NP1sg-ou-NP2sg	Vpl	human	6.47	3.24	0.27
18	V-NP1sg-ou-NP2sg	Vpl	non-human	6.47	3.24	0.27
29	V-NP1sg-ou-NP2sg	Vsg	human	7.16	2.85	0.24
20	V-NP1sg-ou-NP2sg	Vsg	non-human	7.28	2.85	0.24
21	NP1sg-ou-NP2sg-V	Vpl	human	7.35	2.97	0.25
22	NP1sg-ou-NP2sg-V	Vpl	non-human	6.92	3.08	0.26
23	NP1sg-ou-NP2sg-V	Vsg	human	6.97	2.82	0.24
24	NP1sg-ou-NP2sg-V	Vsg	non-human	7.39	2.41	0.20

C.2.2 Mean of acceptability ratings for all conditions after removing participants whose averaged median of ungrammatical items larger than that of grammatical items (kept for model analysis)

	combination	V	Humanness	m.r	stdev.r	se.r
1	NP1pl-ou-NP2sg-V	Vpl	human	8.16	2.44	0.23
2	NP1pl-ou-NP2sg-V	Vpl	non-human	7.68	2.59	0.24
3	NP1pl-ou-NP2sg-V	Vsg	human	2.38	2.81	0.26
4	NP1pl-ou-NP2sg-V	Vsg	non-human	2.39	2.65	0.24
5	V-NP1pl-ou-NP2sg	Vpl	human	7.63	2.81	0.26
6	V-NP1pl-ou-NP2sg	Vpl	non-human	7.56	2.77	0.26
7	V-NP1pl-ou-NP2sg	Vsg	human	2.12	2.75	0.25
8	V-NP1pl-ou-NP2sg	Vsg	non-human	2.87	3.45	0.32
9	NP1sg-ou-NP2pl-V	Vpl	human	8.43	2.06	0.17
10	NP1sg-ou-NP2pl-V	Vpl	non-human	8.37	2.19	0.18
11	NP1sg-ou-NP2pl-V	Vsg	human	2.22	2.39	0.19
12	NP1sg-ou-NP2pl-V	Vsg	non-human	2.43	2.60	0.21
13	V-NP1sg-ou-NP2pl	Vpl	human	7.54	2.67	0.22
14	V-NP1sg-ou-NP2pl	Vpl	non-human	7.62	2.56	0.21
15	V-NP1sg-ou-NP2pl	Vsg	human	3.65	2.86	0.23
16	V-NP1sg-ou-NP2pl	Vsg	non-human	4.02	3.04	0.25
17	V-NP1sg-ou-NP2sg	Vpl	human	6.35	3.25	0.27
18	V-NP1sg-ou-NP2sg	Vpl	non-human	6.36	3.12	0.27
29	V-NP1sg-ou-NP2sg	Vsg	human	7.06	2.85	0.24
20	V-NP1sg-ou-NP2sg	Vsg	non-human	7.18	2.87	0.24
21	NP1sg-ou-NP2sg-V	Vpl	human	7.23	3.00	0.26
22	NP1sg-ou-NP2sg-V	Vpl	non-human	6.78	3.08	0.26
23	NP1sg-ou-NP2sg-V	Vsg	human	6.88	2.83	0.24
24	NP1sg-ou-NP2sg-V	Vsg	non-human	7.30	2.41	0.21

C.3 Model Analysis

C.3.1 *or-coordination*: with two singular nouns

C.3.1.1 Effects of Directionality

This model tests effects of directionality in combinations V-NP1sg-ou-NP2sg and NP1sg-ou-NP2sg-V. In the model, fixed effects were subject-verb order (SV/VS) and V agreement (Vsg/Vpl). The model also included random intercepts and maximal random slopes for subjects and items.

formula: model< −clmm(Note ∼ order*V+(1+ order*V|subject)+ (1+order*V |Item), threshold =‘symmetric’, data=data)

	Model 1
VVsg	0.84
	(0.61)
orderSV	0.62^{*}
	(0.28)
VVsg:orderSV	-0.89^{*}
	(0.42)
central.1	-1.71^{***}
	(0.50)
central.2	-1.16^{*}
	(0.50)
spacing.1	0.63^{***}
	(0.05)
spacing.2	1.60^{***}
	(0.08)
spacing.3	2.75^{***}
	(0.11)
spacing.4	3.68^{***}
	(0.13)
Log Likelihood	−2037.48
AIC	4132.95
BIC	4278.15
Num. obs.	1104
Groups (subject)	46
Groups (Item)	24
Variance: subject: (Intercept)	9.13
Variance: subject: VVsg	14.41
Variance: subject: orderSV	1.01
Variance: subject: VVsg:orderSV	4.09
Variance: Item: (Intercept)	0.68
Variance: Item: VVsg	0.64
Variance: Item: orderSV	0.56
Variance: Item: VVsg:orderSV	0.60

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.1 – Results of mixed-effects ordinal regression model testing effects of directionality when two disjoined nouns are singular

C.3.1.2 Effects of Humanness

Two models test effects of humannness: one for the combination V-NP1sg-ou-NP2sg and the other for the N1sg-ou-N2sg-V combination. Fixed effexts were V*Huamness, random slopes for items were V, for subjects were maximal for the N1sg-ou-N2sg-V, but without interaction for the V-NP1sg-ou-NP2sg.

for the combination NP1sg-ou-NP2sg-V:

formula: model$<-$clmm(Note $\sim$ V*Human+(1+ V*Human|subject)+ (1+V |Item), threshold ='symmetric', data=data)

for the combination V-NP1sg-ou-NP2sg:

formula: model$<-$clmm(Note $\sim$ V*Human+(1+ V+Human|subject)+ (1+V |Item), threshold ='symmetric', data=data)

	NP1sg-ou-NP2sg-V	V-NP1sg-ou-NP2sg
VVsg	-0.48	0.72
	(0.66)	(0.63)
Humannessnon-human	-0.44	0.14
	(0.28)	(0.44)
VVsg:Humannessnon-human	0.74^{*}	0.15
	(0.37)	(0.43)
central.1	-2.77^{***}	-1.54^{**}
	(0.47)	(0.53)
central.2	-2.05^{***}	-1.12^{*}
	(0.47)	(0.52)
spacing.1	0.66^{***}	0.63^{***}
	(0.08)	(0.07)
spacing.2	1.65^{***}	1.61^{***}
	(0.12)	(0.11)
spacing.3	2.82^{***}	2.76^{***}
	(0.16)	(0.15)
spacing.4	3.77^{***}	3.66^{***}
	(0.19)	(0.19)
Log Likelihood	-1020.35	-1063.81
AIC	2084.70	2163.63
BIC	2179.48	2241.37
Num. obs.	549	555
Groups (subject)	46	46
Groups (Item)	24	24
Variance: subject: (Intercept)	10.89	7.94
Variance: subject: VVsg	20.30	13.51
Variance: subject: Humannessnon-human	0.16	0.12
Variance: subject: VVsg:Humannessnon-human	0.71	
Variance: Item: (Intercept)	0.09	0.81
Variance: Item: VVsg	0.04	0.47

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.2 – Results of mixed-effects ordinal regression model testing effects of humanness in the combination NP1sg-ou-NP2sg-V and the V-NP1sg-ou-NP2sg respectively

C.3.2 *or-coordination*: when the closest noun is singular

C.3.2.1 Effects of Directionality

This model compares two combinations where the closest noun is singular and the other noun is plural – V-NP1sg-ou-NP2pl in VS order and NP1pl-ou-NP2sg-V in SV order. In the model, fixed effects were subject-verb order (SV/VS) and V agreement (Vsg/Vpl). The model also included random intercepts and order*V as random slopes for items, but only V as randoms slopes for subject since the two word order were tested in two different experiments.

formula: model$<-$clmm(Note $\sim$ order*V+(1+ V|subject)+ (1+order*V |Item), threshold ='symmetric', data=data)

	Model 1
VVsg	-4.49^{***}
	(0.41)
orderVS	-0.24
	(0.25)
VVsg:orderVS	1.46^{***}
	(0.30)
central.1	-2.60^{***}
	(0.25)
central.2	-2.01^{***}
	(0.24)
spacing.1	0.55^{***}
	(0.04)
spacing.2	1.21^{***}
	(0.07)
spacing.3	2.03^{***}
	(0.09)
spacing.4	2.53^{***}
	(0.10)
Log Likelihood	-2067.06
AIC	4178.13
BIC	4287.55
Num. obs.	1068
Groups (subject)	53
Groups (Item)	24
Variance: subject: (Intercept)	1.33
Variance: subject: VVsg	5.36
Variance: Item: (Intercept)	0.23
Variance: Item: VVsg	0.19
Variance: Item: orderVS	0.70
Variance: Item: VVsg:orderVS	0.46

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.3 – Results of mixed-effects ordinal regression model testing effects of directionality when the closest noun is singular and the other noun is plural

C.3.2.2 Effects of Humanness

Two models test effects of humannness: one for the combination V-NP1sg-ou-NP2pl and the other for the N1pl-ou-N2sg-V combination. Fixed effexts were V*Huamness, random slopes for items were V, for subjects were maximal.

formula: model< −clmm(Note ∼ V*Human+(1+ V*Human|subject)+ (1+V |Item), threshold =‘symmetric’, data=data)

	NP1pl-ou-NP2sg-V	V-NP1sg-ou-NP2pl
VVsg	-6.16^{***}	-4.10^{***}
	(0.83)	(0.64)
Humannessnon-human	-0.77	0.12
	(0.40)	(0.51)
VVsg:Humannessnon-human	0.86	0.20
	(0.48)	(0.45)
central.1	-3.70^{***}	-2.95^{***}
	(0.50)	(0.45)
central.2	-3.03^{***}	-2.22^{***}
	(0.48)	(0.44)
spacing.1	0.54^{***}	0.74^{***}
	(0.08)	(0.07)
spacing.2	1.30^{***}	1.57^{***}
	(0.12)	(0.11)
spacing.3	2.27^{***}	2.65^{***}
	(0.16)	(0.14)
spacing.4	3.00^{***}	3.28^{***}
	(0.19)	(0.17)
Log Likelihood	-801.01	-1145.17
AIC	1646.02	2334.35
BIC	1737.29	2431.08
Num. obs.	468	600
Groups (subject)	39	50
Groups (Item)	24	24
Variance: subject: (Intercept)	4.69	2.80
Variance: subject: VVsg	18.32	13.67
Variance: subject: Humannessnon-human	0.68	0.04
Variance: subject: VVsg:Humannessnon-human	0.61	0.01
Variance: Item: (Intercept)	0.29	1.21
Variance: Item: VVsg	0.15	0.59

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.4 – Results of mixed-effects ordinal regression model testing effects of humanness in the combination NP1pl-ou-NP2sg-V and the V-NP1sg-ou-NP2pl respectively

C.3.3 *or-coordination*: when the closest noun is plural

C.3.3.1 Effects of Directionality

This model compares two combinations where the closest noun is plural and the other noun is singular – the V-NP1pl-ou-NP2sg in VS order and NP1sg-ou-NP2pl-V in SV order. In the model, fixed effects were subject-verb order (SV/VS) and V agreement (Vsg/Vpl). The model also included random intercepts and order*V as random slopes for items, but only V as randoms slopes for subject since the two word order were tested in two different experiments.

formula: model$<-$clmm(Note $\sim$ order*V+(1+ V|subject)+ (1+order*V |Item), threshold ='symmetric', data=data) formula: model< −clmm(Note ∼ feature*agreement+(1+ feature*agreement|subject)+ (1+feature*agreement |Item), threshold ='symmetric', data=data)

	Model 1
VVsg	-4.68^{***}
	(0.35)
orderVS	-0.69^{***}
	(0.19)
VVsg:orderVS	0.77^{**}
	(0.26)
central.1	-2.87^{***}
	(0.22)
central.2	-2.35^{***}
	(0.22)
spacing.1	0.45^{***}
	(0.04)
spacing.2	0.96^{***}
	(0.06)
spacing.3	1.70^{***}
	(0.08)
spacing.4	2.31^{***}
	(0.09)
Log Likelihood	−1936.91
AIC	3917.83
BIC	4027.25
Num. obs.	1068
Groups (subject)	53
Groups (Item)	24
Variance: subject: (Intercept)	1.43
Variance: subject: VVsg	3.87
Variance: Item: (Intercept)	0.00
Variance: Item: VVsg	0.01
Variance: Item: orderVS	0.08
Variance: Item: VVsg:orderVS	0.01

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.5 – Results of mixed-effects ordinal regression model testing effects of directionality when the closest noun is plural and the other noun is singular

C.3.3.2 Effects of Humanness

Two models test effects of humannness: one for the combination V-NP1pl-ou-NP2sg and the other for the N1sg-ou-N2pl-V combination. Fixed effexts were V*Huamness, random slopes for items were V, for subjects were maximal.

formula: model$<-$clmm(Note $\sim$ V*Human+(1+ V*Human|subject)+ (1+V |Item), threshold =‘symmetric’, data=data)

	NP1sg-ou-NP2pl-V	V-NP1pl-ou-NP2sg
VVsg	-8.33^{***}	-5.44^{***}
	(0.81)	(0.78)
Humannessnon-human	-0.20	-0.10
	(0.32)	(0.33)
VVsg:Humannessnon-human	0.25	0.61
	(0.43)	(0.46)
central.1	-5.09^{***}	-2.74^{***}
	(0.53)	(0.43)
central.2	-4.16^{***}	-2.14^{***}
	(0.51)	(0.42)
spacing.1	0.74^{***}	0.54^{***}
	(0.09)	(0.07)
spacing.2	1.62^{***}	1.13^{***}
	(0.14)	(0.11)
spacing.3	3.18^{***}	1.80^{***}
	(0.20)	(0.13)
spacing.4	4.17^{***}	2.79^{***}
	(0.24)	(0.17)
Log Likelihood	-902.94	-807.74
AIC	1849.89	1659.48
BIC	1946.62	1750.75
Num. obs.	600	468
Groups (subject)	50	39
Groups (Item)	24	24
Variance: subject: (Intercept)	7.78	4.33
Variance: subject: VVsg	19.20	16.59
Variance: subject: Humannessnon-human	0.41	0.02
Variance: subject: VVsg:Humannessnon-human	0.27	0.10
Variance: Item: (Intercept)	0.00	0.17
Variance: Item: VVsg	0.00	0.09

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.6 – Results of mixed-effects ordinal regression model testing effects of humanness in the combination NP1sg-ou-NP2pl-V and the V-NP1pl-ou-NP2sg respectively

Appendix D

Predicative Gender Agreement

D.1 Materials

1. **NP1m-et-NP2f-V**: Je me demande où les étudiants et les étudiantes seront conduits/conduites.

   NP1f-et-NP2m-V: Je me demande où les étudiantes et les étudiants seront conduits/conduites.

- **V-NP1m-et-NP2f**: Je me demande où seront conduits/conduites les étudiants et les étudiantes.
- **V-NP1f-et-NP2m-V**: Je me demande où seront conduits/conduites les étudiantes et les étudiants.
- **NP1m-ou-NP2f-V**: Je me demande où les étudiants ou les étudiantes seront conduits/conduites.
- **NP1f-ou-NP2m-V**: Je me demande où les étudiantes ou les étudiants seront conduits/conduites.
- **V-NP1m-ou-NP2f-V**: Je me demande où seront conduits/conduites les étudiants ou les étudiantes.

- **V-NP1f-ou-NP2m-V**: Je me demande où seront conduits/conduites les étudiantes ou les étudiants.

2. Il ne sait plus à quelle heure les citoyens et les citoyennes seront prêts.

3. Elle se demande quel jour les chirurgiens et les infirmières sont pris.
   Q: L'emploi du temps des chirurgiens ou infirmières est-il inconnu ? A: Oui

4. Nous ne savons pas comment mes cousins et mes cousines seront joints.

5. Je sais bien par quoi mes copains et mes copines seront surpris.

6. Ils ignorent où les acteurs et les actrices seront assis.

7. Elles n'ont pas noté quand les garçons et les filles seront inscrits.
   Q: Les garçons sont-ils inscrits ? A: Non

8. Il se demande comment les clients et les clientes seront satisfaits.

9. Elle attend de voir à quelle heure les directeurs et les directrices seront présents.

10. Nous verrons dans quelle équipe les joueurs et les joueuses seront repris.

11. Ils aimeraient savoir par qui les couturiers et les créatrices sont compris.
    Q: La phrase parle-t-elle du secteur de la mode ? A: Oui

12. Elles veulent savoir quand les syndicats et les associations seront satisfaits.

13. Je ne sais pas quel jour les scooters et les trotinettes seront interdits.
    Q: La phrase parle-t-elle du transport ? A: Oui

14. Il se demande par qui les résultats et les notes seront remis.
    Q: Est-ce que les résultats sont remis ? A: Non

15. Elle doute de l'heure à laquelle les discours et les conférences seront retransmis.
    Q: Est-elle certaine de l'heure de retransmission des discours ? A: Non

16. Nous attendons le moment où les frais et les taxes seront déduits.

    Q: Aimerions-nous une diminution des impôts ? A: Oui

17. Ils ignorent de combien les loyers et les charges seront réduits.

    Q: La phrase parle-t-elle de futures dépenses ? A: Oui

18. Elles veulent comprendre comment les sondages et les prévisions sont produits.

19. J'ignore dans quelles rues les rassemblements et les manifestations sont permis.

20. Elle se demande quand les immeubles et les maisons seront refaits.

21. Il ne sait pas pendant quand les parcs et les piscines sont ouverts.

    Q: Est-ce qu'il sait si la piscine sera ouverte demain matin ? A: non

22. Nous attendons de voir où les spectacles et les activités seront construits.

    Q: Est-ce que les spectacles seront produits devant la mairie ? A: Non

23. Ils se demandent à qui les colliers et les bagues seront offerts.

    Q: Est-ce que la phrase parle-t-elle des bijoux ? A: Oui

24. Elles aimeraient savoir comment les cours et les leçons sont appris.

    Q: Est-ce qu'elles s'intéressent au contenu du cours ? A: Non

control items

1. Le fils de la voisine est content d'aller à l'école.

2. Le four de la cuisine est trop crasseux pour faire à manger.

   Q: Le four est-il propre ? A: Non

3. Le mari de ma sœur est acteur à Hollywood.

   Q: Le mari travaille-t-il en France ? A: Non

4. L'amant de ma femme a été pris la main dans le sac.

5. Le fourgon de la police sera vert dorénavant.

   Q: Les agents ont-ils un véhicule ? A: Oui

6. Le rire de ma mère devient de plus en plus agaçant.

7. L'entrée du palais est vraiment somptueuse.

8. La venue du roi paraît assez effrayante.

   Q: Est-ce une monarchie ? A: Oui

9. La cousine de mon père est dessinatrice pour enfants.

   Q: Est-ce qu'un de mes parents a une cousine ? A: Oui

10. La vitrine du magasin semble ancienne et délabrée.

    Q: La vitrine est-elle neuve ? A: Non

11. La place du village est déserte depuis des années.

12. La lumière du soleil devient plus chaude après 14h.

D.2 Results

D.2.1 Mean of acceptability ratings for all conditions before removing participants whose averaged median of ungrammatical items larger than that of grammatical items

	type	verb	Humanness	m.r	stdev.r	se.r
1	V-NP1f-et-NP2m	Vf	human	4.60	3.46	0.27
2	V-NP1f-et-NP2m	Vf	non-human	5.35	3.60	0.28
3	NP1f-et-NP2m-V	Vf	human	3.91	3.35	0.27
4	NP1f-et-NP2m-V	Vf	non-human	4.62	3.54	0.29
5	V-NP1f-et-NP2m	Vm	human	7.20	3.11	0.24
6	V-NP1f-et-NP2m	Vm	non-human	8.45	1.90	0.15
7	NP1f-et-NP2m-V	Vm	human	7.80	2.49	0.20
8	NP1f-et-NP2m-V	Vm	non-human	8.75	1.71	0.14
9	V-NP1m-et-NP2f	Vf	human	4.20	3.44	0.27
10	V-NP1m-et-NP2f	Vf	non-human	4.14	3.54	0.28
11	NP1m-et-NP2f-V	Vf	human	4.30	3.54	0.29
12	NP1m-et-NP2f-V	Vf	non-human	5.65	3.55	0.27
13	V-NP1m-et-NP2f	Vm	human	7.76	2.67	0.21
14	V-NP1m-et-NP2f	Vm	non-human	8.31	2.18	0.17
15	NP1m-et-NP2f-V	Vm	human	7.85	2.39	0.19
16	NP1m-et-NP2f-V	Vm	non-human	8.42	1.83	0.14
1	V-NP1f-ou-NP2m	Vf	human	6.42	3.26	0.40
2	V-NP1f-ou-NP2m	Vf	non-human	6.59	3.24	0.39
3	NP1f-ou-NP2m-V	Vf	human	5.26	3.18	0.39
4	NP1f-ou-NP2m-V	Vf	non-human	5.45	3.46	0.43
5	V-NP1f-ou-NP2m	Vm	human	7.49	2.64	0.31
6	V-NP1f-ou-NP2m	Vm	non-human	8.44	1.81	0.22
7	NP1f-ou-NP2m-V	Vm	human	7.62	2.72	0.33
8	NP1f-ou-NP2m-V	Vm	non-human	8.25	2.68	0.33
9	V-NP1m-ou-NP2f	Vf	human	5.46	3.34	0.41
10	V-NP1m-ou-NP2f	Vf	non-human	5.15	3.81	0.47
11	NP1m-ou-NP2f-V	Vf	human	5.86	3.27	0.41
12	NP1m-ou-NP2f-V	Vf	non-human	6.34	3.42	0.41
13	V-NP1m-ou-NP2f	Vm	human	7.38	2.97	0.36
14	V-NP1m-ou-NP2f	Vm	non-human	8.70	1.70	0.21
15	NP1m-ou-NP2f-V	Vm	human	8.05	2.55	0.32
16	NP1m-ou-NP2f-V	Vm	non-human	7.93	2.78	0.33

D.2.2 Mean of acceptability ratings for all conditions after removing participants whose averaged median of ungrammatical items larger than that of grammatical items (kept for model analysis)

	type	verb	Humanness	m.r	stdev.r	se.r
1	V-NP1f-et-NP2m	Vf	human	3.88	3.25	0.29
2	V-NP1f-et-NP2m	Vf	non-human	4.45	3.47	0.32
3	NP1f-et-NP2m-V	Vf	human	3.17	3.03	0.28
4	NP1f-et-NP2m-V	Vf	non-human	3.65	3.29	0.31
5	V-NP1f-et-NP2m	Vm	human	7.24	3.08	0.28
6	V-NP1f-et-NP2m	Vm	non-human	8.38	2.00	0.19
7	NP1f-et-NP2m-V	Vm	human	7.67	2.73	0.25
8	NP1f-et-NP2m-V	Vm	non-human	8.73	1.76	0.16
9	V-NP1m-et-NP2f	Vf	human	3.52	3.22	0.29
10	V-NP1m-et-NP2f	Vf	non-human	3.42	3.35	0.31
11	NP1m-et-NP2f-V	Vf	human	3.68	3.42	0.33
12	NP1m-et-NP2f-V	Vf	non-human	4.76	3.44	0.31
13	V-NP1m-et-NP2f	Vm	human	8.04	2.37	0.22
14	V-NP1m-et-NP2f	Vm	non-human	8.50	2.04	0.18
15	NP1m-et-NP2f-V	Vm	human	7.83	2.51	0.23
16	NP1m-et-NP2f-V	Vm	non-human	8.51	1.82	0.17
1	V-NP1f-ou-NP2m	Vf	human	6.43	3.18	0.43
2	V-NP1f-ou-NP2m	Vf	non-human	6.33	3.29	0.44
3	NP1f-ou-NP2m-V	Vf	human	4.96	2.89	0.39
4	NP1f-ou-NP2m-V	Vf	non-human	4.73	3.27	0.46
5	V-NP1f-ou-NP2m	Vm	human	7.36	2.74	0.36
6	V-NP1f-ou-NP2m	Vm	non-human	8.49	1.60	0.22
7	NP1f-ou-NP2m-V	Vm	human	7.53	2.73	0.37
8	NP1f-ou-NP2m-V	Vm	non-human	8.09	2.79	0.38
9	V-NP1m-ou-NP2f	Vf	human	5.17	3.20	0.43
10	V-NP1m-ou-NP2f	Vf	non-human	4.30	3.62	0.50
11	NP1m-ou-NP2f-V	Vf	human	5.24	3.05	0.43
12	NP1m-ou-NP2f-V	Vf	non-human	5.93	3.30	0.44
13	V-NP1m-ou-NP2f	Vm	human	7.07	3.04	0.41
14	V-NP1m-ou-NP2f	Vm	non-human	8.56	1.75	0.25
15	NP1m-ou-NP2f-V	Vm	human	7.94	2.54	0.36
16	NP1m-ou-NP2f-V	Vm	non-human	7.91	2.63	0.35

D.3 Model Analysis

D.3.1 and-coordination

D.3.1.1 Effects of position

These models test effects of directionality when the closest noun is the same: one compares combinations V-NP1m-et-NP2f and NP1f-et-NP2m-V (called "closest_masc"), and the other compares V-NP1f-et-NP2m and NP1m-et-NP2f-V (called "closest_fem").

The fixed effects were word ordre (SV/VS)*gender agreement (Vm/Vf). The randoms slopes for subjects and items were also maximal word ordre*gender agreement.

formula: model< −clmm(Note ∼ V*position+(1+ V*position | subject)+ (1+ V*position| Item), threshold =‘symmetric’, data=data)

	closest_masc	closest_fem
positionSV	0.18	0.13
	(0.24)	(0.20)
verbVm	5.18***	3.73***
	(0.52)	(0.47)
positionSV:verbVm	−0.12	−0.00
	(0.33)	(0.30)
central.1	1.53***	0.67*
	(0.36)	(0.31)
central.2	2.17***	1.23***
	(0.37)	(0.31)
spacing.1	0.52***	0.49***
	(0.05)	(0.05)
spacing.2	1.14***	1.14***
	(0.08)	(0.07)
spacing.3	2.16***	2.07***
	(0.11)	(0.10)
spacing.4	3.38***	3.06***
	(0.14)	(0.12)
Log Likelihood	−1669.42	−1818.33
AIC	3396.85	3694.65
BIC	3537.35	3835.70
Num. obs.	939	957
Groups (subject)	79	79
Groups (Item)	24	24
Variance: subject: (Intercept)	6.51	5.44
Variance: subject: positionSV	0.01	0.00
Variance: subject: verbVm	14.13	11.44
Variance: subject: positionSV:verbVm	0.06	0.01
Variance: Item: (Intercept)	0.54	0.16
Variance: Item: positionSV	0.48	0.18
Variance: Item: verbVm	0.39	0.52
Variance: Item: positionSV:verbVm	0.39	0.36

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table D.1 – Results of mixed-effects regression model testing effects of SV/VS oder

Effects of Humanness

As usual, these models test effects of humannness in each combination. Fixed effexts were V*Huamness, random slopes for items were V, for subjects were maximal V*Huamness.

formula: model$<-$clmm(Note $\sim$ V*Human+(1+ V*Human|subject)+ (1+V |Item), threshold =‘symmetric’, data=data)

	NP1m-et-NP2f-V	NP1f-et-NP2m-V	V-NP1f-et-NP2m	V-NP1m-et-NP2f
Humannessnon-human	0.77	0.26	0.64*	−0.14
	(0.48)	(0.33)	(0.26)	(0.48)
verbVm	3.86***	4.61***	3.40***	4.66***
	(0.54)	(0.58)	(0.51)	(0.58)
Humannessnon-human:verbVm	−0.16	0.45	0.11	0.85
	(0.44)	(0.43)	(0.48)	(0.51)
central.1	0.91*	1.39***	0.99**	1.37***
	(0.44)	(0.35)	(0.30)	(0.41)
central.2	1.62***	2.00***	1.40***	2.08***
	(0.45)	(0.37)	(0.31)	(0.43)
spacing.1	0.44***	0.51***	0.54***	0.54***
	(0.07)	(0.07)	(0.07)	(0.08)
spacing.2	1.07***	1.16***	1.18***	1.13***
	(0.11)	(0.11)	(0.10)	(0.12)
spacing.3	2.04***	2.20***	2.04***	2.11***
	(0.17)	(0.16)	(0.14)	(0.18)
spacing.4	3.02***	3.34***	2.95***	3.32***
	(0.23)	(0.22)	(0.18)	(0.25)
Log Likelihood	−926.87	−858.45	−962.51	−889.57
AIC	1897.73	1760.91	1969.02	1823.14
BIC	1989.42	1851.80	2060.85	1914.92
Num. obs.	477	460	480	479
Groups (subject)	79	79	79	79
Groups (Item)	24	24	24	24
Variance: subject: (Intercept)	5.43	4.86	4.24	4.47
Variance: subject: Humannessnon-human	0.68	0.20	0.01	1.17
Variance: subject: verbVm	10.20	13.53	8.58	10.46
Variance: subject: Humannessnon-human:verbVm	1.19	0.20	0.33	1.17
Variance: Item: (Intercept)	0.83	0.20	0.03	0.73
Variance: Item: verbVm	0.08	0.04	0.46	0.28

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table D.2 – Results of mixed-effects ordinal regression model testing effects of humanness in each combination respectively

D.3.2 or-coordination

D.3.2.1 Effects of position

The model's factors were exactly as same as in *and-coordination*

	Model 1	Model 2
positionSV	0.06	-0.60
	(0.33)	(0.39)
verbVm	3.07^{***}	1.47^{***}
	(0.62)	(0.42)
positionSV:verbVm	0.07	0.94
	(0.67)	(0.53)
central.1	-0.05	-1.44^{***}
	(0.44)	(0.43)
central.2	0.67	-0.80
	(0.44)	(0.42)
spacing.1	0.64^{***}	0.56^{***}
	(0.08)	(0.07)
spacing.2	1.18^{***}	1.13^{***}
	(0.11)	(0.11)
spacing.3	1.95^{***}	2.03^{***}
	(0.15)	(0.15)
spacing.4	3.06^{***}	3.13^{***}
	(0.21)	(0.21)
Log Likelihood	-854.10	-864.85
AIC	1766.20	1787.71
BIC	1883.85	1906.03
Num. obs.	427	437
Groups (id)	36	36
Groups (Item)	24	24
Variance: id: (Intercept)	4.99	2.90
Variance: id: positionSV	0.63	1.54
Variance: id: verbVm	7.12	2.64
Variance: id: positionSV:verbVm	3.30	2.96
Variance: Item: (Intercept)	0.34	1.30
Variance: Item: positionSV	0.57	0.77
Variance: Item: verbVm	1.52	0.47
Variance: Item: positionSV:verbVm	3.95	0.71

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table D.3 – Results of mixed-effects regression model testing effects of SV/VS oder

D.3.2.2 Effects of humanness

The models are as same as in *and-coordination* except for excluding the interaction between verb and position for random slopes for subject in the NP1f-ou-NP2m-V combination and the V-NP1m-ou-NP2f combination.

	NP1m-ou-NP2f-V	NP1f-ou-NP2m-V	V-NP1f-ou-NP2m	V-NP1m-ou-NP2f
Humannessnon-human	0.66	-0.00	0.18	-0.45
	(0.43)	(0.37)	(0.62)	(0.41)
verbVm	3.03^{***}	2.90^{***}	0.98^{*}	1.99^{**}
	(0.79)	(0.80)	(0.45)	(0.61)
Humannessnon-human:verbVm	-0.60	0.73	0.81	1.54^{*}
	(0.84)	(0.84)	(0.68)	(0.64)
central.1	-0.52	-0.09	-1.48^{**}	-0.30
	(0.46)	(0.42)	(0.52)	(0.42)
central.2	0.08	0.56	-0.71	0.48
	(0.45)	(0.42)	(0.50)	(0.43)
spacing.1	0.63^{***}	0.73^{***}	0.58^{***}	0.54^{***}
	(0.13)	(0.12)	(0.11)	(0.10)
spacing.2	1.29^{***}	1.25^{***}	1.13^{***}	1.09^{***}
	(0.19)	(0.16)	(0.16)	(0.15)
spacing.3	2.49^{***}	2.11^{***}	1.90^{***}	1.74^{***}
	(0.30)	(0.22)	(0.22)	(0.20)
spacing.4	3.60^{***}	3.35^{***}	3.11^{***}	2.65^{***}
	(0.40)	(0.32)	(0.33)	(0.26)
Log Likelihood	-418.77	-438.02	-452.00	-436.80
AIC	881.55	912.04	948.01	909.59
BIC	955.50	972.71	1023.06	970.01
Num. obs.	213	215	224	212
Groups (id)	36	36	36	36
Groups (Item)	24	24	24	24
Variance: id: (Intercept)	4.34	3.95	3.11	3.47
Variance: id: Humannessnon-human	0.72	0.16	2.36	0.06
Variance: id: verbVm	6.63	8.17	1.08	5.13
Variance: id: Humannessnon-human:verbVm	0.86		4.06	
Variance: Item: (Intercept)	0.07	0.00	0.96	0.13
Variance: Item: verbVm	1.82	2.04	0.13	0.50

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table D.4 – Statistical models

Appendix E

Computational Models of agreement with coordination structures

E.1 Models for *and-coordination*

E.1.1 Annotation of Constraints

E.1.1.1 Number agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
1	NP1sg-et-NP2pl-Vpl	9.10	0	0	0	0	0	0
2	NP1sg-et-NP2pl-Vsg	1.78	0	0	0	-1	-1	0
3	NP1sg-et-NP2sg-Vpl	8.68	0	0	0	-1	0	0
4	NP1sg-et-NP2sg-Vsg	1.99	0	0	0	0	-1	0
5	NP1pl-et-NP2sg-Vpl	8.48	0	0	0	-1	0	0
6	NP1pl-et-NP2sg-Vsg	2.25	0	0	0	0	-1	0
7	NP1pl-et-NP2pl-Vpl	8.74	0	0	0	0	0	0
8	NP1pl-et-NP2pl-Vsg	1.99	0	0	0	-1	-1	0
9	NP1sg-et-NP2sg-Asg	8.21	0	-1	0	0	0	0
10	NP1sg-et-NP2sg-Apl	8.19	-1	0	0	0	0	0
11	Dpl-N1sg-et-N2pl	7.45	-1	0	-1	0	0	0
12	Dsg-N1sg-et-N2pl	6.36	0	-1	0	0	0	0
13	Dpl-N1sg-et-N2sg	6.93	-1	0	-1	0	0	0
14	Dsg-N1sg-et-N2sg	7.25	0	-1	0	0	0	0

E.1.1.2 Geeder Agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
15	NP1f-et-NP2m-Vf	3.40	0	0	0	-1	-1	0
16	NP1f-et-NP2m-Vm	8.20	0	0	0	0	0	0
17	NP1m-et-NP2f-Vf	4.27	0	0	0	0	-1	0
18	NP1m-et-NP2f-Vm	8.17	0	0	0	-1	0	0
19	Vf-NP1f-et-NP2m	4.16	0	0	0	0	-1	0
20	Vm-NP1f-et-NP2m	7.80	0	0	0	-1	0	-1
21	Vf-NP1m-et-NP2f	3.47	0	0	0	-1	-1	-1
22	Vm-NP1m-et-NP2f	8.28	0	0	0	0	0	0
23	N1m-et-N2f-Af	6.37	0	-1	0	0	0	0
24	N1m-et-N2f-Am	5.89	-1	0	0	0	0	0
25	D(A)m-N1f-et-N2m	4.57	-1	0	-1	0	0	0
26	D(A)f-N1f-et-N2m	6.42	0	-1	0	0	0	0
27	D(A)m-N1m-et-N2f	8.31	0	0	0	0	0	0
28	D(A)f-N1m-et-N2f	3.01	-1	-1	-1	0	0	0

E.1.2 Results of leave-one-out cross-validation

	Condition	mean	prediction	mse
1	NP1sg-et-NP2pl-Vpl	9.10	8.76	0.11
2	NP1sg-et-NP2pl-Vsg	1.78	1.91	0.02
3	NP1sg-et-NP2sg-Vpl	8.68	8.56	0.01
4	NP1sg-et-NP2sg-Vsg	1.99	2.25	0.07
5	NP1pl-et-NP2sg-Vpl	8.48	8.68	0.04
6	NP1pl-et-NP2sg-Vsg	2.25	2.09	0.03
7	NP1pl-et-NP2pl-Vpl	8.74	8.99	0.06
8	NP1pl-et-NP2pl-Vsg	1.99	1.79	0.04
9	NP1sg-et-NP2sg-Asg	8.21	6.81	1.95
10	NP1sg-et-NP2sg-Apl	8.19	7.29	0.81
11	Dpl-N1sg-et-N2pl	7.45	6.94	0.26
12	Dsg-N1sg-et-N2pl	6.36	7.73	1.88
13	Dpl-N1sg-et-N2sg	6.93	7.45	0.27
14	Dsg-N1sg-et-N2sg	7.25	7.29	0.00
15	NP1f-et-NP2m-Vf	3.40	4.07	0.45
16	NP1f-et-NP2m-Vm	8.20	8.35	0.02
17	NP1m-et-NP2f-Vf	4.27	3.95	0.10
18	NP1m-et-NP2f-Vm	8.17	7.65	0.27
19	Vf-NP1f-et-NP2m	4.16	4.01	0.02
20	Vm-NP1f-et-NP2m	7.80	7.70	0.01
21	Vf-NP1m-et-NP2f	3.47	3.58	0.01
22	Vm-NP1m-et-NP2f	8.28	8.33	0.00
23	N1m-et-N2f-Af	6.37	6.54	0.03
24	N1m-et-N2f-Am	5.89	5.93	0.00
25	D(A)m-N1f-et-N2m	4.57	4.97	0.16
26	D(A)f-N1f-et-N2m	6.42	6.50	0.01
27	D(A)m-N1m-et-N2f	8.31	8.32	0.00
28	D(A)f-N1m-et-N2f	3.01	2.62	0.15

E.2 Models for *and-coordination*

E.2.1 Model I: Baseline

E.2.1.1 Annotation of Constraints

Number agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
1	Vsg-NP1sg-ou-NP2sg	7.12	0	0	0	0	-1	0
2	Vpl-NP1sg-ou-NP2sg	6.35	0	0	0	-1	0	-1
3	NP1sg-ou-NP2sg-Vpl	7.01	0	0	0	-1	0	0
4	NP1sg-ou-NP2sg-Vsg	7.09	0	0	0	0	-1	0
5	N1sg-ou-N2sg-Asg	8.35	0	-1	0	0	0	0
6	N1sg-ou-N2sg-Apl	8.37	-1	0	0	0	0	0
7	Dpl-N1sg-ou-N2sg	6.98	-1	0	-1	0	0	0
8	Dsg-N1sg-ou-N2sg	7.80	0	-1	0	0	0	0
9	NP1sg-ou-NP2pl-Vpl	8.40	0	0	0	0	0	0
10	NP1sg-ou-NP2pl-Vsg	2.32	0	0	0	-1	-1	0
11	Vpl-NP1sg-ou-NP2pl	7.58	0	0	0	-1	0	-1
12	Vsg-NP1sg-ou-NP2pl	3.83	0	0	0	0	-1	0
13	NP1pl-ou-NP2sg-Vpl	7.92	0	0	0	-1	0	0
14	NP1pl-ou-NP2sg-Vsg	2.39	0	0	0	0	-1	0
15	Vpl-NP1pl-ou-NP2sg	7.60	0	0	0	0	0	0
16	Vsg-NP1pl-ou-NP2sg	2.50	0	0	0	-1	-1	-1
17	Dpl-N1sg-ou-N2pl	6.96	-1	0	-1	0	0	0
18	Dsg-N1sg-ou-N2pl	6.43	0	-1	0	0	0	0

Gender agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
19	NP1f-ou-NP2m-Vf	4.44	0	0	0	-1	-1	0
20	NP1f-ou-NP2m-Vm	8.00	0	0	0	0	0	0
21	NP1m-ou-NP2f-Vf	5.25	0	0	0	0	-1	0
22	NP1m-ou-NP2f-Vm	7.81	0	0	0	-1	0	0
23	Vf-NP1f-ou-NP2m	5.34	0	0	0	0	-1	0
24	Vm-NP1f-ou-NP2m	7.58	0	0	0	-1	0	-1
25	Vf-NP1m-ou-NP2f	3.79	0	0	0	-1	-1	-1
26	Vm-NP1m-ou-NP2f	8.02	0	0	0	0	0	0

E.2.1.2 prediction of the model trained with *and-coordination*

	Condition	Mean	Prediction	MSE
1	Vsg-NP1sg-ou-NP2sg	7.12	2.15	24.68
2	Vpl-NP1sg-ou-NP2sg	6.35	8.61	5.10
3	NP1sg-ou-NP2sg-Vpl	7.01	8.61	2.55
4	NP1sg-ou-NP2sg-Vsg	7.09	2.15	24.39
5	N1sg-ou-N2sg-Asg	8.35	7.28	1.15
6	N1sg-ou-N2sg-Apl	8.37	8.19	0.03
7	Dpl-N1sg-ou-N2sg	6.98	7.19	0.05
8	Dsg-N1sg-ou-N2sg	7.80	7.28	0.27
9	NP1sg-ou-NP2pl-Vpl	8.40	8.89	0.24
10	NP1sg-ou-NP2pl-Vsg	2.32	1.87	0.21
11	Vpl-NP1sg-ou-NP2pl	7.58	8.61	1.06
12	Vsg-NP1sg-ou-NP2pl	3.83	2.15	2.82
13	NP1pl-ou-NP2sg-Vpl	7.92	8.61	0.47
14	NP1pl-ou-NP2sg-Vsg	2.39	2.15	0.06
15	Vpl-NP1pl-ou-NP2sg	7.60	8.89	1.67
16	Vsg-NP1pl-ou-NP2sg	2.50	1.87	0.40
17	Dpl-N1sg-ou-N2pl	6.96	7.19	0.06
18	Dsg-N1sg-ou-N2pl	6.43	7.28	0.72
19	NP1f-ou-NP2m-Vf	4.44	3.66	0.60
20	NP1f-ou-NP2m-Vm	8.00	8.32	0.10
21	NP1m-ou-NP2f-Vf	5.25	4.07	1.40
22	NP1m-ou-NP2f-Vm	7.81	7.91	0.01
23	Vf-NP1f-ou-NP2m	5.34	4.07	1.62
24	Vm-NP1f-ou-NP2m	7.58	7.77	0.03
25	Vf-NP1m-ou-NP2f	3.79	3.52	0.08
26	Vm-NP1m-ou-NP2f	8.02	8.32	0.09

E.2.2 Model II: Agreement with disjoined NP is a 'grammatical lacuna'

E.2.2.1 Annotation of Constraints

Number agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
1	Vsg-NP1sg-ou-NP2sg	7.12	0	0	0	0	0	0
2	Vpl-NP1sg-ou-NP2sg	6.35	0	0	0	-1	0	-1
3	NP1sg-ou-NP2sg-Vpl	7.01	0	0	0	-1	0	0
4	NP1sg-ou-NP2sg-Vsg	7.09	0	0	0	0	0	0
5	N1sg-ou-N2sg-Asg	8.35	0	0	0	0	0	0
6	N1sg-ou-N2sg-Apl	8.37	-1	0	0	0	0	0
7	Dpl-N1sg-ou-N2sg	6.98	-1	0	-1	0	0	0
8	Dsg-N1sg-ou-N2sg	7.80	0	0	0	0	0	0
9	NP1sg-ou-NP2pl-Vpl	8.40	0	0	0	0	0	0
10	NP1sg-ou-NP2pl-Vsg	2.32	0	0	0	-1	-1	0
11	Vpl-NP1sg-ou-NP2pl	7.58	0	0	0	-1	0	-1
12	Vsg-NP1sg-ou-NP2pl	3.83	0	0	0	0	-1	0
13	NP1pl-ou-NP2sg-Vpl	7.92	0	0	0	-1	0	0
14	NP1pl-ou-NP2sg-Vsg	2.39	0	0	0	0	-1	0
15	Vpl-NP1pl-ou-NP2sg	7.60	0	0	0	0	0	0
16	Vsg-NP1pl-ou-NP2sg	2.50	0	0	0	-1	-1	-1
17	Dpl-N1sg-ou-N2pl	6.96	-1	0	-1	0	0	0
18	Dsg-N1sg-ou-N2pl	6.43	0	-1	0	0	0	0

Gender agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
19	NP1f-ou-NP2m-Vf	4.44	0	0	0	-1	0	0
20	NP1f-ou-NP2m-Vm	8.00	0	0	0	0	0	0
21	NP1m-ou-NP2f-Vf	5.25	0	0	0	0	0	0
22	NP1m-ou-NP2f-Vm	7.81	0	0	0	-1	0	0
23	Vf-NP1f-ou-NP2m	5.34	0	0	0	0	0	0
24	Vm-NP1f-ou-NP2m	7.58	0	0	0	-1	0	-1
25	Vf-NP1m-ou-NP2f	3.79	0	0	0	-1	0	-1
26	Vm-NP1m-ou-NP2f	8.02	0	0	0	0	0	0

E.2.2.2 Results of cross-validation

	Condition	Mean	Prediction	MSE
1	Vsg-NP1sg-ou-NP2sg	7.12	7.64	0.27
2	Vpl-NP1sg-ou-NP2sg	6.35	7.29	0.89
3	NP1sg-ou-NP2sg-Vpl	7.01	7.34	0.11
4	NP1sg-ou-NP2sg-Vsg	7.09	7.65	0.31
5	N1sg-ou-N2sg-Asg	8.35	7.40	0.90
6	N1sg-ou-N2sg-Apl	8.37	7.32	1.10
7	Dpl-N1sg-ou-N2sg	6.98	7.43	0.21
8	Dsg-N1sg-ou-N2sg	7.80	7.51	0.08
9	NP1sg-ou-NP2pl-Vpl	8.40	7.39	1.01
10	NP1sg-ou-NP2pl-Vsg	2.32	3.28	0.91
11	Vpl-NP1sg-ou-NP2pl	7.58	6.82	0.58
12	Vsg-NP1sg-ou-NP2pl	3.83	2.88	0.90
13	NP1pl-ou-NP2sg-Vpl	7.92	7.00	0.84
14	NP1pl-ou-NP2sg-Vsg	2.39	3.63	1.54
15	Vpl-NP1pl-ou-NP2sg	7.60	7.55	0.00
16	Vsg-NP1pl-ou-NP2sg	2.50	2.81	0.10
17	Dpl-N1sg-ou-N2pl	6.96	7.44	0.23
18	Dsg-N1sg-ou-N2pl	6.43	7.56	1.28
19	NP1f-ou-NP2m-Vf	4.44	6.84	5.77
20	NP1f-ou-NP2m-Vm	8.00	6.22	3.18
21	NP1m-ou-NP2f-Vf	5.25	6.70	2.10
22	NP1m-ou-NP2f-Vm	7.81	5.59	4.95
23	Vf-NP1f-ou-NP2m	5.34	6.99	2.72
24	Vm-NP1f-ou-NP2m	7.58	4.50	9.51
25	Vf-NP1m-ou-NP2f	3.79	6.09	5.27
26	Vm-NP1m-ou-NP2f	8.02	6.13	3.59

E.2.3 Model III: implicit resolution ruled for or-coordination

E.2.3.1 Annotation of Constraints

Number agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
1	Vsg-NP1sg-ou-NP2sg	7.12	0	0	0	0	-1	0
2	Vpl-NP1sg-ou-NP2sg	6.35	0	0	0	-1	0	-1
3	NP1sg-ou-NP2sg-Vpl	7.01	0	0	0	-1	0	0
4	NP1sg-ou-NP2sg-Vsg	7.09	0	0	0	0	-1	0
5	N1sg-ou-N2sg-Asg	8.35	0	-1	0	0	0	0
6	N1sg-ou-N2sg-Apl	8.37	-1	0	0	0	0	0
7	Dpl-N1sg-ou-N2sg	6.98	-1	0	-1	0	0	0
8	Dsg-N1sg-ou-N2sg	7.80	0	-1	0	0	0	0
9	NP1sg-ou-NP2pl-Vpl	8.40	0	0	0	0	0	0
10	NP1sg-ou-NP2pl-Vsg	2.32	0	0	0	-1	-1	0
11	Vpl-NP1sg-ou-NP2pl	7.58	0	0	0	-1	0	-1
12	Vsg-NP1sg-ou-NP2pl	3.83	0	0	0	0	-1	0
13	NP1pl-ou-NP2sg-Vpl	7.92	0	0	0	-1	0	0
14	NP1pl-ou-NP2sg-Vsg	2.39	0	0	0	0	-1	0
15	Vpl-NP1pl-ou-NP2sg	7.60	0	0	0	0	0	0
16	Vsg-NP1pl-ou-NP2sg	2.50	0	0	0	-1	-1	-1
17	Dpl-N1sg-ou-N2pl	6.96	-1	0	-1	0	0	0
18	Dsg-N1sg-ou-N2pl	6.43	0	-1	0	0	0	0

Gender agreement

	Condition	mean	CCA [Att]	RA [Att]	EA [Att]	CCA [Pred]	RA [Pred]	EA [Pred]
19	NP1f-ou-NP2m-Vf	4.44	0	0	0	-1	-1	0
20	NP1f-ou-NP2m-Vm	8.00	0	0	0	0	0	0
21	NP1m-ou-NP2f-Vf	5.25	0	0	0	0	-1	0
22	NP1m-ou-NP2f-Vm	7.81	0	0	0	-1	0	0
23	Vf-NP1f-ou-NP2m	5.34	0	0	0	0	-1	0
24	Vm-NP1f-ou-NP2m	7.58	0	0	0	-1	0	-1
25	Vf-NP1m-ou-NP2f	3.79	0	0	0	-1	-1	-1
26	Vm-NP1m-ou-NP2f	8.02	0	0	0	0	0	0

E.2.3.2 Results of cross-validation

	Condition	Mean	Prediction	MSE
1	Vsg-NP1sg-ou-NP2sg	7.12	6.79	0.11
2	Vpl-NP1sg-ou-NP2sg	6.35	7.56	1.45
3	NP1sg-ou-NP2sg-Vpl	7.01	7.69	0.46
4	NP1sg-ou-NP2sg-Vsg	7.09	6.80	0.09
5	N1sg-ou-N2sg-Asg	8.35	7.41	0.87
6	N1sg-ou-N2sg-Apl	8.37	7.30	1.15
7	Dpl-N1sg-ou-N2sg	6.98	7.01	0.00
8	Dsg-N1sg-ou-N2sg	7.80	7.56	0.06
9	NP1sg-ou-NP2pl-Vpl	8.40	8.32	0.01
10	NP1sg-ou-NP2pl-Vsg	2.32	2.57	0.06
11	Vpl-NP1sg-ou-NP2pl	7.58	6.91	0.45
12	Vsg-NP1sg-ou-NP2pl	3.83	3.14	0.48
13	NP1pl-ou-NP2sg-Vpl	7.92	7.14	0.61
14	NP1pl-ou-NP2sg-Vsg	2.39	3.75	1.85
15	Vpl-NP1pl-ou-NP2sg	7.60	8.54	0.88
16	Vsg-NP1pl-ou-NP2sg	2.50	1.84	0.43
17	Dpl-N1sg-ou-N2pl	6.96	7.03	0.00
18	Dsg-N1sg-ou-N2pl	6.43	8.00	2.47
19	NP1f-ou-NP2m-Vf	4.44	4.75	0.10
20	NP1f-ou-NP2m-Vm	8.00	8.37	0.14
21	NP1m-ou-NP2f-Vf	5.25	4.99	0.07
22	NP1m-ou-NP2f-Vm	7.81	7.52	0.08
23	Vf-NP1f-ou-NP2m	5.34	4.93	0.16
24	Vm-NP1f-ou-NP2m	7.58	6.74	0.71
25	Vf-NP1m-ou-NP2f	3.79	4.67	0.77
26	Vm-NP1m-ou-NP2f	8.02	8.36	0.11