UNIVERSITÉ AIX-MARSEILLE I

Département de Sciences du Langage
Ecole doctorale Cognition,
Langage, Education

UNIVERSITY *of* EDINBURGH

Department of Psychology
School of Philosophy,
Psychology & Language
Sciences

Ph.D. / Doctorat

GRAMMATICAL GENDER PROCESSING IN FRENCH
AS A FIRST AND A SECOND LANGUAGE

(Le traitement du genre grammatical en français
Langue première et seconde)

Alice FOUCART

Supervisors / Directeurs de thèse :

Dr. Cheryl Frenck-Mestre, Directeur de Recherche, CNRS
Dr. Holly Branigan, Reader, University of Edinburgh
Dr. Ellen G. Bard, Reader, University of Edinburgh

Jury / Examiners

Dr. S. Kotz, Max Planck Institute for Human Cognitive and Brain Sciences
Prof. Maryellen MacDonald, University Wisconsin-Madison
Dr. F.-Xavier Alario, Chargé de Recherche, CNRS
Prof. Monique Vion, Université de Provence

DECLARATION

I declare that this thesis has been composed by myself and the research presented is my own. No portion of the work has been submitted for any other degree or professional qualification.

Alice Foucart

ABSTRACT

The present thesis investigates grammatical gender processing in French as a first and second language. It focuses mainly on whether non-native speakers can achieve native-like representation and processing of gender, and whether the native language (L1) influences the acquisition of the second language (L2).

Theoretical linguistic models have made two contrasting assumptions concerning the ability of late bilinguals to acquire grammatical gender in their L2. While some models propose that grammatical features, such as gender, are no longer available for L2 acquisition if they are not present in L1 (Hawkins & Chan, 1997), others assume that these features are still available via the universal grammar if required in the L2 (Schwartz & Sprouse, 1996; White, 1989, 2003). These assumptions, however, are supported only by off-line studies and do not provide a comprehensive account for gender representation and processing. The present thesis uses online techniques to address these questions both in language comprehension and language production.

The first chapters are devoted to comprehension processes and examined French native speakers, English-French and German-French bilinguals' performance during the processing of correct and syntactically anomalous sentences, using ERPs and eye-movements to record behaviour. We concluded that, like native speakers, English-French bilinguals are sensitive to gender agreement violations. Thus, we argue that late bilinguals are able to acquire the gender system of their L2 even if this grammatical feature is not present in their L1. On the other hand, the performance of the German speakers we tested suggests that the presence of a competing gender system in the native language may hamper gender acquisition in L2. The influence of the native language may vary, however, according to both proficiency and how gender systems map across languages, as suggest the results we obtained with Spanish bilinguals tested in language production.

In a second series of experiments, we examined determiner selection in French to further investigate gender representation and processing, but in language production. Using a picture-word interference paradigm, we compared the production of simple and complex noun phrases (NP) in French native speakers, English-French and Spanish-French bilinguals. From our results, we argue that

gender representation is similar in L1 and L2, but that gender processing is less incremental in non-native speakers in that they do not compute agreement between the noun and other elements of the NP as automatically as native speakers do. The absence of interference between the two gender systems of the Spanish-French bilinguals we tested suggests that the gender systems of the two languages may be autonomous in highly proficient bilinguals.

Our results suggest that highly proficient bilinguals can reach native-like representation and processing of gender in their L2 and that such is not constrained by either the age of onset of learning or the grammar of the learners L1

ABSTRACT (FRENCH)

La présente thèse est consacrée à l'étude du traitement du genre grammatical en français première et seconde langue. Le principal but est d'examiner la possibilité pour les locuteurs non natifs d'acquérir une représentation et un traitement du genre similaire à celui des locuteurs natifs, et d'évaluer l'influence de la langue maternelle (L1) sur la seconde langue (L2).

Certains modèles linguistiques ont proposé deux alternatives contrastées concernant la capacité des bilingues tardifs à acquérir le genre grammatical dans leur L2. Alors que certains modèles proposent que les traits grammaticaux, tel que le genre, ne sont plus disponibles pour l'acquisition d'une seconde langue s'ils ne sont pas présents dans la langue maternelle (Hawkins & Chan, 1997), d'autres supposent que ces traits sont toujours disponibles via la grammaire universelle s'ils sont nécessaires en L2 (Schwartz & Sprouse, 1996; White, 1989, 2003). Ces alternatives ne sont cependant soutenues que par des études off-line et ne fournissent pas d'explications complètes en ce qui concerne la représentation et le traitement du genre. La présente thèse utilise des techniques on-line afin d'adresser ces questions aussi bien en compréhension qu'en production de langage.

Les premiers chapitres sont consacrés aux processus impliqués dans la compréhension de langage. Ils comparent la performance des locuteurs natifs à celle des bilingues anglais-francais et allemand-francais lors du traitement de phrases syntaxiquement correctes et incorrectes, à l'aide des techniques de potentiels évoqués et de mouvements oculaires. Les expériences présentées dans ces chapitres ont révélé que, tout comme les locuteurs natifs, les anglophones sont sensibles aux violations d'accord en genre en français. Ainsi, nous avançons que les bilingues tardifs dont la langue maternelle ne possède pas le genre sont néanmoins capables d'acquérir un système de genre dans leur seconde langue. En revanche, la performance des germanophones testés lors des expériences suggère que la présence d'un système de genre en L1 peut perturber l'acquisition d'un tel système en L2. Cependant, il semble que l'influence de la langue maternelle peut varier en fonction de la compétence ainsi que de la proximité des systèmes dans les deux langues comme le suggèrent les résultats obtenus avec les hispanophones testés lors de la production de langage.

Dans une seconde série d'expériences concernant la production de langage, la sélection du déterminant en français a été examinée afin d'approfondir l'étude de la représentation et du traitement du genre. La production de groupes nominaux simples et complexes chez les français natifs et les bilingues anglais-francais et espagnol-francais a été comparée à l'aide du paradigme d'interférence image-mot. D'après les résultats, il semble que la représentation du genre est similaire en L1 et L2, mais le traitement est moins automatique chez les bilingues que chez les locuteurs natifs. L'absence d'interférence entre les deux systèmes de genre chez bilingues espagnol-francais que nous avons testés suggère que les systèmes des deux langues pourraient être autonomes chez les bilingues avancés.

Nos résultats semblent montrer que les bilingues avancés peuvent acquérir une représentation et un traitement du genre dans leur L2 similaires à celui des locuteurs natifs, et ce indépendamment de l'âge auquel l'apprentissage commence ou de la grammaire de la langue maternelle.

AKNOWLEDGEMENTS

I would like to thank my supervisors, Cheryl Frenck-Mestre, Holly Branigan and Ellen Bard, for all their advice and support. Holly is the living example that doing a thesis that deals with both language comprehension and language production is doable. She was always helpful and very encouraging. *Merci Beaucoup*! Cheryl is largely responsible for my interest in psycholinguistics; she was always available and has always been understanding whether my problem was scientifically related or not. So I would like to thank her not only as my supervisor, but also as a friend.

I would also like to thank Anna for being there whenever I needed some help with my work, but also for her precious friendship. *Gracias a* Mikel for his comments about the thesis and for entertaining me with his jokes. A big thank you to my officemates who have cheered me up with their encouragements and with chocolate and cookies!

Merci beaucoup a mes amis de France who, despite the distance have always been, and will always be close to me, and of course, to my friends in Scotland who, because they did not have the distance, had to cope with my complaining on a more regular basis! Thanks for being so patient and supportive during the 'non-existent-social life period' of writing up!

Finally, and more importantly, I would like to dedicate this thesis to my mother and my sister without whom it would not have been possible. Thanks for always being there for me.

TABLE OF CONTENTS

TABLES AND FIGURES

TABLES

FIGURES

INTRODUCTION

1 INTRODUCTION

The aim of the present thesis is to investigate grammatical gender processing in French as a first (L1) and second language (L2). The way native speakers represent and process gender in French is already a matter of debate, but it becomes even more complex when it concerns L2 speakers who start learning French late in life (i.e., after adolescence), especially when gender is not present in their native language (e.g., English). Learning an L2 involves the acquisition of both competence and performance in this language. For instance, learning gender in French involves acquiring both the knowledge of gender (i.e., gender assignment) and the way to process this knowledge within a syntactic structure (i.e., gender agreement). The term *process* can have more than one meaning; in the present thesis, we use a definition of this term which is concerned with morpho-syntactic analysis, and refers to the realisation of gender agreement between the noun and other elements related to it.

Psycholinguistic models have investigated gender representation and processing in L1 with various experimental paradigms such as picture-word interference, priming, tip-of the-tongue, and various methodologies such as event-related brain potential (ERPs) and eye-tracking. These models, however, still diverge on the question of how native speakers represent and process gender. In production, the

question of gender selection has particularly divided psycholinguists; some suggest that gender is automatically selected as soon as the lexical node is selected (Caramazza, 1997) while others claim that gender is selected only if required for syntactic structure construction (Levelt, Roelofs & Meyer, 1999). One consistent assumption made across production and comprehension studies is that gender is a syntactic process. Since L2 models are based on L1 models, such unresolved questions concerning gender representation and processing in monolinguals have to be addressed before conclusions can be drawn regarding similarities and differences in L1 and L2.

Linguistic models have investigated the ability of late bilinguals[1] to acquire gender in their L2 when it is not present in their native language. They agree that L2 speakers can assign gender to nouns, but they diverge on L2 speakers' ability to process gender within a syntactic structure. While some models assume that if features such as gender are not present in L1 they are no longer available when required for L2 acquisition (Hawkins & Chan, 1997), others claim that these features are still available via the universal grammar (UG) (Schwartz & Sprouse, 1996; White, 1989, 2003). As we will demonstrate (chapter 1), the assumptions made by linguistic models do not provide a proper account of the underlying processes involved in gender processing. Furthermore, these assumptions emerged from linguistic investigations of syntactic knowledge in L2 that mainly used off-line methods (see Hawkins, 2001, White, 2003, for a review) and often involved a small number of participants. Thus, linguistic models are useful as they provide descriptive approach of language, they, however, do not provide a complete view of gender representation and processing.

In psycholinguistics, the question of syntactic processing in L2 has been more often addressed in language comprehension studies (see Clahsen & Fesler, 2006, for a review) than in production studies that focused mainly on the lexical level (see Costa, 2005, for a review). In comprehension, ERP and eye-tracking studies have shown different results, some suggesting that processing of a particular language is

---

[1] Throughout the thesis, the term 'bilingual' will be used to refer to late L2 learners (unless specified otherwise). Hence, these two terms will be used in an interchangeable manner. When required, the level of proficiency will be specified.

similar in native and non-native speakers, others implying that native-like syntactic processing cannot be achieved in L2. Furthermore, syntactic processing seems to be more dependent on proficiency and age of acquisition than semantic processing.

At present, gender processing in L2 has not received much attention. Two ERP studies have compared gender processing in L1 and L2, but they have reached contrasting conclusions (Foucart & Frenck-Mestre, under revision; Sabourin, 2003). Sabourin suggested that L2 speakers can attain native-like performance regarding gender processing only if gender is present in their native language and if the gender systems are similar across languages. In contrast, Foucart and Frenck-Mestre found comparable patterns for native and non-native speakers even when the two gender systems were not similar (e.g., French and German). Thus, these two studies agree on the ability of L2 speakers to achieve native-like proficiency concerning gender processing, but they diverge on how much of an influence the native language has on L2. This question of how the L2 is affected by the L1 has been addressed in production with regard to autonomous and shared gender systems across languages (Costa, Kovacic, Franck & Caramazza, 2003). Costa et al. investigated whether the gender of the language in use was affected by the gender of the language not in use. Although their results suggested that the two gender systems are autonomous, they could not provide a comprehensive model to support their claim.

In the present thesis, we aim to shed light on the questions that are still unanswered in relation to gender representation and processing in L1 and L2. In this thesis, we address the question of whether gender is represented and processed in a similar manner in native and non-native speakers of French. To provide a wide picture, we examine this question both in language comprehension and in language production. We assume that the presence of a linguistic system in L1 facilitates the acquisition of an L2 either by sharing the already existing architecture or by building up a similar one. Previous studies have suggested that the native language has an influence on the acquisition of the L2. The presence of common features and syntactic structures across languages may have an influence on their representation and processing in L2.

We examine this assumption by comparing the performance of French native speakers with that of bilinguals whose L1 either possesses grammatical gender (i.e., German-French[2] and Spanish-French speakers) or does not (i.e., English-French speakers). We use experimental psychological methods such as ERPs and eye-tracking in comprehension and picture-word interference paradigm in production to investigate the underlying processes involved in gender processing that theoretical linguistic models have failed to account for. The present thesis provides essential evidence for monolingual models and examines whether these models are suitable for L2 production and comprehension.

2   OVERVIEW OF THE THESIS

To investigate how gender is represented and processed in L1 and L2, we first present some linguistic background. Chapter 1 provides a brief introduction of gender based on Corbett's comprehensive analysis of gender systems (1991), with a description of gender agreement and assignment systems. We then focus on gender acquisition in L2 and examine two linguistic models in more detail, showing how such linguistic models have never engaged in the processes involved in gender production and comprehension. This leads to the research questions addressed in the present thesis and a discussion of how we intend to answer them with experiments based on psycholinguistic models and studies.

Chapters 2 and 3 focus on comprehension of language. Chapter 2 introduces the ERP and eye-tracking methodologies used in the experiments reported in Chapter 3. The debate related to the significance of ERP components is presented. The literature regarding gender processing in L1 and L2 is reviewed, and conclusions on the information available at present in relation to L2 processing are given. We particularly focus on a three-phase model proposed by Friederici (2002) which claims to represent universal syntactic processing mechanisms. In Chapter 3, we report three experiments examining whether gender processing is similar in native and non-native speakers, and whether it is influenced by the L2 speaker's native language. In two ERP and one eye-tracking experiment(s), French native speakers,

---

[2] In line with L2 literature, we adopt the convention that the first cited language refers to the L1 and the second language to the L2. For example, a German-French speaker is a speaker whose native language is German and second language French.

English-French and German-French learners read sentences containing gender agreement violations between the noun and the post-posed adjective (Experiment 1), the pre-posed adjective and the noun, and the noun and the predicative adjective (Experiment 2 and 3). Our results challenge the assumptions made in Friederici's model and thus suggest that if the model does not account for monolinguals' syntactic processing, it cannot be extended to bilinguals.

Chapter 4 and 5 are centred on production of language. In Chapter 4, gender is presented through its representation in L1 and L2 production models. First, models of monolingual production and studies that investigated the representation of grammatical gender in production are reviewed. Then models of bilingual production are described as well as studies supporting their assumptions. Finally, we focus on the representation of grammatical gender in bilingual production. This chapter highlights the lack of research regarding gender representation and processing in L2, which we attempt to fill with the experiments presented in chapter 5. Chapter 5 reports seven picture-word interference experiments examining determiner selection in French L1 and L2. In this paradigm, picture-word pairs are either congruent or incongruent in gender. We first conducted a series of experiments (Experiments 4, 5, 6, and 7) with French native speakers in which they had to produce simple (e.g., determiner + noun) and complex (determiner + adjective + noun and determiner + noun + adjective) NPs. We then examined the performance of English-French and Spanish-French bilinguals with the same task and the same materials (Experiments 8, 9, and 10) to compare the selection of determiners in French in native and non-native speakers. The examination of determiner selection gives us the opportunity to further investigate the main questions addressed in the present thesis in relation to the similarities in gender representation and processing in L1 and L2, and the influence of the native language on L2 processing.

Finally, Chapter 6 provides a summary of the findings and the conclusions drawn regarding the representation and processing of gender in L2. These conclusions are discussed in a psycholinguistic framework, but also contrasted with the assumptions made by the linguistic models presented in chapter 1.

CHAPTER 1

THE LINGUISTICS OF GENDER

This chapter provides a brief introduction to *gender* largely based on Corbett's comprehensive analysis of gender systems (1991), and presents the research questions addressed in the present thesis. First, we give a definition of gender and briefly describe its agreement and assignment systems. Then, we move on to the acquisition of gender in L2 with a special focus on two models. These models propose two opposed theories on the question of gender acquisition in L2. We will, however, point out some issues that challenge the relevance of these linguistic models to psychological models of gender representation and processing in L1 and L2. This leads to pertinent questions in relation to gender in L1 and L2 that will be investigated in the following chapters using an approach based on psycholinguistic models and experiments.

1   THE LINGUISTICS OF GENDER

1.1   What is gender?

Gender is a categorisation of nouns. Its origin is unclear; it seems, however, that in European languages gender systems initially included three classes: masculine, feminine and neuter. These classes are still present in some languages such as German or Russian, though in other languages such as French and Italian, they were reduced to two (masculine and feminine); and in languages such as English, they are unmarked in lexical nouns (but still marked in pronouns). Despite overlapping origins of Indo-European languages and the common etymology of many words, gender can be different across languages. For example, 'the key' is feminine in French (*la clef*) but is masculine in German (*der Schlüssel*).

There are two types of genders, 'natural gender' and 'grammatical gender'. Natural or semantic gender straightforwardly reflects the semantics of the noun, the things in the world that it is used to represent. Natural gender is in a sense imposed by those characteristics (e.g., male/female, animate/inanimate, human/non-human). Natural gender exists in all languages, in contrast to grammatical gender which is only present in some. Grammatical gender is a classification system for nouns themselves. Corbett defines it as follows:

> To understand what linguists mean by 'gender' a good starting point is Hockett's definition: 'Genders are classes of nouns reflected in the behavior of associated words' (1958: 231). A language may have two or more such classes or genders. The classification frequently corresponds to a real-word distinction of sex, at least in part, but often too it does not ('gender' derives etymologically from Latin *genus*, via Old French *gendre*, and originally meant 'kind' or 'sort'). The word 'gender' is not used for just a group of nouns but also for the whole category; thus we may say that a particular language has, say, three genders, masculine, feminine and neuter, and that the language has the category of gender. Corbett (1991, p.1)

Although every noun in a gender language has its own gender, gender can be marked or unmarked on the noun itself, either straightforwardly (as in Russian surnames, where *Ryazanova* is *Ryazanov*'s sister) or probabilistically (as in French, where nouns ending in *–ion* are mainly feminine, for example). In highly inflectional languages, gender, number and case are marked on the noun's inflectional affixes (e.g. Greek, Serbo-Croatian). Greek, in fact, has natural and morphological gender with stem, affixes, and modifiers providing clues of varying strength to the category of the noun. Thus, for nouns representing animates, gender is usually associated with the sex of the entity. Masculine nouns mainly end in *-ος, -ας* and *–ης* (e.g., *πατέρας*, 'father'), and feminine nouns in *–α* and *–η* (e.g., *μητέρα*, 'mother'). Because some affixes are common across gender, however, (e.g., *καρέκλα* fem, 'chair'; *πάπλωμα*neu, 'mattress'), unambiguous gender marking will often depend on, principally, determiners (articles and deictics), adjectives, and pronouns. The syntactic behaviour of these associated words is called 'agreement'. Inflectional affixes, like forms of the words which agree with nouns, indicate not only the gender (1a), but also the number (1b) and case (1c) of the noun. There are three inflectional classes of masculine and neuter nouns, and two classes of feminine nouns. Only one example of each is presented here, and only in the most common cases.

(1a) ο βράχ**ος** masc ('vraxos'; 'rock')

η καρέκλ**α** fem ('karekla'; 'chair')

το σύννεφ**ο** neu ('sinefo'; 'cloud')

(1b) οι βράχ**οι** masc ('vraxi')

οι καρέκλ**ες** fem ('karekles)

τα σύννεφ**α** neu ('sinefa')

(1c)   ('vraxos'; rock)

Nom.	ο	βράχ-ος
Gen.	του	βράχ-ου
Acc.	τον	βράχ-ο

The example of the Greek gender system shows that gender can be straightforwardly marked on the noun in some languages, in contrast to other

languages such as French, in which gender is not marked on affixes at all but is indicated only by the form of the words associated with the noun. For example, in French, while certain stems are often associated with a gender (*-ette* with feminine, for example) we are largely dependent on agreement to know that the noun *table* ('table') is feminine. In view of this kind of gender marking, gender is considered to be responsible for the syntactic cohesion between words within a phrase. This cohesion is marked morphologically via the form of adjective or determiner. In fact, one might even consider the determiner to be an obligatory gender-marking prefix on the noun: as in the examples in (2)

> (2a) *un$_{masc}$ livre$_{masc}$ vert$_{masc}$* 'a green book'
>
> *le$_{masc}$ livre$_{masc}$ vert$_{masc}$* 'the green book'
>
> **livre$_{masc}$ vert$_{masc}$* 'green book'
>
> (2a) *une$_{fem}$ table$_{fem}$ verte$_{fem}$,* 'a green table'
>
> *la$_{fem}$ table$_{fem}$ verte$_{fem}$,* 'the green table'
>
> **table$_{fem}$ verte$_{fem}$,* 'green table'

So gender can be considered as a syntactic phenomenon that has morphological representations. Gender agreement follows language-specific rules that are clearly defined and thus can easily be learned. In contrast, learning the gender of the noun itself is a more complicated task. In the next section the gender agreement systems of the languages of interest in the present thesis are presented (i.e., French, German and Spanish, as there is no determiner/adjective agreement system in English). The cross-linguistic differences relevant for our study will be pointed out. Once the agreement rules have been described, we will then move on to the more complex question of gender assignment.

1.2   Gender agreement system

By definition, gender agreement systems operate in languages that have a formal gender system. Agreement is the term used to describe the relationship between two elements, whereby the form of one element determines the form of another element. For instance, German, Spanish and French nouns assign gender to determiners,

adjectives and participles which modify them and to pronouns which co-refer with them. The gender agreement system follows rules which are language specific (Table 1).

Table 1

Presentation of determiner agreement systems in German, Spanish and French

	Singular		Plural	
	Def. art.	**Ind. art.**	**Def. art.**	**Ind. art.**
German				
Masculine	der Tisch ('table')	ein Tisch	die Tische	ø Tische
Feminine	die Tür ('door')	eine Tür	die Türen	ø Türen
Neuter	das Auto ('car')	ein Auto	die Autos	ø Autos
Spanish				
Masculine	el coche ('car')	un coche	los coches	unos coches
Feminine	la silla ('chair')	una silla	las sillas	unas sillas
French				
Masculine	le ballon ('ball')	un ballon	les ballons	des ballons
Feminine	la fleur ('flower')	une fleur	les fleurs	des fleurs

Note. Abbreviations: definite article (Def. art.), indefinite article (Ind. art.)

In French, German and Spanish, the noun is almost always associated with a determiner. In contrast, adjectives are not compulsory on grammatical grounds; their role is to specify the attributes of entities denoted by nouns, thus, they can be called 'specifiers'. In languages that possess a grammatical gender system, adjectives agree in gender with the noun they specify. They can have various positions in the sentence. Within the noun phrase (NP), adjectives can be pre-nominal and/or post-nominal. In Germanic languages, adjectives are only pre-nominal (with a few exceptions, e.g., 'the president elect'; 'a land rich in history'), whereas in Romance languages, they can be both pre- and post-nominal. This cross-linguistic difference can be explained by the way agreement is realised within the NP (see below). These differences will be of importance for the experiments reported in the following chapters. In these experiments, we will examine whether L2 learners process gender

in a similar way depending on whether the syntactic structure exists in their L1 or does not (e.g., noun + adjective NPs).

Like determiner systems, the agreement systems for adjectives reveal cross-linguistic differences. Romance languages share many rules with each other but only partial overlap with Germanic languages (Table 2). For instance, in French and Spanish, agreement between the adjective and the noun does not depend on word order, though it may not be marked on some 'invariable'. Thus, all adjectives, inside (pre- and post-nominal) and outside (post-verbal, predicative) the NP agree in gender with the noun. In contrast, in German, agreement is determined by order: the pre-posed adjective agrees with the noun, whereas the predicative adjective is invariable.

Table 2

Presentation of agreement systems for pre-posed, post-posed, and predicative adjectives in German (nominative case), Spanish and French.

	Pre-posed adjectives	
	Singular	**Plural**
German		
Masculine	der kleine Tisch ('the small table')	die kleinen Tische
Feminine	die kleine Tür ('the small door')	die kleinen Türen
Neuter	das kleine Auto ('the small car')	die kleinen Autos
Spanish		
Masculine	el pequeño coche	los pequeños coches
Feminine	la pequeña silla	las pequeñas sillas
French		
Masculine	le petit ballon ('the small ball')	les petits ballons
Feminine	la petite fleur ('the small flower')	les petites fleurs

	Post-posed adjectives	
	Singular	**Plural**
German	ø	ø
Spanish		
Masculine	el coche pequeño ('the small car')	los coches pequeños
Feminine	la silla pequeña ('the small chair')	las sillas pequeñas
French		
Masculine	le ballon vert ('the green ball')	les ballons verts
Feminine	la fleur verte ('the green flower')	les fleurs vertes

	Predicative adjectives	
	Singular	**Plural**
German		
Masculine	der Tisch ist klein	die Tische sind klein
Feminine	die Tür ist klein	die Türen sind klein
neuter	das Auto ist klein	die Autos sind klein
Spanish		
Masculine	el coche es pequeño	los coches son pequeños
Feminine	la silla es pequeña	las sillas pequeñas
French		
Masculine	le ballon est vert/petit	les ballons sont verts
Feminine	la fleur est verte/petite	les fleurs sont vertes

In sum, even if they present cross-linguistic differences, gender agreement systems all obey very strict rules. But how exactly is gender agreement realised?

One linguistic theory regarding gender agreement was first proposed by Chomsky (1995) and later developed by Carstens (2000). Here, we adopt this theory for exposition and better understanding of the linguistic models presented later in the chapter, this alternative is, however, not fundamental for the conclusions developed in the thesis. Gender is claimed to be an inherent feature of nouns (Carroll, 1989; Carstens, 2000). For instance, in French, the lexical entry of each noun must contain a feature specifying whether the noun is masculine [+ masc] or feminine [-masc]. According to this theory, agreement is due to a feature checking mechanism between the feature of the noun and other corresponding features in the structure of the NP. In other words, gender is an *interpretable* feature found in the noun: it conveys information required for semantic interpretation. In contrast, determiners and adjectives have *uninterpretable* gender features. These uninterpretable features are deleted by the checking mechanism that matches noun features (e.g., [+masc]) with the corresponding features of the determiner (head/head) and/or adjective (specifier/head).

Once a noun is selected from the lexicon, it enters into a relationship with other categories, which are number (Num) and determiner (Det), in order to create the syntactic structure of the NP. In Romance languages, it is proposed that the noun raises overtly higher than the adjective, from N to Num (due to the strong features in Num), which gives the noun-adjective order (see 3), in contrast to the adjective-noun order in Germanic languages (due to weak features). Further information on this question can be found in Bernstein (1991), Cinque (1994), Longobardi (1994), Bosque and Picallo (1996), Carstens (2000) and Laenzlinger (2005).

(3)
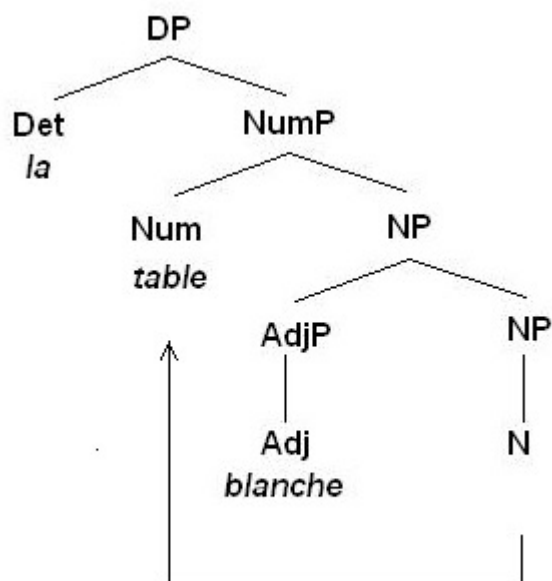
This theory is a good description of the facts of gender agreement phenomenon in the language. But what happens when language is used? How is gender processed when people speak, read, or listen? Psycholinguistic studies have investigated gender processing in language comprehension and production, and psychological models have been proposed to account for gender representation and processing. We will review some of these studies and models at relevant places in the following chapters.

1.3   Gender assignment

While gender agreement systems rely on rules that can be learned, gender assignment appears to be much more complex. Is it totally arbitrary or are there rules? Linguists have attempted to provide some answers which also prove to be of interest for psycholinguistics as they can have implications for how lexical access is achieved as well as for the organisation of the lemma level.

Once linguists claimed that there was 'no practical criterion by which the gender of a noun in German, French or Latin could be determined' (Bloomfield, 1933:280, cited in Corbett, 1991), it followed that there was no linguistically based system for

learning noun gender. However, speakers can assign gender to nouns they have never come across before, foreign (loan) words, and even non-words (Corbett, 1991). Thus, it seems that some system must be used to assign gender.

Corbett has concluded that 'assignment is essentially systematic in all languages' (Corbett, 1991, p. 1350). As opposed to natural gender which is assigned by a 'semantic system', grammatical gender requires a 'formal system' which uses the form of the words. As we have seen, languages like French can make some use of the morphophonology of the noun, while others, such as Russian, can exploit a complex set of inflectional affixes to distinguish genders. However, even if the assignment system of a language requires a main feature (e.g. phonology in French), other properties of the noun are not totally ignored/irrelevant (e.g. morphology, semantics).

In this respect, the systems of the languages we will deal with in the present thesis differ in kind. English uses natural gender almost exclusively, marking it on personal (*he/she*), reflexive (*himself/herself*) and possessive (*his/her*) pronouns for animates. With very few exceptions (like *she* for *ship*), inanimates are obligatorily neuter. Animate non-humans and groups of humans may also be treated as neuter.

In contrast, German still has three genders: masculine, feminine and neuter, which mark case (nominative, accusative, dative and genitive) distinctively. German uses the morphological system to mark gender, either through the morphology of the base or through the marking of determiners. Sometimes, a noun that would be assigned a natural gender semantically will be of a different gender for morphological reasons. For example, *Mann* ('man') is masculine, but *Männchen* ('small man') is neuter (Mills, 1986). The diminutive suffix *–chen* imposes the neuter gender on the noun. In the same way, suffixes like *ung*, *-heit*, *-erei*, *-schaft* and *–keit* tend to mark words as feminine (for a detailed study see Köpcke & Zubin, 1984).

Spanish and French use only masculine and feminine as grammatical genders. Although the gender systems of these languages are often discussed as if they were arbitrary (Corbett, 1991) gender has morphophonological associations, which create a certain consistency in relation to gender marking. The final syllable or syllables of the word appear to be relevant for 78% of the most frequent words in Spanish, and

85% of the most common words in French (Mel'cuk, 1958; Tucker, Lambert & Rigault, 1977). Whether or not these regularities are used to predict noun gender and/or to accelerate lexical processing is, however, debated. Some studies suggest that endings are used by young children to assign gender to nouns until the development of grammatical agreement within the NP (Karmiloff-Smith, 1979), whereas others have suggested that endings are used even by older speakers (Holmes & Dejean de la Batie, 1999; Holmes & Segui, 2004).

According to Corbett's (1991) theory, all gender systems are based on semantics and the only difference between languages depends on their use of morphophonological cues. In a recent study, Mirković, MacDonald and Seidenberg (2005) investigated whether the combination of semantic and morphophonological properties would increase the probability of correctly predicting gender. They first analysed a corpus to collect information on the Serbian gender system, which was then supplied to a computational model developed by Mirković, Seidenberg and Joanisse (2004) to test the ability of connectionist networks to learn a complex gender system. While morphophonological cues proved highly reliable, additional semantic cues (e.g., animacy) seemed to speed up learning. This is in line with Corbett's theory that claims that grammatical gender can be learned and represented from morphophonological and semantic regularities.

The use of these morphophonological features was one of the ways to investigate how gender is acquired in L1 children. Results were contrasted to gender acquisition in L2. The similarities and differences are reported in the following section.

2   GENDER ACQUISITION IN L1 AND L2

Studies in various languages have reached the same conclusions in relation to gender acquisition in L1. At an early stage, children tend to use morphophonological cues to assign gender, but this phenomenon gradually moves towards a stage where they use syntactic cues, however, without completely suppressing the former (Karmiloff-Smith, 1979; MacWhinney, 1978; Perez-Pereira, 1991). The proposed explanation is

that syntactic features are not developed in early grammar, and it is only when these features are eventually activated that children become sensitive to syntactic cues. Carroll (1989) claimed that determiners are first considered by French children as prefixes which do not have their own morphosyntactic representation, and which are phonologically represented as arbitrary segments of the noun they agree with. During this stage, children would rely on semantic and morphophonological cues to assign gender, and it is only later in development that children consider determiners as independent units. This new status of determiners is claimed to trigger the universal features of gender, which initiate the step from morphophonological/semantic to a syntactically based system, where determiners are used to categorise nouns as masculine or feminine.

Studies in L1 have also revealed other common aspects to gender assignment across languages. First, children tend to overuse one gender more than the other. For example, in French, as in most languages, the default gender is masculine (Hulk & Tellier, 1999). Second, gender agreement between the definite article and the noun is acquired before the agreement between the indefinite article and the noun. Finally, agreement between the article and the noun is mastered before agreement between the adjective and the noun (Dewaele & Veronique, 2000; Koehn, 1994; Müller, 1990).

While (typically developing) children easily acquire and always master grammatical gender in their L1, it seems that it is not as an easy task for L2 adult learners. Although some studies have revealed similarities between L1 and L2 gender acquisition, there is evidence that gender is not represented in the same way in L1 and L2.

Some observable facts are similar in L1 development and in L2 acquisition. For example, it seems that the agreement between the definite article and the noun is acquired and mastered before the agreement between the indefinite article and the noun (Bartning, 2000; Hawkins, 1998; Sabourin, 2003). Also, like L1 learners at a certain stage, L2 learners tend to overuse a default gender (not necessarily the same for each speaker within the same language). And finally, as in L1 development,

agreement between the article and the noun seems to be more accurate and more rapidly acquired than agreement between the adjective and the noun (Bartning, 2000; Bruhn de Garavito & White, 2002; Dewaele & Veronique, 2001).

Despite these similarities, some studies have shown that gender is represented differently in L1 and L2. Non-native learners do not seem to rely on regularities of gender marking in the L2. While L1 children rely on morphophonological cues to assign gender to nouns, L2 learners do not show a difference between the acquisition of the gender system of a language with a transparent gender system (i.e., gender is reflected by the affixe of the noun, such as masculine –o versus feminine –a, in Spanish and Italian; Andersen, 1984; Bruhn de Garavito & White, 2002; Franceschina, 2001; Oliphant, 1998), or that of a language with an opaque system (i.e., the affix of the noun does not necessarily indicate the gender of the noun, such as in French and Dutch; Guillelmon & Grosjean, 2001, and Sabourin, Stowe, & de Haan, 2006).

In the next section, we will focus on two (theoretical linguistic) SLA models that used linguistic theory to make contrasting assumptions in relation to the capacity of late L2 learners for acquiring features such as gender. We will also review studies that support their assumptions. In a final part, we will, however, point out some problems that prevent these models from offering a usable account of gender representation and processing in L2.

3   FFFH vs. FTFA MODELS

Linguists have been divided on the question of the position of universal grammar (UG) in second language acquisition, and more precisely on the question of UG parameter resetting (see White, 1989, 2003, for a review). According to the *no parameter resetting* hypothesis, L2 learners have access to UG only through their L1. Thus, only L1 parameters are available, and as they cannot be reset, learners are unable to acquire new parameters in their L2 (Clashen & Muysken, 1989). This hypothesis differs from the *full-access* theories, which claim that parameters can be reset for L2 acquisition (Schwartz & Sprouse, 1996; White, 1989, 2003).

Grammatical gender is one of the features involving parametric variations across grammars of different languages.

Another issue in SLA research is the influence of the L1 on the L2, which is referred to as language 'transfer', and is defined as follows:

> The influence of the Native Language of the language learner on his/her performance in the second language. Positive Transfer, which consists in characteristics of the two languages that are similar, is claimed to facilitate performance in the second language whereas Negative Transfer, respects in which the two languages differ, is claimed to interfere with performance. (Ritchie & Bhatia, 1996, p. 704).

For example, when Spanish native speakers learn French, since the gender systems are very similar across these two languages, a positive transfer can facilitate the acquisition of the gender system of the L2. On the other hand, when German native speakers learn French, since their gender system does not map the French system as directly as the Spanish system does; it is possible that a negative transfer hampers the acquisition of the gender system of their L2. In other words, there may be lexical interference for the assignment of gender to nouns that do not share the same gender across languages, and German speakers may also apply the agreement rule of their L1 system in their L2. So does L1 affect L2 in relation to gender representation and processing? The two models described below diverge on this question.

3.1   Failed functional features hypothesis

In line with the no parameter resetting hypothesis, the failed functional features hypothesis (FFFH) suggests that after a critical period (roughly adolescence), learners are no longer able to acquire abstract grammatical features not available in their L1 (Hawkins & Chan, 1997). Features which are not present in the native language cannot be represented by the interlanguage grammar. Thus, if L1 and L2 parameters differ, L2 learners will never be able to achieve native-like mental representation of abstract features.

As mentioned earlier, grammatical gender, as a feature not present in all languages, is parameterised. As an agreement feature of the noun, gender is said to be interpretable, while uninterpretable features are only in an agreement checking relation with the noun (e.g., determiners, adjectives).

According to the FFFH, new interpretable features can be acquired in L2, whereas new uninterpretable features cannot be. Thus FFFH predicts that agreement checking should not be possible for learners whose native language does not possess these features (Hawkins, 1998; Hawkins & Franceschina, 2004). In consequence, if grammatical gender is not available in L1, then the gender of isolated nouns can be acquired, but gender agreement checking cannot. In essence, L2 learners can assign gender to nouns off-line, but are not able to process it on-line. This analysis accords generally with Carroll's *precursor theory*, which proposes that features which are not triggered in L1 degenerate and thus are no longer available when required in L2 (Carroll, 1989). However, her theory slightly differs from the FFFH claim in the sense that for Carroll, it is the interpretable features of the noun that cannot be acquired; in other words, the absence of gender in L1 hampers the representation of the gender feature in L2.

3.1.1 Studies supporting the FFFH

Hawkins (1998) analysed the production data of highly proficient English learners of French (Hawkins, 1998, cited in Hawkins & Franceschina, 2004). Participants were asked to describe an animated film, resulting in a 3-minute transcript. Individual transcripts were then analysed to evaluate the use of *le/la* and *un/une* determiners. Overall, more errors were made on indefinite articles (71/366, 19%) than on definite articles (39/433, 9%). A default gender was sometimes adopted but differed individually, *le* being over-generalised by some speakers, and *la* by others. Furthermore, the default gender used by a speaker was not necessarily consistent across determiners; in other words, the same speaker could over-generalise the masculine form of the definite article and the feminine form of the indefinite article, or vice-versa. This implies that English learners establish separate entries for *le*, *un*, *la*, *une*, in contrast to native speakers who establish an uninterpretable feature on the determiner corresponding to the interpretable feature of the noun [+masc] for *le/un*

determiners and [-masc] for *la/une* determiners. The author concluded that when uninterpretable features are absent from the native language (e.g., English), late L2 learners will always rely on the ending of the noun to select determiner forms much as L1 children do, but they will never trigger grammatical agreement between determiner and noun as native speakers do as they grow older. Their failure is attributed to the unavailability of uninterpretable features (here on the determiner) not required in their own L1. Thus, as proposed by FFFH, if the determiner does not have an uninterpretable feature, checking with the interpretable feature of the noun cannot be realised.

Franceschina (2001) obtained similar results observing recordings of spontaneous conversation between a researcher and an English native speaker highly proficient in L2 Spanish. The participant, Martin, had spent 24 years in immersion, 19 of them uninterrupted. Results showed that gender errors on articles (8.3%) and adjectives (7%) were more frequent than number errors for the same categories (0.5% and 2%, respectively). Most gender errors were due to an over-generalisation of the masculine article. In line with the FFFH model, the author concluded that the participant could correctly assign gender on nouns, but failed to realise agreement (checking) with determiners and adjectives because of the absence of uninterpretable features on these L2 categories.

Hawkins and Franceschina (2004) tested the hypothesis that if uninterpretable features are present in L1, late learners should be able to establish uninterpretable features on determiners in their L2 like native speakers. They analysed the spontaneous speech of 3 English (i.e., language without gender) and 3 Italian (i.e., language with gender) native speakers, all highly proficient learners of L2 Spanish. Italian speakers did not produce any gender mistakes out of 95 NPs, and English speakers only made 10 mistakes out of 119 NPs (i.e., 8%). The authors considered the low rate of errors as a difference in the underlying grammatical representation of agreement within the NP between English speakers, and Italian and native Spanish speakers. They assumed that English speakers rely on endings to assign gender to nouns, but that with enough exposure, they are able to learn the exceptions (e.g., *la mano*, 'the hand', feminine noun ending in 'o'). However, Hawkins and Franceschina accounted for the low error rate produced by English speakers by

claiming that they may still over-generalise some phonological patterns even when their long immersion should make them native-like.

These studies are consistent with the assumption made by the FFFH model that if uninterpretable features are not present in L1, they cannot be acquired later in life when required in L2. If uninterpretatble features are not established in L2, checking with the interpretable feature of the noun cannot be realised. Thus, according to the FFFH model, L2 learners whose L1 does not possess gender will never be able to master gender agreement in their L2. This contrasts with the assumptions of the FTFA model presented in the following section.

3.2   Full transfer full access

The FFFH and the full transfer full access (FTFA) models have a common assumption which is that, initially, the representation of grammatical features in the interlanguage will be based on features available in L1. However, FTFA (Schwartz & Sprouse, 1996; White 1989) claims that new features required by L2 *can* be acquired, regardless of the age of acquisition. In other words, L2 learners still have access to the full set of abstract features initially provided by UG. In sum, new parameters can be added to L1 parameters in interlanguage grammars, and thus, in principle, learners are able to acquire native-like mental representation of L2 abstract features. Hence, if uninterpretable features can be acquired, the feature-checking can be realised and agreement completed.

3.2.1 Studies supporting the FTFA model

In reply to Hawkins (1998), Bruhn de Garavito and White (2002) examined whether L2 learners whose L1 does possess gender acquire gender more easily in their L2. They had French learners of Spanish describe cards to the experimenter in order to produce naturalistic communication. One group of participants (Group1) had had one year of Spanish teaching in a classroom environment, and the other group (Group2) had had 2 years. Results revealed no differences in relation to word order; that is to say that adjectives were correctly positioned (mostly post-posed adjectives). This is not surprising since adjectives are mostly post-nominal in both French and Spanish. It implies that noun raising is correctly realised due to strong features in these

languages (L1 or L2). Regarding gender agreement, accuracy was higher for definite articles (Group1: 14.5%; Group2: 8%) than for indefinite articles (Group1: 23%; Group2: 15%). This difference of accuracy across determiners is similar to that found in Hawkins (1998) for English learners of French. The authors also stressed a decrease in the number of errors as proficiency increases. They also noted an overall tendency to over-generalise masculine determiners. However, some speakers over-generalised masculine, others feminine, and others did not prefer either. Furthermore, this generalisation seems to disappear with proficiency since it did not occur for Group2 with definite articles. In the same vein, more gender agreement errors were made on adjectives (Group1: 31%; Group2: 29%) than on determiners (Group1: 18.5%; Group2: 11%), and masculine adjectives were more often used with feminine nouns (Group1: 78%; Group2: 63.5%) than feminine adjectives with masculine nouns (Group1: 4%; Group2: 4%). Comparing their results to those obtained by Hawkins (1998) with English learners of French the authors found similar performance regardless of the presence or absence of gender in L1.

To investigate these similarities further, another study was conducted comparing late L2 learners whose L1 either possessed grammatical gender or did not (White, Valenzuela, Martyna, Kozlowska-MacGreogor, & Leung, 2004). White et al. (2004) challenged the claim made by the FFFH that uninterpretable features cannot be acquired in L2 if they are not present in L1. They examined French and English late learners of Spanish with low, intermediate or advanced proficiency. Participants were asked to complete two production tasks, a vocabulary test and a picture identification task. In the first production task the experimenter had a card with a character and participants had to ask questions to guess who the character was (an adaptation of the game 'Guess Who'). The second task involved the descriptions of pictures. In the picture identification task, participants had to read a story that contained number target and gender target sentences. The object depicted in the sentence was not clearly mentioned, and was only implied by the determiner and the adjective (e.g., *Ponlas ahi cerca de la roja*, 'put them over by the red [one]'). Then, three pictures were presented and participants had to pick the one corresponding to the object referred to in the sentence. Production data showed a very low error rate regarding word order. Thus, even English speakers were able to produce adjectives

in the post-nominal position. This result implies that L2 learners can reset the value of Num feature from weak to strong in their L2. Results were similar for number agreement in determiners and adjectives (>99%). For gender, accuracy was higher for determiners (English: 88%, 92%, 97%; French: 83%, 95%, 99%, for low, intermediate and advanced proficiency, respectively) than for adjectives (English: 76%, 91%, 98%; French: 71%, 90%, 98, for low, intermediate and advanced proficiency, respectively). In comprehension, number accuracy was very high as well. Low proficiency learners had more difficulty with gender (English: 56%; French: 66%) than with number (English: 83%; French: 78%) regardless of their L1, while advanced learners did not show any problem with either gender (English: 94%; French: 96%) or number agreement (English: 99%, French: 96%). The authors concluded that, in contrast to the FFFH assumption, late L2 learners are able to acquire uninterpretable features in their L2 even if they are not present in their L1. This is in line with the FTFA model that proposes that at some point in L2 acquisition, interpretable and uninterpretable features available via the interlanguage grammar become available for L2 even if they are not required in L1. Once these features are available checking can be realised and agreement between determiner and noun is achieved in a near-native way.

3.3. Issues and Research questions

3.3.1 Issues

Even if they diverge on their conclusions, the common aim of the two linguistic models we described in the previous section was to provide an account of gender acquisition in L2. They both proposed a theory and conducted studies to support their assumptions. These approaches, however, present some problems. The main criticism that can be made about linguistic models is that they provide only a simplified version of the processes involved in gender processing. When investigating gender acquisition in L2, these models focus only on knowledge but they do not engage with processing issues. Linguistic models are a good description of the language itself, but they are insufficient when it comes to the question of how language is processed during language use.

Another criticism that can be addressed to linguistic models concerns the methods of the experiments that support them. A few examples can be taken from the studies we reported in relation to the task, the number of participants, and the analyses. First, all these experiments are based on the analysis of spontaneous production data. This type of task does not allow any control from the experimenter (e.g., frequency of nouns, length, gender, etc.). Second, Franceschina (2001) drew conclusions concerning gender acquisition in L2 based on a single case study, and Hawkins and Franceschina (2004) only had 3 participants in each group. Many factors can influence a speaker's performance, therefore the performance of one single individual cannot be considered as representative of a population of L2 learners. A large sample of the population is necessary to draw robust conclusions. Third, some studies did not involve statistical analyses and were based on numerical results. For example, Hawkins and Franceschina (2004) compared error rates. Within a group, one participant who produced numerically more mistakes than the others can bias results. Also the Italian and English groups were not directly statistically compared. Another criticism specific to this study is that the authors acknowledged a comment made by a reviewer who pointed out that, according to the literature, when L2 speakers produce less than 10% errors, this is considered as a native-like performance, but they did not take this comment into consideration in the interpretation of their results. Thus, Hawkins and Franceschina's conclusions were not supported by their results. Finally, even though Hawkins' (1998) results are consistent with the proposal that definite article agreement is mastered before indefinite article agreement, we would like to point out that the error rate for indefinite article may have been increased by the pronunciation of determiners. English learners of French tend to pronounce the determiner *un* as *une*. If it is indeed the case in this study, the apparent error rate was not only due to gender errors but also to mispronunciation.

3.3   Research questions

Given the difficulties in interpreting the data to support the linguistically based models, we still need further research to understand how gender is represented and processed. This is what we propose to do in the present thesis by investigating gender

processing in French as a first and second language. For this purpose, we will base our hypotheses on psycholinguistic models which are better supported, in this case by studies using experimental psychological methods. We will examine both the competence (i.e., knowledge of gender offline) and the performance (i.e., gender processing online) of L2 speakers of French to answer our main question: how do L2 speakers represent and process gender?

To understand how gender is processed by non-native speakers, it is essential to first understand how gender is processed by native speakers. Various methods will be used to compare L1 and L2 gender processing to point out the similarities and/or differences. The electro-physiological method (ERPs) will reveal whether the nature of the underlying processes involved in gender processing are similar for native and non-native speakers. The sensitivity to gender agreement reflected by ERP components in comprehension will be compared to effects obtained with behavioural experiments in production (e.g., naming latencies). The results will provide a wide picture of gender processing in L2 that will be discussed in the framework of models of language comprehension and production.

The second main issue to take into consideration in the study of gender processing in L2 is whether it is affected by L1. To investigate this question we will compare French native speakers to three different groups of L2 speakers according to the absence (e.g., English) or presence (e.g., German and Spanish) of a grammatical gender in their L1. For English speakers, an influence of L1 on L2 would result in difficulties in processing gender in French due to the absence of gender in their L1. For German and Spanish speakers, an influence of L1 could either facilitate the acquisition of gender in French, or hamper it if there is interference between gender systems of L1 and L2. For Spanish speakers a lexical interference could appear, so that they would use the gender of Spanish nouns in French even if the nouns do not share the same gender across languages. For German speakers, both lexical and ruled-base interference could occur. Since gender agreement rules vary in German and French, German speakers may apply the rules of the gender system of their L1 in their L2. For example, they may not compute agreement between the noun and the predicative adjective in French since such agreement is not realised in their native language. Word order can also be affected by L1. While linguistic models propose

that new word orders (e.g., adjective position) can only be acquired if features can be reset in L2, we assume, on the basis of the performance of proficient L2 speakers in general, that new word orders can be learned. To process this issue, however, we will examine whether gender agreement is processed in a similar way in syntactic structures that are identical across languages (e.g., pre-posed adjectives) and in new structures (post-posed adjectives).

CHAPTER SUMMARY

In this chapter we introduced the principal interest of the present thesis: grammatical gender. We first gave a definition of gender and briefly described its agreement and assignment systems. We then turned to the question of gender acquisition in L2 and we presented two theoretical linguistic SLA models that have attempted to account for it. We took these two models as an example to point out some issues with linguistic models regarding their investigation of gender representation and processing. As the evidence stands, these models have failed to provide a complete account for gender processing in L2, and we raised some questions that still need to be answered. In the following chapter we will investigate these questions with hypotheses based on psycholinguistic models and studies, and experiments using psychological methods. In the final chapter, we will return to the linguistic models to contrast their conclusions and ours in relation to gender representation and processing in L1 and L2. The next chapter reviews studies that have investigated gender in L1 and L2 using ERP and eye-tracking methodologies.

CHAPTER 2

GENDER IN COMPREHENSION: METHODOLOGIES AND LITERATURE REVIEW

In the present thesis, we used two methodologies to investigate grammatical gender processing in language comprehension: event-related brain potentials (ERPs) and eye-tracking. Prior to reporting our experiments (chapter 3) the rationale of using these two techniques is presented. We first introduce the ERP methodology, the principal components that are used and the debates their significance generates among psycholinguists. We will particularly focus on a model proposed by Friederici (2002) which suggests that language processing is carried out in three main stages. We develop its assumptions and the critiques it has received. We also briefly present the eye-tracking methodology and its interpretations. We then review various studies that have examined L1 and L2 processing using these methodologies and we sum up the conclusions they have reached.

1 ERPs IN LANGUAGE COMPREHENSION

1.1 ERP methodology

ERPs are used to record brain activity while participants process stimuli by means of electrodes placed on the scalp. Electrodes are historically placed according to the distances between anatomic regions of the brain. For instance, in the 10-20 electrode placement system (Jasper, 1958), electrodes are set up along two major axes (the anterior/posterior axis and the coronal axis) which converge at the vertex of the head, where the central electrode, Cz, is positioned (see Figure 1). ERPs can be used to study both visual and auditory online comprehension of words or sentences.

ERPs represent the voltage difference between a reference electrode, and all the other electrodes displayed on the scalp. The reference is placed on a fairly inactive region (i.e., relatively insensitive to brain activity), generally on the mastoid bone, but close enough to the active electrodes to be a relevant reference. Electrical activity recorded from the brain (in microvolts) at scalp electrodes is amplified on-line. Electrodes must be shielded from artefacts produced by electrical equipment. While trials are filtered off-line to remove noise due to extraneous electrical activity, some artefacts are too large to be removed, such as muscular activity and eye-movements. For this reason, participants must be comfortably seated and relaxed, and are asked to refrain from moving their body or eyes, or to blink, during the trials. Nonetheless, roughly 5% of trials have to be rejected because of artefact.
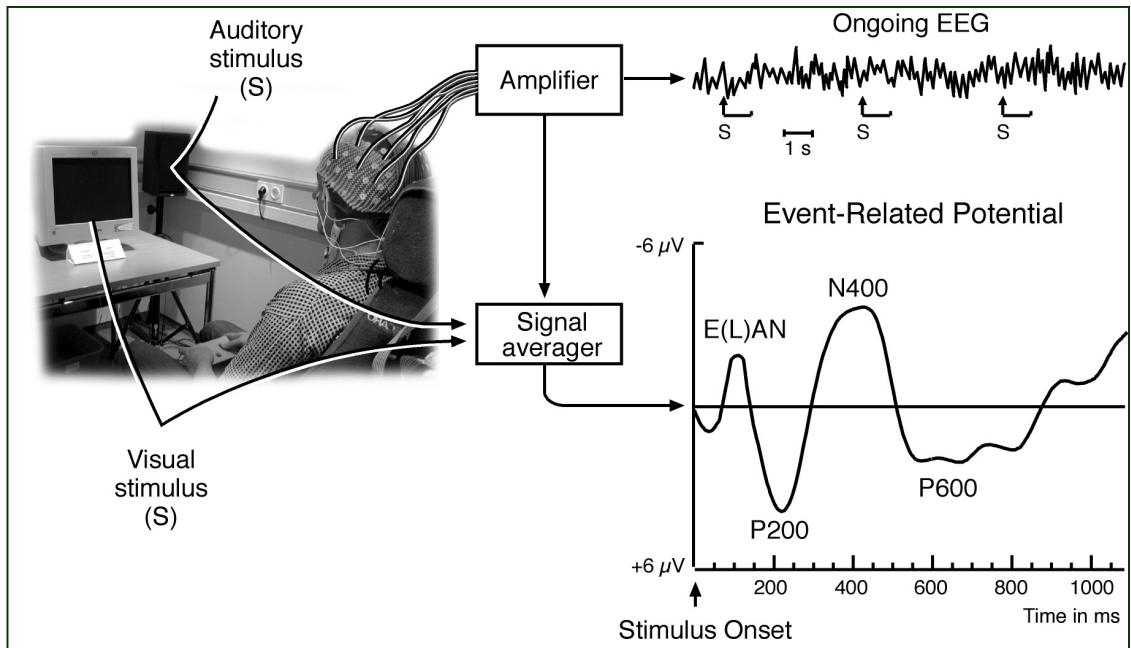
Figure 1: Illustration of ERP methodology

It is important to note that, unlike other neuroimaging methodologies such as fMRI and MEG, ERPs do not indicate precisely what region of the brain is activated. Instead, they represent the activity of a large number of neurones that can be detected at some distance from their source. So, generally, the scalp distribution of an effect does not allow one to directly determine the cortical region activated by a certain process in the brain.

Many trials must be averaged to obtain a reliable trace of brain wave activity (i.e., ERP components) in response to diverse types of stimuli. The ERP wave is composed of a series of positive and negative peaks which emerge depending on the type of stimuli and task requirements. These peaks are named according to their polarity (i.e., *N* for negative; *P* for positive) and their position on the waveform (e.g., N1 is the first negative peak; P1 the first positive one) or their latency (e.g., P600 is a positive peak with a peak latency of 600ms). Both the amplitude and peak latency of components are measured in relation to specific time windows, generally determined prior to the experiment and based on the literature. Waves must be quantified in order for the data to be analysed with ANOVAs, for example. Latencies on the waveform can provide information in relation to the processes triggered by different types of stimuli.

1.2   ERP components

1.2.1 N400

The N400 component (see Figure 2) was first reported in a study conducted by Kutas and Hilyard (1980). They observed a negative peak in response to a semantic mismatch between a word and the sentence context, as illustrated in (1). In this sentence, the final word 'dog' provokes a central-parietal negative wave between 300 and 500 ms with a peak at 400ms, the amplitude of which was larger than that elicited by a word semantically related to coffee and with high cloze probability, like 'sugar'.

(1) I take my coffee with cream and *dog.*

The amplitude of the N400 varies depending on the semantic relevance of a single word (or words) to sentence or discourse context. The lesser the cloze probability of a word in a sentence context, the greater the N400 amplitude (see Figure 2). The difference in amplitude of the N400 wave for two words (called the N400 effect) is generally accepted to be evidence of the difficulty of integrating the word in sentence context. The scalp distribution of the N400 is usually larger at posterior than anterior sites, and the effect is slightly larger on the right hemisphere for written input, but symmetrical for spoken words or sentences.

Though, the N400 was first associated with semantic integration, further studies have shown that the N400 can be found for most types of words, reflecting aspects of lexical processing (Brown & Hagoort, 1993; Kutas & Hilyard, 1980; Osterhout & Holcomb, 1992, 1995; for a review, Kutas & Van Petten, 1988). Neville, Mills and Lawson (1992) used open- and closed-class words in an attempt to distinguish semantic and syntactic processing in comprehension. Open-class words vary in frequency and concreteness as they convey meaning (e.g., verbs, adjectives, nouns), but closed-class words are short, frequent grammatical words (e.g., articles, conjunctions, prepositions). An N400 effect was elicited by semantically anomalous open-class words, while anomalous closed-class words provoked an earlier response, dubbed the "N280". The scalp distributions also revealed some differences, being

non lateralised and posterior for open-class words, and anterior in the left hemisphere for closed-class words. Neville et al. (1992) concluded that the syntactic processing of closed-class words involved different neural systems and distinguishable processes. In response to Neville et al.'s study, Osterhout, Bersick, and McKinnon (1997) tested the hypothesis that the difference in timing and scalp distribution found for open- and closed-class words may be due to word length and frequency. They recorded brain activity while participants were reading normal or scrambled prose. ERPs were averaged as a function of word class (open vs. closed) and grammatical category (article, noun, verb, etc). Osterhout et al. found early negativities (starting from N280) for short frequent words, but observed no difference of components across word classes (however, latency was longer for open-class words). They concluded that word length and frequency were responsible for latency changes in negativities (closed-class words being shorter and more frequent), and that the difference of scalp distribution varied as a function of grammatical category but not word class.

In more recent studies, the N400 effect has been associated with L2 learning (McLaughlin, Osterhout & Kim, 2004; Osterhout, McLaughlin, Pitkänen, Frenck-Mestre & Molinaro, 2006). Osterhout et al. (2006) investigated how much L2 exposure is required before learners can process their L2 online in comprehension. They undertook a longitudinal study with English adult speakers learning French. These learners were complete beginners, learning their L2 in a classroom environment. They were tested after one month, four months and eight months of instruction. The experiment contained a semantic condition (2a), a verbal agreement condition (2b) and a nominal number agreement condition (2c).

(2a) *Sept plus cinq/livre* font douze*

   Seven plus five/ book* equal twelve.

(2b) *Tu adores/*adorez le français*

   You love/loves* French

(2c) *Tu manges des hamburgers/*hamburger pour dîner*

   You are having some hamburgers/hamburger* for dinner.

In (2a), the noun *livre* ('book') is semantically anomalous, (2b) contains a verbal-person agreement violation phonologically that is realised, and (2c) contains a nominal number agreement violation that is phonologically silent. French native speakers were tested as a control group. Their results showed a classic N400 effect in response to semantically anomalous words, and a large P600 effect for both types of syntactic violations. Like native speakers, learners revealed an N400 effect for semantically anomalous words. This effect was found even after only one month of instruction and only slightly varied as learners' language competence increased. In contrast, the results for verbal-person violations differed from those of native speakers. Learners initially showed an N400 effect in response to these syntactic violations as opposed to the expected P600 effect. After a few months, however, this N400 effect was replaced by a P600 effect. Phonologically silent nominal number agreement violations produced no effect. The authors suggested that the N400 effect found for the verbal-person condition emerged because of the different stages of acquisition. First, learners memorise groups of morphemes, then they attribute a meaning to these morphemes, when they become more proficient (after a few months), they assimilate the verbal person agreement rule, and a violation of this rule provokes a P600 effect similar to how it does for native speakers.

1.2.2 P600

The P00 effect (see figure 2) was first reported by Osterhout and Holcomb (1992) in a study in which they investigated the ERP response to syntactic anomalies. In this study, they manipulated grammatical constraints, creating syntactic ambiguities. While the verb 'hope' (3a) is an intransitive verb and does not allow for a direct object complement, the verb 'persuade' is optionally transitive and licenses both a direct object (3b) and a clausal complement (3c).

(3a) The broker hoped to sell the stock...

(3b) The broker persuaded the man to sell the stock...

(3c) The broker persuaded to sell the stock was sent to jail.

The authors investigated whether verb sub-categorisation could influence parsing and, more specifically block garden pathing. The results showed a positive wave between 500 and 800ms showing that it is easier to process 'to' following intransitive verbs (e.g. hope) than following optionally transitive verbs (e.g. persuade). These results provide evidence against the serial parser model (Frazier & Rayner, 1982), which suggests that readers have an initial preferred analysis that involves the fewest nodes in the syntactic tree, independent of particular constraints imposed by the verb. Osterhout and Holcomb named the effect the "P600" according to its latency and amplitude, but it is also known as SPS, Syntactic Positive Shift, due to its functional characteristics (Hagoort, Brown and Groothusen, 1993). Osterhout and Holcomb concluded that ERP components reflected different linguistic processes, the P600 being an indicator of syntactic integration vs. the N400, linked to semantic integration. The P600 has since been replicated in other studies which manipulated various types of syntactic anomalies and ambiguities (Friederici, Hahne, & Mecklinger, 1996; Gouvea, Philips, Kazanina, & Poeppel, submitted).

The P600 effect was replicated in Dutch for violations of verb-noun number agreement and phrase structure (Hagoort et al., 1993) and has since been found in numerous languages (e.g., English, German, Dutch, French, Spanish, Hebrew) in response to different types of anomalies such as phrase structure violations (Hagoort et al 1993); verbal person agreement violations (e.g., *Every Monday he mows/*mow the lawn*; Coulson, King and Kutas, 1998); gender, number and case violations (Hagoort & Brown, 1999; Osterhout & Mobley, 1995, see below for details).

The P600 effect obtained in case of syntactic ambiguities has been said to have an equal distribution across different scalp locations or more frontal, as opposed to a more posterior distribution in case of syntactic violations (Hagoort, Brown, & Osterhout, 1999). However, some differences in the scalp distribution of the P600 effect have been found across studies examining syntactic anomalies (lateralised vs. symmetrical distribution; Osterhout & Holcomb, 1992; Neville, Nicol, Barss, Forster & Garrett, 1991), and the topography of the P600 is still a question of debate (Coulson et al., 1998).

A controversial proposal considers the P600 effect as being part of the same family as the P300 effect which is provoked by unexpected, task-relevant events.

This hypothesis was tested in two studies which reached contradictory conclusions (Coulson et al., 1998; Osterhout, McKinnon, Bersick & Corey, 1996). Osterhout et al. (1996) compared sentences containing a subject-verb agreement violation (5a), a grammatically correct but graphically anomalous word (5b), and sentences containing both anomalies.

(5a) The doctors <u>believes</u> the operation was a success.

(5b) The doctors <u>BELIEVE</u> the operation was a success.

A classic P300 effect appeared after graphically anomalous words, and a P600 with a distinct latency, amplitude and scalp distribution after syntactic violations. Sentences containing both anomalies created additive effects which first appeared similar to a P300 but then extended to a P600 effect, producing a large positive wave. The authors concluded that, to a certain extent, the P600 effect was neurally and cognitively dissimilar to the P300 family. This claim directly contradicted what Coulson et al. concluded from their own results. The latter authors suggested that the P600 effect was associated with the P300 effect because it was sensitive to the probability of syntactic violation (the amplitude being larger in case of highly improbable violations). In a reply to Coulson et al., Osterhout and Hagoort (1999) first underlined some experimental design problems (i.e., the absence of a control condition) in Coulson et al.'s study. They also argued that the fact that the P300 effect was probability sensitive was not a valid reason for including all components sensitive to probability (e.g., the P600 effect) in the P300 family. They also pointed out that the additive results obtained with both unexpected and syntactic anomalies (Osterhout et al., 1996) implied that the neural generators of syntactic violations were distinct from the P300 generators, all ERP waveforms being the reflection of several underlying processes. Finally they noted that the scalp distributions of the P300 and P600 effects were very different. For a detailed discussion, see Osterhout and Hagoort (1999).

Similarly, the process underlying the P600 effect divides researchers. Indeed, the P600 effect is sometimes considered as the third stage, revisional stage, of syntactic processing in comprehension, the first two stages being reflected by the

ELAN and LAN effects (Friederici, et al., 1996; Friederici, 2002, , although this has been contested (Osterhout, Mclaughlin, Kim, Greenwald & Inoue, 2004). This will be developed in the subsequent section.

1.2.3 (Early) left anterior negativities (ELAN/LAN)

The LAN effect was first reported in the early nineties (Osterhout & Holcomb, 1992; Friederici, 2002). It resembles the N400 effect in that it occurs in the same time window (300-500ms), but differs in its scalp distribution which is usually more frontal and larger on the left than right hemisphere. Unlike the N400 effect which reflects semantic anomalies, the LAN effect is usually associated with syntactic processing. It can sometimes emerge in an earlier time window (ELAN, generally 125-180ms, see Figure 2) in response to word category violations (Friederici, Hahne & Mecklinger, 1996; Friederici, 2002, Neville, Nicol, Barss, Forster & Garrett, 1991). Friederici et al. (1996) presented sentences that require a noun phrase (6a) and sentences in which a preposition had been inserted between the copula and the past participle (6b), creating a syntactic category violation.

(6a) *Das Metal wurde <u>veredelt</u> von dem Goldschmied den man auszeichnete.*

   The metal was refined by the goldsmith who was honoured.

(6b) *Das Metal wurde zur <u>veredelt</u> von dem Goldschimed den man auszeichnete.*

   The metal was for refined by the goldsmith who was honoured.

The syntactic category violations provoked an ELAN effect. The authors concluded that early negativities reflect the processing of word-category information. However, this conclusion was called into question by other studies in which the ELAN effect was found in case of number, case, gender and tense violations (Münte, Heinze, & Mangun, 1993). In these studies the word category was correct, but an ELAN was nevertheless found in response to morpho-syntactic violations. Thus, the ELAN component cannot be restricted as the representation of word category violations detection as suggested by Friederici's model (2002).

The LAN effect has been associated with working memory (Coulson et al., 1998; Klunder & Kutas, 1993, King & Kutas, 1995). For instance, King and Kutas

(1995) found a LAN effect elicited by a verb immediately following a filler in an object-relative clause (7a), in contrast to a verb in a subject-relative clause (7b).

(7a) The reporter who the senator harshly attacked admitted the error.
(7b) The reporter who harshly attacked the senator admitted the error.

In both sentences, the subject of the sentence is modified by the relative clause, but the role played by the subject varies in each sentence. Processing a subject-object (OR) relative (7a) is costlier for working memory than processing a subject-subject relative (SR) sentence (7b). A LAN effect was found for both verbs in OR sentences compared to SR sentences. This suggests that a LAN effect can be due to referential ambiguities taxing working memory, and thus argues that LAN effects do not only reveal syntactic processing, but are nonetheless definitely elicited by tasks involving language comprehension.

The functional interpretation of the (E)LAN and the P600 effects is a question of debate in psycholinguistics. Friederici and collaborators (Friederici, 2002; Friederici et al, 1996) have suggested a three-phase functional model reflected by distinct ERP components. The first phase is the detection of word category anomalies (ELAN); it represents an initial autonomous process of phrase structure construction. In the second phase, semantic (N400) and morpho-syntactic (LAN) processing occurs, and the final phase consists of syntactic reanalysis and repair (P600). This model is based mainly on the claim that the ERP response elicited by syntactic violations is biphasic, consisting of, first the detection of the error (LAN) and then, the repair of this error (P600).

Osterhout et al. (2004) raised several criticisms. The first is the reliability of the LAN effect. Indeed, while the LAN effect is found in some studies in response to syntactic violations (Friederici et al., 1996; Hagoort & Brown 1999, Münte et al., 1993; Osterhout & Holcomb, 1992), numerous studies have failed to obtain it (Foucart & Frenck-Mestre, under revision; Hagoort et al., 1993, Osterhout & Mobley, 1995). Therefore the processes underlying the LAN effect are still unclear; in this respect, it has recently been suggested that LAN effects could be a family of

effects (Krott, Baayen & Hagoort, 2006). Second, Osterhout et al. (2004) have suggested that Friederici et al. (1996) may have had overlapping components due to the difficulty of establishing a baseline for auditory stimuli. Third, Osterhout et al. put forward the possibility that the biphasic response (LAN + P600) may not be found in all individual subjects. In the studies on which Friederici's model was based, ERPs were averaged across participants. However, in a recent study, Inoue and Osterhout (2005) presented syntactically anomalous sentences to Japanese native speakers. The ERP response they obtained for anomalies first appeared biphasic, composed of a LAN and P600 effect. Participants were separated into two groups on the basis of the magnitude of their individual LAN effect and data were reanalysed for each group individually. The group that showed a sizable LAN effect also displayed a small P600 effect, but the group that showed a large P600 effect did not display any LAN effect. The important point is that averaging over all participants can sometimes obscure what really occurs within a single subject. If this was the case in the studies Friederici reported, then the three-phase model is not warranted. In the present thesis, we adopt a critical view of this model and challenge the claim that it reflects universal syntactic processing mechanisms. The experiments reported in chapter 3 provide a test of the model.
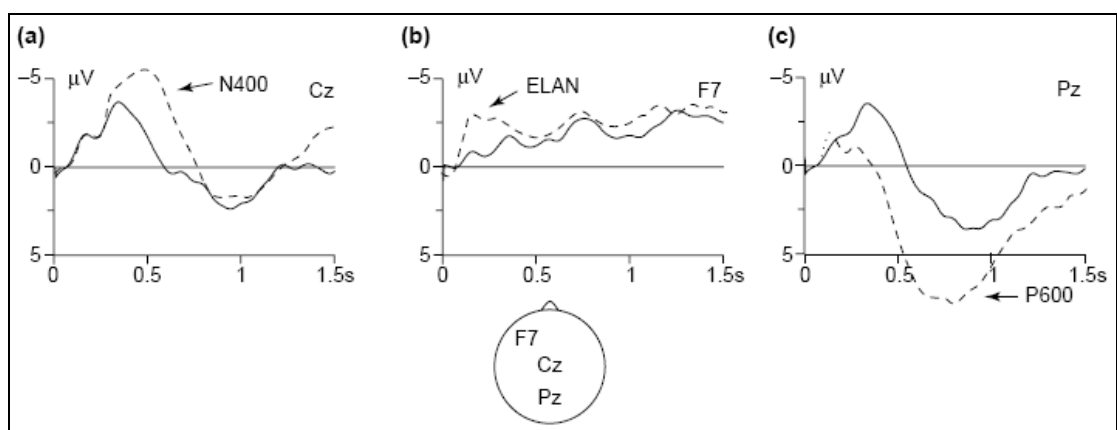
Figure 2: ERP components, a) N400, b) ELAN, c) P600 (adapted from Friederici, 2002)

1.3   ERPs in second language

In the previous section, we observed that, even if the interpretation of some components requires further research, ERPs can provide crucial information on processes involved in online language comprehension. ERPs have only recently started being used to examine L2 processing; however, some preliminary conclusions can already be drawn. In the present section, we will give an overview of a few ERP studies in L2.

1.3.1 Sentence processing in L2

In the introduction to ERP methodology, we mentioned that the N400 component was elicited by lexico-semantic anomalies, and the LAN and P600 effects by syntactic anomalies (Friederici, 2002; Kutas & Hillyard, 1980; Osterhout & Holcomb, 1992). Studies involving semantic and syntactic violations have been conducted to compare L1 and L2 processing.

One of the earliest studies to tackle this question was undertaken by Ardal, Donald, Meuter, Muldrew, and Luce (1990)[3]. They visually presented semantically anomalous sentences to early and late bilinguals (L1 French, L2 English), and to English native speakers. The aim of their study was to investigate whether the latency and the amplitude of the N400 effect would be the same for bilinguals as for native speakers, if the N400 effect was indeed obtained in the L2. Semantic violations provoked an N400 effect both in monolinguals and bilinguals; but, the effect was slightly delayed for bilinguals. The results were obtained for bilinguals regardless of the age of acquisition.

Weber-Fox and Neville (1996) also compared native and non-native speakers to examine semantic and syntactic processing. They addressed the issue of the critical period hypothesis by testing Chinese-English bilinguals ranging from early to late (1-3, 4-6, 7-10, 11-13, >16 years, age of acquisition). Native speakers showed an early (125ms, ELAN) and a late left anterior negativity (300-500ms, LAN), as well as a

---

[3] Meuter, Donald and Ardal (1987) conducted a preliminary study examining variations in the N400 in first (English or French) and second language (French or English). They used the same types of violations as in the later study (Ardan et al., 1990). The results were a trend for the N400 but at only one electrode site and for only one of the bilingual groups. No conclusions could be drawn from this preliminary study concerning semantic processing in L2.

P600 effect in response to word category violations, and an N400 effect in response to semantic anomalies. The results obtained for L2 learners revealed no early left negativity, except for one group (age of acquisition between 11 and 13 years), but because of a larger bilateral distribution rather than being left-lateralized, the authors concluded that it could not be considered a genuine ELAN. The late negativity was found for all L2 groups, but was more widely distributed for groups with age of acquisition above 11. Bilinguals up to the age of 10 showed a pattern similar to that of natives for the P600 effect. The 11-13 group revealed a delayed P600 effect to violations; whereas no effect was found for later learners. The authors concluded that semantic processing is similar in nature in L1 and L2 (only differing in latency and amplitude), but that syntactic processing in L2 is influenced by the age of acquisition. The similarity of pattern for early bilinguals suggests that the achievement of native-like processing in L2 is possible when the L2 is acquired early in life. In contrast, as revealed by the delayed latency, late learners will always show some differences even with enough exposure.

Hahne (2001) compared native speakers of German and Russian learners of German (age of acquisition <10) in response to phrase structure anomalies and semantically anomalous words. She manipulated the presence of these violations in auditory sentences, as illustrated in 8a (correct), 8b (syntactically incorrect) and 8c (semantically incorrect).

(8a) *Die Tür wurde <u>geschlossen</u>.*

   The door was being closed

(8b) *Das Geschäft wurde am* <u>geschlossen</u>.*

   The shop was being on closed

(8c) *Der Ozean wurde <u>geschlossen</u>.*
   The ocean was being closed.

Semantic violations elicited an N400 effect for both groups; however, the effect obtained in the bilingual group had reduced amplitude and later peak latency. Native speakers displayed an early left anterior negativity (ELAN) and a P600 in response to syntactic anomalies. Russian L2 learners did not show an ELAN, but a delayed P600

was present. From this pattern of results Hahne concluded that L2 speakers do not process syntactic information in the same way as native speakers do.

In a similar study, Hahne and Friederici (2001) compared native German speakers and Japanese late L2 learners of German for the same types of violations. Japanese speakers had overall lower proficiency than the Russian speakers involved in the above-mentioned study. The results nonetheless revealed an N400 effect for semantic violations with a similar pattern for native speakers and Japanese-German learners. For word category violations L2 learners did not show any online effect even though they were able to detect these anomalies off-line, as revealed by the grammaticality judgement they had to make at the end of each sentence. The same grammaticality judgement performed by Russian L2 learners showed that these speakers had a higher proficiency than Japanese speakers. The authors concluded that the presence of a P600 effect in case of syntactic violations depends on proficiency. Clearly another factor that could account for the presence vs. absence of P600 in the L2 groups was the similarity between L1 and L2. Indeed, Russian speakers are familiar with the structure in which the violations occurred given that it exists in Russian, whereas this structure does not exist in Japanese.

In a recent ERP study, Hahne, Mueller and Clahsen (2006) examined the processing of inflected words by native Russian advanced learners of German. In response to incorrectly inflected past-participle (e.g., *gelauft* instead of *gelaufen*, 'run'), L2 learners showed an anterior negativity followed by a P600. For incorrect inflection of noun plurals, L2 learners displayed a P600 when the regular pattern was generalised (i.e., *–s* replaced the *–n*; e.g., *Tuben* vs. **Tubes*), but an N400 effect when the irregular pattern was generalised. The authors concluded that L2 speakers were able to process inflectional morphology in a native-like manner in cases where the rules are systematic, but are less capable of such for more complex rules such as those governing nominal pluralization in German.

This conclusion was further supported by Rossi, Gugler, Friederici, and Hahne (2006), who presented sentences containing word category violations, or morpho-syntactic agreement violations or both types of violations to high and low proficiency German and Italian L2 learners. The results for high proficiency learners were similar to those found for native speakers (albeit with some differences in

amplitude): an ELAN and P600 effect for word category violations and a LAN and P600 effect for morpho-syntactic violations. In contrast, low proficiency learners did not show any LAN effect and displayed a delayed P600 effect. The authors concluded that late L2 learners who achieve high proficiency can process language similarly to native speakers provided sufficient exposure to the L2, and they suggested that Friederici's (2002) three-phase model could be applied to L2 language processing. Thus, they claimed that advanced L2 learners process language in 3 stages: (1) phrase structure construction process (ELAN), (2) morpho-syntactic processing (LAN), and (3) reanalysis and repair (P600). In chapter 3, we present experiments that challenge this model both for native and non-native speakers.

In sum, this body of research on L2 syntactic processing suggests that high proficient L2 speakers can achieve native-like processing even if they start learning their L2 late in life. This is one of our concerns in the present thesis. In the following chapters we report experiments investigating whether L2 speakers process grammatical gender in a similar way as French native speakers.

1.3.2 Lexical processing in L2

ERPs also make it possible to use a semantic priming paradigm to investigate lexico-semantic processing in the bilingual lexicon. Many monolingual, bilingual and cross-linguistic studies have used this paradigm in behavioural experiments. Semantic priming is manifested by shorter RTs in lexical decision or semantic categorization for a word preceded by a semantically related word than for a word preceded by a semantically unrelated word. ERP studies in native speakers have revealed an N400 effect in response to semantically unrelated words. It is not however clear whether the effect represents post-lexical integration or pre-lexical processes. This paradigm can be used in bilingual studies to compare L1 and L2 processes, as well as for cross-linguistic studies.

In a series of studies, Kotz (2001) and Kotz and Elston-Gütler (2004) examined lexical and conceptual processing in bilinguals. These studies used categorical (e.g., *boy-junior*) and associative priming (e.g., *boy-girl*) on early (before the age of 4, Kotz, 2001) and late (after the age of 11, Kotz & Elston-Gütler, 2004) German-

English bilinguals. Early bilinguals displayed an N400 effect for both types of priming, as did native speakers. In contrast, late bilinguals showed an N400 effect only for associative priming; no effect was found for conceptual priming. Moreover, the authors reported a larger N400 effect for high proficient than for low proficient bilinguals. The same influence of proficiency was found in a more recent study in which Elston-Gütler, Paulmann and Kotz (2005) tested L2 priming with the English translation of German homographs. From these three studies, the authors concluded that the conceptual link in L2 depends on the age of acquisition; in contrast, associative priming can be found in late bilinguals but is influenced by proficiency.

In this section, we gave an overview of a few ERP studies that examined L2 processing. We observed that semantic processing seems to be similar in L1 and L2 (reflected by the N400, sometimes delayed and smaller in L2), and that syntactic processing seems to be influenced by age of acquisition. However, before we draw any conclusions, let us focus on what really is the interest of the present thesis: grammatical gender processing. In the next section, we will report ERP studies that investigated gender processing in L1 and L2, and in the final section we will draw some conclusions about L2 processing.

1.4   ERPs and grammatical gender processing

1.4.1 L1 studies

In the previous chapters, we noted that grammatical gender can be assigned to the noun using rules (e.g., morphophonological rules); in this respect, gender can be considered as a lexical feature. However, as the gender of a noun is, in most languages, only reflected through its agreement with other words, it can also be seen as a syntactic feature. Monolingual ERP studies have examined the online processing of gender agreement. ERP methodology is appropriate to the study of gender processing because violations can elicit either a lexico-semantic effect (N400) or syntactic effects (P600, LAN). The general finding of these studies is that gender agreement violations between two elements in sentence context provoke a P600 effect (Foucart & Frenck-Mestre, under revision; Hagoort & Brown, 1999). This effect is sometimes preceded by a LAN effect (Friederici et al., 1996, but see

Osterhout et al., 2004). These results have been obtained in various languages and for violations between various different elements of the sentence (e.g., article and noun, Hagoort & Brown, 1999; noun and adjective, Barber & Carreiras, 2005).

Hagoort and Brown (1999) examined grammatical gender processing in the case of violations between the definite article and the noun, in Dutch. Their participants read sentences in which the definite article either agreed or not with the gender of the noun it preceded. In response to gender mismatch/agreement violations, a P600 (or SPS) emerged. The same results were found for the same type of violation in French (Foucart & Frenck-Mestre, under revision) and in German (Gunter, Friederci & Schriefers, 2000). However, in German, Gunter et al. also found a LAN effect for these agreement violations. They accounted for the presence of this early effect by assuming that semantic (N400) and syntactic (LAN) processes would be autonomous during an early stage, and would interact during a later stage (P600). This claim was in line with the proposal developed in Friederici's (2002) three-phase functional model (see section 1.2.3 for more detail). In contrast, Hagoort and Brown claimed that the absence of a LAN effect was due to the type of violation involved in their study. Indeed, previous studies had shown that the LAN effect was elicited by word category (Friederici et al., 1996; Friederici, 2002, Neville et al., 1991) or morpho-syntactic (Münte et al., 1993) violations. Hagoort and Brown manipulated only syntactic violations of agreement between the article and the noun (see example 9), which does not involve any marked bound morpheme in Dutch, and all word categories were correct.

(9) De_{com}/*Het_{*neu} kapotte paraplu$_{com}$ staat in de garage,

   The broken umbrella is in the garage

Gender processing has also been investigated in case of agreement violation between the noun and the adjective, in Spanish (Barber & Carreiras, 2003, 2005). Agreement violations were examined in various conditions: article-noun word pairs (10a), noun-adjective word pairs (10b), article-noun at the beginning of the sentence (10c), and noun-predicative adjective in the middle of the sentence (10d).

(10a) el_{masc}/*la_{fem} $piano_{masc}$

    The piano

(10b) $faro_{masc}$ $alto_{masc}$/*$alta_{fem}$

    Lighthouse high

(10c) el_{masc}/*la_{fem} $piano_{masc}$ *estaba viejo y desafinado*

    The piano was old and off-key

(10d) *El* $faro_{masc}$ $alto_{masc}$/*$alta_{fem}$ *y luminoso*

    The lighthouse is high and bright.

The results varied according to the context of the stimuli (i.e., word pair or sentential context). An N400 effect emerged in the word pair condition, whereas a P600 effect was observed in sentential context. The N400 effect found in the word pair condition reflects an attempt to integrate the lexical features of the word. Inasmuch the task was to match words, a lexical integration was necessary; however, in the absence of proper syntactic structure (as opposed to sentence context), no syntactic integration was required to complete the task. In contrast, in sentential context, gender agreement violations provoked a LAN-P600 pattern. The P600 effect was more posterior and larger over the right hemisphere. The LAN effect was similar regardless of where violations occurred within the sentence (beginning vs. middle), whereas the P600 was larger when violations occurred in the middle of the sentence. It should be stressed that violations at the beginning of the sentence involved an article and a noun, whereas in the middle of the sentence a noun and a predicative adjective were involved. Thus, some violations occurred within the NP and others outside the NP. The fact that the P600 effect was larger for violations in the middle of the sentence could reflect costlier reanalysis processes due to a more complex agreement (i.e., noun-predicative adjective vs. article-noun). The authors also raised the question of vocabulary type, target words being either nouns (beginning position) or adjectives (middle position). However, they did not mention the frequency of the agreement constraints. In Spanish, although agreement is obligatory it is less frequent between the noun and the adjective than between the article and the noun. Thus, due

to a 'frequency-based effect', errors are more likely to occur for agreement with the adjective than for agreement with the article.

Gender processing has also been examined for agreement violations in response to other types of sentential agreement. Osterhout and Mobley (1995) manipulated anaphora that contained reflexive-antecedent gender agreement violations (e.g., *The woman congratulated herself/*himself for the promotion*). Agreement violations provoked a robust P600 effect. The same effect was obtained for subject-predicate agreement in Hebrew (Deutsch & Bentin, 2001, see 2.2.1 for detail). In Dutch, gender agreement violations between the relative pronoun and the antecedent in relative clauses also elicited a P600 effect (van Berkum, Brown & Hagoort, 1999). These studies attest that grammatical gender violations generally provoke a P600 effect even if the violations do not occur within the NP.

In sum, all of the studies to date that have examined grammatical gender processing revealed a P600 effect in response to gender agreement violations (with the exception of violations occurring in word pairs which triggered an N400 effect). This effect was obtained regardless of the elements involved (e.g., article-noun, adjective-noun, reflexive-antecedent) or the position of violations (within the NP or outside the NP). The P600 effect was sometimes preceded by a LAN effect (Barber & Carreiras, 2005; Deutsch & Bentin, 2001; Gunter et al., 2000), but not consistently (Foucart & Frenck-Mestre, under revision; Hagoort & Brown, 1999). The LAN and P600 effects have been associated with syntactic integration, the LAN supposedly reflecting syntactic violation detection, and the P600 effect syntactic reanalysis or repair (Friederici, 2002, but see Osterhout et al., 2004). Thus, the common theory that emerges from these studies is that in L1, gender is represented syntactically, and that the online processing of grammatical gender is not a conceptual and/or semantic, but a syntactically driven process. The question raised here is whether L1 and L2 gender processing are similar in this regard. The next section is a review of studies that have investigated gender processing in L2.

1.4.2 L2 studies

In the previous section, we reported empirical evidence suggesting that gender is syntactically processed in L1. The interesting question is whether gender is processed in the same way in L2. Recent studies have shown that native-like syntactic process mechanisms can be acquired by high proficient L2 speakers (Rossi et al., 2006). On the other hand, others suggested that if the L2 is not acquired early in life, processes will not be as 'automatic' as it is for native speakers (Weber-Fox & Neville, 1996). This question is central in the following chapter that reports experiments investigating whether gender processing is similar in native and non-native speakers. At present, only a few studies have used ERPs to investigate the question of grammatical gender processing in L2; they are reported in this section.

Foucart and Frenck-Mestre (under revision) compared grammatical gender processing in French native speakers and German late bilinguals. German speakers had started learning French after the age of 10, but they had reached an advanced level (they studied in a French university). They manipulated gender concord in short, visually presented sentence contexts in which the definite article either agreed (11a) or violated agreement (11b) with the following noun.

(11a) *La$_{fem}$ clef$_{fem}$ était dans la serrure*
(11b) *Le$_{masc}$ clef*$_{fem}$ était dans la serrure*
　　The key was in the keyhole

Stimuli were inanimate nouns, such that gender was not semantically determined. The gender of nouns was manipulated such that stimuli either shared the same gender across French and German or did not,. Agreement violations elicited a P600 effect for both native French speakers and L2 speakers with no difference in latency across groups. No early left negativity was obtained for these syntactic anomalies, in either group. The grammaticality judgements that participants had to make at the end of each sentence revealed two sub-groups within the bilinguals. One group appeared to be more proficient than the other. The more proficient group showed the same ERP pattern as natives in response to agreement violations,

whereas the less proficient group showed a P600 effect only when noun had the same gender in both languages. The results suggest that online gender processing in L2 depends on proficiency, with a greater influence of the L1 for less proficient bilinguals. These results are in line with those found for semantic processing (Kotz, 2001; Kotz & Elston-Gütler, 2004; Elston-Gütler, et al., 2005), showing that L2 processing in late learners depends on proficiency. They are also in line with recent work by Hahne et al. (2006) and Rossi et al. (2006), showing native-like ERP patterns for advanced L2 speakers in studies of syntactic processing.

As suggested by the few L2 ERP studies on syntactic processing (Foucart & Frenck-Mestre, under revision; Hahne, 2001, Hahne & Friederici, 2001), the degree of overlap of the native and second language may influence syntactic processing in the L2. To investigate this question, it seems crucial to compare L2 learners from various language backgrounds. We are only aware of one study that has performed such a comparison to date. Sabourin (2003) compared native speakers of Dutch to German, English and Romance (i.e., Italian, French, Portuguese and Spanish) L2 speakers of Dutch. She first tested her participants in an off-line experiment in which they had to assign gender to Dutch words. German speakers performed at native-like level, Romance language speakers were not as accurate as Germans but were still above chance, whereas English learners of Dutch performed at chance. In a subsequent ERP experiment, Sabourin manipulated subject-verb agreement and grammatical gender violations (within the NP and the relative pronouns). Native speakers showed a P600 for both types of violations. German speakers showed the same pattern of response as native speakers (although with lower amplitude). Romance language and English speakers displayed a P600 effect in response to subject-verb violations; however the effect was more widely distributed than for native and German speakers. They did not show a P600 effect for gender violations. The author concluded that native-like processing of grammatical gender will be acquired in the L2 only if the grammatical feature is both present in L1 and similar across L1 and L2 (i.e., German). Simply having grammatical gender in the L1 was apparently not sufficient, according to Sabourin's results for the Romance speakers.

These results should be considered with caution, as there were large discrepancies in number of participants (native Dutch, N = 23; L2 learners: German,

N = 14; Romance, N = 8; English, N = 9) and years of exposure to Dutch (German, 3-32 years; Romance, 3-23 years; English, 3-27 years). In the Romance group, there was no distinction between native speakers of French, Italian, Portuguese and Spanish. Moreover, some experimental bias could have influenced the results as well as the fact that the author decided to use a significance level of .05 for native speakers and of .1 for bilinguals before comparing their results. Nevertheless, this study was a first attempt to test the influence and potential transfer of grammatical properties from L1 to L2 with ERPs. Further research on this question is warranted.

1.4.3 Conclusions on L2 processing

ERPs have just recently started to be used to investigate L2 processes and they have already provided crucial information that complements findings obtained with other methodologies. The studies conducted so far have shown that lexico-semantic processing in L1 and L2 is very similar. Semantic violations in sentence context provoke an N400 effect in L1 and L2, though sometimes with delayed latency and reduced amplitude in L2 speakers (Ardal et al, 1990; Hahne, 2001). In contrast to semantic processing, syntactic processing has been claimed to differ in L1 and L2 at least as revealed by the processing of violations. On the one hand, a P600 effect similar to that found in native speakers has been revealed in L2 learners in case of syntactic anomalies (Foucart & Frenck-Mestre, under revision; Hahne, 2001; Hahne, Mueller, & Clahsen, 2006; Sabourin, 2003; Weber-Fox & Neville, 1996), suggesting that native-like syntactic processing can be achieved in L2. On the other hand, this effect was not found for all L2 learners (Hahne, 2001; Hahne & Friederici, 2001; Sabourin, 2003). Early and late negativities had not been reported in L2 (Foucart & Frenck-Mestre, under revision; Hahne, 2001) until very recently (Hahne, et al., 2006; Rossi, et al., 2006). Note, nonetheless, that these negativities have not been consistently reported in monolinguals and their interpretation is still in question (Müller & Hagoort, 2006). Friederici (2002) proposed a three-phase model to represent universal syntactic processing mechanism reflected by the ELAN, LAN and P600 effects. More recently Friederici and collaborators (Rossi et al., 2006) conducted a bilingual study from which they concluded that the three-phase model was also suitable for L2 processing. This model has generated criticisms, one of them

being that the effects are not consistent across studies (i.e., presence of (E)LAN). Thus, before any conclusion can be drawn concerning (E)LAN effects in L2, a general consensus should be achieved about their implications in monolinguals.

In sum, whereas semantic processing is quite similar in L1 and L2, syntactic processing seems to depend on proficiency, age of acquisition and L2 learners' native language. The influence of the native language and possible transfer from L1 to L2 need to be further investigated in studies comparing native speakers and L2 learners of different native languages. These questions will be addressed in the experiments reported in chapter 3.

2   EYE-MOVEMENTS IN LANGUAGE COMPREHENSION

2.1   Introduction to eye-movements

Eye-tracking is a valuable methodology for psycholinguistics as it provides an on-line record of the processes involved in 'natural' reading. In contrast to the typical ERP paradigm where sentences are presented word by word, eye-tracking allows complete sentences to be presented and reading speed to be controlled by the reader. In this section, we will provide a brief introduction of this methodology based on Frenck-Mestre (2005), illustrated with a recording obtained in the experiment reported in chapter 3 (for further information on eye-movement recording in psycholinguistics, see Brysbaert and Vitu, 1998).

Eye-movement recordings can be analysed in several ways. Because a reader can both perform multiple scans on individual words and re-read parts of the sentence, several time measurements can be distinguished. The first time a sentence is read is called the 'first pass' reading time, and the second scanning is the 'second pass' reading time. These two reading times can be usually added to obtain the 'total' reading time. Sentences are divided into regions of interest (RoI) defined by the experimenter. The first time the eye enters a RoI, from the left of the region is called 'first fixation', whereas all subsequent fixations occurring within the same region prior to exiting this region (to the right or left) are referred to as the 'gaze duration' (sum of all fixations from when the reader initially enters a region until s/he moves

on to another region, to the left or right). Other measurements such as length of saccades, RoI skipping or regressions (re-reading of a RoI) can reveal differences in processing difficulty. Let us illustrate these eye-movement measurements with the example below (Figure 3). Figure 3 represents a recording from a French native speaker who was reading a sentence containing a gender agreement violation between the noun and the predicative adjective. RoIs are separated by slashes. In the 'noun region' (the third RoI), there is a first fixation of 220ms and a second fixation of 200ms, so that the gaze duration is 420ms for first pass reading. As the reader did not re-read this region, there is no second pass measure to add and the total reading time is also 420ms. Small regions (such as the article or the copula here) are often skipped, mostly because the eyes usually do not land on short words, but also due to the fact that when the eyes are reading a word, the periphery of this word is also scanned (Frenck-Mestre, 2005). Let us now look at the last RoI. For this region, the first fixation time (580ms) and the gaze duration (800ms) are very long, which could either show a 'sentence wrap-up effect' (i.e., readers spend more time on this region because it is the comprehension point of the sentence; Just and Carpenter, 1980), or reflect that the reader has detected the anomaly in the sentence. The regression from the last region to the previous region, which contains the violation, suggests that the reader has identified the anomaly. The 'adjective region' has a first fixation of 280ms and a re-fixation, during a secondary reading of the region, of 310ms, such that the total reading time for this region is 590ms. The presence of a first fixation in this region eliminates the possibility that re-reading was due to skipping of this RoI during first pass. Thus, fixation duration for the region containing the violation as well as for the last region reveals effects of processing difficulty.
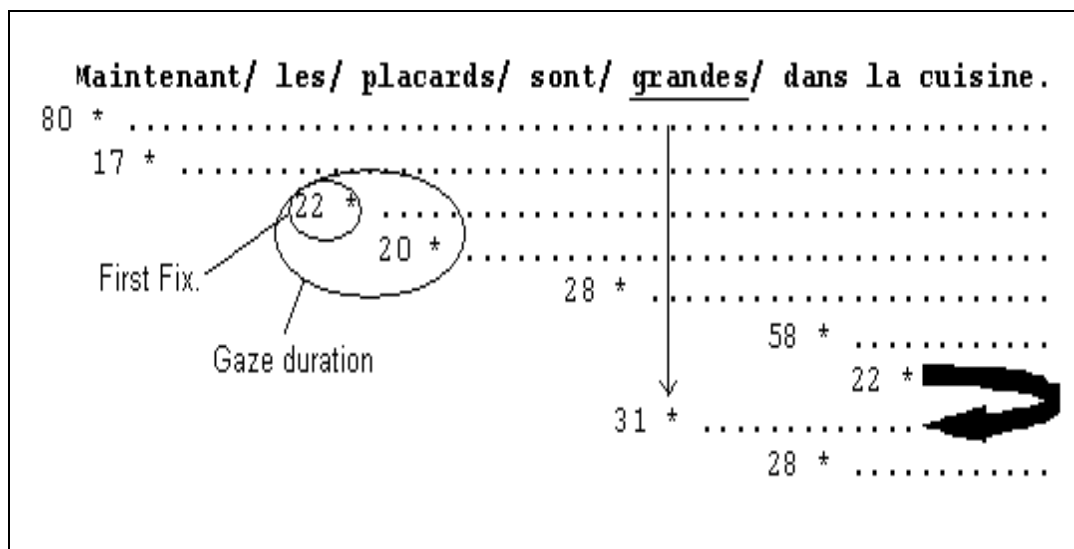
Figure 3: Illustration of eye-movements measurements.

The present example clearly shows that eye-movements can reveal information about the point in time (first or second pass through the sentence) and the location (RoI) where the processing difficulty takes place, as well as the way the reader resolves this difficulty to facilitate sentence comprehension (i.e., re-reading, regression, increase fixation duration). Boland (2004) suggested that first fixation and first pass reading time might reflect syntactic generation, and be influenced by lexical frequency but not by discourse congruency. During the first pass, fixation duration may be increased by (sub)category and other syntactic constraints, and it is only when the structure has been determined that anomaly detection may be reflected by discourse congruency (Boland, 2004; Boland & Blodgett, 2001). Generally, first pass measures are associated with word analysis and word integration in its local context, whereas second pass reflects later processes of sentence integration and, if necessary, reanalysis of sentence (Rayner & Pollatsek, 1989). In sum, eye-movements can provide essential information on syntactic and semantic processes as well as later processes involved in sentence comprehension.

2.2   Eye-movements: a brief literature review

2.2.1 Eye-movements in L1

For monolinguals, eye-movements during reading have been used to examine aspects of language processing such as the effects of lexical neighbourhood (Perea &

Pollatsek, 1998), the processing of syllables (Carreiras & Perea, 2004), phonological and orthographic processing (Rayner, Pollatsek & Binder, 1998), morphological processing (Pollatsek, Hyona & Bertram, 2000), lexical ambiguity (Rayner, Cook, Juhasz, & Frazier, 2006), syntactic processing (Carreiras & Clifton, 1999), plausibility (Pickering & Traxler, 1998), and discourse context effects (Altmann, Garnham & Denis, 1992; Boland, 2004; Boland & Blodgett, 2001). A review of studies on eye-movements in reading can be found in Rayner (1998). See also Carreiras and Clifton (2004) for further details on this methodology and its interpretation.

As the focus of the present thesis is gender processing, we will reduce the review of monolingual research to one of the rare studies that investigated gender agreement with eye-movements[4]. Deutsch and Bentin (2001) examined the role of syntactic and semantic factors in sentential processing of grammatical gender agreement in Hebrew. In Hebrew, verbs are inflected for person and tense, but also for number and gender. Deutsch and Bentin (2001) manipulated subject-verb gender agreement, using either animate or inanimate subjects, marked or unmarked predicates (see examples in Table 3 [5]). Participants made longer first fixations when the predicate was incongruent with the subject than when it was congruent; this effect, however, was obtained only when the gender of the predicate was morphologically marked. There was also an interaction showing a larger effect for animate than inanimate subjects. Second pass reading times confirmed the gender agreement effect with no interaction with animacy or markedness. The authors concluded that the interaction between animacy and gender agreement in first pass suggests that semantic information may be available in early processing. However, the interaction with morphology suggests that when predicates are not marked morphologically, the syntactic violation is less apparent and thus takes longer to be processed.

---

[4] The same paper includes ERPs. The combination of the two methodologies allowed the authors to draw conclusions about online processing in comprehension. These results will be reported in chapter 3.
[5] To maintain the original transliteration, the table was directly imported from Deutsch & Bentin (2001)

Table 3

Examples of the four experimental condition in Hebrew with English translation (imported from Deutsch and Bentin, 2001 for reason of characters).

	Animate	Inanimate
Unmarked		
Congruent	"The woman saw that *the boy had fallen into the pond.*" "Hʔiʃa raʔata ki *hayeled* (article "ha" + subject masc. sing. "the boy") napal (predicate masc. sing. "had fallen") letox habrexa."	"The woman saw that *the diamond had fallen into the pond.*" "Hʔiʃa raʔata ki *hayahalom* (article "ha" + subject masc. sing. "the diamond") napal (predicate masc. sing. "had fallen") letox habrexa."
Incongruent	"The woman saw *that the girl had fallen into the pond.*" "Hʔiʃa raʔata ki *hayalda* (article "ha" + subject fem. sing. "the girl") napal (predicate masc. sing. "had fallen") letox habrexa."	"The woman saw that *the necklace had fallen into the pond.*" "Hʔiʃa raʔata ki *haʃarʃeret* (article "ha" + subject fem. sing. "the necklace") napal (predicate masc. sing. "had fallen") letox habrexa."
Marked		
Congruent	"I enjoyed seeing how *the actors were enchanting the tired audience.*" "ʔani neheneti lirʔot keytzad *hasaxkanim* (article "ha" + subject masc. pl. "the actors") maksim**im** (predicate masc. pl. "enchanting") ʔet hakahal haṣayef."	"I enjoyed seeing how *the movies were enchanting the tired audience.*" "ʔani neheneti lirʔot keitzad *hasratim* (article "ha" + subject masc. pl. "the movies") maksim**im** (predicate masc. pl. "enchanting") ʔet hakahal haṣayef."
Incongruent	"I enjoyed seeing how *the actresses were enchanting the tired audience.*" "ʔani neheneti lirʔot keytzad *hasaxkaniot* (article "ha" + subject fem. pl. "the actresses") maksim**im** (predicate masc. pl. "enchanting") ʔet hakahal haṣayef."	"I enjoyed seeing how *the pictures were enchanting the tired audience.*" "ʔani neheneti lirʔot keytzad *hatmunot* (article "ha" + subject fem. pl. "the pictures") maksim**im** (predicate masc. pl. "enchanting") ʔet hakahal haṣayef".

As far as we are aware, no studies have investigated grammatical gender processing within the NP with eye-movements in monolinguals. Bilingual studies using eye-tracking are not numerous and the few studies available do not concern local gender agreement (i.e., within the NP). Nevertheless, they are of interest for the present thesis as they compare native and non-native sentence processing. In the next section, a handful of these studies will be presented.

2.2.2 Eye-movements in L2

Frenck-Mestre and Pynte (1997) examined sentence processing in native and non-native speakers using syntactic ambiguity resolution. In a first experiment, they compared French native speakers and late English-French bilinguals. They manipulated sentences that contained local syntactic ambiguity (see examples 12a

and 12b) to check whether lexical properties of the critical verb would affect syntactic ambiguity resolution.

(12a) *Il rate le train <u>de peu / de midi</u> et décide alors de chercher un hôtel.*
He misses the train <u>by little / of noon</u> and decided thus to look for a hotel.

(12b) *Il accuse l'ambassadeur <u>d'Indonésie / d'espionnage</u> mais il n'est pas certain des faits.*
He accuses the ambassador <u>of Indonesia / of espionage</u> but he isn't certain of the facts.

In example (12a), the verb is transitive, but it is generally followed by only one complement (monotransitive), whereas in example (12b), the verb usually takes two complements (ditransitive). Both native and non-native readers showed differences of ambiguity resolution as function of the type of verb. All readers were faster to read sentences in which the target segment modified the preceding noun (e.g., *de midi* in example 12a), than those in which the target segment modified the preceding verb (e.g., *de peu* in example 12b). The reverse was found for ditransitive verbs, NP attachment taking longer to process than VP attachment. The analysis of standard eye-movements measures revealed an earlier difference between monotransitive and ditransitive verbs for bilinguals (from first fixation), suggesting that non-native speakers were even more sensitive to verb subcategorisation information than monolinguals.

In a second experiment, the same authors tested French-English and English French bilinguals with the same type of syntactic ambiguities. However, this time, sentences contained verbs that had different properties in the bilinguals' two languages, as opposed to having similar structure in their first experiment.

(13a) Every time the dog obeyed the pretty little girl showed her approval.
Chaque fois que le chien obéissait la jolie petite montrait sa joie.

(13b) Every time the dog barked the pretty little girl showed her approval.
Chaque fois que le chien aboyait la jolie petite montrait sa joie.

In example (13a), the sentence in English is ambiguous up to the main verb ('showed') because the subordinate verb 'obey' can be either transitive or

intransitive, whereas there is no ambiguity in example (13b) because 'bark' is intransitive and the reader must, either immediately or shortly thereafter, treat the subsequent NP as the head of a sentential complement. However, in French both sentences are disambiguated at the subordinate verb as both 'obey' and 'bark' are intransitive verbs. Results showed that bilinguals revealed some hesitation in their second language when reading structures containing conflicting lexical information across their two languages. However, despite this momentary localized effect of transfer, similar patterns of eye-movements were obtained for both groups when ambiguity was resolved.

These experiments are in line with other bilingual studies using eye-movement recordings: all suggest that native and non-native immediate syntactic parsing are similar and influenced by the same factors (Hoover & Dwivedi, 1998; Juffs & Harrington, 1996). For a review on eye-movement and syntactic processing in a second language, see Frenck-Mestre (2004; 2005). Only a few aspects of syntactic processing in L2 have been studied using this methodology so far, and further research needs to be undertaken. In chapter 3, we report an experiment comparing syntactic processing in L1 and L2.

3 ERPs VS. EYE-MOVEMENTS IN SECOND LANGUAGE COMPREHENSION

As we have seen, both ERP and eye-movement methodologies can detect very subtle effects; they reveal where difficulties occur in reading a sentence. However, the studies we reported showed different results for L2 processing with ERPs and eye-movements. While eye-tracking studies have suggested similar syntactic parsing in L1 and L2, ERPs revealed different effects that are influenced by proficiency and age of acquisition. These discrepancies can be accounted for by several differences. First, the types of results obtained with the methodologies are not similar. Indeed, both ERPs and eye-movements provide information on *when* and *where* in the sentence the difficulty is processed; however, only ERP components can reveal the *nature* of the processing involved in the resolution of the difficulty (even though the meaning of some components remain a question of debate). Second, the types of syntactic

processing investigated were not the same for the two methodologies. ERP studies have mainly examined syntactic anomalies, whereas eye-movements observed syntactic ambiguities. Third, the question addressed in most ERP studies was the 'critical period hypothesis' (but see Osterhout et al., 2004; 2006). Early and late bilinguals were compared on responses to syntactic anomalies; and late bilinguals and monolinguals were compared on responses to syntactic and semantic anomalies. Eye-movements only studied late bilinguals' expertise of L2 processing. There is a common finding across methodologies, nonetheless, that shows that native speakers and late bilinguals demonstrate very similar patterns in relation to sentence processing.

These comments prove that it would be of great interest to combine ERPs and eye-movements to study syntactic and semantic ambiguities and/or anomalies in second language. So far, only one monolingual study has used these two methodologies with the same materials in native speakers of Hebrew (Deutsch & Bentin, 2001). They examined the interrelation between syntactic analysis of agreement and semantic processing. The results they reported were consistent across methodologies. The effects obtained were complementary and allowed the authors to draw conclusions and discuss their finding in relation with interactive, constrained-based models for on-line sentence processing.

To explain the differences between the results obtained with ERPs and with eye-movements, more studies must be conducted comparing the same population and the same type of processing. ERPs could show the processing involved in the resolution of ambiguity or anomaly, whereas eye-movements would show how the reader resolves difficulties (e.g., re-reading). In chapter 3, we will present a bilingual experiment examining gender agreement violation between the noun and the adjective in first and second language using both methodologies.

CHAPTER SUMMARY

In this chapter we introduced ERP and eye-tracking methodologies and reported various studies investigating L1 and L2 processing using these methodologies. Overall, these studies have shown that in contrast to semantic processing that is quite similar in L1 and L2, syntactic processing shows differences that vary according to

age of acquisition and proficiency. We also presented Friederici's (2002) model which claims to represent universal syntactic processing mechanisms both in monolinguals and highly proficient bilinguals. On the other hand, we pointed out critiques of this model. In line with the studies we reviewed in this chapter, we conducted two ERP and one eye-tracking experiments to test Friederici's model and obtain essential information on gender processing in L1 and L2. These experiments are reported in the next chapter.

CHAPTER 3

GENDER IN COMPREHENSION: EMPIRICAL DATA

In this chapter we report three experiments examining gender processing in L1 and L2 to investigate similarities between processing in native and non-native speakers, and how much of an influence the native language has on L2 processing. It is important to note that we draw conclusions from the results obtained with the L2 speakers we tested. Thus, these conclusions provide information about gender representation and processing in L2, but may vary with speakers' level of proficiency. In two ERP and one eye-tracking experiments, French native speakers, English-French and German-French learners read sentences containing gender agreement violations between the noun and the post-posed adjective (Experiment 1), the pre-posed adjective and the noun, and the noun and the predicative adjective (Experiments 2 and 3). Prior to drawing any strong conclusions about the similarities between L1 and L2 in the acquisition of gender agreement, we first tested the assumptions made in Friederici's (2002) three-phase model in relation to syntactic process mechanisms in monolinguals. Subsequently, we examined the performance of L2 participants in a psycholinguistic framework.

1 EXPERIMENT 1

Experiment 1 is the first of three experiments investigating how L2 speakers represent and process grammatical gender in comprehension. One important question in SLA concerns the similarities between L1 and L2 language processing. In the previous chapter, we reviewed ERP studies of semantic processing, most of which have revealed that processing is similar in native and non-native speakers. The comparison of native and non-native speakers' ERP responses to lexico-semantic anomalies showed similar patterns in L1 and L2, however some differences are noteworthy; the N400 effect provoked by these anomalies (Kutas & Hillyard, 1980) sometimes appears with a delayed latency and reduced amplitude in L2 speakers (Ardal et al., 1990; Hahne, 2001). Syntactic processing has also been investigated in monolingual ERP studies that report a P600 effect in response to syntactic violations, preceded or not by early negativities. Studies examining grammatical gender show a P600 effect in response to gender agreement violations within the NP but also between other elements of the sentence (Deutsch & Bentin, 2001; Osterhout & Mobley, 1995; van Berkum et al., 1999). For gender agreement violations within the NP, a P600 effect has been observed in Dutch (Hagoort & Brown, 1999), in French (Foucart & Frenck-Mestre, under revision) and in German (Gunter et al., 2000). This effect was either preceded by a LAN effect (Gunter et al., 2000) or not (Hagoort & Brown, 1999; Foucart & Frenck-Mestre, under revision). Unlike semantic processing, syntactic processing in an L2 seems to differ from L1 processing. While some studies revealed a similar P600 effect for native speakers and L2 learners in case of syntactic violations (Foucart & Frenck-Mestre, under revision; Hahne, 2001; Sabourin, 2003; Weber-Fox & Neville, 1996), other studies failed to do so (Hahne, 2001; Hahne & Friederici, 2001; Sabourin, 2003; Weber-Fox & Neville, 1996). Some of these studies found a P600 effect depending on the group of participants (Hahne, 2001; Sabourin, 2003; Weber-Fox & Neville, 1996) which suggests that overlap of grammatical features between the L1 and L2 and/or age of acquisition may play a role in the degree of similarity of the ERP response. Early left negativities have only recently been reported in L2 learners (Hahne et al., 2006; Rossi et al., 2006). The absence of ELAN in previous studies may be due to participants' proficiency.

Friederici and collaborators (Rossi et al, 2006) have recently suggested that the three-phase model proposed to represent universal syntactic processing in monolinguals (cf. Friederici et al., 1996; chapter 2) could serve as a theoretical framework for bilinguals. This model proposes an initial stage of autonomous phrase structure construction (reflected by an ELAN), a second phase where morpho-syntactic processing occurs (reflected by a LAN), and a third phase of reanalysis and repair (reflected by the P600). This model has been called into question on various accounts (Osterhout et al, 2004), one of which is that the presence of early negativities in response to syntactic violations is not consistent across studies. Moreover, Krott et al. have suggested recently that LAN effects can be considered as a class of effects, since the causes of the emergence of negativities are different. While a LAN effect can be displayed for syntactic violations, it can also be found for morphological mismatch between the word presented and its stored representation in the mental lexicon (Krott et al., 2006). In the experiments reported in this chapter, we tested whether syntactic violations (gender agreement violations) provoke negativities or not. If negativities are found, the assumptions made in Friederici's model would be supported. In contrast, if no negativity emerges, the claim that the model represents universal syntactic mechanisms would be jeopardised. It is important to note that we do *not* challenge the claim that L2 processing can be represented in an L1 model. Actually, we do share the assumption that highly proficient L2 speakers can achieve native-like processing, as shown by ERPs, regardless of the age of acquisition (Frenck-Mestre, 2002; Hahne et al., 2006; Schwartz & Sprouse, 1996; Rossi et al., 2006).

So far, only one study has investigated grammatical gender processing with ERPs in L2 learners from various L1 backgrounds (Sabourin, 2003, see chapter 2 for details). Sabourin (2003) compared native speakers of Dutch and L2 speakers of Dutch who were native speakers of German, English and Romance languages (there was no distinction between native speakers of French, Italian, Portuguese and Spanish). Results for gender agreement violations between the determiner and the noun showed a P600 effect for Dutch native speakers. Among the L2 learners,

German speakers revealed a pattern similar to that of native speakers, while no effects emerged for English and Romance speakers. The author concluded that not only does grammatical gender have to be present in the learner's native language for a gender system to be acquired in L2, but the two systems must also be very similar. However, these results have to be considered with caution, as there were discrepancies both within and across participant groups (e.g., number of participants and L2 experience, see chapter 2 for detail). In contrast to these results, Foucart and Frenck-Mestre (under revision) found a similar P600 effect for native speakers of French and German-French learners in response to gender agreement violations between the definite article and the noun in French sentences (e.g., *la$_{fem}$/*le$_{masc}$ clef$_{fem}$ était dans la serrure*; 'the key was in the keyhole'). Since the agreement systems of French and German are not as close as those of German and Dutch, the fact that German learners showed a similar pattern to French native speakers suggests that grammatical gender agreement can be processed on-line, in a native-like fashion, in L2 even if there is no direct mapping between the gender systems of the two languages.

To investigate the question of similarity between L1 and L2 gender processing, we compared French native speakers to two groups of adult learners whose proficiency was high enough to permit them to attend courses in a French university: English-French and German-French advanced learners. In Experiment 1, we manipulated gender agreement violations between post-posed adjectives and nouns. We used post-posed adjectives first because it is the most frequent position for adjectives in French. Second, we took for granted that L2 speakers were able to acquire new word orders in their L2, but we wanted to examine whether computing gender agreement was costlier when occurring within a new structure (post-posed adjectives) than within a structure identical in L1 and L2 (pre-posed and predicative adjectives). Agreement violations for post-posed adjectives have not been examined in a sentential context with ERPs[6] to our knowledge. In line with previous studies examining gender agreement violations within the NP, we expected a P600 effect for

---

[6] Barber & Carreiras (2005) examined gender agreement violations between the noun and the post-posed adjective but in word pairs. They found a N400 effect and concluded that the effect was most likely due to the type of presentation (word pair vs. sentence context).

French native speakers, either preceded or not by a LAN effect. For L2 learners, we expected to find a P600 effect elicited by gender agreement violations in both groups of learners. However, it is possible that the presence of a grammatical gender system in German could affect gender agreement in the L2, French. This leads us to the question of the influence of the native language on L2.

The choice of population was made according to the grammatical properties of the native language in relation to the second language. We selected English-French learners because English does not possess a system of syntactic gender for nouns, expressing only natural gender via pronouns. In contrast, German and French do have genuine grammatical gender system, which differs in number of genders as well as in adjective position relative to the noun. The interesting question for English speakers is whether they are able to process gender agreement in their L2 despite the absence of grammatical gender in their L1. In contrast, the question for German speakers is whether they process gender independently in their L2 or whether they apply the system of their L1 to their L2. This interference could be lexical and/or ruled-based. In other words, German speakers may assign the gender of German nouns to French nouns even if gender is not shared across languages, and they may also apply the agreement rules of their L1 in French even if they differ from one language to the other. If they do apply their L1 gender system, gender processing in French will be hampered, and the effects that emerge in the German group (if any) should differ from those of native speakers. To enable us to investigate this question, we selected stimuli that either shared the same gender in French and German or did not. This variable, called Language Coherency, tested whether German speakers are able to process the lexical gender of French independently of the stored lexical gender of German nouns.

1.1 Method

1.1.1 Participants

Fourteen French native speakers, 14 English-French and 14 German-French learners received 20 euros for their participation. The mean age of all participants was 22 years. They had normal or corrected-to-normal vision. All were students at the University of Provence. The L2 learners were Erasmus students; they had all studied

French at school (mean 8 years for both groups) and passed the required exam to attend courses in a French university (individual results not available). After the experiment, they were asked to complete an offline test which consisted of circling the correct gender marked article of the words presented during the experiment (see Appendix A). Results were roughly similar for English (errors: 7.3%, SD: 4.7) and German speakers (errors: 4.2%, SD: 3.7; t (26) = 1.56, p = .13). Non-native participants were also asked to self-rate their level of French on a scale from 1 to 6 (1 = very poor; 6 = excellent) for different aspect of language. Germans estimated their level slightly higher (written comprehension, 4.8; oral comprehension, 4.8; written production, 3.8; oral production, 4.2) than English speakers (written comprehension, 4.3; oral comprehension, 4.3; written production, 3.6; oral production, 3.6). However, since no significant difference was found between the two groups, proficiency was not considered as a covariate in the experiment (written comprehension, t (26) = .82, p = .41; oral comprehension, t (26) = .96, p = .34; written production, t (26) = .32, p = .74; oral production, t (26) = 1.38, p = .18).

1.1.2 Materials

Ninety-six nouns were presented embedded in short sentence contexts. These nouns were inanimate, masculine or feminine (48 of each gender), of low to medium frequency (mean per million: 33.3, Brulex, Content, Mousty, & Radeau, 1990) and between 3 and 8 letters in length (mean 5.8, see Appendix B). NPs were composed of a plural definite article, a noun and an adjective (complete materials are presented in Appendix C). The plural form of the article was used, so that no gender information was provided (in French, the plural form of the definite determiner is identical both for masculine and feminine words; e.g., *le$_{masc}$ livre$_{masc}$* ('the book'), *la$_{fem}$ table$_{fem}$* ('the table') → *les livres, les tables*). Nouns preceding the critical, post-posed adjectives were selected so that they either shared the same gender in French and German or not (e.g., French, la *clef*$_{fem}$; German, *der Schlüssel*$_{masc}$; the key). Cognates across the 3 languages were avoided. Nouns were equated for length and frequency across genders and gender-coherency across languages. In addition to these 96 nouns, a set of 40 adjectives were selected (frequency mean per million: 130.1, between 4 and 8 letters, mean 5.9). The critical adjectives were both orthographically and phonologically modified when related to a feminine noun (e.g., *le balai vert; la*

chaise verte; 'the green broom', 'the green chair'). These 40 adjectives were paired with the 96 nouns, with each adjective presented between 1 and 6 times. The noun-adjective pairs were presented visually in a short sentence context. Each sentence following the same pattern: adverb (or adverbial phrase), plural definite article, noun, critical adjective, copula and complement (see Table 4). In addition to the syntactic manipulation, 48 semantically anomalous sentences were created. They contained the same stimuli presented in the syntactically correct form, but associated with semantically anomalous adjectives. These sentences were used as a control, and since the concern of the present thesis is syntactic processing the results for semantic sentences will not be reported here. Forty-eight sentences were added as fillers. The pattern of filler sentences was similar to experimental sentences, but nouns shared the same gender in both languages, and adjectives were invariable so that gender was not marked on the adjective (e.g., *les vélos*$_{masc}$ *rouges*; *les chaussures*$_{fem}$ *rouges*; the red bikes, the red shoes). Two lists were created such that each syntactic noun-adjective pair was seen in both conditions (gender agreement vs. disagreement), and each semantic pair was as well (correct vs. anomalous), but in only one condition for a given participant. An example of all conditions is presented in Table 4.

Two lists were created such that all nouns were seen in both syntactic and semantic conditions (correct vs. incorrect) but in only one condition per list. In each, there were 24 sentences per condition, defined by Agreement (gender agreement between the noun and the critical adjective), Language Coherency (nouns of same vs. different gender in French and German) for syntactic sentences and by Semantic (correct vs. anomalous) for semantic sentences. The sentences were distributed in a fixed-random order; and six fixed random orders were created per list. Each list began with 4 training sentences.

Table 4

Example of all the conditions presented in Experiment 1

Condition	Examples

Syntactic (gender agreement vs. disagreement)

Opposite gender across languages

Correct — *En été, les chaises$_{fem}$ blanches$_{fem}$ sont dans le jardin.*

Incorrect — *En été, les chaises$_{fem}$ blancs$_{masc}$ sont dans le jardin.**
In summer, the white$_{fem/masc*}$ chairs$_{fem}$ are in the garden

Same gender across languages

Correct — *Les balais$_{masc}$ verts$_{masc}$ sont dans le garage.*

Incorrect — *Les balais$_{masc}$ vertes$_{fem*}$ sont dans le garage.**
The green$_{masc/fem*}$ brooms are in the garage.

Semantic (correct v incorrect meaning)

Opposite gender across languages

Correct — *Les tableaux anciens sont au musée.*
The old pictures are at the museum.

Incorrect — *Les tableaux cuits sont au musée.**
The cooked pictures are at the museum.

Same gender across languages

Correct — Cette année, les montres rondes sont très tendance.
This year, round watches are very fashion.

Incorrect — *Les montres prudentes sont très chères.**
Careful watches are very expensive.

1.1.3 Procedure

Sentences were presented visually, at a rate of 650 ms (500 ms presentation followed by 150 ms blank screen) in a single block of 196 sentences. Following each sentence, a "yes/no" prompt was presented, and participants were requested to judge whether the sentence was correct or not (syntactically and/or semantically). Half of the participants were told to press the 'yes-button' with their left hand; the other half used their right hand. Responses to the questions were recorded. Participants were seated comfortably in a dimly lit, sound attenuated, electrically shielded room during recording. They were requested not to move any part of their body or to make any eye movements outside of rest periods ('yes/no' prompt). A short break was provided in the middle of the experiment.

1.1.4 EEG Recording

EEG activity was recorded continuously from 21 scalp locations (see Figure 4), using tin electrodes attached to an elastic cap (Electrocap International). Scalp sites included standard International 10-20 locations (Jasper, 1958) over frontal, central, temporal, posterior temporal, parietal and occipital areas (Fp1, Fp2, F7, F3, C3, Fz, Cz, Pz, T5, P3, F4, F8, C4, T6, P4, O1, O2) of the left and right hemispheres. In addition, electrodes were placed centrally between homologous anterior and central sites (Fc5, Fc6), central and parietal sites (Cp5, Cp6). Horizontal eye-movements were monitored by means of an electrode placed at the outer canthus of the right eye while blinks and vertical eye-movements were monitored via an electrode beneath the left eye. All electrodes were referenced to the left mastoid. An electrode was placed over the right mastoid to ascertain whether any effects of experimental variables were visible on the mastoid recordings (none were found). The EEG was amplified with a bandpass of 0.1 – 40 Hz (3dB cutoff) by means of an SAI Bioamp 32 channel Model and was digitized on-line at 200 Hz. EEG were later filtered below 15 Hz. The electrode impedance threshold value was set to 3 khm for scalp electrodes and 15 khm for face electrodes. Epochs began 100 ms prior to stimulus onset and continued 1100 ms thereafter. Average ERPs were formed off-line from trials free of muscular and/or ocular behaviour and amplifier blocking (behavioural rejection was performed by a computerized routine and led to less than 6% of rejections per stimulus category overall). Averaging was performed without regard to behavioural responses.
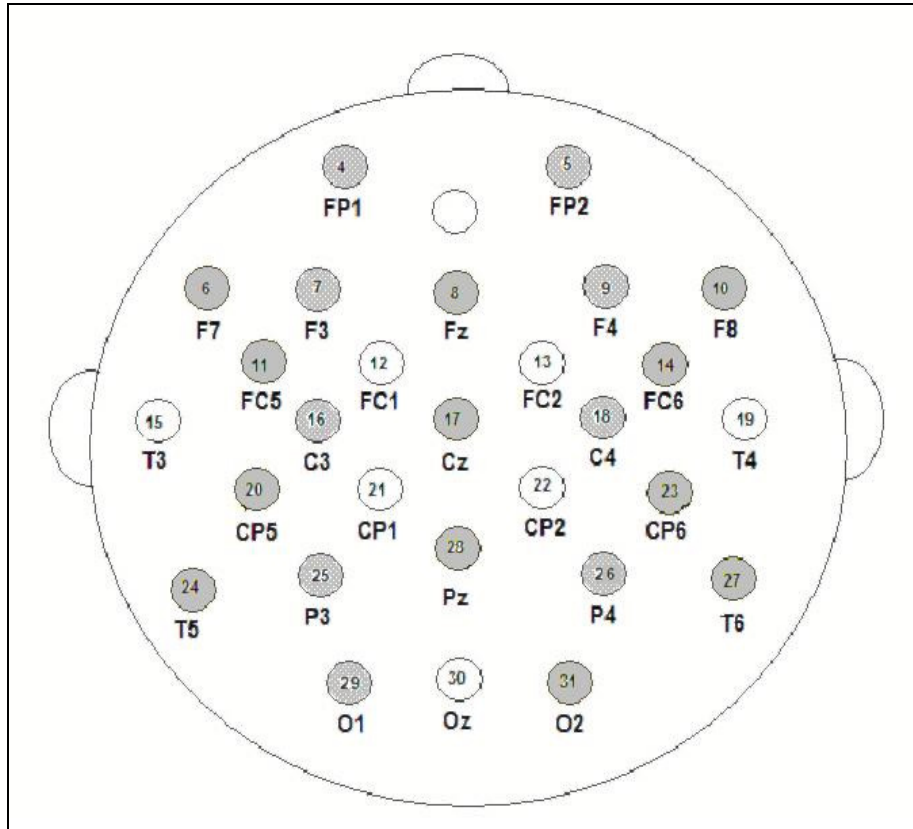
Figure 4: Scalp electrode locations used in Experiment 1 and 2

1.1.5 Data Analysis

The ERP data were quantified by calculating the mean voltage amplitudes and peak latencies, for four time windows: 80-180, 160-280, 300-500 and 500-800 ms post-presentation of the critical adjective. These windows were selected based on prior studies of visual processing of linguistic stimuli, and roughly correspond to the temporal windows associated with the N1, P2, N400 and/or LAN, and P600 components that are frequently observed in these studies. The main components of interest, based on prior studies of grammatical gender, were the P600 (defined as the mean positive amplitude 500–800 ms post stimulus) and the LAN (defined as the mean negative amplitude 300-500 post-stimulus). Analyses were also performed on the earlier time windows to ascertain any possible earlier differences between sentence conditions. Data were analysed at midline and lateral sites. Three-way ANOVAs with repeated measures for Agreement (gender agreement vs. violation),

Language Coherency (opposite vs. same gender in French and German), and Electrode (Fz, Cz, Pz) were performed on data acquired at midline sites. Four-way ANOVAs with repeated measures on Agreement, Language Coherency, Hemisphere and Electrode were performed on data acquired over seven lateral sites per hemisphere (F7, F3, Fc5, C3, Cp5, T5, P3, F4, F8, Fc6, C4, Cp6, T6, P4). The factor Noun Gender (masculine vs. feminine words) was not included in the analyses as grand averages revealed no differences for this factor (<1). The Greenhouse-Geisser (1959) correction was applied to repeated measures with greater than one degree of freedom. All significant differences involving more than 2 conditions were confirmed by post-hoc comparisons.

1.2 Results

The grand means revealed differences in the waveforms for adjectives that agreed in gender with the preceding noun as compared to those that did not. French native speakers (Figure 5) and English-French learners (Figure 6) showed a positive deflection in the waveform for sentences containing gender agreement errors, between 500-800ms after the onset of the critical adjective, corresponding to a P600. Descriptively, German-French learners (Figure 7) showed a negative deflection in the waveforms at the 100-180ms time-window, corresponding to the N100 components, for sentences containing gender-agreement errors. These differences were confirmed in ANOVAs performed on the mean voltages obtained for each sentence condition as a function of time window and electrode sites.

No main effects or interactions were found in the N100 (100-180 ms) and P200 (160-280 ms) and N400 (300-500 ms) time-windows.

P600 (500-800 ms)

An effect of Agreement was found at midline (F (1, 39) = 11.53, $p <$ .002) and at lateral sites (F (1, 39) = 13.26, $p <$ .0007). The effect of Agreement tended to be modified by Group at midline (F (2, 39) = 2.84, $p <$ .07), and the interaction was significant at lateral sites (F (2, 39) = 5.89, $p <$ .005). At lateral sites, Agreement was also modified by a significant interaction involving Group x Agreement x

Hemisphere x Electrode (F (12, 234) = 2.37, p < .006). Post hoc comparisons (Scheffé) revealed a larger positivity for French native speakers and English L2 learners than for German learners. They also showed that the effect was widespread for native speakers, in contrast to a more lateral effect for English learners.

Given the interactions with Group, subsequent ANOVAs were performed on the different time windows for each group independently.

French native speakers

No significant differences emerged as a function of experimental factors prior to the 500-800ms window after the target word. A significant P600 effect was found at midline (F (1, 13) = 6.46, p < .02) and at lateral sites (F (1, 13) = 9.78, p < .008). Adjectives that disagreed in gender with the previous noun provoked a positive deflection relative to those that agreed in gender (see Figure 5). As might be expected for monolinguals, no effect of Language Coherency was found, nor did this factor interact with Agreement.
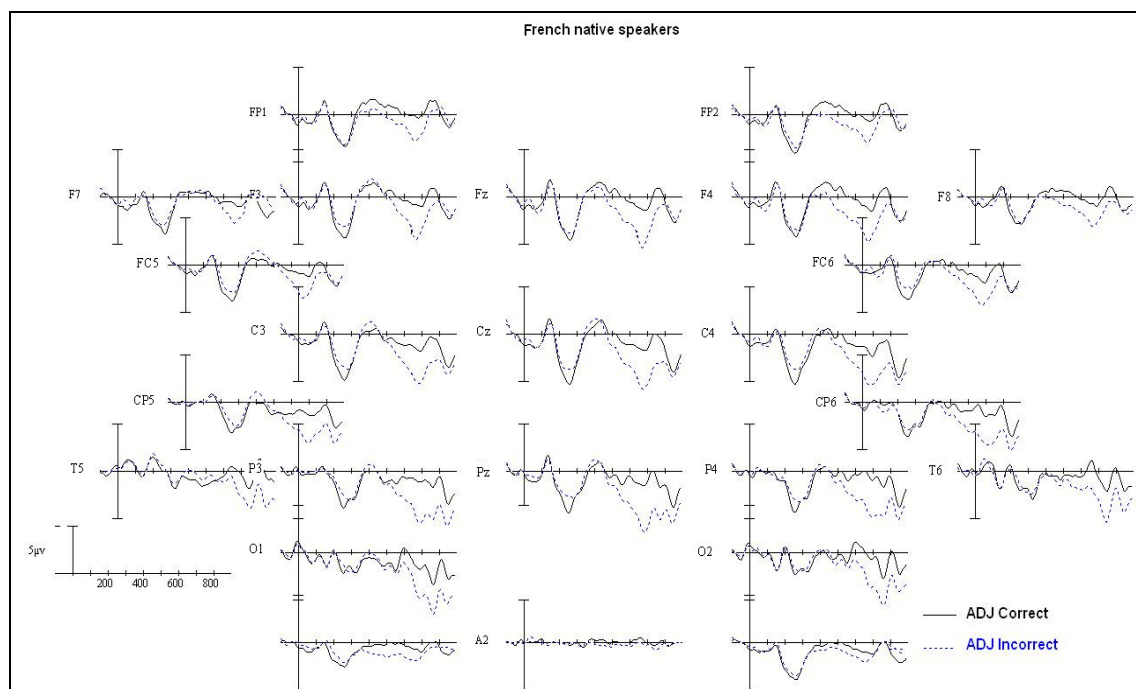
Figure 5: French native speakers. P600 effect when the noun and the post-posed adjective disagree in gender.

<u>English-French learners</u>

No significant effects emerged as a function of experimental factors prior to the 500-800ms window after target word onset. In the 500-800ms time-window a main effect of Agreement was found at midline (F (1, 13) = 10.73, p < .006) as well as at lateral sites (F (1, 13) = 9.54, p < .009); a P600 effect was elicited by gender agreement errors in these learners. No other effects of experimental factors reached significance. To examine the P600 effect further, the performance of this group was directly compared to that of native French speakers. There was a significant Group x Agreement interaction for peak amplitude (F (2, 39) = 13.35, p < .03) at midline, and post hoc comparisons showed a larger and more (typical) posterior P600 effect for French native speakers than for English-French learners who displayed a more frontally distributed effect (see Figure 6). No other experimental factors were significant.
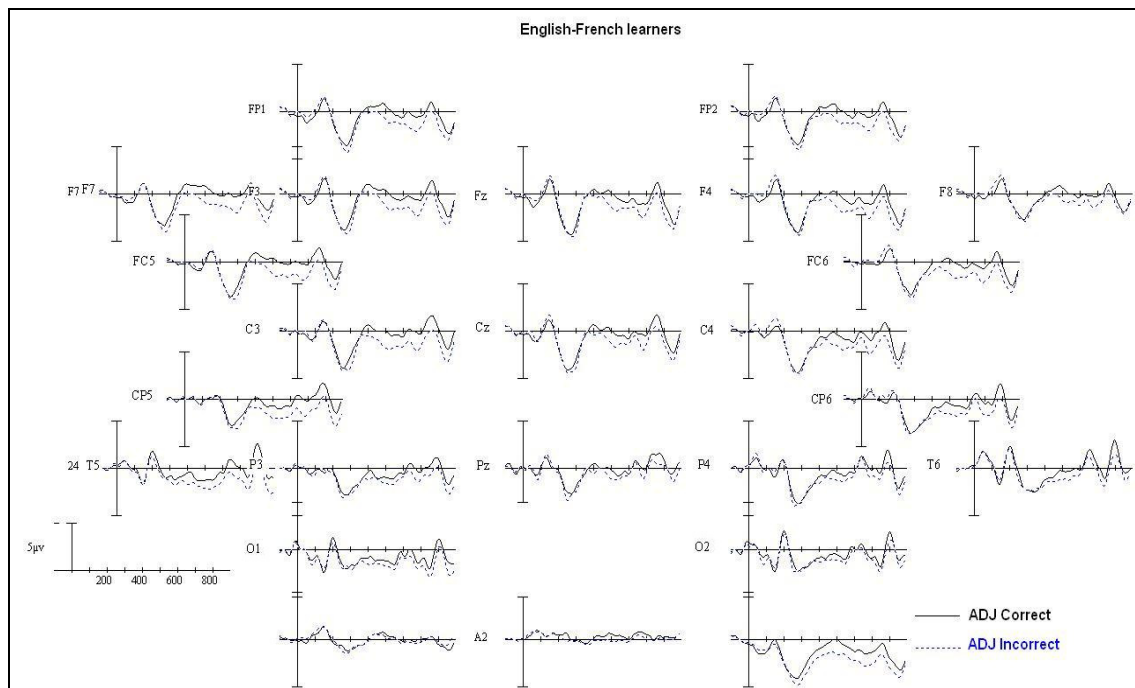
Figure 6: English-French learners. P600 effect to gender agreement errors, between the noun and the post-posed adjective.

<u>German-French learners</u>

The results for German speakers revealed only a significant main effect at midline (F (1, 13) = 5.35, p < .04) as well as at lateral sites (F (1, 13) = 8.25, p < .01) for gender

violations on the adjective following the noun in the N100 time window. This effect had too broad a scalp distribution to be associated with an ELAN. No other main effects or interactions were significant, in any other time window.
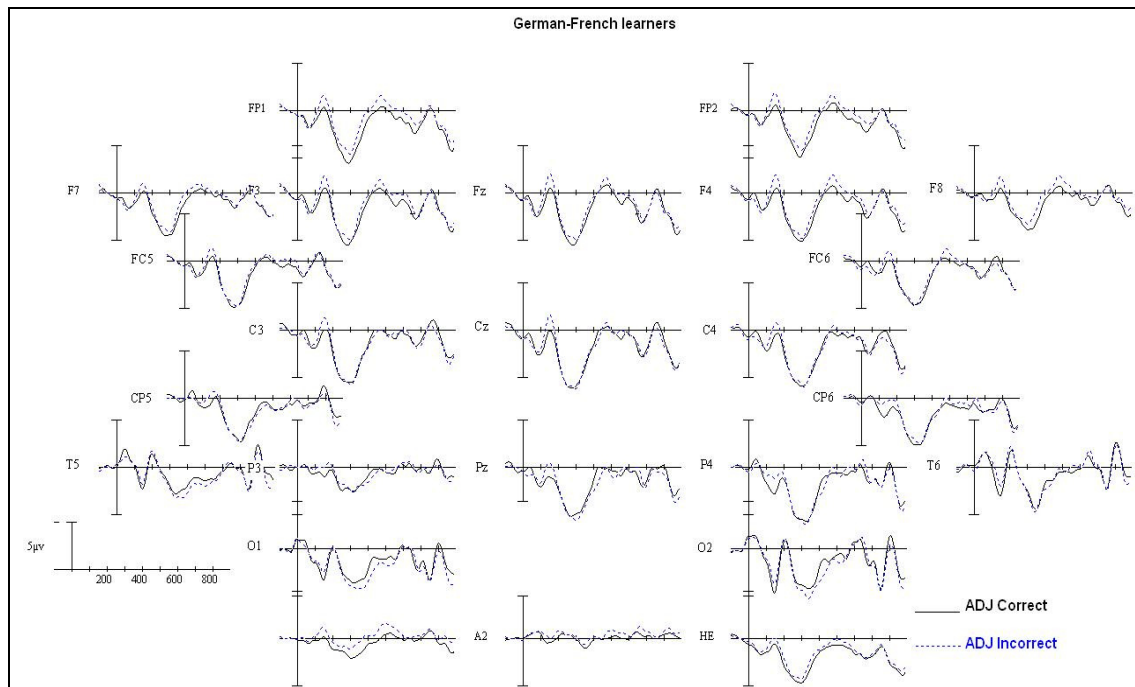
Figure 7: German-French learners. ERP traces for gender agreement errors between the noun and the post-posed adjective and for correct sentences.

1.3 Discussion

In the present experiment we manipulated gender agreement between the noun and the post-posed adjective to investigate whether native and non-native speakers process gender in a similar way, and whether L2 processing is influenced by the speaker's native language.

Before comparing L1 and L2 processing, it is essential to examine native speakers' processing of gender agreement. As predicted, native speakers displayed a P600 effect for gender agreement violations between a noun and a post-posed adjective. This suggests that grammatical gender is processed at the syntactic level, in line with previous studies (Hagoort & Brown, 1999; Osterhout & Mobley, 1995). This effect was not preceded by any (early) negativity, which contrasts with the proposal made by the three-phase functional model (Friederici, 2002). Recall that

this model proposes a first phase consisting of word category anomaly detection (ELAN), a second phase of morpho-syntactic anomaly detection (LAN), and a third phase where syntactic reanalysis and repair occur (P600). Our results, like those obtained in previous studies (Foucart & Frenck-Mestre, under revision; Hagoort et al., 1993, Osterhout & Mobley, 1995), did not show this triphasic process: no (E)LAN preceded the P600. As such, our results do not provide support for the functional model proposed by Friederici et al. (1996; 2002) and question its validity as a model of universal syntactic processing mechanisms.

Among the L2 French learners, native English speakers produced a P600 effect with a similar latency to that found in native speakers, but reduced amplitude and a more frontal distribution. These results are consistent with previous studies showing slight differences in latency and amplitude between L1 and L2 processing (Ardal et al., 1990; Hahne, 2001), but differ from studies showing a larger P600 effect for non-native than for native speakers, suggesting greater difficulty in syntactic integration processes (Hahne & Friederici, 2001). Our results contrast with those obtained by Sabourin (2003), whose English learners of Dutch did not show any effect in response to gender agreement violations in their second language. The presence of a P600 effect here suggests that English speakers are sensitive to gender agreement violations, and hence that they are able to realise agreement in their L2 even within a new syntactic structure (post-posed adjective). This is in line with the proposal made by Friederici and collaborators (Rossi et al., 2006) that highly proficient L2 learners can reach native-like processing levels even if they learned their L2 late in life. Nevertheless, it is important to note that, like native speakers, English-French learners did not show any negativity prior to the P600 effect, and therefore did not display the three ERP components proposed to reflect different stages of syntactic processing and repair in Friederici's three-phase model (Friederici et al., 1996; 2002).

German learners showed only an early negativity to gender agreement errors, which could not be associated with an ELAN because of its widespread distribution. No sign of a P600 effect was apparent in this group. The absence of a P600 effect for

this group can be accounted for by two potential explanations. First, it is important to note that, in German, plural masculine and feminine nouns share the same definite article as well as the same agreement with the adjective (see Chapter 1 for a presentation of German agreement system). There is no distinction in agreement with the adjective for masculine and feminine plural nouns across all cases (e.g., *die kleinen Tische*$_{masc}$, *die kleinen Türen*$_{fem}$). Thus, the first explanation could be that German learners apply rules from their L1 to their L2. This can be beneficial when agreement rules are similar in both languages and learners only have to correctly assign gender to nouns, but as soon as the agreement system differs from L1 to L2, L2 learners will be handicapped in their L2. This would explain why German learners showed a P600 effect similar to native speakers for gender agreement violations between a definite article and a singular noun in French (Foucart & Frenck-Mestre, 2005; under revision), but do not show any effect here, when agreement involved a plural noun and adjective. This hypothesis is referred to as 'the common plural agreement' hypothesis hereafter. The second explanation is related to L1 influence as well, as it concerns the absence of post-posed adjectives in German. The fact that the word order noun + adjective does not exist in German may prevent these learners from engaging in the syntactic process of gender agreement when the adjective is in a post-nominal position. This theory is in line with that proposed by Sabourin and Haverkort (2003) to explain the absence of an effect in German learners of Dutch. In their study, German speakers revealed a pattern similar to that of native Dutch speakers when structures were identical in both languages, but failed to do so when structures differed. This hypothesis is referred to as 'the absence of structure' hypothesis hereafter. However, this explanation seems rather unlikely since the results obtained for our English speakers and in previous studies (White et al., 2004) suggested that agreement can be processed in new syntactic structures. These hypotheses were tested in the Experiments 2 and 3 which involved gender agreement with pre-posed and predicative adjectives.

2 EXPERIMENT 2

In Experiment 1, we suggested that the absence of an effect for German speakers could be due either to the fact that plural agreement is common for masculine and feminine words in German (i.e., 'common plural agreement' hypothesis, see discussion of Experiment 1); or to the absence of post-posed adjectives in the L1 (i.e., 'absence of structure' hypothesis, see discussion of Experiment 1). The present experiment tested these hypotheses. If German speakers do not show a P600 effect for gender agreement violations between pre-posed adjectives and nouns, then the 'common plural agreement' hypothesis would be supported. In contrast, if they show a P600 effect, then the 'absence of structure' hypothesis would be supported.

In this experiment, we again manipulated gender agreement violations to investigate the similarities between L1 and L2 gender processing, and the influence of the native language on the acquisition of grammatical gender in L2. Therefore, we used word orders that appear in all 3 languages to check whether L2 learners automatically process grammatical gender agreement independently of whether it occurs within a structure that exists in their L1 (i.e., pre-posed and predicative adjectives) or does not (i.e., post-posed adjectives). Violations involved either the pre-posed adjective and the following noun, or the noun and the predicative adjective (see examples below). In line with studies on syntactic violations, we expected a P600 effect to gender agreement violations in native speakers. Given the results obtained for similar agreement violations in Experiment 1, we did not expect any earlier negativity. If indeed no negativity emerges, the three-phase model proposed by Friederici (2002) would be further challenged.

The results of Experiment 1 led us to expect a P600 effect for English learners similar to that we observed for gender violations between the noun and the post-posed adjective. Consistent performance would suggest, again, that highly proficient L2 speakers can reach native-like processing levels.

2.1 Method

2.1.1 Participants

Twelve French native speakers, 12 English-French and 12 German-French learners received 20 euros for their participation. Some participants had taken part in the first

experiment (5 English speakers; 5 German speakers) to reduce the variability due to participants' knowledge of French. However, as some prior participants had gone back to their home country, they had to be replaced. Experiments 2 was conducted 5 months after Experiment 1, and analyses revealed no significant difference between the results for the group who had taken part into the previous experiment and the new group. The mean age of all participants was 21.6 years. They all had normal or corrected-to-normal vision. L2 learners were Erasmus students at the University of Provence. They had all studied French at school (mean 8 years for both groups) prior to their arrival in France. They had all passed the exam that allows foreign students to attend courses in a French university (detailed results not available). English and German speakers obtained very similar results on the off-line test, conducted after the main ERP experiment, which consisted in circling the correct gender-marked article for the critical nouns presented during the experiment (English, mean: 5.6 errors, SD: 3.9; German, mean: 5.6 errors, SD: 3.5; t (22) = .06, p = .91). When asked to self-rate their level in French, German and English learners produced fairly similar results (Germans, written comprehension, 4.6; oral comprehension, 4.4; written production, 4; oral production, 3.9; English, written comprehension, 4.5; oral comprehension, 4.3; written production, 3.9; oral production, 3.7) and no significant difference was found between their self-assessments (written comprehension, t (22) = .25, p = .79 oral comprehension, t (22) = .24, p = .80; written production, t (22) = .49, p = .63; oral production, t (22) = .81, p = .42).

2.1.2 Materials

The same 96 nouns as in Experiment 1 were used (complete materials are presented in Appendix B); however, the pattern of the sentences was different (see Appendix D). Instead of a post-posed adjective, sentences contained either a pre-posed or a predicative adjective. The pattern of sentences was either: adverb (or adverbial phrase), plural definite article, critical adjective, noun, copula and complement; or adverb (or adverbial phrase), plural definite article, noun, copula, critical adjective and complement. Critical adjectives were manipulated so that gender agreement with the noun was either correct or incorrect (an example of all conditions is presented in Table 5). Twenty-four sentences were presented per condition, defined by

Agreement (gender agreement between the noun and the critical adjective), Language Coherency (nouns of same vs. different gender in French and German) and Noun Gender (masculine vs. feminine nouns). Two lists were created such that all nouns were seen in both gender agreement conditions but in only one condition per list. The sentences were presented in a fixed-random order, and six fixed random orders were created per list. The experiment proper was preceded by 4 training sentences.

Table 5

Example of all the conditions presented in Experiment 2 and 3

Condition	Examples
Pre-posed adjective (correct vs. incorrect gender agreement)	
Opposite gender across languages	
Correct	*Les lourdes$_{fem}$ chaises$_{fem}$ sont dans le salon.*
Incorrect	*Les lourds $_{masc*}$ chaises$_{fem}$ sont dans le salon*.*
	The heavy chairs are in the living room.
Same gender across languages	
Correct	*Les grands$_{masc}$ balais$_{masc}$ sont dans la cave.*
Incorrect	*Les grandes$_{fem*}$ balais$_{masc}$ sont dans la cave.**
	The big brooms are in the cellar.
Predicative adjective (correct vs. incorrect gender agreement)	
Opposite gender across languages	
Correct	*Les pommes$_{fem}$ sont vertes$_{fem}$ sur cet arbre.*
Incorrect	*Les pommes$_{fem}$ sont verts* $_{masc*}$ sur cet arbre.*
	Apples are green on this tree.
Same gender across languages	
Correct	*Les jambons $_{masc}$ sont cuits $_{masc}$ au four.*
Incorrect	*Les jambons $_{masc}$ sont cuites*$_{fem*}$ au four.*
	Hams are cooked in the oven.

2.1.3 Procedure and EEG recording

These were identical to Experiment 1.

2.1.4 Data analysis

This was identical to Experiment 1 with the exception of the P600 time window, which was reduced to a shorter period, i.e., from 500–700 ms, due to visual inspection which revealed both a shorter latency and smaller amplitude (in comparison to a classic 500-800ms effect).

2.2 Results

RESULTS FOR PREDICATIVE ADJECTIVES

The grand means revealed differences in the waveforms for predicative adjectives that agreed in gender with the preceding nouns as compared to those that did not. Descriptively, waveforms for French native speakers (Figure 8) revealed a positive deflection between 500-700ms after the onset of the critical incorrect adjective, whereas English-French learners (Figure 9) and German-French learners (Figure 10) did not show any differences based on agreement. ANOVAs were performed on these data.

No main effects or interactions were found in the N100 (100-180ms), P200 (160-280 ms) and N400 (300-500ms) time-windows.

P600 (500-700ms)

A main effect of Electrode was found at midline (F (2, 66) = 12.5, $p < .0001$) and at lateral sites (F (6, 198) = 4.21, $p < .0001$). At midline the interaction of Group x Noun Gender x Agreement x Electrode tended towards significance (F (4, 66) = 2.99, $p < .08$). This interaction revealed a positivity for agreement violations for French native speakers but not for L2 learners.

Given the trend for interaction, further ANOVAs were performed on the different time windows for each group independently.

French native speakers

No significant differences emerged as a function of experimental factors prior to the 500-700ms window after the onset of the critical adjective. A significant P600 effect

of Agreement appeared at midline (F (1, 11) = 5.92, p < .03). At lateral sites, the effect tended towards significance (F (1, 11) = 4.45, p < .06). This effect revealed that French native speakers were sensitive to gender agreement violations. No differences were found as a function of the factor Language Coherency (F<1), nor did this factor interact with Agreement (F<1) (see Figure 8).
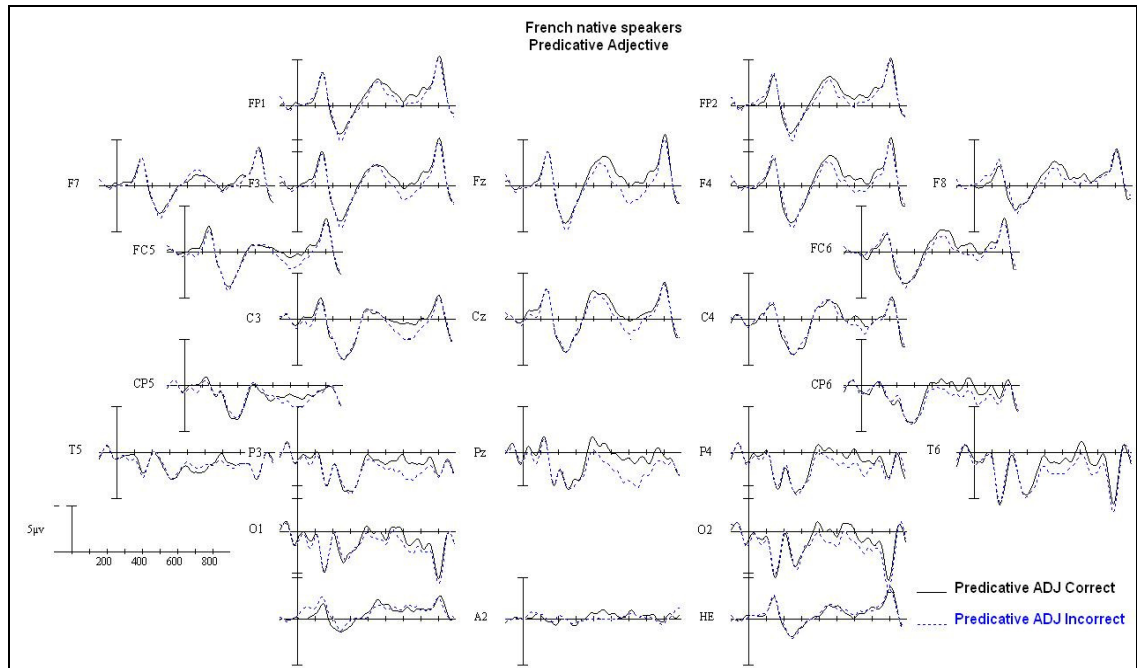
Figure 8: French native speakers. P600 effect in response to gender agreement violations between the noun and the predicative adjective

English-French learners

No significant differences emerged as a function of experimental factors, nor were any interactions observed, in any time window (all Fs < 1).
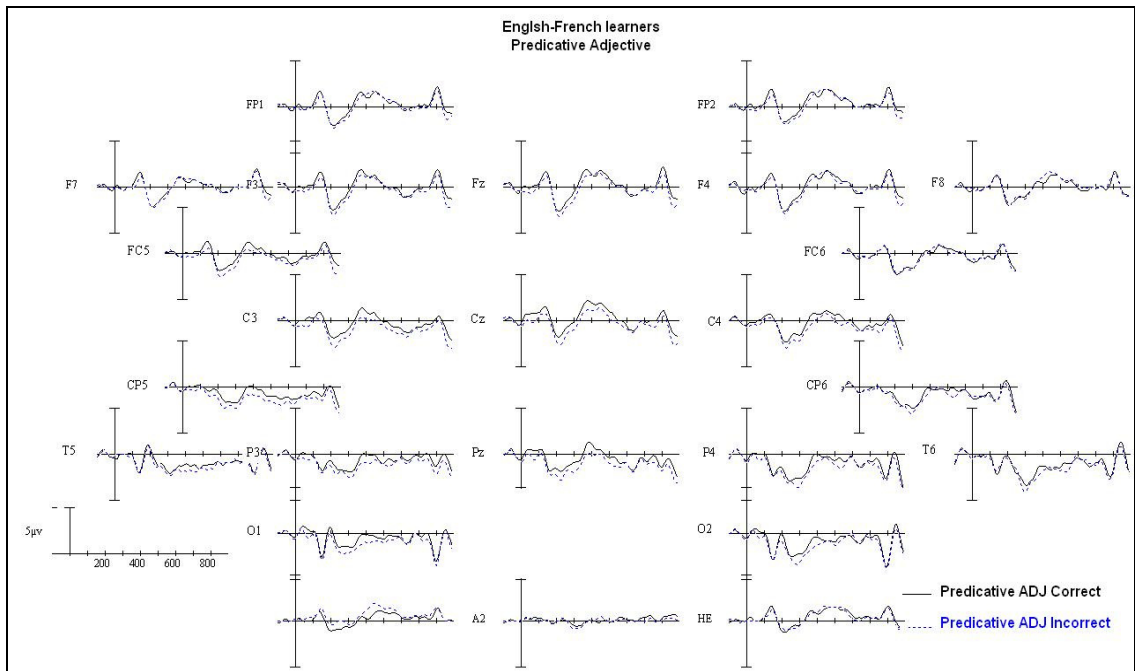
Figure 9: English-French learners' ERP response to gender agreement violations between the noun and the predicative adjective

German-French learners

No significant differences emerged as a function of experimental factors, nor were any interactions observed, in any time window (all Fs < 1).
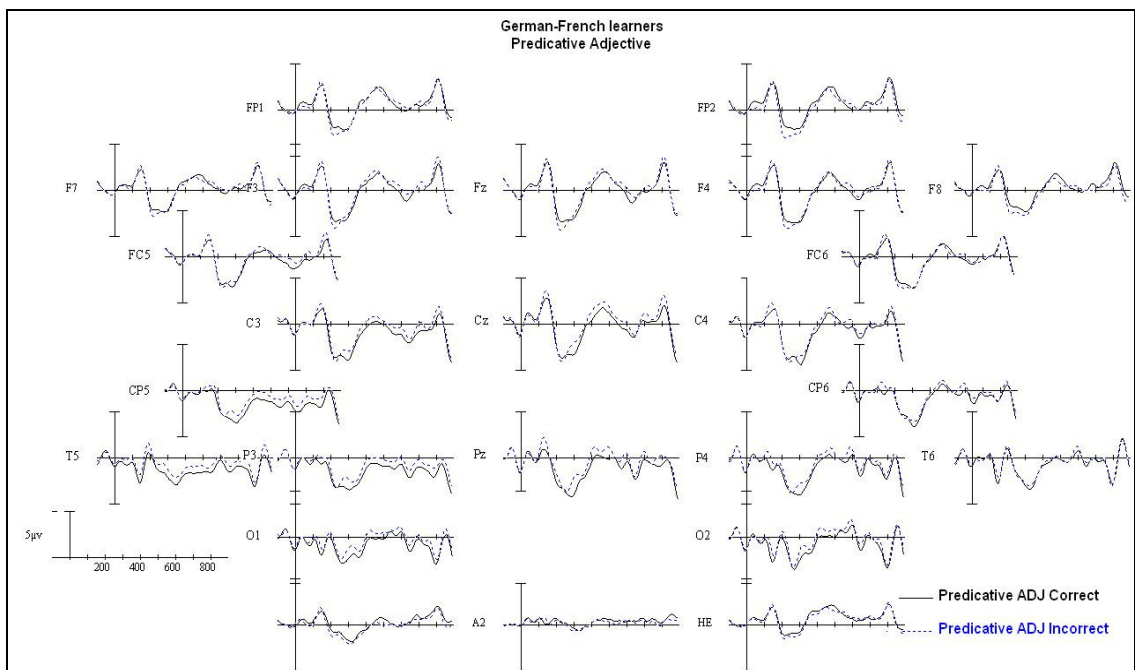
Figure 10: German-French learners' ERP response to gender agreement violations between the noun and the predicative adjective

97

Gender agreement violations between the adjective and the following noun provoked differences in the waveforms that depended both on participant group and time window. Descriptively, the grand mean for French native speakers (Figure 11) showed a positive deflection in waveform for these agreement violations between 500-700ms after the onset of the critical noun. English-French learners (Figure 12) revealed a negative deflection in waveform for agreement violations in the 100-180ms and 300-500ms time-windows. German-French learners (Figure 13) did not show any differences, in any time window. ANOVAs were performed on these data.

N100 (100-180ms)
At midline, there was a trend for the effect of Agreement (F (1, 33) = 3.07, p < .09) which was significantly modified by Electrode (F (2, 66) = 21.18, p < .0001).

P200 (160-280ms)
No main effects or interactions were found for this time-window.

N400 (300-500ms)
A main effect of Agreement emerged at midline (F (1, 33) = 5.9, p < .02) and was modified by Electrode (F (2, 66) = 17.74, p < .0001). An interaction of Group x Agreement was significant at midline (F (2, 33) = 6.55, p < .02) as well as at lateral sites (F (2, 32) = 5.58, p < .008). This interaction was confirmed by post-hoc analyses which revealed a negativity for English-French learners, but not for native speakers and German-French learners. No differences were found as a function of the factor Language Coherency or Noun Gender, nor did these factors interact with Agreement.

P600 (500-700ms)
A significant effect of Electrode emerged at midline (F (2, 66) = 5.98, p < .02) and at lateral sites (F (1, 33) = 20.46, p < .0001). It was modified by an interaction with Group and Agreement (midline (F (2, 33) = 6.74, p < .01); lateral sites (F (2, 33) =

6.75, $p < .01$). Post-hoc analyses confirmed the presence of a P600 effect to agreement violations for French native speakers but not for English and German learners. This effect was larger at posterior than frontal sites. No other experimental factors were significant, nor did they interact with Agreement.

Given the interactions with Group, subsequent ANOVAs were performed on the different time-windows for each group independently.

French native speakers

Gender violations between the adjective and the following noun provoked a P600 effect. A significant effect of Agreement appeared 500-700ms after the onset of the critical noun (at midline ($F (1, 11) = 12.65$, $p < .004$); at lateral sites ($F (1, 11) = 8.49$, $p < .01$). No other experimental factors were significant, nor did they interact with Agreement.
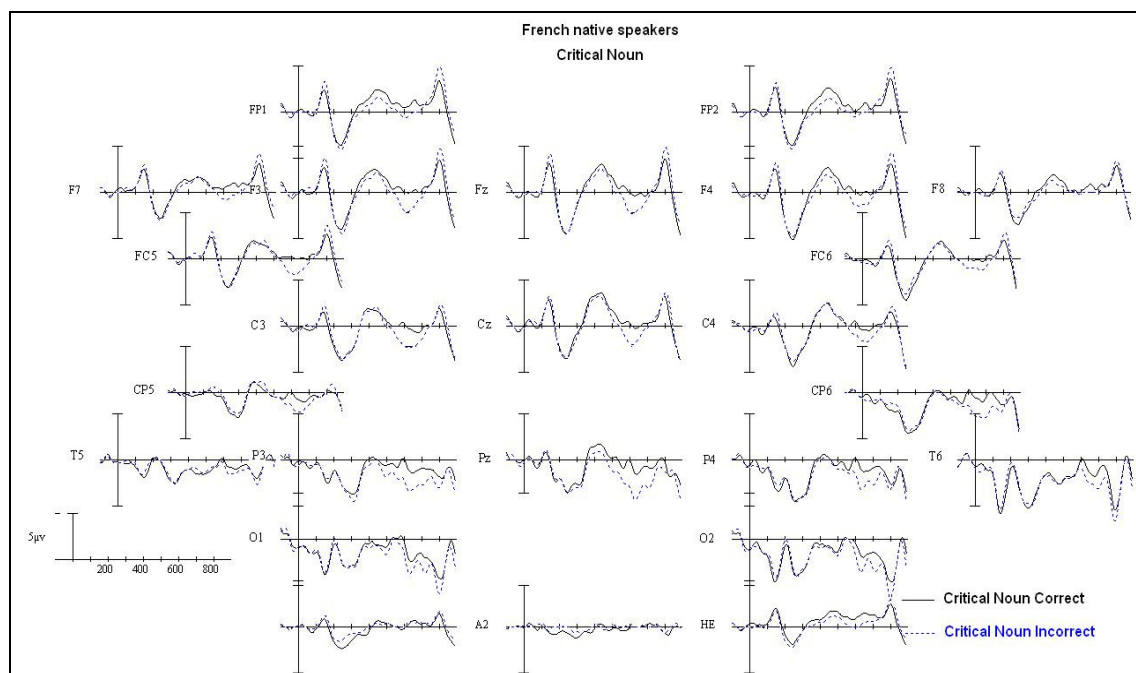
Figure11: French native speakers' ERP response to gender agreement violations between the pre-posed adjective and the critical noun

English-French learners

Gender violations between the pre-posed adjective and the noun provoked negative deflections in the waveform in two time windows: 100-180ms (N100) and 300-500ms (N400) after the onset of the critical noun. In both time windows, a significant effect of Agreement was found at midline (N100 (F (1, 11) = 12.13, p < .005); N400 (F (1, 11) = 21.69, p < .0004) and at lateral sites (N100 (F (1, 11) = 7.35, p < .02); N400 (F (1, 11) = 11.5, p < .006). This effect was modified by a significant effect of Electrode at midline (N100 (F (2, 22) = 6.62, p < .02); N400 (F (2, 22) = 21.19, p < .0001) and a trend at lateral sites (N100 (F (6, 54) = 3.09, p <.08); N400 (F (6, 66) = 7.56, p < .007). Post hoc comparisons showed that the effect was larger at anterior sites. The early negative effect was too widely distributed to be associated with an ELAN effect. No effects of Language Coherency or Noun Gender were found (F < 1), nor did they interact with Agreement (F < 1).
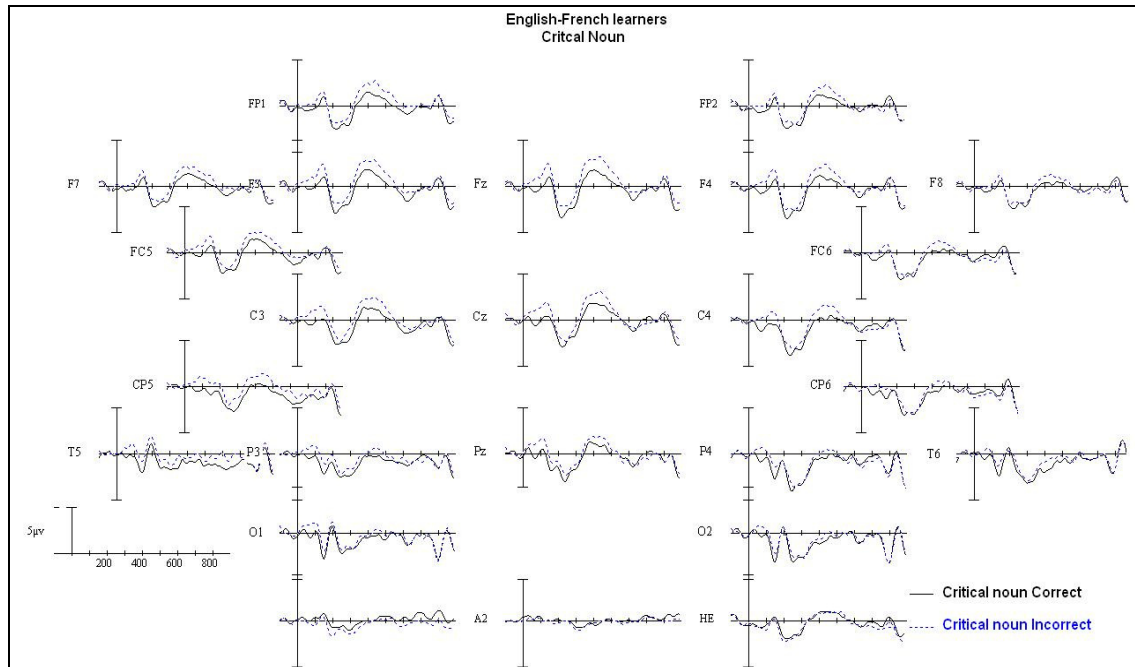
Figure 12: English-French learners' ERP response to gender agreement violations between the pre-posed adjective and the critical noun

German-French learners

No experimental factors yielded significant differences (all Fs < 1), nor did they interact with any factor.
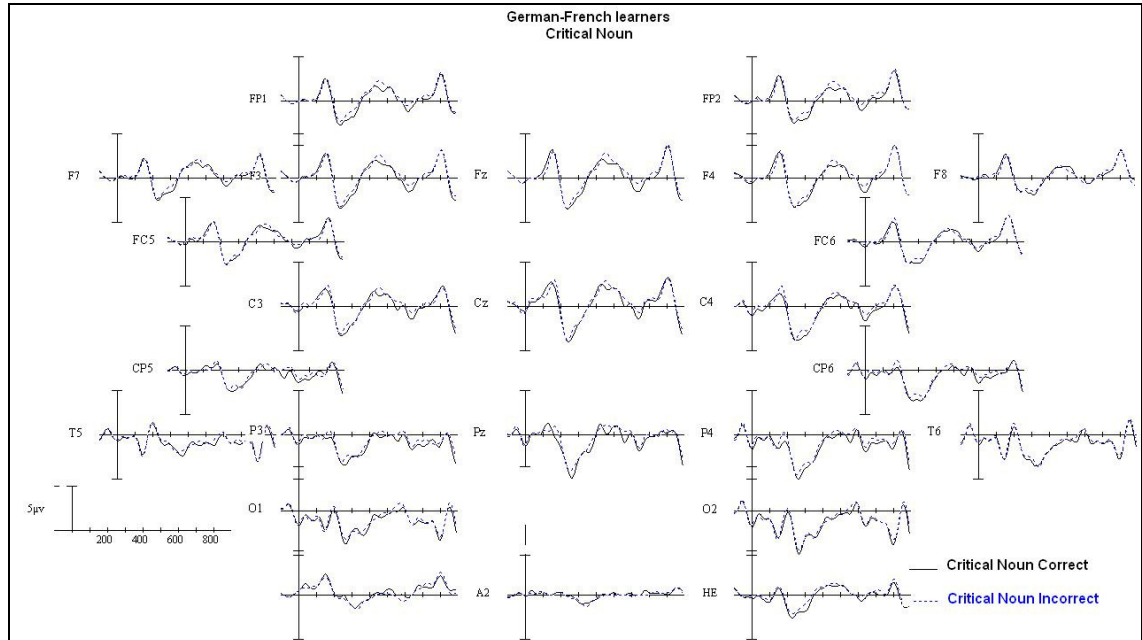
Figure 13: German-French learners' ERP response to gender agreement violations between the pre-posed adjective and the critical noun

2.3　Discussion

In the present experiment, we manipulated gender agreement violations between pre-posed adjectives and nouns, and nouns and predicative adjectives, to investigate syntactic processing in L1 and L2. In line with previous studies, French native speakers displayed a P600 effect in response to gender agreement violations for both types of adjectives (Barber & Carreiras, 2005). These results are consistent with those obtained in Experiment 1 for the same kind of violations on post-posed adjectives. Again, no negativity preceded the P600 effect, which poses a challenge to Friederici's (2002) model of language comprehension.

English-French learners did not show any effect for gender agreement violations between the noun and predicative adjective. The absence of effect may be due to the distance between the noun and the adjective (i.e., separated by the copula). It is possible that English learners are not able to compute gender agreement when the agreement is not local (within the NP). Barber and Carreiras (2005) also found

101

evidence that processing predicative adjective was costlier than when agreement occurred within the NP, even in native speakers who displayed a larger P600 effect. In contrast to the results for predicative adjectives, English speakers showed a N400 effect for gender agreement violations between the pre-posed adjective and the noun. This effect was preceded by an early negativity which, however, was too widespread to be an ELAN. The N400 effect is not the classic effect generally triggered by syntactic violations. However, recent studies have shown that when learners are still in the process of acquiring their L2, they produce an N400 in response to syntactic violations. When proficiency increases, this N400 effect gradually turns into a classic P600 as can be found in native speakers (Inoue & Osterhout, 2005; Osterhout et al., 2004). Hence, it is possible that our participants are still in the process of acquiring agreement between the pre-posed adjective and the noun, despite their advanced proficiency. The present results show a difference between the way native speakers and English-French learners process gender agreement on pre-posed and predicative adjectives. However, in line with longitudinal studies, we can hypothesize that English speakers will achieve native-like processing when their proficiency increases. The L2 speakers we tested had spent a few months in France and were highly proficient, however, we can imagine that their results would vary with additional exposure to French. Furthermore, the N400 effect we obtained for these speakers shows that even though processing is not yet native-like, English speakers are sensitive to gender agreement violations in their L2 despite the absence of grammatical gender in their L1.

German-French learners did not show any effect of grammatical gender agreement errors. The absence of an effect supports the 'common plural agreement' hypothesis, which assumes that German learners apply rules from their L1 to their L2 and treat grammatical gender according to their native gender agreement system (i.e., common agreement for all genders in the plural), and 'ignore' the agreement system in French. It is likely that once they become more proficient, they will eventually apply the rules of the French system and process agreement as native speakers, however, our current data do not allow us to test this assumption. Further research on German native speakers who have been exposed to French for several years is required to investigate this question.

3 EXPERIMENT 3

Here, we used the design of Experiment 2 with the same materials and same population (some had taken part into Experiments 1 and 2) using eye-tracking. To our knowledge, only one previous monolingual study has used these two methodologies to investigate the same violations using a single set of materials (Deutsch & Bentin, 2001). It is commonly accepted that first pass reading time measures reflect single word analysis and integration of a word in its local context, whereas total reading time measures reflect later processes of sentence integration (Boland, 2004) and/or sentence reanalysis (Rayner & Pollatsek, 1989). Thus, the results obtained with eye-tracking combined with those obtained with ERPs in Experiments 1 and 2 provide information on the time-course of processes involved in language comprehension. The present method allowed us to investigate whether the gender agreement violations that triggered a P600 effect in the ERPs trace is be detected early (first pass measures) or late (second pass measures). This sheds light on the underlying process reflected by the P600 and on the assumption made in Friederici's (2002) model that the P600 indicates syntactic reanalysis and repair. The information about gender processing in L1 is essential for the purpose of the present thesis as it allows the comparison of L1 and L2 processing and further investigation of the similarities between L1 and L2 gender processing. The use of the same material, which manipulated both gender agreement and gender coherency across languages (i.e., same vs. opposed gender in French and German), not only offered the possibility to compare results across methodologies, but also to examine our second concern about the influence the native language has on the L2.

At present, no eye-movement study to our knowledge has focused specifically on grammatical gender processing within the NP, but based on the results obtained in eye-movement studies that examined syntactic processing in monolinguals, we expected longer fixation times in response to gender agreement violations for French native speakers. The handful of studies that have investigated L2 processing with eye-movements concentrated on syntactic ambiguity (see Frenck-Mestre, 2005, for a review) and revealed similar patterns in L1 and L2. Hence, based on L1 studies, we expect L2 learners to show longer fixation times in case of gender agreement violations, like native speakers.

3.1 Method

3.1.1 Participants

Twelve French native speakers, 12 English-French and 12 German French learners took part in this experiment. Most of them had taken part into Experiment 2 (English 10; German 9) in order to minimise variability due to participants' knowledge of their L2. Experiments were conducted 4 months apart, and analyses showed no significant difference between groups of participants (i.e., 'previous' and 'new' participants) suggesting that participation in Experiment 2 did not influence participants' performance in Experiment 3. Participants had normal uncorrected vision. They received 5 euros for their participation. English and German speakers were Erasmus students at the University of Provence who had passed the language test required to enter a French university (individual results not available). Their level was advanced enough to be able to follow university courses in French. They had all studied French formally prior to their stay in France (English speakers, 6.5 years; German speakers, 7.8 years). Non-native speakers were asked to complete an off-line test in which they had to circle the correct gender of the words used in the experiment. The results were fairly similar for English (mean: 5.2 errors; SD: 3) and Germans (mean: 5.1 errors; SD: 3.3; t (22) = .07, p = .94). They were also asked to self-rate their level in French, and again, results did not differ for English (written comprehension, 4.8; oral comprehension, 4.6; written production, 4.3; oral production, 4.3) and German speakers (written comprehension, 4.5; oral comprehension, 4.3; written production, 4; oral production, 3.8). No significant difference was found for prociency between the two groups (written comprehension, t (22) = .78, p = .43; oral comprehension, t (22) = .72, p = .47; written production, t (22) = .82, p = .42; oral production, t (22) = .91, p = .38).

3.1.2 Materials

In this experiment, we presented the same materials as in Experiment 2 (complete materials are presented in Appendix B and D). Ninety-six sentences contained a predicative adjective and 96 contained a pre-posed adjective (an example of all conditions is presented in Table 5). As in Experiment 2, twenty-four sentences were presented per condition, defined by Agreement (correct vs. incorrect gender

agreement between the noun and the critical adjective), Language Coherency (nouns of same vs. different gender in French and German) and Noun Gender (masculine vs. feminine nouns). A Latin square design was used such that the same sentence was seen in both correct and incorrect conditions but not by the same participant. Sentences were randomised for each participant. The experiment proper was preceded by 4 training sentences.

3.1.3 Apparatus and Procedure

Eye movements were recorded using a Dr. Bouis eye-tracker. Horizontal signals from the right eye of the participants were sampled every 5ms using a 12-bit A/D device interfaced to an Opus 386 computer. Participants were sitting at 60 cm from the screen, with their heads restrained with a bite-bar and adjustable head and chin rests. Every four sentences, five asterisks were displayed on the screen in order to calibrate the apparatus. Sentences were presented one after another on a single line at the centre of the screen. Before the sentence appeared on the screen, participants fixated a point on the left of the screen; once the eye was detected, the sentence was presented. The task was to read the sentences silently and decide whether they made sense or not by pressing yes/no buttons on a response box (filler sentences were semantically anomalous).

3.1.4 Data analysis

For the analyses, sentences were divided into 6 regions. Sentences containing a pre-posed adjective were composed of: (R1) an adverb (or adverbial phrase) plus a plural definite article, (R2) a pre-posed adjective, (R3) the critical noun, (R4) a copula, and (R5 and R6) a complement divided into two regions. Sentences containing a predicative adjective were composed of: (R1) an adverb, plus a plural definite article, (R2) a noun, (R3) a copula, (R4) the critical adjective, and (R5 and R6) a complement divided into two regions. Examples are provided in 1 and 2, below.

	R1	R2	R3	R4	R5	R6

(1) *Souvent les / petites/ pommes/ sont/ bien/ sucrées.*
   Usually small apples are very sweet

	R1	R2	R3	R4	R5	R6

(2) *En automne les /pommes/ sont/ vertes/ sur cet/ arbre.*
   In autumn apples are green on this tree.

Sentences of a pair were identical with the exception of the adjective which was either congruent or incongruent in gender with the noun. Each region was a minimum of 5 characters (including blanks) to reduce the likelihood that the region be skipped. Despite such, the copula was skipped on more than 80% of trials. For sentences containing a predicative adjective, the copula was collapsed with the following region (R4+R5), as it was of interest to check if any effects emerged directly after the critical noun. When either of the two critical regions of interest was skipped (i.e., adjective or noun), the sentence was excluded from analyses, as reliable agreement between the noun and the adjective could not be performed unless both were processed.

Preliminary analyses did not reveal any differences as a function of experimental factors for the initial and final regions, nor for the spill-over region adjacent to the critical adjective or noun. The only regions that revealed significant effects were the critical noun (following the pre-posed adjective) and the predicative adjective (following the noun) themselves. Three-way ANOVAs were conducted on reading times for these regions with repeated measures for Agreement (correct vs. incorrect gender agreement between the noun and the adjective), Language Coherency (same vs. different gender in French and German) and Noun Gender (masculine vs. feminine nouns). Results are reported for first pass (first fixation and gaze duration) as well as for second pass (total reading time) measures. Means of all regions are reported for all groups for first and second pass in Appendix E (Tables 10-15).

3.2   Results

RESULTS FOR NOUN / PREDICATIVE ADJECTIVE AGREEMENT

First pass - First fixation

Mean first fixations are reported for the critical predicative adjective (R4) in Figure 14. Analyses of the predicative adjective (R4) revealed a trend for an effect of Agreement by participants (F_1 (1, 33) = 3.14, $p < .09$; $F_2 <1$), which tended to be modified by the interaction with Group and Noun Gender by participants (F_1 (2, 33) = 2.82, $p < .07$) and was significantly so by items (F_2 (2, 88) = 5.36, $p < .01$).

Reading times were slightly longer for adjectives that were incongruent in gender with the noun (286 ms) than for adjectives that were congruent (277 ms).

Gaze duration

Mean gaze durations are reported for the critical predicative adjective (R4) in Figure 14. Analysis of the predicative adjective region revealed a main effect of Agreement (F_1 (1, 33) = 12.1, p < .001; F_2 (1, 44) = 4.29, p < .04). This effect was modified by the interaction with Noun Gender (F_1 (1, 33) = 21.8, p < .001; F_2 (1, 44) = 10.6, p < .002). Post-hoc analyses (Scheffé) revealed that the main effect of Agreement was significant only for masculine nouns. Independent analyses on sentences containing masculine and feminine nouns confirmed these results, showing a significant effect of Agreement for masculine nouns by participants (F_1 (1, 33) = 31.5, p < .001) and a trend by items (F_2 (1, 47) = 3.67, p < .06), but no effect for feminine nouns (F_1 <1; F_2<1). For masculine nouns only, reading times were longer for adjectives that disagreed in gender with the noun (403 ms) than for those that agreed (347 ms). Analyses for feminine nouns revealed only an interaction of Group x Language Coherency x Agreement (F_1 (2, 33) = 3.86, p < .03; F_2 (2, 44) = 4, p < .02). This interaction revealed that German speakers displayed a reverse effect for nouns that are feminine in French but masculine in German, which was not apparent in the other two participant groups. For German participants, fixation durations were longer for feminine nouns when gender agreement was correct in French (but incorrect in German) than when it was incorrect. Given this interaction further analyses were conducted on groups independently.

Second pass – Total reading time

Mean total reading times are reported for the critical predicative adjective (R4) in Figure 14. Analyses of this region revealed a main effect of Agreement (F_1 (1, 33) = 18.1, p < .001; F_2 (1, 44) = 8.74, p < .001) which was modified by the interaction with Noun Gender F_1 (1, 33) = 19.2, p < .001; F_2 (1, 44) = 4.32, p < .04). Post-hoc analyses (Scheffé) showed, again, that the effect of agreement was significant only for masculine nouns. Analyses of simple effects confirmed the effect of agreement for masculine nouns (F_1 (1, 33) = 31.1, p < .001; F_2 (1, 47) = 8.49, p < .01), due to

longer reading times for incongruent (704 ms) than for congruent adjectives (572 ms), and revealed no reliable difference for feminine nouns (F_1<1; F_2<1).
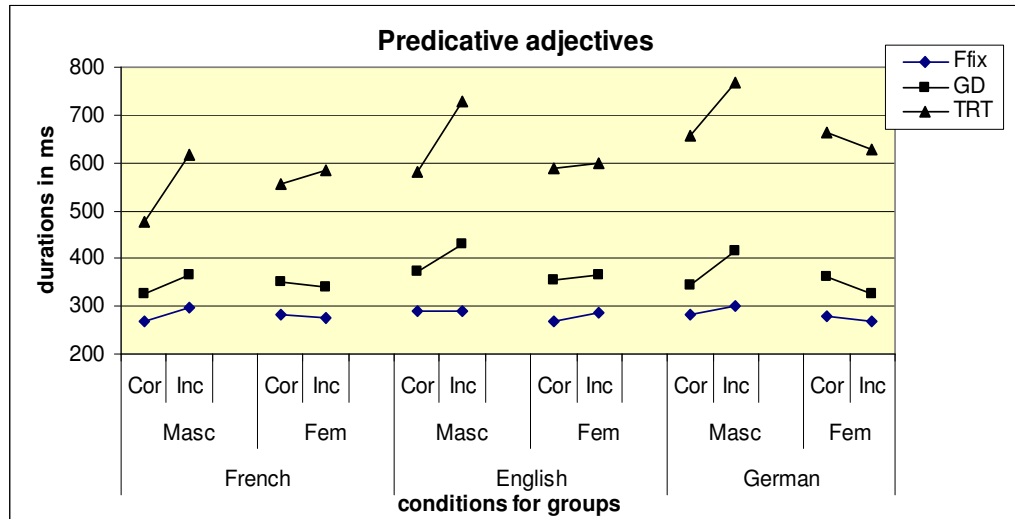
Figure 14: First and second pass means by participants for sentences containing nouns and predicative adjectives as a function of gender agreement and participant group. Conditions are masculine (Masc), feminine (Fem), correct (Cor) and incorrect (Inc).

French native speakers

First pass - First fixation

Analyses of mean first fixations for the critical predicative adjective (R4) revealed only an interaction involving Noun gender x Gender Agreement (F_1 (1, 11) = 9.89, p < .01; F_2 (1, 44) = 3.9, p < .05). The analysis of simple effects confirmed the effect of agreement for masculine nouns (F_1 (1, 11) = 5.94, p < .03; F_2, <1) while no effect was found for feminine nouns (F_1 and F_2, <1). Reading times were longer when masculine nouns and predicate adjectives disagreed (296 ms) than when they agreed (267 ms) in gender.

Gaze duration

The analysis of mean gaze durations for the critical predicative adjective (R4) also revealed an interaction between Noun Gender x Gender Agreement (F_1 (1, 11) = 4.99, p < .05; F_2 (1, 44) = 4.21, p < .05). The analysis of simple effects confirmed a

significant increase in reading times when the predicative adjective did not agree in gender with the preceding noun for masculine nouns (F_1 (1, 11) = 4.81, p < .05, F_2 (1, 22) = 4.37, p < .05) but not for feminine nouns (F_1 and F_2, <1). For masculine nouns only, reading time were longer when nouns and predicative adjectives were incongruent (365 ms) than when they were congruent (325 ms) in gender.

Second pass – Total reading time

The analysis of mean reading times for the critical predicative adjective (R4) revealed a significant effect of Gender Agreement (F_1 (1, 11) = 11.7, p < .01; F_2 (1, 44) = 5.57, p < .02) that was modified by an interaction with Noun Gender by participants (F_1 (1, 11) = 4.89, p < 05; F_2, <1). Independent analyses revealed a significant increase in reading time for adjectives that disagreed (616 ms) than when they agreed (478 ms) in gender with masculine nouns (F_1 (1, 11) = 11.8, P < .01), but no reliable differences between gender conditions for feminine nouns (F_1 and F_2, <1).

English-French learners

First pass - First fixation

The analysis of mean first fixation durations for the critical predicative adjective (R4) revealed a main effect of Noun Gender by participants (F_1 (1, 11) = 5.06, p < .05; F_2, <1). Reading times were longer for adjectives that referred to a masculine noun (290 ms) than for those that referred to a feminine noun (277 ms). No other main effects or interactions were significant.

Gaze duration

The analysis of mean gaze durations for the critical predicative adjective (R4) showed significant effects of Noun Gender (F_1 (1, 11) = 8.57, p < .01; F_2 (1, 44) = 4.66, p < .04) and Gender Agreement (F_1 (1, 11) = 10.96, p < .001); F_2 (1, 44) = 4.31, p < .04). Longer reading times were found for adjectives specifying a masculine noun (400 ms) than a feminine noun (361 ms), and for adjectives incongruent (397 ms) than congruent (363 ms) in gender with the noun. No other main effects or interactions were significant

Second pass – Total reading time

The analysis of mean total reading times for the critical predicative adjective (R4) showed a significant effect of Gender Agreement (F_1 (1, 11) = 6.54, $p < .03$; F_2 (1, 44) = 4.43, $p < .04$). There was also a trend for the main effect of Noun Gender by participants (F_1 (1, 11) = 4.07, $p < .07$; $F_2 < 1$) and for the interaction between Noun Gender x Gender Agreement by participants (F_1 (1, 11) = 3.96, $p < .07$; F_2, <1). Independent analyses revealed a significant effect of Gender Agreement for masculine nouns (F_1 (1, 11) = 8.30, $p < .01$) F_2 (1, 23) = 4.46, $p < .05$), with longer reading times for adjectives that disagreed in gender (727 ms) than for those that agreed in gender (581 ms), but not for feminine nouns (600 ms and 587 ms for gender agreement and disagreement, respectively, *F1* and *F2* <1).

German-French learners

First pass - First fixation

The analysis of mean first fixations for German-French learners for the critical predicative adjective (R4) revealed a significant main effect of Noun Gender by participants that was marginal by items (F_1 (1, 11) = 5.35, $p < .04$; F_2 (1, 44) = 3.56, $p < .07$). Reading times (Figure 15) were longer for adjectives that referred to a masculine noun (291 ms) than for those that referred to a feminine noun (274 ms).

Gaze duration

The analysis of mean gaze durations on the critical predicative adjective (R4) showed a significant effect of Noun Gender (F_1 (1, 11) = 8.01, $p < .02$; F_2 (1, 44) = 4.64, $p < .04$) that was modified by an interaction with Agreement (F_1 (1, 11) = 20.02, $p < .001$; F_2 (1, 44) = 11.3, $p < .001$). The analysis of simple effects revealed longer gaze duration when agreement was incorrect (i.e., feminine adjective forms, 415 ms) than when it was correct (345 ms) for masculine nouns (F_1 (1, 11) = 23.3, $p < .001$; F_2 (1, 22) = 6.68, $p < .02$). For feminine nouns a trend for a reversed effect of Agreement was found, by participants (F_1 (1, 11) = 3.95, $p < .07$) that reached significance by items (F_2 (1, 22) = 5.79, $p < .02$). Mean gaze durations (Figure 15) were longer when the predicative adjective agreed in gender with the preceding

feminine noun (i.e., feminine adjective forms, 360 ms) than when it did not (325 ms). This interaction effect was further modified by an interaction with Language Coherency, in the subject analysis (F_1 (1, 11) = 5.57, p < .04; F_2 (1, 22) = 3.65, p < .07). Post-hoc analyses (Scheffé) revealed that for feminine nouns, the effect of gender agreement was dependent upon the overlap of noun gender in French and German. No effect of agreement was visible on the predicative adjective when the noun was feminine in German as well as in French, whereas gender agreement errors actually facilitated processing of the predicative adjective when the noun was feminine in French but masculine in German. For masculine nouns, the effect of gender agreement was independent of the overlap between German and French noun gender.

Second pass – Total reading time

The analysis of total reading times revealed a main effect of Noun Gender by participants (F_1 (1, 11) = 5.03, p < .05; F_2 < 1) and an interaction of Noun Gender and Agreement by participants (F_1 (1, 11) = 6.75, p < .001; F_2 < 1). The analysis of simple effects showed a significant effect of Agreement for masculine nouns (F_1 (1, 11) = 14.5, p < .002; F_2 < 1) but no effect for feminine nouns (F_1 < 1; F_2 < 1); that is to say that German speakers were sensitive to gender agreement violations only when they occurred on masculine nouns (i.e., a masculine noun associated with a feminine adjective). For masculine nouns only, reading times (Figure 15) were longer when adjectives disagreed (768 ms) than when they agreed (656 ms) in gender with the noun. The interaction with Language Coherency that was found for gaze duration was no longer significant for total reading time (F_1 and F_2, < 1). No other effects were significant, nor did they interact with Agreement.
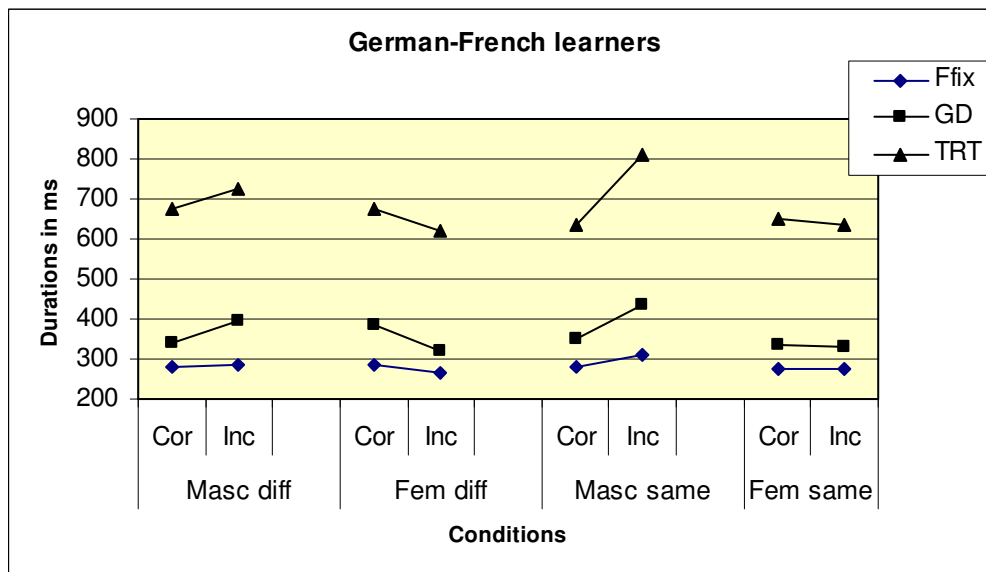
Figure 15: Mean first fixation, gaze durations and total reading times for German-French learners, for the critical predicative adjective region. Results are given separately for nouns with different vs. same genders in French and German. Conditions are masculine (Masc) or feminine (Fem), different (diff) or same (same) gender across languages, and correct (Cor) and incorrect (Inc).

RESULTS FOR PRE-POSED ADJECTIVE / CRITICAL NOUN AGREEMENT

First pass - First fixation

First fixation means are reported for the critical noun region (R3) in Figure 16. The analysis of the critical noun region following the pre-posed adjective revealed only a significant effect of Group by items and a trend by participants (F_1 (2, 33) = 2.52, $p <$ .09; F_2 (2, 88) = 21.9, $p <$ .001). Mean first fixations were significantly longer for L2 learners than for French native speakers (324 ms, 321 ms and 289 for English, German and French speakers, respectively). No other factors were significant nor did they interact with Agreement.

Gaze duration

Mean gaze durations are reported for the critical noun (R3) in Figure 16. Analysis of the critical noun region showed a significant main effect of Group (F_1 (2, 33) = 5.06, $p <$ .01; F_2 (2, 88) = 32, $p <$ .001) which was modified by an interaction with Agreement by items ($F_1 < 1$; F_2 (2, 88) = 3.28, $p <$ .04). Again, mean gaze fixations

112

were shorter for native speakers than for L2 speakers (335 ms, 399 ms, and 406 ms for French, English and German, respectively).

Second pass – Total reading time

Mean total reading times are reported for the critical noun (R3) in Figure 16. Analyses of the critical noun following the pre-posed adjective revealed a significant effect of Group (F_1 (2, 33) = 9.11, p < .001; F_2 (2, 88) = 58.6, p < .001). Longer reading times were found for L2 speakers than for native speakers (620 ms, 720 ms, and 473 ms for English, German and French, respectively). There was also a trend for the main effect of Agreement by participants (F_1 (1, 33) = 3.74, p < .06; F_2 < 1). No other main effects or interactions were significant.

As a result of the interactions with Group, further ANOVAs were performed on first pass and total reading times for the critical noun region for each group independently.

French native speakers

First pass - First fixation

Analyses of first fixations the critical noun (R3) for French native speakers revealed a significant main effect of Agreement by items with a trend by participants (F_1 (1, 11) = 3.76, p < .08; F_2 (1, 44) = 4.61, p < .04). First fixation durations were longer for nouns that presented gender agreement violations (298 ms) than for nouns that agreed in gender with the preceding adjective (280 ms).

Gaze duration

The analyses of gaze durations showed a significant effect of Agreement by items (F_1 (1, 11) = 3.12, p < .11; F_2 (1, 44) = 4.94, p < .03), due to longer gaze durations when the pre-posed adjective and the noun disagreed in gender (347 ms) than when they agreed (324 ms).

113

Second pass – Total reading time

Analyses of total reading times revealed a significant effect of Agreement (F_1 (1, 11) = 6.69, $p < .03$; F_2 (1, 44) = 8.39, $p < .01$). Reading times were longer when the gender of the pre-posed adjective and the noun were incongruent (506 ms) than when congruent (440 ms). No other main effects or interactions were significant.

English-French learners

No main effects or interactions were found for any measure of reading times.

German-French learners

No main effects or interactions were found for any measure of reading times.
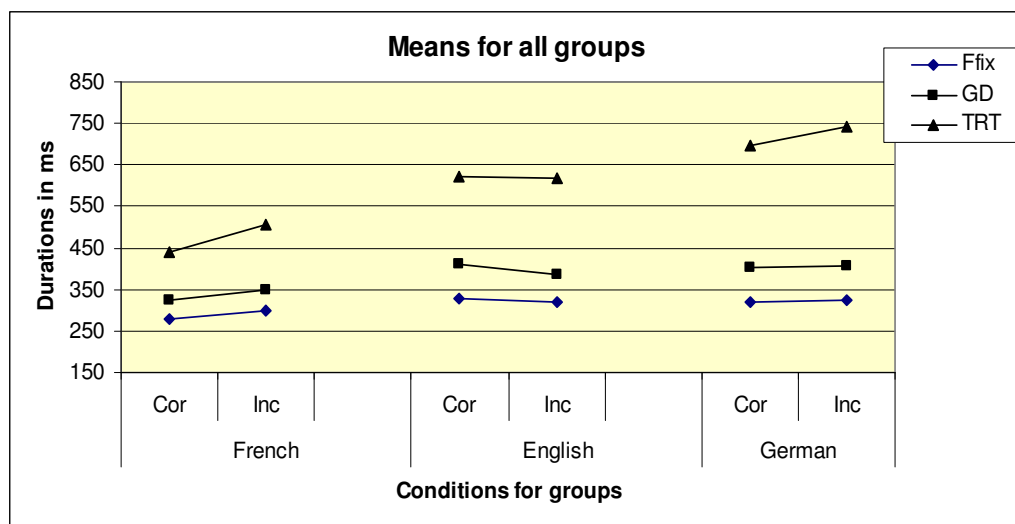
Figure 16: First and second pass means by participants for the critical noun as a function of gender agreement and participant group. Conditions are correct (Cor) and incorrect (Inc).

3.3 Discussion

In Experiment 3, we re-examined the processing of gender agreement with the materials used in Experiment 2 via eye-tracking. In both experiments, we manipulated gender agreement violations between pre-posed adjectives and nouns, and nouns and predicative adjectives.

French native speakers showed longer reading times in response to gender agreement violations between pre-posed adjectives and nouns. For gender agreement violations on predicative adjectives, they also showed longer reading times, but only for masculine nouns. It seems that when the violation occurs locally (pre-posed adjective, i.e., within the NP), it is more easily (but not more rapidly) detected than when the violation occurs for more distant relations in the sentence (predicative adjective), in line with previous studies (Barber & Carreiras, 2005). Indeed, when there is another element, such as a copula, between the noun and the adjective, native speakers showed sensitivity to violations for the default gender only. In French, masculine is the default gender (Hulk & Tellier, 1999) and our results show that French speakers are more sensitive to violations when a [-masc] adjective is associated to a [+masc] noun, than the reverse.

For predicative adjectives, a significant effect of Agreement was found from the first fixation, which suggests that gender agreement violations for this type of adjective were detected very early. For pre-posed adjectives, the effect of Agreement was only significant by items and revealed a trend by participants for first fixations and gaze duration, and was confirmed by a significant effect for total reading time. These results imply that gender agreement is processed very early. In the ERP experiments, these violations provoked a P600 effect. This suggests that the P600 effect may not only reflect a late process of syntactic reanalysis and repair as proposed by Friederici's (2002) model, but may also indicate earlier detection of syntactic violations.

English-French and German-French learners did not show sensitivity to gender agreement violations between a pre-posed adjective and subsequent noun. For the English speakers, it is possible that they may not have yet fully acquired the rule that imposes agreement between the pre-posed adjective and the noun in French, given the absence of grammatical gender agreement in the NP in English. It is worth noting that when English speakers are taught adjective agreement in French in a classroom, the focus is on post-posed adjectives, first, because this syntactic structure is rare in English and therefore, more training is necessary; second, because post-posed adjectives are more frequent in French and learners encounter them from their first

lessons with colours, for example (e.g., *le livre vert$_{masc}$,* the green book; *la chaise vert-e$_{fem}$* the green chair). Although our participants were advanced learners of French, it is possible that they had not yet mastered the agreement of pre-posed adjectives online. In other words, English speakers may detect gender agreement violations but not efficiently enough to affect processing in reading. These results converge with the N400 effect obtained with ERPs (Experiment 2) for the same type of adjectives. The N400 effect has recently been considered as evidence of an acquisition process (Inoue & Osterhout, 2005; Osterhout et al., 2004). It is possible that the English speakers are still in the process of acquiring the agreement rule between the pre-posed and noun in French as suggested by the N400 effect. Our ERP and eye-tracking results for pre-posed adjectives suggest that, at the moment, this process is not yet syntactically developed enough in the English-French learners tested here, which explains the difference in processing for L2 and native speakers for this type of adjective.

For German learners, the absence of an effect in response to gender agreement violations between the pre-posed adjective and the noun is consistent with the absence of effect with ERPs. These results argue for the 'common plural agreement' hypothesis that suggests that German speakers apply the rules of the gender system of their L1 to their L2 and thereby do not carry out agreement between adjectives and plural nouns in French because such agreement does not exist in their L1.

In contrast, L2 learners did show sensitivity to gender agreement violations between the noun and the predicative adjective. The effect appeared only on gaze duration, with longer reading times in the case of gender agreement errors. As a consequence we can say that it is slightly delayed compared to the native speaker effect (where the effect is visible from first fixation). Akin to the data for native speakers, this effect emerged only for masculine nouns in both L2 groups. Interestingly, German learners showed longer fixation times for gender agreement violations for masculine nouns. In contrast, for feminine nouns, German speakers showed longer fixation times only for nouns that are masculine in German (but feminine in French). For instance, the word 'key' is feminine in French (e.g., *la clef$_{fem}$*) but masculine in German (e.g., *der Schlüssel$_{masc}$*). When German speakers read '*la clef$_{fem}$ blanche$_{fem}$*', which is correct in French, it seems that they treat 'key'

as a masculine word as in their L1, which provokes a gender agreement violation when they process the feminine marked adjective. However, the interaction with Language Coherency was only found for gaze duration, and was not significant for total reading time. This suggests that early gender processing is influenced by L1 for German speakers (as shown by the interaction with Language Coherency on gaze duration), since they assign the gender of German nouns to French nouns. This influence, however, eventually disappears once L2 learners have had enough time to process gender in their L2 (as shown by the absence of an interaction on total reading time). In line with bilingual studies (Hawkins, 1998), the results we obtained for English and German speakers converge with the idea that L2 learners adopt a default gender in their L2 – here, masculine - that is learned faster than the other gender and has a more stable representation.

In sum, this eye-tracking experiment suggests that when gender agreement occurs within the noun phrase (here, between the pre-posed adjective and the noun), L2 learners do not process gender as native speakers do. In contrast, when agreement takes place between the noun and the predicative adjective, gender processing is similar in L1 and L2, although slightly delayed in L2. This is in line with data from ERP studies which suggest that L2 syntactic processing is usually later than L1 processing (Ardal et al., 1990; Hahne, 2001). With regard to the native language influence, it seems that English speakers are not handicapped by the absence of a complex grammatical gender system in their L1. Although they show some difficulty in computing agreement between the pre-posed adjective and the noun, they seem to be sensitive to violations at some level, as revealed by our ERP results showing an N400 effect to gender agreement errors. They also seem to process gender in a similar way to native speakers when agreement occurs between the noun and the predicative adjective. This supports the claim that even when the language is learned late in life, highly proficient L2 speakers can achieve native-like processing (at least for some structure) as suggested in previous studies (Rossi et al., 2006). For German speakers, it seems that the presence of grammatical gender in their L1 hampers early gender processing in their L2. The effect obtained for gaze duration for nouns that are feminine in German but masculine in French suggests that the gender of German nouns is activated first, but once L2 speakers have had time to further process

gender, they eventually assign the correct gender to French nouns (as suggested by the absence of interaction with Language Coherency for total reading time). It is possible that L2 speakers adopt masculine as the default gender both in their L1 and L2. Thus, like French native speakers, they are sensitive to gender agreement violations only when they occur on masculine nouns, independently of the language. In other words, if a noun has a different gender in French and German, L2 speakers seem to always select the masculine in early processing and eventually correct it if necessary. If the adjective agreement does not match with this selection (even though it is correct in the language they are reading) processing is delayed in an early stage. It is highly plausible that this influence from L1 to L2 decreases as proficiency increases, but further research with more proficient German-French speakers is required to confirm this assumption.

CHAPTER SUMMARY

In this chapter we reported three experiments investigating whether gender is processed in a similar way by native and non-native speakers, and whether processing in L2 is influenced by the native language. In these experiments we compared French native speakers, English-French and German-French learners. In Experiment 1, participants read sentences containing gender agreement violations between the noun and the post-posed adjective. The recordings of participants' brain activity (ERPs) showed a P600 effect for native speakers and English learners in response to these syntactic violations, but no effect for German learners.

In Experiment 2, we manipulated gender agreement violations between a pre-posed adjective and the noun, and the noun and a predicative adjective, again using ERPs to record participants' sensitivity to these violations. Results showed a P600 effect for French native speakers in response to syntactic violations for both types of adjectives. English learners revealed a N400 effect for violations on pre-posed adjectives, which suggests that they may still be in the process of learning gender agreement with this type of adjective. They did not show any effect for violations between the noun and the predicative adjective, which suggests that when the violation is not local (within the NP) it is less easily detected. As previous studies have shown, gender agreement between a noun and a predicative adjective is

syntactically more complex than agreement within the NP (Barber & Carreiras, 2005). It is possible that this additional complexity renders the processing of predicative adjectives longer to acquire for L2 speakers. German learners did not show any effect; the data is consistent with the possibility that they apply the rules of the gender system of their L1 to their L2, which hampers gender processing in the L2.

In Experiment 3, we examined the same types of agreement violations, in the same materials, using an eye-movement methodology. For pre-posed adjectives, French native speakers revealed longer fixation times in response to gender violations. L2 learners did not show any effect for this type of violation. In response to gender agreement violations between the noun and the predicative adjective, French native speakers had longer reading times again, however, only for masculine nouns. English and German learners revealed the same effect but slightly delayed (it appeared on gaze duration vs. first fixation for native speakers). Like native speakers, German learners showed an effect when gender agreement violations occurred on masculine nouns, but they also showed a reversed effect at an early stage of processing when nouns were feminine in French but masculine in German (only for gaze duration). At a later stage (total reading time), this influence of L1 disappeared. The off-line test and the eye-movement results suggest that German learners are able to correctly assign gender to French nouns, but it seems that initial gender processing is affected when gender differs across languages.

With regard to the questions we addressed in these experiments, no straightforward conclusions can be draw in relation to the similarity between L1 and L2 gender processing. It seems that, depending on the position of the adjective in the sentence, L2 learners are able to attain native-like gender processing. However, the syntactic complexity of the structure and the influence of L1 can hamper processing in L2. Regarding the influence of L1 on L2, while one would think that having gender in L1 would facilitate the acquisition of gender in L2, the results we obtained show that it is not a straightforward conclusion. English speakers whose native language does not possess gender showed a similar pattern to French native speakers (depending on the position of the adjective), whereas German speakers seemed to first apply the gender system of their L1 to their L2, which hampers gender

processing at early stages in French. At later stages of processing, this influence from L1 seems to disappear. As is usually the case in bilingual studies, we might expect that once learners' proficiency increases, processing will be native-like independently of the position of the adjective or of the native language. This assumption requires further investigation.

Our results further suggest that the assumptions made in Friederici's (2002) model are not as universally valid as previously claimed. First, the ERP experiments revealed no negativity preceding the P600 effect resulting from gender agreement violations. Second, the eye-tracking experiments showed very early effects in response to the same violations. The combination of these two methodologies suggests that the P600 effect does not reflect only reanalysis and repair, but can also be associated with earlier processes.

In the final chapter, we discuss these conclusions in combination with those obtained from the experiments investigating gender processing in language production in the following chapters.

CHAPTER 4

GENDER IN PRODUCTION:
MODELS AND LITERATURE REVIEW

In the preceding chapters, we investigated the question of gender processing in language comprehension. To gain a wide picture of the similarities and/or differences in L1 and L2, we will also examine gender processing in language production (chapter 5). As for comprehension, the experiments we conducted are based on psycholinguistic models and studies of language production in L1 and L2. The current chapter presents these models which are supported by experimental evidence obtained in priming, speech errors, tip-of-the-tongue (TOT), and picture-word interference studies. We particularly focus on the representation of gender in these models (see Schriefers & Jescheniak, 1999, for a review of grammatical gender production).

1   MONOLINGUAL MODELS OF PRODUCTION

1.1   General architecture of models of language production.

Experimental evidence has led to a general consensus about the architecture of L1 language production. Most models agree that the production of a word proceeds through various stages, organised in three levels, or strata (Bock & Levelt, 1994; Caramazza, 1997; Dell, 1986, Garrett, 1980; Levelt, 1989; Levelt et al., 1999). The first level is the conceptual level, where the message to be expressed is initiated. When one wants to communicate a message, the pre-linguistic message of the sentence, the word's so-called lexical concept is activated at this level. Once the concept is activated, the next step is to retrieve the corresponding lemma in the mental lexicon. This second step occurs at the syntactic level. The selected lemma is the one that receives the highest activation from the selected lexical concept. Selected lexical items are organised in phrase and sentence structures following the syntactic rules of the language to be used. At the third level, the phonological word's syllabification is built depending on the syntactic and phonological context. Finally, the message is ready for articulation.

Models disagree on whether processing must be completed at one level before it starts at the following level (discrete or serial models), or whether activation is spread to all levels, allowing processing to start at lower levels before processing at higher levels has been completed (cascaded models). The question of whether processing across levels is strictly feed-forward or whether feedback is possible is also a matter of debate.

In the following sections, we will focus on the assumptions that are relevant for the present thesis, embodied in the models of Levelt et al. (1999) and Caramazza (1997). First, we will describe the basic architecture of language production proposed in Levelt et al.'s (1999) model, which underlines both L1 models and L2 models (de Bot, 1992; Poulisse, 1997). We will then present the modifications proposed by (Caramazza, 1997). Finally, we will focus on the representation of grammatical gender in production models through the review of experimental studies on gender retrieval.

1.2 Levelt, Roelofs, and Meyer's model (1999)

Levelt et al. (1999) consider word production as a process divided into four main levels, each of them generating its own characteristic output representation (Figure 17). The levels produce lexical concepts, lemmas, morpho-phonological words, and phonetic gesture scores respectively. In this model, lexical concepts are represented as unitary nodes in a concept network. When a node is activated, the nodes it is linked with are activated as well. For instance, if the word to be produced is KITTEN, then the lexical concepts of CAT and ANIMAL will also be activated. Once the concept is selected at the conceptual level (or stratum), the corresponding lemma, the syntactic component of the word, must then be retrieved in the mental lexicon (syntactic stratum). This theory is relevant for lexical words (open-class words), not for function words (closed-class words), which are indirectly elected through the activation of the open-class words they are associated with. Once the lemma is selected, its syntactic properties become available via the links between various different nodes. The lemma node is connected to category information (e.g., noun, verb), to feature information (e.g., gender) and also to diacritics, which are context-dependent parameters (e.g., number). A single node is shared by all lemmas of the same category or feature. For instance, there is one masculine gender node and all lemmas sharing the same gender are connected to this unique node. For example, the French nouns *le livre$_{masc}$* ('book') and *le verre$_{masc}$* ('glass') are both linked to the 'masculine node', whereas *la chaise$_{fem}$* ('chair') and *la voiture$_{fem}$* ('car') are linked to the 'feminine node'. However, they are all linked to the 'noun node' and the 'singular node'. Once the syntactic information associated with the lemma is available a syntactic structure can be built. According to Levelt et al., the selection of a lemma does not necessarily activate syntactic information. For instance, the gender of a noun will be activated only if required for agreement with another element (e.g., article, adjective). Furthermore, each lemma node is connected to a lexeme node, which is responsible for the morphological form of the word. At this third stage, the first step is to retrieve the morpheme. Then, its metrical and segmental information will lead to the phonological word's syllabification and, finally, articulation.
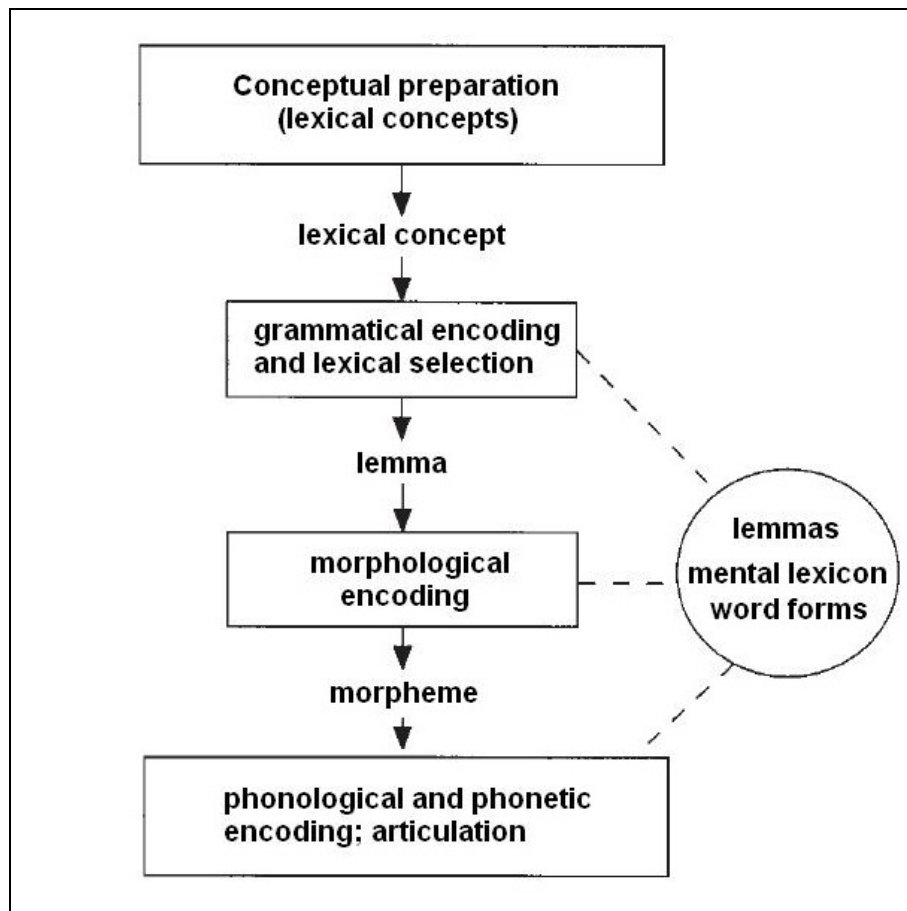
Figure 17: The theory of word production in outline with the four levels.
Adapted from Levelt et al. (1999)

In Levelt et al.'s model (1999), processing at each level is strictly serial. For instance, the morphophonological form of a word retrieved at the word form (third level) can be activated only after the lemma of this word has been selected. This succession of discrete processes contrasts with cascaded processing. The main difference is that discrete processing activates only the word form of the selected lemma, whereas cascaded processing allows the activation of the word form of all activated lexical candidates.

Levelt et al.'s model proposes unidirectional links between levels, but also between the lemma and the syntactic feature nodes. This implies that lemma selection cannot be influenced either by the morphological form of the word, or by its syntactic features. In contrast, interactive models propose bi-directional links so

that lemma selection can be modulated by feedback received from syntactic nodes, and also from the morphological form of the word due to a bottom-up connection. Interactivity also allows phonological neighbours to influence lemma selection. Directionality is a question of debate, and is one of the main divergences across models.

1.3   Divergent assumptions: Caramazza's (1997) model

Though most models agree on the basic architecture of language production, they differ regarding how this architecture functions. For instance, Caramazza's Independent Network model (IN) shares the tripartite architecture of production as proposed in other models of word production, but is composed of independent networks: the lexical-semantic network, the lexical-syntactic network and the phonological/orthographic lexeme network. They respectively represent words' meanings (e.g., semantic properties, features), words' syntactic features (e.g., grammatical category, gender, tense) and words' form (see Figure 18). The lexical-syntactic network is divided into different sub-networks, each of them containing specific information (e.g., category nodes, gender nodes, tense nodes).

As soon as a lexical-semantic representation is activated, it sends activation to the lexical-syntactic and to the phonological/orthographic lexeme networks. Phonological and orthographic lexemes receive direct and independent activation, which allow an independent selection, whereas the activation received by the lexical-syntactic network is only sufficient for priming. In other words, the activation spread from the semantic to the syntactic network is only sufficient to prime, or activate, a syntactic property: this property will be selected only when further activation is received from the lexeme network. All the lexemes sharing semantic features with the selected lemma are simultaneously activated by the lexical-semantic representation. The connections between the lexical-syntactic network and the phonological/orthographic network allow activation to flow from the selected lexemes towards the grammatical features previously primed by the lexical-semantic network. Activation is cascaded and feedforward, which means that a stage can be activated without the previous stage being completed, but connections between levels are unidirectional.
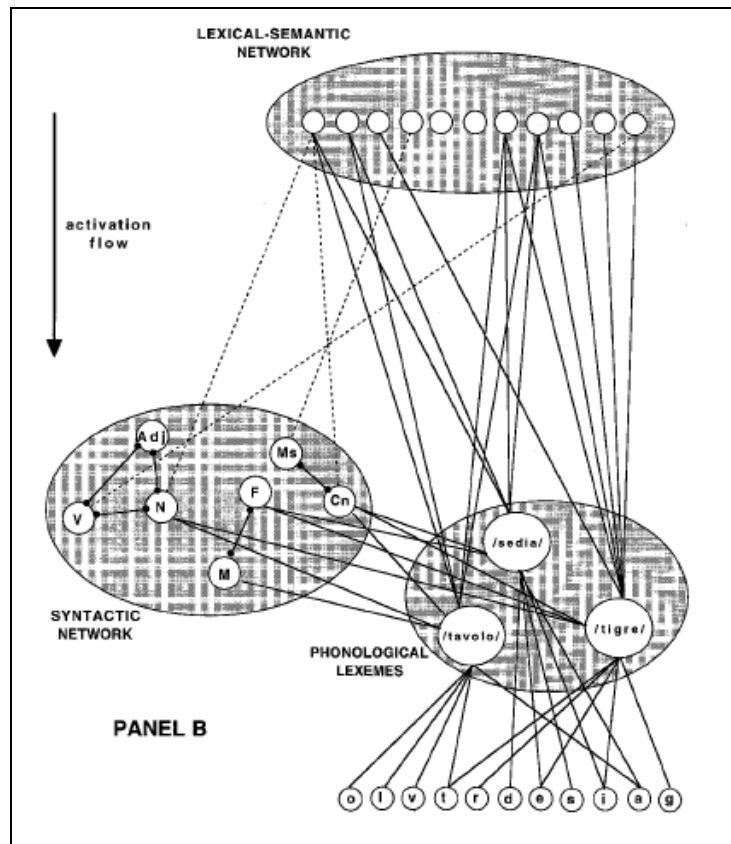
Figure18: Representation of the IN model. The flow of information is from semantic to lexeme and syntactic networks and then on to segmental information. N=noun; V=verb; Adj=adjective; M=masculine; F=feminine; CN=count noun; Ms=mass noun. Dotted lines indicate weak activation. Links within a network are inhibitory. Adapted from Caramazza (1997).

1.4 Summary

In this section we have described the similarities and divergences between two models of language production (Caramazza, 1997; Levelt et al., 1999). We will now review some studies that examined gender retrieval. These studies provide information on which one of these models to adopt to account for the data found in the present thesis, and in general.

2 THE REPRESENTATION OF GRAMMATICAL GENDER PRODUCTION

Word production models consider grammatical gender as an inherent property of the lemma, represented at the syntactic level. As previously mentioned, in Levelt et al.'s model (1999), the selection of a lemma does not necessarily imply the selection of its gender node. In other words, the production of bare nouns involves gender being activated but not selected, whereas the lemma itself has to be both activated and selected. The gender node is selected only when required for computing agreement between noun and targets, such as articles or adjectives. In contrast, Caramazza (1997) argues that as soon as a lemma is selected, its syntactic features are selected as well. These claims have been investigated empirically via the use of speech errors, TOT, ERPs and picture-word interference (see Schriefers & Jescheniak, 1999, for a review), reviewed below.

2.1 Gender retrieval: evidence from Tip-of-the-tongue studies (TOT)

While in a TOT state, speakers have the feeling they know a word but cannot produce it. Nonetheless, they are generally able to retrieve some information about this word, which in turn may reveal something about the time course of activation in word production. Caramazza and Miozzo (1997) conducted a TOT study in Italian in which participants were shown pictures. When participants manifested they were in a TOT state, they were asked questions about the word which they could not retrieve such as its gender and/or partial phonological information. Stimuli were uncommon Italian words (e.g., *euthanasia*, 'euthanasia'; *biga*, 'chariot'; *geroglifico*, 'hieroglyphic'). The information participants gave revealed that in the majority of the cases, they knew the gender (73.8%) and the final phoneme of the word (67.1%). These results replicated with those found by Vigliocco, Antonini, and Garrett (1997), in which gender was correctly reported on 84% of trials. In both studies, the ending of the noun did not determine gender responses (ending being either regular, e.g., *-o* for masculine words and *–a* for feminine words; or irregular, e.g., *–e, -a,* and *–i* for masculine words and *–e, -o*, and *–i* for feminine words in Italian). These studies suggest that lexical-syntactic and phonological properties of words are separated, as speakers seem to be able to retrieve the gender of a word (syntactic feature) without having access to its full phonological form. However, Caramazza and Miozzo (1997)

have shown that responses provided by speakers concerning the grammatical gender and the initial phoneme of the word were equally successful. Their results revealed no correlation between the syntactic and phonological responses. The authors claim that these results provide evidence that speakers can retrieve limited phonological information of the word without automatically retrieving its lexical-syntactic features. This claim contrasts with Levelt et al's model (1999) and supports the IN model (Caramazza, 1997). In Levelt et al's model, the word's phonological information can be retrieved only once its lemma and syntactic features have been selected, due to the serial aspect of the model. In the IN model (cascaded model), however, activation is sent to different levels at the same time, so that the word's phonological information can be partially retrieved even if the syntactic properties are not yet available. One of the arguments against this theory is that TOT studies are off-line judgements and do not involve normal retrieval processes, thus do not reflect normal lexical processing.

2.2   Gender retrieval: evidence from ERPs

In an ERP study, van Turennout, Hagoort and Brown (1998) obtained on-line data inconsistent with Caramazza and Miozzo's hypothesis (1997) concerning the time course of activation. The authors looked at lateralised readiness potentials (LRP), a measure 'reflecting the average amount of lateralisation occurring as a result of specific motor reparation' (van Turennout et al., 1998, p.652) to examine the time-course of processes involved in speech production, in particular, grammatical and phonological processing. In this experiment, participants' brain activity was recorded while they performed a double task. They first had to press a button to indicate the gender of Dutch nouns (common or neutral, denoted by the determiners *de* or *het* articles), but only when these nouns began with a certain phoneme (go/no-go task). In a second experiment, they had to press a button to indicate the initial phoneme of the noun, but only if the noun was of a particular gender. Pictures were presented in four different conditions: *de* word-initial /b/ (e.g., *bloem*, 'flower'), *de* word-initial /s/ (e.g., *schoen*, 'shoe'), *de* word-initial /v/ (e.g., *voet*, 'foot'), and *de* word-initial /k/ (e.g., *kast*, 'cupboard'). *De* words were experimental items, whereas *het* words were fillers in order to avoid between-item variability. LRP effects were found for go and

no-go trials for the first task (gender decision), whereas for the second task (initial phoneme decision) effects were only obtained for go trials. The fact that grammatical gender can inhibit phonological decision but not the inverse shows that the syntactic features of a word, at least its grammatical gender, are available before its initial phoneme. Examining the LRP waveforms, the authors concluded that when a lemma has been retrieved, an additional period of 40ms is required to retrieve a word's initial phoneme. These results suggest that the lemma is retrieved and the syntactic structure is built at the grammatical encoding level before phonological processing has started, hence they contrast with those obtained off-line by Caramazza and Miozzo (1997) in a TOT study. They are in line, however, with the model of speech production proposed by Levelt et al. (1999).

2.3   Gender retrieval: evidence from picture-word interference studies

Recent studies have used the picture-word interference paradigm to investigate the retrieval of grammatical gender in word production. In this paradigm, participants have to name a picture while ignoring a distractor word. In the investigation of grammatical gender, this paradigm has been used with picture-word pairs that are either congruent or incongruent in gender. Results obtained in Germanic languages (La Heij, Mak, Sander, & Willeboordse, 1998; Schiller & Caramazza, 1999; Schriefers, 1993; Schriefers & Teruel, 2000; van Berkum, 1997) support Levelt et al.'s model, whereas the null results obtained in Romance languages (Alario & Caramazza, 2002; Costa, Sebastian-Galles, Miozzo, & Caramazza, 1999; Miozzo & Caramazza, 1999) seem to go against it. The divergences between the results obtained in Germanic and Romance languages have raised questions concerning the selection of gender features and determiners. These studies are reviewed in the present section.

Schriefers (1993) investigated the syntactic process involved in the production of NPs in Dutch. In Dutch, gender is marked by the definite article (e.g., de_{com} $stoel_{com}$, 'the chair'; het_{neu} bed_{neu}, 'the bed') and by the inflectional suffix of the adjective (e.g., $groene_{com}$ $stoel_{com}$, 'green chair'; $groen_{neu}$ bed_{neu}; 'green bed'). Native speakers were asked to name a coloured picture using article + adjective + noun NPs

(experiment 1) and adjective + noun NPs (experiment 2). Each picture was presented with a distractor word that was either congruent (picture: $stoel_{com}$, 'chair'; distractor: $tafel_{com}$, 'table') or incongruent (picture: $stoel_{com}$; distractor: bed_{neu}, 'bed') in gender with the picture to be named[7]. Participants were told to ignore the distractor word. Participants were slower to produce the name of a picture when it did not share the same gender with the distractor word than when it did. This was true both when the noun was preceded by determiner + adjective + noun NPs (naming latencies were 56 ms longer for incongruent than for congruent pairs) and when it was preceded by an adjective only (31 ms effect). The author argued that the gender congruency effect was due to competition between the gender of the distractor and the gender of the picture to be named, which slows down the production of the NP relative to a gender congruent picture-word pair. According to Levelt et al's (1999) model, the lemma of a noun activates its grammatical gender node, thus, when the same gender node is activated by two lemmas (picture and distractor in congruent condition) the amount of activation increases, and the gender node is selected. In contrast, in the incongruent condition, two gender nodes are activated and compete for selection, resulting in a delay in naming.

La Heij et al. (1998) used the same paradigm in a study in which participants had to produce article + noun NPs (1a) or a bare noun. Response times were 30ms longer when the gender of the picture differed from that of the distractor than when they were congruent, which confirmed the gender congruency effect found by Schriefers (1993)[8]. La Heij et al., however, did not find a gender congruency effect when participants had to produce a bare noun. Levelt et al.'s (1999) claim that the gender of a noun is automatically activated but selected only if required for agreement within its syntactic context (e.g., article or adjective), which explains the absence of gender congruency effect in the production of bare nouns.

---

[7] In this study as well as in others reviewed in this section semantic processing during production was also investigated, however, as we are focusing on gender retrieval, the results will not be reported here.
[8] The robustness of the effect could indeed be questioned as Schriefers (1993) used a very small set of pictures (10 pictures), and the design of the experiment was created such that participants had to name the same picture several times (average of 13 times).

Similar results were found in German (1b; Schriefers & Teruel, 2000), and for adjective + noun NPs in Dutch (1c; van Berkum, 1997), and for determiner + adjective + noun NPs in German (1d; Schriefers & Teruel, 2000)

(1a) de_{com} $trein_{com}$ (train)/$mond_{com}$ (moon)

de_{com} $trein_{com}$/bed_{neu} (bed);)

(1b) der_{masc} $Tisch_{masc}$ (red table)/$Schlüssel_{masc}$ (key)

der_{masc} $Tisch_{masc}$/$Lampe_{fem}$ (lamp)

(1c) $kleine_{com}$ $auto_{com}$ (small car)/$plaat_{com}$ (plate)

$kleine_{com}$ $auto_{com}$/$strand_{neu}$ (beach)

(1d) der_{masc} $rote$ $Tisch_{masc}$ (red table)/$Schlüssel_{masc}$ (key)

der_{masc} $rote$ $Tisch_{masc}$/$Lampe_{fem}$ (lamp)

It is important to note that the effect has been obtained at various stimulus onset asynchronies (SOA). The SOA manipulation implies that there is a delay between the presentation of the picture and the distractor word. The gender congruency effect has been found at 0 SOA in Dutch (La Heij et al., 1998) as well as in German (Schiller & Caramazza, 1999, 2003) when stimuli were visually presented. When auditory stimuli were used, the effect appeared at +75 and + 150 SOAs (Schriefers & Teruel, 2000).

In relation to Romance languages, Miozzo and Caramazza (1999) tried to replicate the gender congruency effect in Italian. In a series of experiments, they had participants name determiner + adjective + noun NPs (Exp.1), determiner + noun NPs (Exp.2), masculine determiner + noun NPs (Exp. 3), and determiner + adjective + noun NPs (Exp.5) Despite the consistent paradigm and the variety of NPs to be produced, they consistently failed to reproduce the gender congruency effect. This paradigm was used in other Romance languages, but the effect again failed to be replicated in Spanish (Costa et al., 1999), and in Catalan (Costa et al., 1999).

For French, the language we focus on in the present thesis, Alario and Caramazza (2002) investigated the production of determiners and the process of

determiner form selection. In one of their experiments they attempted to replicate a gender congruency effect to examine whether the gender of the distractor word has an effect on picture naming latencies. They used congruent (e.g., *nuage$_{masc}$-phare$_{masc}$*, 'cloud'-'lighthouse') and incongruent (e.g., *nuage$_{masc}$-carte$_{fem}$*, 'cloud'-'map') pairs, but in similar fashion to the Romance languages studied, no difference was found in naming latencies between conditions.

Furthermore, Miozzo, Costa and Caramazza (2002) investigated whether the absence of effect in Romance languages was a question of SOA since a gender congruency effect had been found at positive SOA in German (Schriefers & Teruel, 2000). They presented either congruent (*limone$_{masc}$*, 'lemon'/*polo$_{masc}$*, 'pole) or incongruent (*limone$_{masc}$/bara$_{fem}$* 'coffin') picture-word pairs at 0, +100 and +200 SOAs. Again, they failed to replicate the effect in both Italian and Spanish.

The studies we have reviewed so far clearly have revealed cross-linguistic differences in gender production. Various accounts have been offered for the presence vs. the absence of gender congruency effect in Germanic and Romance languages. Miozzo and Caramazza (1999) suggest that a potential reason for this cross-linguistic difference could be the role of phonology in the selection of determiners in Dutch and Italian. Indeed, in Dutch the selection of determiners is straightforward; neuter nouns are associated with the determiner *het*, and non-neuter nouns (common, previously masculine and feminine; see van Berkum, 1997) are associated with the determiner *de*. In order for a determiner to be selected, only the gender (and number) of the noun has to be retrieved. As soon as a lemma (and its syntactic features) has been selected, the form of the determiner is selected as well. In Italian, determiner selection is more complex. To be selected, a determiner needs the gender of the noun to be retrieved, but also the initial phonemes of the noun. The feminine singular determiner in Italian has only one form (*la*), but the masculine singular determiner can take two different forms depending on whether it precedes a vowel, a consonant cluster or an affricate (*lo*) or a consonant (*il*). Because both syntactic and phonological features are required in Italian, and phonological features are retrieved later than syntactic features (van Turennout et al., 1998), the selection of determiners takes longer in Italian than in Dutch where only gender is required.

Italian is thus considered as a 'late selection language' and Dutch, an 'early selection language'. Miozzo and Caramazza (1999) argue that any event that occurs at the same time as gender selection, such as competition with a distractor gender, will hinder determiner selection (as it is the case for the gender congruency effect found in Dutch; Schriefers, 1993). However, since the selection of determiners takes longer in Italian, the gender conflict provoked by the distractor is already resolved by the time phonological features are available and the determiner selected. The authors conclude that the gender congruency effect may exist in Italian, but may be invisible. This theory was later extended to other Romance languages such as Spanish (Costa et al., 1999), Catalan (Costa et al., 1999) and French (Alario & Caramazza, 2002). Thus, Miozzo and Caramazza (1999) suggest that the gender congruency effect is not a matter of gender selection, but rather of determiner selection.

In a further study, Schiller and Caramazza (2003) contrasted two hypotheses in relation to the gender congruency effect. In the case of incongruence between the gender of the picture and the gender of the distractor, the gender selection interference hypothesis (GSIH) predicts competition for the selection of the gender node (Schriefers, 1993). In contrast, the determiner selection interference hypothesis (DSIH) predicts competition for the selection of the determiner form (Miozzo & Caramazza, 1999). The predictions were tested using two early selection languages, German and Dutch. These two languages have different determiners in singular (in German, *der*, *die*, *das*; in Dutch, *de*, *het*), but a single determiner form for plural forms (in German, *die*; in Dutch, *de*). Participants were asked to name pictures with article + noun NPs[9] either in singular or in plural, depending on the number of pictures displayed on the screen (1 or 2) as illustrated in examples 2a (German, singular), 2b (German, plural), 3a (Dutch, singular) and 3b (Dutch, plural).

(2a) *der Tisch* (table)

(2b) *die Tische*

(3a) *de tafel* (table)

(3b) *de tafels*

---

[9] Other NPs had to be produced in different experiments in this study (e.g.,, adjective + noun NPs and article + adjective + noun NPs), but the differences of results across experiments are not relevant for the question addressed here.

A significant gender congruency effect appeared for singular NP production (naming latencies were longer by 20ms and 31ms for incongruent than for congruent pairs in German and Dutch, respectively), but no effect was found for plural NP production. These results show that when the determiner is shared by all genders (plural), there is no competition for the determiner form. In contrast, when the form of the determiners differs due to (singular) noun gender, then there is interference for the selection of the determiner at the level of form selection when the picture and the distractor do not share the same gender. This implies that the gender node of the distractor is activated and that it sends activation to its determiner form, resulting in selection competition with the determiner of the picture. These results support the DSIH as they suggest that grammatical feature selection is a non-competitive process, grammatical features being automatically available as part of the lexical node. Thus, the gender congruency effect obtained in Dutch and German may rather be a determiner congruency effect.

The authors also suggested that the DSIH could account for the absence of a gender congruency effect in the production of bare nouns. Since no determiner has to be selected for the production of bare nouns, there is no competition at the level of form selection (La Heij et al., 1998, but see Cubelli, Lotto, Paolieri, Girelli, & Job, 2005).

In a theoretical framework, the DSIH suggests that even if a noun is not to be produced (i.e., distractor) and its lexical node is not selected for production, its word form can still be activated. This is compatible with cascaded models (Caramazza, 1997) but not with discrete serial stage model (Levelt et al., 1999).

2.4   Summary

In this section, L1 language production models were presented (Caramazza, 1997; Levelt et al., 1999). We emphasized that although psycholinguists agree on the tripartite architecture of language production, divergences across models exist. We particularly focused on the representation of grammatical gender in various models and we reported studies that challenged these models and highlighted cross-linguistic differences in the selection of determiners. While Levelt et al.'s model (1999) is supported by the gender congruency effect found in picture word interference studies

in Germanic languages, recent studies suggesting that the gender congruency effect may be a determiner congruency effect seem to be more in favour of cascaded models (Caramazza, 1997; Dell, 1992). We adopt the proposal that the effect found in the case of gender incongruent picture-word pairs is a matter of determiner selection, thus it is worth pointing out some distinctions in the selection of determiners in Romance languages (see next chapter). The experiments reported in chapter 5 use the picture-word interference paradigm to investigate determiner selection in French. The main difference between these experiments and Alario and Caramazza's (2002) study is the SOA between the picture and distractor word. From the examination of determiner selection we will obtain essential information on gender processing in production. However, before we move on to the experimental chapter, we will first address the question of whether the processes involved in monolingual language production function in bilingual production. In the next section we will present bilingual models of lexical access and speech production. Then, the rare studies that have investigated the processing of syntactic information in L2 will be reviewed. Finally, we will focus on the representation of grammatical gender in the bilingual mind.

3 BILINGUAL MODELS OF PRODUCTION

As we noted in the previous section, models of monolingual production already generate disagreement among psycholinguists even though they only concern the production of one language. Models of bilingual production further complicate matters as they have to deal with two or more languages, which may explain why research on production in bilinguals is not very extensive. Most bilingual models are an adaptation of monolingual models (de Bot, 1992; Poulisse & Bongaerts, 1994). The underlying processes involved in monolingual and bilingual production are very similar; nevertheless additional assumptions have to be made in order to understand how bilinguals select one language or the other. It has been suggested that the process responsible for language selection in bilinguals is comparable to that used by monolinguals to select relevant registers as a function of the person addressed and the discourse situation (La Heij, 2005; Paradis, 1987). For example, one would not

use the same vocabulary when talking to an employer and when talking to a friend. Thus, if monolinguals have the capacity of selecting a register, and also the capacity of becoming bilingual themselves, then any monolingual model should also be suitable for bilingual production.

Furthermore, in the same way as monolinguals adapt their register depending on the social status of their interlocutor, bilinguals have the ability to adapt their language *mode* depending on the linguistic knowledge of their interlocutor (Grosjean, 2000). For instance, when a French-English bilingual interacts with an English speaker who does not know French, the bilingual speaker must use the *monolingual mode* (i.e., only one language, in this case, English). In contrast, if the same bilingual speaker interacts with other French-English bilinguals, the *bilingual mode* may be used, that is to say that both languages may be used since all interlocutors are familiar with each of them. The bilingual mode may be used to alternate sentences in French and English (i.e., inter-sentential code switching), or even to mix both languages within the same sentence (i.e., intra-sentential code switching). This ability to choose which language to use or to mix both languages on purpose or accidentally must be accounted for in models.

Models have been proposed to account for bilingual production (Costa, Miozzo, & Caramazza, 1999; de Bot, 1992; Green, 1986, 1998; Poulisse & Bongaerts, 1994). Most of them agree on the presence of a common conceptual store shared by both languages (see Francis, 2005, for a review), but they also diverge in many ways, mainly on the subject of language control. In the present section, models of lexical access and speech production in bilinguals will be presented. As the present thesis is concerned with grammatical gender processing, models representing processing of syntactic information will be given greater attention. However, since the experiments reported in the following chapter deal with free-standing morphemes which are driven by the grammatical gender of the head noun of the NP, it is essential to understand how lexical selection is realised in bilinguals. In turn, we will review some of the handful of studies that have investigated syntactic production in bilinguals. Finally, we will focus on the representation of grammatical gender in bilingual production.

3.1 Models of lexical access in bilingual production

According to monolingual models, once a semantic concept is activated it sends activation to its lexical node. If models of bilingual production assume that the two languages share a common conceptual store, the question arises as to whether the activation of the conceptual system is passed on to both languages. Early studies have suggested the presence of an on/off switch that would send activation only to the language in use and prevent the lexical nodes of the other language from being activated. This switching device would only allow one lexicon to be activated at a time, as in monolingual speakers (McNamara & Kushnir, 1971). A similar proposal suggests that only the lexical nodes of the language in use are considered for selection by the lexical mechanism (Costa et al., 1999; Costa & Caramazza, 1999; Roelofs, 1998). According to these models, lexical nodes are tagged according to the language they belong to. When a word is to be produced, the conceptual level sends the same amount of activation to the lexical nodes of both languages, but only those that are tagged for the language in use can be selected. Consequently, there is no competition for selection between the lexical nodes across languages. For example, when a French-English bilingual wants to produce the word *chair* in English, the semantic concept CHAIR sends activation to both the French lexical node *chaise* and the English lexical node *chair*, but only *chair* will be considered for selection because it is tagged as being an English word.

To test their hypothesis, Costa et al. (1999) used a bilingual version of the picture-word interference paradigm to investigate whether there is lexical competition across languages. Catalan-Spanish early bilinguals were asked to name pictures in Catalan while ignoring distractor words presented in either Catalan or Spanish. Among other results, they found shorter naming latencies when the picture and the distractor were identical in the same language, as well as when the picture was presented with its translation in the other language, compared to unrelated picture-word pairs. For example, participants were faster to name a picture of a table in Catalan (i.e., *taula,* 'table') when presented with an identical distractor (i.e., *taula*) or its Spanish translation (i.e., *mesa*), than with unrelated distractors (e.g., *gos* and *perro*, 'dog' in Catalan and Spanish, respectively). The authors assumed that the effect was due to the extra activation that a target picture receives when the distractor

is the translation of the picture name, since a distractor activates both its lexical node and its translation. For instance, the target name '*taula*' receives activation from the semantic concept of the picture TABLE, and also receives extra activation from the translation of the distractor *mesa*. Since the lexical node of the language not in use (e.g., *mesa*) does not have the correct language tag and thus is not considered for selection, there is no competition with the Catalan lexical node. Thus, the production of the target picture is facilitated when picture-word pairs are related (extra activation is received, e.g., *taula-mesa*), than when they are unrelated (e.g., *taula-perro*). The authors concluded that their results are in line with a language specific selection model.

In contrast, other models of bilingual production have suggested the existence of an inhibitory mechanism which reduces the activation of the lexical nodes of the language not in use (de Bot, 1992; Green, 1986, 1998; Poulisse & Bongaerts, 1994). For example, when a French-English bilingual wants to produce the word CHAIR in English, the lexical node *chair* will receive more activation than the lexical node *chaise*, thus preventing the selection of the French lexical node. This proposal considers language selection as language non-specific since the lexical nodes of both languages are activated, but to different degrees.

This proposal has been supported by studies showing that the language not in use can interfere with the language in use (Hermans, Bongaerts, de Bot, & Schreuder, 1998; Poulisse & Bongaerts, 1994). Hermans et al. (1998) used the picture-word interference paradigm to investigate a potential cross-linguistic effect in Dutch-English bilinguals. Participants were asked to name a picture in their L2 (i.e., English) while ignoring auditory distractor words presented in their L2 or L1 (i.e., Dutch). Picture-word pairs were either semantically or phonologically related, or unrelated. For example, the name of the picture MOUNTAIN (*berg* in Dutch) was associated with either a semantically related distractor (e.g., L2, *valley*; L1, *dal*), a distractor phonologically related to the target language (e.g., L2, *mouth*; L1, *mouv*, 'sleeve') or to the translation of the non-target language (e.g., L2, *bench*; L1, *berm*, 'verge'), or unrelated (e.g., L2, *present*, L1, *kaars*, 'candle'). Naming latencies were longer when picture-word pairs were semantically related, but shorter when they

were phonologically related. This effect was found regardless of whether pictures and distractors shared the same language. The authors concluded that the translation of the L1 word had to be activated in order to interfere with L2 selection. The presence of a distractor phonologically related to L1 translation (e.g., *bench-berm*) increases the activation of this lexical node provoking a competition for selection with the picture name. These results support a language non-specific selection model. Costa et al. (1999) suggested that the difference between results of their study and Hermans et al.'s (1998) may have been due to the response language (L1 in Costa et al. vs. L2 in Hermans et al.) and the proficiency of the participants (the restriction of lexical selection is easier for highly proficient bilinguals as in Costa et al.).

The question of whether the language not in use can interfere with the language in use is still a matter of debate (Costa, Mahon, Savova, & Caramazza, 2003; Hermans, 2004). In the same way, models make different assumptions concerning the process involved in language switching (de Bot & Schreuder, 1993; Green, 1998; Grosjean, 2001; Poulisse & Bongaerts, 1994). Some models such as the Inhibitory Control model (IC model, Green, 1986, 1998) assume that switching from one language to the other is possible because two speech plans are created simultaneously in bilingual production. One plan is created for the language in use (the selected language), and another one for the other language (the active language). In this case, if any event occurs that prevents production in the language in use (or if the speaker feels like using the other language), the bilingual can switch to the other plan and carry on in the other language. It seems to be costlier, however, to switch from L2 to L1 (especially for unbalanced bilinguals) since the dominant language has to be maximally suppressed to prevent interference with the less dominant language. Thus, it seems that capacity for switching from one language to the other also depends on the proficiency in the L2 (Costa & Santesteban, 2004; Green, 1998, Meuter & Allport, 1999).

One issue these models do not address concerns the organisation of the selected lexical items into syntactic structures. Only a few models have attempted to account for syntactic mechanisms in bilingual production. The present thesis focuses on

grammatical gender processing, and one way to look at this question is to examine how elements are related to each other as a function of gender within a phrase or a sentence. In the next section, we present models of speech production in bilinguals.

3.2   Models of speech production in bilinguals

Most models of bilingual speech production are a bilingual adaptation of Levelt's (1989) influential monolingual model (de Bot, 1992; de Bot & Schreuder, 1993; Poulisse & Bongaerts, 1994). These models attempt to give a proposal for bilingual speech production from the conceptualisation of message to articulation. Thus, they agree that the message to be produced starts from the conceptual level which sends activation to its lexical node (the syntactic level), and once the latter is grammatically encoded it is sent to the phonological level to be articulated. Models diverge on the organisation of language information at each level. In this section, some models of bilingual speech production are reviewed.

De Bot (1992) was the first to propose a complete model to account for bilingual speech production. As Levelt's model (1989) is based on a large amount of psycholinguistic research, de Bot decided to adapt it to bilingual production with a minimum of changes. De Bot uses the term bilingual to refer to a person who has acquired a certain proficiency in a second language; this proficiency can vary from low to (near) native. Thus, the model needs to cover all the issues bilingual production can generate. For example, the model has to account for the fact that language systems can be used independently or simultaneously (i.e., code-switching), that languages can interfere with each other (i.e., cross-linguistic influences), that bilinguals usually have a dominant language (i.e., unbalanced proficiency), and that the number of language systems can be unlimited without affecting production.

De Bot went through each stage of Levelt's model and proposed an adaptation for a bilingual version. The first issue he came across was the mechanism involved in the selection of language. He compared the selection of language to the selection of register in the monolingual version of the model. He assumed that the target language is selected in the conceptualizer. In a first stage, the language is selected according to the discourse situation (e.g., the interlocutor's linguistic knowledge),

and in a second stage, language specific encoding takes place depending on the system of the selected language (i.e., vocabulary, syntax, phonemes, etc).

The second issue occurs at the level referred to as formulator in Levelt's model. Since some languages are very dissimilar such as French and Arabic, or much closer such as French and Spanish for example (e.g., cognate, syntactic characteristics, etc), de Bot proposed that the formulator is language specific, meaning that grammatical and phonological encoding are separate for each language. However, he suggested that the degree of separation will vary according to the similarities between two languages. These variations would range in between two extremes: i) separate formulator and separate lexicon for each language, ii) a unique system in which all information would be stored. Thus, some elements could be shared by L1 and L2 when similar in both languages, and separated when different across languages. De Bot suggested that the separation of the two languages will increase simultaneously with proficiency. For example, a speaker who knows a few words in a foreign language would integrate these words into the first language system, which is flexible enough, but a balanced bilingual would have two separate systems. How separation occurs as proficiency increases is still unclear. In relation to code-switching, de Bot adopted Green's assumption (1986) that two plans are generated simultaneously in both languages, so that if, for any reason, a switch has to be made, the active language can rapidly become the selected language.

For the mental lexicon de Bot followed Paradis' 'Subset hypothesis' (1987) which claims that L1 and L2 lexical items form subsets. These subsets are created as a function of constant use, so that links between lexical items of the same language are more likely to be strengthened, resulting in separate subsets for each language. However, if a bilingual is frequently in a situation of code-switching, the links between lexical items of both languages will be as strong. De Bot adopted the assumption of an inhibitory mechanism (Green, 1986), which suppresses the activation of the language not in use to avoid interference with the selected language. Once the language is selected at the conceptual level, the process is similar to that of monolinguals, thus the lexical item is retrieved as well as the syntactic features, which are necessary for the organisation of the syntactic structure. At the articulatory

level, de Bot proposes a single articulator that contains a large range of phonemes and syllables.

Despite the goal of proposing a complete model of bilingual speech production, de Bot focused more on language selection and lexicon organisation than on the processing of syntactic information into structure according to L2 constraints. He acknowledged that some questions addressed in the models were yet to be verified with empirical evidence. Furthermore, Poulisse (1997) asked how two parallel speech plans can be constructed if only one language is activated enough to be selected.

De Bot and Schreuder (1993) proposed a revised version of the model in which they eliminated the assumption of two speech plans and added a new component. This component, called the verbalizer, is located between the conceptualizer and the formulator. Its role is to chunk pieces of conceptual information into semantic representations of lemmas (lexicalizable chunks) to facilitate lexical access. The language to be used is selected before chunking takes place, the principle being that the preverbal message sends a language-specific cue to the verbalizer which uses it to retrieve lexical items. However, the way messages are chunked is unclear.

Like de Bot and Schreuder (1993), Poulisse and Bongaerts (1994) assumed that the decision to separate or mix languages is realised by specifying language selection in the preverbal message. The specification is represented by language components similar to the cues used in de Bot and Schreuder's model, which are involved in the activation of lexical items. Poulisse and Bongaerts suggested that words of both languages are stored in one lexicon and are tagged according to their language (as Green's assumption, 1986). The authors analysed the speech production of Dutch-English bilinguals and they noticed some blends such as *he cwame* (Dutch *kwam* and English *came*) and *elchother* (Dutch *elkaar* and English *other*). These blends suggest that lexical items of both languages can be activated simultaneously, furthermore, when languages compete for selection it is likely that L1 gets selected over L2, especially in unbalanced bilinguals. Their study was in line with Myers-Scotton's 'matrix language frame model' (1992) which suggests that one of the languages is the dominant 'matrix' language in conversation. This matrix language provides the

morphosyntactic frames, and constituents from the other language (the 'embedded language') are inserted into these frameworks. However, these models account for language switching and not bilingual speech production in the monolingual mode (i.e., either L1 or L2, but only one language).

A more recent model of bilingual speech production has been proposed by Hartsuiker, Pickering and Veltkamp (2004) based on Pickering and Branigan's combinatorial node model (1998). Pickering and Branigan suggested that lemma nodes are linked to other nodes representing the word's syntactic properties. Different types of nodes are found, such as feature nodes (e.g., gender), and categorical nodes (e.g., noun, verb). They also assumed the presence of combinatorial nodes, specifying the possible combinations of the word in grammatical structures. For example, the verb *chase* can be used in an active or a passive structure, thus it is linked to both the active and the passive combinatorial nodes. The appropriate node is activated according to the type of sentence the speaker wants to produce (i.e., active or passive). Like feature nodes, combinatorial nodes are shared between lemmas, so that all verbs that can be used in an active construction are linked to the same node. Hartsuiker et al. adapted this model and proposed that lemmas of the two languages in the bilingual mind are linked to the same category and combinatory nodes (when languages have similar grammatical structures). Thus the grammatical structure is activated through the activation of the lemma and the combinatory nodes. Individual lemma nodes are tagged for language (Dijsktra & van Heuven, 2002). The language in use depends on the lexical items inserted into the structure. For example, the verb *chase* and its Spanish translation *perseguir* are both connected to the same semantic and combinatory nodes. This model provides information for language switching and construction 'borrowing' from one language to the other. Their proposal is based on the results of a syntactic priming study reported in the next section.

In this section we presented a few models of lexical access and speech production in bilinguals. In contrast to monolingual models, bilingual models suffer a lack of empirical evidence in relation to L2 speech production. In the next section we

review a few studies that have investigated syntactic information processing in bilinguals.

3.2.1. Studies investigating syntactic processing in L2

Recently studies have compared sentence processing in production in L1 and L2 using syntactic priming or looking at error production in sentence completion. While these studies are not as numerous as those examining L2 comprehension, the information they provide sheds light on L2 production. The conclusions drawn from these studies added to the conclusions of L2 comprehension studies reported in chapter 2 will provide a global view of syntactic processing in L2.

Priming studies have recently been used to investigate L2 production. Syntactic priming is the observable fact that speakers are more likely to use one syntactic structure if this structure has recently occurred in the discourse (Bock, 1986). For example, Branigan, Pickering, and Cleland (2000) established a paradigm in which a naïve participant and a confederate describe cards to each other. They found that the naïve participant used a syntactic structure more often when it had been employed by the confederate. Hartsuiker et al. (2004) adapted this paradigm to investigate whether syntactic information is shared between languages. They had Spanish-English bilinguals describe cards to each other; the naïve participant spoke English and the confederate spoke Spanish. Prime sentences consisted of active (e.g., *el taxi persigue el camión*, 'the taxi chases the truck') and passive sentences (e.g., *el camión es persiguido por el taxi*, 'the truck is chased by the taxi'). They observed that participants were more likely to produce an English passive sentence when preceded by a Spanish passive sentence than preceded by an active sentence. This suggests that syntactic representations are language non-specific and therefore are shared between languages.

Similar results were found in Loebell and Bock's study (2003) with active sentences with German-English bilinguals. Participants had to repeat a sentence in either their L1 or L2 and describe an unrelated picture in the other language. In contrast, no effect was found for passive sentences. The authors suggested that it may have been due to the use of different structures across languages. Indeed, German

144

and English share the same structure for active sentences, but such is not the case for passive sentences, with the verb occurring at the end of the sentence in German (e.g., *Die Böden warden täglich von den Hausmeister gereinigt*, literally, 'the floors are daily by the janitor cleaned') but not in English (e.g., *the floors are cleaned daily by the janitor*). This study also revealed a syntactic priming effect with dative sentences (double object and prepositional object sentences) as later found in Schoonbaert, Hartsuiker and Pickering (2007)

Schoonbaert et al. (2007) used the same paradigm as Hartsuiker et al. (2004) to test syntactic priming within and across languages. In four experiments they tested whether the naive participant would repeat the same syntactic structure as previously used by the confederate. They used two constructions, a prepositional object (4a) and double object (4b).

(4a) The cook shows a hat to the boxer
    De kok toont een hoed aan de bokser
(4b) The cook shows the boxer a hat
    De kok toont de bokser een hoed

Participants were all native speakers of Dutch with English as their L2. In the first experiment, participants heard a prime in English (L2) and produced a target sentence in English (L2). In the second experiment, they heard a prime in Dutch (L1) and produced the target in English (L2). In the third experiment, both primes and targets were in Dutch. In the last experiment, primes were in English and target sentences in Dutch. Their results showed a syntactic priming effect within L1, within L2, from L1 to L2 and from L2 to L1. These results are in line with Branigan et al.'s model (2000) concerning syntactic priming in monolinguals (i.e., primes and targets in L1 Dutch), or in L2 monolingual mode (i.e., primes and targets in L2 English). The cross-linguistic results fit into Hartsuiker et al.'s model (2004) as they show that hearing a verb in one language (L1 or L2) activates the lemma node of this verb and its combinatorial node (e.g., the prepositional object node, in Schoonbaert et al.'s experiment). As combinatorial nodes are shared between languages according to the

model, the recent activation of the combinatorial node boosts the probability that the speaker will use the same construction in the other language.

Desmet and Declercq (2006) also used priming to investigate the attachment of relative clauses to noun phrases. They used sentences such as *Someone shot the servant of the actress who was on the balcony*. In this type of sentences, the relative clause can be attached either to *the servant* (high attachment) or *the actress* (low attachment). It has been shown that monolinguals are more likely to produce high attachment relative clauses (e.g., *the servant*) when preceding by high attachment primes than low-attachment primes (e.g., *the actress*) (Scheepers, 2003). Desmet and Declercq (2006) replicated the same experiment with Dutch-English bilinguals who were asked to complete beginnings of sentences. Participants were more likely to use a high attachment clause in English after completing a high attachment prime in Dutch compared to after completing a low attachment prime. Dutch primes were disambiguated by gender, the relative pronoun corresponding to either a neuter or common noun in Dutch. These results again suggest that syntactic representations are shared between languages.

The studies reported above suggest that syntactic representations are shared between languages at least in relation to the organisation of syntactic information into structures for sentence production. We can ask whether gender is also shared between languages or whether there are two independent gender systems for L1 and L2. In the next section, we review some studies that investigated this question.

4   GRAMMATICAL GENDER IN BILINGUAL PRODUCTION

As far as we are aware very few studies have addressed the question of gender systems in bilingual speech production. Costa, Kovacic, Franck, and Caramazza (2003) examined the presence of a potential interaction between gender systems of L1 and L2, in other words, whether gender retrieval of the language in use is affected by the grammatical features of the other language. As proposed in some of the models we presented in the previous section, the authors assumed that the conceptual system is shared by both languages in the bilingual mind, and that words of both lexicons are activated by the semantic system (Costa et al., 1999; de Bot, 1992,

Green, 1998, Poulisse, 1997). Costa et al. tested two contrasting hypotheses concerning the representation of gender systems in bilinguals. The first hypothesis, the gender integrated view, suggests that L1 and L2 share a common gender system. Thus, if a word has the same gender in L1 and L2, the gender node will be activated from two sources. For example, if a French-Spanish bilingual wants to produce the word *apple* in French, the concept APPLE will be activated and will send activation to both the French lexical item *pomme* and Spanish lexical item *manzana*. As both French and Spanish words share the same gender, the feminine node will be activated from both L1 and L2 lexical items. In contrast, if the same bilingual wants to produce the word *car* which is feminine in French (*la voiture*) but masculine in Spanish (*el coche*) each lexical item will be linked to a different gender node. The second hypothesis, the language autonomy view, proposes that gender systems of the two languages are completely independent. Thus, the fact that words share the same gender (or not) does not affect the retrieval of gender. The authors also took into consideration the question of gender activation, contrasting the assumption that gender retrieval depends on its level of activation (Levelt et al, 1999), and the assumption that gender becomes automatically available as soon as the lexical item is activated (Caramazza, 1997).

To test these hypotheses, they conducted five experiments in which bilinguals had to name a picture in their L2; this picture either shared gender with its translation in L1 or did not. Two types of language pairs were used according to the structure of their gender system: i) languages that have different gender systems (e.g., Croatian-Italian), ii) languages that have similar gender systems (Spanish-Catalan, and Italian-French). The use of different language pairs was to check whether the similarity between gender systems would favour the presence of a shared gender system. Croatian-Italian bilinguals, Spanish-Catalan, Catalan-Spanish bilinguals and Italian-French bilinguals were asked to name pictures with an NP in their L2 (Italian, Catalan, Spanish and French, respectively). Monolinguals of each language were used as a control group. Results showed no difference in naming latencies for L2 pictures that shared gender with their L1 translation and for pictures that did not. Furthermore, the results for monolinguals were similar to those obtained for bilinguals. The absence of difference between the two types of picture (shared gender

or not) argued against the proposal of an integrated gender system and selection by level of activation. The authors suggested that the two gender systems of a bilingual might be independent and that gender is automatically available; in this case, the only selected gender would be that corresponding to the selected lexical item; alternatively, they suggested that gender systems might be integrated and gender access automatic. Although they did not have a clear-cut model to account for their results, they highlighted the importance of the fact that the gender retrieval of the language in use is *not* affected by the gender of the other language of a bilingual. They also mentioned that the extent to which gender systems are autonomous may vary according to the proficiency of the bilingual.

With a similar concern, Bordag, Opitz and Pechmann (2006) examined the influence of noun termination on gender processing in L1 and L2. They conducted two picture-naming and two grammaticality judgement experiments with German monolinguals and English learners of German. In both types of experiments they used nouns that had typical, ambiguous or atypical endings for gender in German. In the production experiment, participants were asked to name pictures either with a bare noun (e.g. *Haus*, 'house') or with an adjective and a noun, the adjective being gender marked (e.g. *große*, 'big', for feminine; *großer* for masculine; and *großes* for neuter). Shorter naming latencies were expected for nouns that had a gender typical ending. In the grammaticality judgement experiment, the demonstrative pronoun was either congruent or incongruent in gender with the noun. Longer decision latencies and more errors were expected when the incongruence occurred with nouns that had ambiguous or atypical endings. Results for both types of experiments showed that gender processing was not influenced by the type of noun endings in monolinguals, whereas in L2, gender processing seemed to be easier for nouns that had typical endings than for those that do not. The authors concluded that, in like fashion to native children, L2 speakers make use of phonological cues during gender processing whereas adult native speakers do not. Hence, it seems that, in children and L2 speakers, there is a connection between phonological and grammatical levels of processing as proposed by models such as Caramazza's (1997). The authors suggested that this connection may no longer exist in adult native speakers or may be

too weak to influence gender processing. They also proposed that the phonological-grammatical connection may also disappear/weaken in highly proficient L2 speakers.

Bordag and Pechmann (2007) found similar results with L1 Czech and L2 German speakers. In the same study, they also investigated L1 interference on gender processing. Czech native speakers had to produce a noun or an adjective + noun NP either in their L1 or L2 depending on the colour displayed on the screen. Stimuli were selected so that they either shared the same gender in Czech and in German or did not. Results revealed longer naming latencies when nouns did not have the same gender across languages than when they did. The authors concluded that interaction between L1 and L2 systems does not only occur at conceptual and phonological levels, but also at the grammatical encoding level. In contrast to Costa et al.'s (2003) claim that L1 and L2 gender systems are autonomous, Bordag and Pechmann suggested that the two languages share their gender nodes. This difference of conclusions across studies may be due to participants' proficiency in their L2; Costa et al.'s (2003) participants were much more proficient than L2 learners who took part in Bordag et al. (2006) and Bordag and Pechmann's studies. The proposal suggesting various stages of acquisition through which the role of phonological cues would progressively decrease/disappear could account for the difference found in low/intermediate and advanced bilinguals regarding gender processing in L2.

Recently, Salamoura and Williams (2007) examined the representation of grammatical gender in L2 speakers. Native speakers of Greek had to translate a noun or an adjective + noun into their L2 German. Results showed that they were slower to translate nouns that did not share gender across language than those that did. The authors concluded that the influence of L1 gender on L2 production reflects shared representation of gender feature in L1 and L2 systems.

Thus, the question of integration or autonomy of L1 and L2 gender systems requires further investigation; the experiments reported in chapter 5 address this issue.

CHAPTER SUMMARY

In this chapter we presented models of production in monolinguals and bilinguals, which agree on the basic architecture of language production despite a few

divergences. We noted that L2 models propose assumptions to adapt L1 models to L2 production, but while monolingual speech production models are supported by numerous psycholinguistic studies, bilingual models still suffer from a lack of empirical evidence. We aim to shed light on L2 production by conducting experiments investigating determiner selection in French. Monolinguals and bilinguals will be tested to expose similarities in gender representation and processing in L1 and L2. To examine the influence of L1 on L2, two groups of L2 speakers were selected; one with a complex gender system in their native language (e.g., Spanish) and the other without (e.g., English). These experiments are reported in chapter 5.

CHAPTER 5

GENDER PRODUCTION: EMPIRICAL DATA

In the present chapter, we report seven experiments examining determiner selection in French L1 and L2. These experiments used the picture-word interference paradigm to investigate whether a determiner congruency effect would be obtained, in line with previous studies (La Heij et al., 1998; Schiller & Caramazza, 1999; Schriefers, 1993; Schriefers & Teruel, 2000; van Berkum, 1997). In the first series of experiments (Experiments 4, 5, 6, and 7) native speakers of French had to produce simple (determiner + noun) and complex (determiner + adjective + noun or determiner + noun + adjective) NPs. These experiments tested the early/late selection language hypothesis proposed by Miozzo and Caramazza (1999). In the second set of experiments (Experiments 8, 9, and 10), the same methods were repeated with English-French and Spanish-French bilinguals to compare the selection of determiners in French in native and non-native speakers. Through the examination of gender representation and processing with regard to determiners, we further investigated the main questions addressed in the present thesis in relation to the similarities in gender representation and processing in L1 and L2, and the influence of the native language on L2 processing.

1 THE DETERMINER CONGRUENCY EFFECT: EARLY VS. LATE SELECTION LANGUAGES

In the following experiments, we tested two hypotheses regarding the selection of determiners in French using the picture-word interference paradigm. The aim was to obtain further information on the representation and processing of gender in L1 before comparing it with the representation and processing of gender in L2.

We first tested the determiner congruency effect[10]. This effect, which shows longer latencies for gender incongruent picture-word pairs than for congruent pairs, has been investigated in previous studies that revealed cross-linguistic differences between Germanic and Romance languages (see chapter 4, section 2.3 for details). According to Miozzo and Caramazza (1999), the presence vs. absence of a determiner congruency effect may be explained by differences in how determiners are selected in Germanic and Romance languages. Germanic languages are considered 'early selection languages' since a determiner is selected as soon as its gender has been retrieved. In contrast, in Romance languages, a determiner requires both its gender and its local phonological context to be retrieved before it is selected (e.g., in Italian, *lo* when preceding a vowel, a consonant cluster or an affricate, e.g., *lo scoiattolo* (squirrel), but *il* when preceding a consonant, e.g., *il treno* (train), and in French *le* or *la* preceding become *l'* when preceding a vowel). Since determiner selection is early in Germanic languages, competition between the gender of the picture and that of the distractor delays the selection of the determiner. Conversely, since determiner selection is late in Romance languages, the conflict provoked by the picture-word gender competition is already resolved by the time the phonological features of the word are retrieved and determiner is selected. Thus, the determiner congruency effect is thought of not as being non-existent in Romance languages, but rather invisible.

Miozzo and Caramazza's (1999) hypothesis has been called into question, however, by Schriefers and Teruel (1999[11]). In a cross-linguistic study comparing

---

[10] We adopt Miozzo and Caramazza's theoretical approach (1999) that longer naming latencies in picture-word paradigm are due to a competition for determiner form and not for gender and, we will thus use the term 'determiner congruency' effect even when referring to earlier studies that suggested a gender congruency effect.

[11] This study is reported in the Proceedings of the 21st Annual Conference of the Cognitive Science Society, (1999, 637-642). The results for German speakers were published in Schriefers and Teruel (2000), but the results for French speakers have never been reported in a refereed journal.

German and French speakers, they manipulated the SOA of the distractor (-150ms; 0ms; +150ms; +300ms). German speakers had to name pictures with determiner + colour adjective + noun NPs (e.g., *der gruene Tisch,* 'the green table'), and French speakers had to produce determiner + noun + adjective NPs. In the experiment involving French native speakers, nouns either started with a consonant (C-noun) followed by an inflected or uninflected adjective (e.g., *la chaise vert-e/rouge,* 'the green/red chair') or with a vowel (V-noun) followed by an uninflected adjective (e.g., *l'assiette jaune,* 'the yellow plate). The elision of the French determiner with vowel-initial nouns neutralizes gender marking (e.g., *l'avion$_{masc}$* 'the plane', *l'assiette$_{fem}$* 'the plate'). German participants displayed a determiner congruency effect usually present in Germanic languages but only at +150 SOA (naming latencies for incongruent pairs were 29ms longer than for congruent pairs). The delay in the effect compared to the determiner congruency effect previously obtained at 0 SOA in Dutch (La Heij et al., 1998) and in German (Schiller & Caramazza, 1999) can be accounted for by the fact that Schriefers and Teruel used auditory stimuli (vs. visual stimuli in other studies). French participants showed a determiner congruency effect both at +300ms for NPs containing consonant-initial nouns whose determiners are gender marked (effect = 31ms), and at 0 SOA for vowel-initial nouns with no marked gender (effect = 38ms). Whether an adjective was inflected or uninflected had no effect. The authors concluded that gender interference occurs independently of the phonological form of the noun; however, they do not have a clear-cut explanation for the time delay of the effect between C-noun and V-noun NPs in French.

Miozzo, Costa and Caramazza (2002) examined whether the SOA could influence the determiner congruency effect in Romance languages. In two experiments, they tested Italian and Spanish speakers, respectively. Participants had to name pictures with article + noun NPs. Pictures were displayed with a distractor that was either congruent or incongruent in gender and that appeared at various positive SOAs (0ms; + 100ms, + 200ms). No effect of determiner congruency was found in either language. The authors concluded that the presence vs. the absence of a determiner congruency effect was not a question of SOA variation, but revealed

differences in determiner selection in Germanic (early selection languages) and Romance languages (late selection languages).

At present, there is no evidence for determiner congruency effects at positive SOAs in either Italian or Spanish (Miozzo et al., 2002), and only an inconsistent determiner congruency effect in French (Schriefers & Teruel, 1999). If we assume that the cross-linguistic divergences found in Germanic and Romance languages are a matter of determiner selection, then it is important to point out some differences in determiner form selection in Italian, Spanish and French. In Italian, the feminine singular article has only one form (*la*), but the masculine singular article can have two forms depending on the initial segment of the noun (*il* or *lo*). In Spanish, the masculine singular article has only one form (*el*), and the feminine singular article has mainly the form *la*, but becomes *el* when followed by a noun beginning with a stressed /a/. In French, the feminine singular article is *la*, and the masculine is *le*, but when followed by a vowel in its local context, the article is elided and becomes *l'* for both genders[12]. Two hypotheses have been proposed in relation to the definite article in French (Alario & Caramazza, 2002; Schriefers & Teruel, 1999). In the first hypothesis, *le/la* and *l'* are considered as two different determiners (similar to *il* and *lo* in Italian). In this case, according to the early/late language selection hypothesis proposed by Miozzo and Caramazza (1999), the determiner form is selected only when both syntactic (i.e., gender) and phonological features (depending on the local context) are retrieved. Thus, French, like Italian would be considered as late selection languages. We will refer to this hypothesis as the 'different determiner hypothesis'. In contrast, the second hypothesis considers *l'* as the reduced form of the determiner forms *le/la* resulting from a late phonetic adjustment of the determiner form (depending on the initial phoneme of the local context). In this case, *le/la* are selected as soon as the lemma is selected and syntactic features become available, making French, like Dutch, an early selection language (Schriefer & Teruel, 1999). We will refer to this hypothesis as the 'reduced form hypothesis'.

---

[12] The rule for definite article in French is fairly straightforward as opposed to Italian and Spanish, and even to the selection of other determiners in French such as possessive and demonstrative determiners. In this chapter, when using the term 'determiner selection', we will always refer to the definite article selection unless specified otherwise.

If the 'reduced form hypothesis' is correct, then a determiner congruency effect should be found in French, as it is in other early selection languages. However, at present, the determiner congruency effect has never been clearly reported in French. Alario and Caramazza (2002) investigated the presence of this effect in French, but failed to replicate the results obtained in Dutch (La Heij et al., 1998) and German (Schiller & Caramazza, 1999). It is important to note though that in their study, they only presented the picture-word pairs at 0 SOA. If we adopt the 'reduced form hypothesis', then we assume that *le/la* are always selected, and that *l'* is a late phonetic adjustment rule realised post-selection. It is possible that this post-selection rule may provoke a slight delay in the definitive selection of the determiner. In other words, *le/la* would always be selected 'by default', but could only be 'fully' selected once the post-selection rule has been checked, according to the local context, i.e., whether the form of the determiner needs to be reduced or not. This delay would render the selection of determiner in French slightly slower than in Germanic languages, but still faster than in other Romance languages.

1.1 Experiment 4: determiner + noun NP

In Experiment 4 we used a picture-word interference paradigm to test two hypotheses. The first hypothesis considers *le/la* and *l'* as two different determiners, making French a late selection language like Italian ('different determiner hypothesis'). If this hypothesis proves to be true, no determiner congruency effect should be found. In contrast, the second hypothesis considers *l'* as the reduced form of *le/la*, *l'* being the result of a late phonetic adjustment rule ('reduced form hypothesis'). If this hypothesis is valid, a determiner congruency effect should be found in French like the one in Germanic languages. However, this effect should be found at positive SOA (in contrast to 0 SOA Germanic languages[13]) due to the potential delay produced by the phonetic adjustment rule checking (local phonetic context).

---

[13] Note that determiner congruency effect has been found at positive SOA in German but only with auditory stimuli (Schriefers & Teruel, 2000)

1.1.1 Method

Participants

Eighteen French native speakers, students at the University of Provence, volunteered for the experiment. The mean age was 22.7 years. They all had normal or corrected-to-normal vision.

Material

We selected 48 pictures of inanimate objects, half were masculine, and half were feminine (materials are presented in Appendix F). Picture names were balanced in frequency and length (mean frequency per million: masc. 40.6, fem. 41.2, t (46) = .05, p = .96); length mean of letters: masc. 5.4, fem. 6.9, t (46) = 1.3, p = .23; Brulex, Content, Mousty, & Radeau, 1990). The first phoneme of each stimulus was a consonant, so that the vowel of the article was never elided and the article always appeared in the standard form (*le/la*). Thirty-two additional words were selected as distractors, 16 masculine and 16 feminine words (mean average frequency per million: 302.5; mean length: 5). Pictures were presented either with a gender-congruent distractor (congruent condition), or with a gender-incongruent distractor (incongruent condition, see Figure 19), or with a row of Xs (control condition). Picture-word pairs were semantically and phonologically unrelated. Three lists were created, such that each word was seen in all conditions across lists but in only one condition per list, and presented to an equal number of participants. Each list included 48 test items with 12 in each condition, and 32 filler trials (fillers were presented only with Xs, not with distractor) and began with six training trials. The order of presentation was randomised for each participant. The picture-word pairs were shown at + 200ms SOA, that is to say that the distractor appeared 200ms after the picture appeared on the screen. A positive SOA was chosen because according to the second hypothesis we are testing ('reduced form hypothesis), the local context of the determiner must first be checked for the determiner to be selected. Since this adjustment may delay determiner selection, we delayed the presentation of the distractor to detect any competition for selection in case of incongruent picture-word pairs. In a previous study, a determiner congruency effect was found at +300ms in French (Schriefers & Teruel, 1999), however, delays in the determiner congruency

effect have been reported for auditory stimuli compared to visual stimuli (Schriefers & Teruel, 2000). In the present experiment stimuli are visually presented, thus we decided to present the distractor at +200 SOA.

Picture: *la cuillère*fem (spoon)
Distractor: *la fleur*fem (flower)

Picture: *la cuillère*fem
Distractor: *le papier*masc (paper)
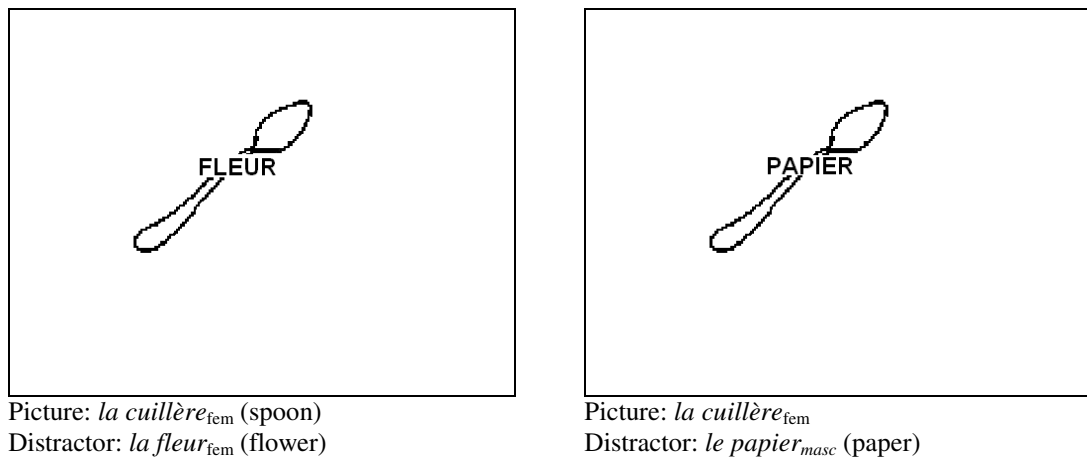
Figure 19: Example of picture-word pairs in congruent and incongruent conditions.

Procedure

The experiment was run using the E-Prime software (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants were given both oral and written instructions. They were told to name the pictures with both the definite article + noun NPs (e.g., *la chaise*, the chair), and to ignore the superimposed words. Before the experiment proper, the pictures were presented in a Power Point file with superimposed Xs to represent the position where the distractors would appear in the experiment (the distractors were written in Arial 18 and had a slightly different position between pictures, but always the same position in the three conditions for the same picture). Participants were required to think of the name they would spontaneously used to describe the picture they saw on the screen, and then the name they were expected to produce for this particular picture during the experiment appeared. The experiment was preceded by a training session of 6 trials. Each trial of the experiment started with a fixation point (an asterisk for 500ms), followed by a blank screen (500ms), then the picture was displayed and the distractor appeared with a 200ms delay. The pairs would stay on the screen until a response was provided, up to a maximum of 2000ms. Response

times were recorded via a microphone from the onset of the produced NP as determined by a voice key.

1.1.2 Results

Before further analyses, trials were screened for voice-key disfunctioning, disfluencies and incorrect responses. RTs greater than 3 standard deviations from the participant individual mean and those over 1300ms were replaced by the participant's mean (3.3%). Two items were rejected because they generated too many naming errors (some participants thought *bouclier*, 'shield' was a badge, and *haricot*, 'bean' was a banana). ANOVAs were performed by participants (F_1) and by items (F_2) on the means obtained from the subtraction between congruent and control conditions, and incongruent and control conditions (means are reported in Table 6 and illustrated in Figure 20). Collapsing means enabled us to compare congruent and incongruent conditions directly; the control condition was used only to check the difficulty of the task. The aim of the experiment was to determiner whether naming latencies were longer when the gender of picture and the distractor word were incongruent than when they were congruent. A significant main effect of determiner congruency was found (F_1 (1, 17) = 7.21, $p < .01$; F_2 (1, 45) = 5.26, $p < .02$), showing longer naming latencies for gender incongruent than for congruent pairs. Similar analyses were conducted on error rates (1.2%) but no significant effect was found (Fs <1).

Table 6

Results of Experiment 4 for all Conditions

	Control	Congruent	Incongruent
Means	631	627	681
Standard Deviation	113	72	94
Errors	3 (1%)	3 (1%)	4 (1.4%)
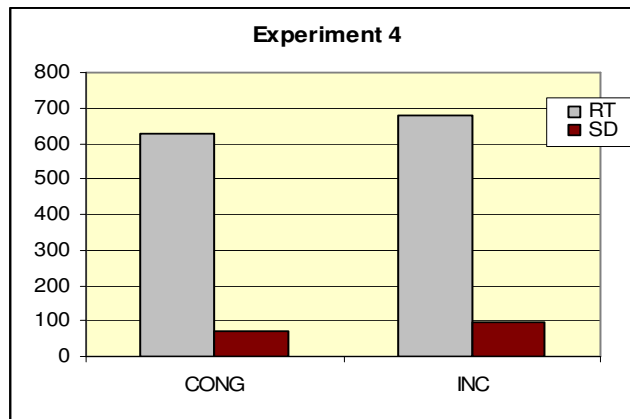
Figure 20: Naming latencies and standard deviations for congruent (CONG) and incongruent (INC) conditions by participants in Experiment 4.

1.1.3 Discussion

In this experiment, we tested two hypotheses regarding determiner selection in French, the 'different determiner hypothesis' and the 'reduced form hypothesis'. We tested these hypotheses using the picture-word interference paradigm with a delayed presentation of the distractor word at +200 SOA (due to the fact that determiner selection may occur later than in Germanic languages in which the determiner congruency effect is usually found at 0 SOA). Naming of the pictures was slower when picture-word pairs were incongruent in gender than when they were congruent. These results are consistent with those found in Germanic languages (La Heij et al., 1998; Shiller & Caramazza, 1999, 2003). They support the 'reduced form hypothesis' regarding the selection of determiners in French, making French an early selection language (at least regarding the definite article). According to the early/late selection language hypothesis (Miozzo & Caramazza, 1999), an effect is found in early selection languages because determiner selection occurs as soon as the lemma is selected and syntactic features become available. Thus, any event that takes place, such as competition between the gender of the picture and the distractor, delays the selection of determiner. In contrast, in late selection languages, since determiner selection only occurs when both gender and phonological features are retrieved, the conflict provoked by the picture-word gender competition is already resolved by the time the phonological features of the word are retrieved and determiner is selected.

159

The fact that our results showed a determiner congruency effect at positive SOA (+200) whereas it was not revealed at 0 SOA (Alario & Caramazza, 2002) suggests that the checking of the local context for post-selection adjustment provokes a delay in determiner selection. At 0 SOA, this delay is too long and therefore the conflict provoked by the picture-word gender competition is resolved by the time the local context is checked and determiner is selected. This could be the reason why no effect was found at 0 SOA. At positive SOA, the local context has had enough time to be checked for potential adjustment, thus in case of gender incongruence between the picture and the distractor there is competition for determiner selection which results in longer naming latencies. This could account for the presence of a gender congruence, or determiner congruence, effect in French at positive SOA.

These results contrast with previous results as they reveal a determiner congruency effect in French. Such an effect has never been clearly demonstrated before in French[14] or indeed in any Romance language. To make sure that these results were not due to any experimental bias or the particular choice of stimuli, and before we draw any further conclusions of the present results, we tested the robustness of the effect we obtained. In Experiment 5, we replicated the same picture-word interference paradigm with a new set of stimuli and a new sample of French native speakers who did not take part in experiment 4.

1.2   Experiment 5: determiner + noun NP
1.2.1 Method

Participants

Eighteen French native speakers, students at the University of Provence, volunteered for the experiment. The mean age was 20.3 years. They all had normal or corrected-to-normal vision. None had taken part in Experiment 4.

---

[14] Schriefers and Teruel (1999) did find a determiner congruency effect in French, but their results were inconsistent in a sense that they varied across conditions and the authors did not have a clear-cut explanation to account for these variations.

Material and Procedure

Forty-eight new pictures were selected; they were balanced in frequency and length (mean frequency per million, masc 27.3, fem 26.7, t (46) = .15, p = .91; mean number of letters, masc 6, fem 6, Brulex, Content et al., 1990). New distractors were selected as well (mean frequency per million: 127.9; mean number of letters: 5.6), and appeared in each condition within each list (congruent and incongruent; the control condition presented Xs). A list of the materials is presented in Appendix G. The procedure was identical to that used in Experiment 4.

1.2.2 Results

Trials were screened for voice-key disfunctioning, disfluencies and incorrect responses. RTs more than 3 standard deviations from the participant individual mean and those over 1300ms were replaced by the participant's mean (5.1%). As in Experiment 4, two items had to be rejected because participants produced too many errors (*jambon,* 'ham' was frequently incorrectly named, and *bougie*, 'candle' was often described as a chandelier). As in Experiment 4, we examined congruent-control differences and incongruent-control differences to compare directly the effect of congruent and incongruent conditions. ANOVAs were performed by participants (F_1) and by items (F_2) on these means (means are reported in Table 7 and illustrated in Figure 21). A significant determiner congruence effect was found (F_1 (1, 17) = 10.2, p < .01; F_2 (1, 45) = 5.86, p < .02) showing longer naming latencies for gender incongruent pairs than for congruent pairs. Error rates (1%) did not reveal any significant effect.

Table 7

Results of Experiment 5 for all Conditions

	Control	Congruent	Incongruent
Means	706	686	729
Standard Deviation	131	125	126
Errors	2 (0.7%)	3 (1%)	4 (0.7%)
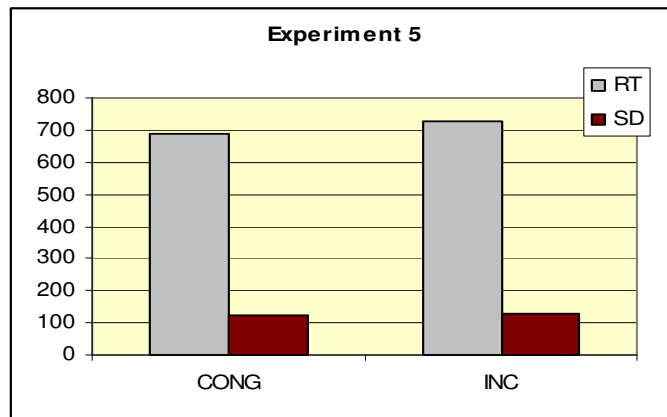
Figure 21: Naming latencies and standard deviations for congruent (CONG) and incongruent (INC) conditions by participants in Experiment 5.

1.2.3 Discussion

Our results replicated the effect obtained in Experiment 4. Even though the pattern of results was slightly different (i.e., the effect seems to be more centred on incongruent in Exp.4 than in Exp. 5), we, once again, found longer naming latencies for picture-word pairs that did not share the same gender than pairs that did. These results are in keeping with the 'reduced form hypothesis'. They are consistent with an account in which determiners are selected early in French, as in Dutch and German, and with the assumption of a slight delay due to a phonetic adjustment rule checking.

The present results support the determiner selection interference hypothesis (DSIH; see chapter 4 for details; Miozzo & Caramazza, 1997; Schiller & Caramazza, 2003), which claims that there is interference for the selection of the determiner at the level of form selection when picture-word pairs are gender incongruent. This suggests that the gender node of the distractor is activated and that it sends activation to its determiner form, which triggers competition for selection with the determiner of the picture. This implies that even if the distractor does not have to be produced, and its lexical node is not selected for production, its word form can still be activated – in direct contradiction to serial models which suggest that only the word form of a

selected word can be selected. Thus, our results are consistent with a cascaded model such as Caramazza's IN model (1997).

Our results challenge the early/late selection language hypothesis proposed by Miozzo and Caramazza (1999) since, according to this hypothesis, no determiner congruence effect should be found in languages in which determiner selection depends on phonological context. Our results clearly show that it is not always the case. To account for the presence of a determiner congruency effect in French, we propose that the early/late selection does not depend on the language but on the type of determiner within a language. This requires further explanation. In relation to determiner selection, Caramazza, Miozzo, Costa, Schiller and Alario (2001) suggested that the point at which determiners are selected is determined by the 'maximum consistency' principle. This means that, if in a language some determiners require the phonological context to be checked, then even if a few determiners could be selected earlier (i.e., independent of their local context), the maximum consistency principle is applied so that all determiners are selected at the same point within this language. In other words, even if determiners that require the phonological context to be selected are rare in a language, the language will still function as a late selection language. Caramazza et al. took the case of the Spanish definite article as an example. As already mentioned, in Spanish the masculine determiner *el* only takes one form, whereas the feminine determiner mainly has the form *la* (e.g., *la puerta*, the door), but also takes the form *el* when followed by a stressed /a/ (e.g., *el agua*, the water). Thus, even if the selection of the masculine determiner would make Spanish an early selection language, the irregularity of the feminine determiner makes it a late selection language (due to the maximum consistency principle), hence the absence of a determiner congruency effect in Spanish.

Our results demand some modification to this claim. It is important to stress again that our experiments concerned the selection of the definite article *only*. In French, the rule for the selection of some determiners depends on the phonological context, i.e., a vowel must be preceded by a consonant; we refer to this as the phonetic adjustment rule. For the definite article both the masculine and feminine

article are affected by this rule (i.e., *le/la* both become *l'* when followed by a vowel). In contrast, for other types of determiner such as possessive or demonstrative determiners, either the masculine or feminine determiner is affected. The masculine possessive determiner always takes the form *mon* (e.g., *mon couteau*, 'my knife'), whereas the feminine determiner generally takes the form *ma* (e.g., *ma chaussure*, 'my shoe') but becomes *mon* when followed by a vowel (e.g., *mon assiette*, 'my plate'). Conversely, for demonstrative determiners, the masculine form varies; being generally *ce* (e.g., *ce couteau*, 'this knife') but *cet* when followed by a vowel (e.g., *cet arbre*, 'this tree'), while feminine always takes the form *cette* (e.g., *cette assiette*, 'this plate'; *cet* and *cette* have the same pronunciation /sɛt/). The present experiments (Experiments 4 and 5) support the idea that the definite article is selected early (despite a short delay due to phonological context checking). Thus, it seems possible that, in contrast to what Caramazza et al. (2001) suggested, the rule for determiner selection is not generalised to *all* determiners, but varies across types of determiner within the same language. In other words, if the phonetic adjustment rule affects both genders in the same way, such as the definite article in French, then determiners will be selected early despite the phonological context checking. Similarly, the indefinite articles which are not affected by the local context in French (e.g., *un couteau$_{masc}$*, *un arbre$_{masc}$; une chaussure$_{fem}$, une assiette$_{fem}$*) will be selected early despite the late section of other determiners in French. In contrast, if the phonetic adjustment rule affects only one of the genders (e.g., feminine for possessive determiners and masculine for demonstrative determiners in French; feminine definite article in Spanish) then the maximum consistency principle is applied and the determiner is selected late. In sum, we suggest that the hypothesis initially proposed by Miozzo and Caramazza is somehow misdirected: instead of early/late selection *languages*, there are early/late selection *determiners*.

The present thesis does not investigate this hypothesis, but the question could be addressed in future research using indefinite article in French, or comparing definite articles and demonstrative/possessive determiners. In chapter 6 we propose relevant experiments to further investigate this hypothesis.

In sum, Experiments 4 and 5 investigated determiner selection in French. Our results suggest that determiners are selected early (at least regarding the definite article) despite a late phonetic adjustment rule that involves checking the local phonological context of the determiner. Our results are also consistent with an account in which the effect (i.e., longer naming latencies) obtained in previous studies when picture-word pairs were incongruent in gender is due to competition for determiner selection at the level of form selection (La Heij et al., 1998; Schiller & Caramazza, 1999; Schriefers, 1993; Schriefers & Teruel, 2000; van Berkum, 1997). Thus, in relation to the representation of gender in L1, we can conclude that once a lexical node has been selected, the selection of gender is automatic and non-competitive. This is in line with Caramazza's (1997) model but diverges from the assumption made in Levelt et al.'s (1999) model that gender is only activated when required for agreement.

The selection of determiner seems fairly straightforward in a simple NP; once the lexical item is selected, gender is automatically selected and the determiner form is selected as well. But is the process as straightforward when there is an additional element (e.g., adjective) within the NP and hence additional agreement has to be processed? In Experiments 6 and 7 we investigated whether determiner selection is affected by the presence and position of an adjective within the NP. This provides information on determiner selection but also on grammatical encoding in L1 (i.e., gender agreement processing). The performance of native speakers was then compared to that of L2 speakers to investigate gender representation and processing in L2 (Experiments 8, 9, and 10).

2   DETERMINER SELECTION: PHONOLOGICAL FEATURES AND GRAMMATICAL CATEGORY

The question of whether determiner selection is affected by the presence and position of an adjective can be addressed by looking at phonological context checking. In Experiments 4 and 5 we pointed out the importance of the phonological context in determiner selection. We mentioned that in French, as in other languages, the form of some determiners is modified when preceding a vowel, independently of the grammatical category of the following word. For example, as mentioned earlier, the

form of the determiner *le/la* is reduced to *l'* when followed by a vowel regardless of whether the following word is a noun or an adjective (e.g., *l'assiette* 'the plate'; *l'ancienne assiette* 'the old plate'). But when the word following the determiner is an adjective, does determiner selection depend only on the phonological features of the adjective (first phonological word of the NP), or is it also affected by the phonological features of the noun (second phonological word)? In other words, is determiner selection influenced by the phonological features of the second phonological word of the NP?

It has been suggested that the level of activation of the phonological information of the second phonological word of an NP influences naming latencies (Alario & Caramazza, 2002; Costa & Caramazza, 2002; Miozzo & Caramazza, 1999). For instance, in a picture naming experiment in Italian, Miozzo and Caramazza (1999) manipulated the initial phoneme of both the adjective and the noun in determiner + adjective + noun NPs. Initial phonemes either led to the selection of the same determiner (e.g., *il grande treno; il treno*, the big train, the train) or conflicted (e.g., *il grande sgabello, lo sgabello*, the big stool, the stool). Their results suggested that the phonology of the noun in determiner + adjective + noun NPs influences the selection of the determiner form. Similar results were found in French for possessive and demonstrative determiner + adjective + noun NPs (Alario & Caramazza, 2002). Longer naming latencies were observed when the adjective and the noun conflicted for determiner selection (e.g., *ma nouvelle ampoule,* 'my new bulb') than when they were phonologically consistent (e.g., *mon ancienne ampoule,* 'my old bulb'). Costa and Caramazza (2002) investigated this effect in a picture-word interference study using determiner + noun and determiner + adjective + noun NPs in English, as well as determiner + noun + adjective NPs in Spanish. Pictures and distractors in the English experiment, and adjectives and distractors in the Spanish experiments were phonologically related or unrelated. Their results showed faster naming latencies when picture-word pairs were phonologically related (e.g., English, *globe-glow;* Spanish, *azucar* 'sugar'-*azul* 'blue') than when they were unrelated (e.g., English, *globe-peak*; Spanish, *drama* 'drama'-*azul*). These studies suggest that the determiner form is influenced by the phonological information of the lexical nodes of both the first and the second phonological words in the NP. The influence of the second

phonological word of the NP on the determiner form seems to be independent of the grammatical category of this second word since the effect has been found for both adjectives and nouns. However, these studies do not indicate whether the encoding of the second phonological word has to be completed before the first phonological word can be sent to the articulation stage.

In the next experiment, we used a picture-word interference paradigm to investigate whether the phonological features of the noun influence determiner selection even if the noun is the second phonological word of the NP (determiner + adjective + noun). The structure of the NP depends on the features of the noun; its gender has to be retrieved for the determiner and the inflection of the adjective to be selected. Therefore, the features of the noun are selected first. If we assume that its phonological features are automatically activated once the noun is selected, two hypotheses are possible regarding the selection of determiners. If, on the basis of previous studies (Alario & Caramazza, 2002; Costa & Caramazza, 2002; Miozzo & Caramazza, 1999), we suppose that the phonological features of the second phonological word affect determiner selection, we should find that since the phonological features of the noun are selected first, they would be checked first for determiner selection. If this is indeed the case that the phonological features of the adjective have to be checked next to select determiner form (i.e., phonological context checking), we suppose that the whole process may be completed only after the conflict for determiner selection between gender incongruent picture and distractor is resolved (even if the phonological features of the noun and adjective are consistent). In this case, no determiner congruency effect would be found.

In contrast, if the phonological features of the noun have no influence, the selection of determiner form should be similar for determiner + adjective + noun and determiner + noun NPs. In other words, once the gender of the noun is retrieved (i.e., it is available for determiner selection and adjective inflection) and the phonological context checked for adjustment rule (i.e., the initial phoneme of the adjective), the determiner form is selected. In this case, a similar determiner congruency effect should be found for determiner + adjective + noun NPs, as in Experiments 4 and 5.

2.1 Experiment 6: determiner + adjective + noun NP

2.1.1 Method

Participants

Eighteen French native speakers, students at the University of Provence, volunteered for the experiment. The mean age was 21.35 years. They all had normal or corrected-to-normal vision. Some had taken part in Experiment 4; however, analyses revealed that their participation in the previous experiment did not influence their performance in Experiment 6 (no significant differences between groups of 'previous' and 'new' participants).

Material and Procedure

The set of stimuli and distractor words created for Experiment 4 was used in this experiment. Pictures were presented in different sizes (small or big). Size adjectives are pre-posed in French. The adjective to be produced was either *petit* ('small') or *grand* ('big'), both having orally realised gender marking for the feminine (*grande, petite*). A list of the materials is presented in Appendix F. The procedure was the same as in Experiment 4.

2.1.2 Results

As in previous experiments, trials were screened for voice-key disfunctioning, disfluencies and incorrect responses. RTs more than 3 standard deviations from the participants' individual mean and those over 1300ms were replaced by the participant's mean (6.3%). As in experiments 4 and 5, congruent-control conditions and incongruent-control conditions were collapsed and ANOVAs were performed on means by participants (F_1) and by items (F_2) (means are available in Table 8 and illustrated in Figure 22). Results did not show any determiner effect (F_1 (1, 17) = 1.67, $p < 1$; F_2 (1, 47) = .02, $p < 1$). The large difference between the means and the fact that they are going in the wrong direction (i.e., naming latencies longer for congruent than incongruent condition) was due to two participants' results in the congruent condition. The analyses of error rates (1%) did not show any significant effect.

Table 8

Results of Experiment 6 for all Conditions

	Control	Congruent	Incongruent
Means	643	677	651
Standard Deviation	99	92	84
Errors	3 (1%)	3 (1%)	2 (0.7%)
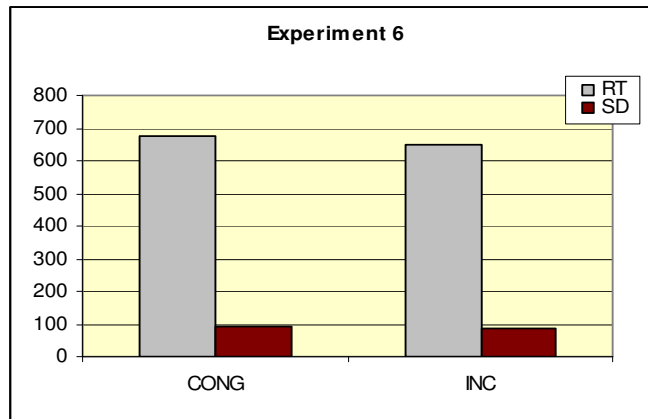
Figure 22: Naming latencies and standard deviations for congruent (CONG) and incongruent (INC) conditions by participants in Experiment 6.

2.1.3 Discussion

In this experiment, we investigated whether the phonological features of the noun affect determiner selection even if the noun is the second phonological word of the NP (the first phonological word being the adjective). We presented pictures and distractor words that either shared the same gender or did not. In contrast with Experiments 4 and 5, no differences were found between naming latencies for gender congruent and incongruent picture-word pairs. We predicted that if the phonological features of the noun are selected before the adjective is selected, the whole process might not be completed soon enough for a competition for determiner selection. Indeed, if the lexical node of the noun and its phonological features are selected first, and then the phonological context has to be checked for potential adjustment (i.e., the

initial phoneme of the adjective), the determiner selection is 'late'. Thus, the gender conflict provoked by a distractor is already resolved by the time the determiner is selected. Therefore, no determiner congruency effect can be seen. Hence, we predict that if the same experiment were run with the distractors presented at longer SOA (e.g., 250 ms instead of 200 ms), both noun and adjective features would have time to be checked to compete for determiner form selection between the picture and the distractor, and a determiner congruency effect would be found.

The null effect we obtained is consistent with the assumption made in previous studies that the phonological features of the second phonological word of the NP affect determiner selection. However, our results suggest that the features of the second phonological word influence determiner selection when the second word is the *noun*. But previous studies have shown that the features of the second phonological word of the NP affect determiner selection regardless of its grammatical category (Costa & Caramazza, 2002). In a further experiment, we therefore tested whether the phonological features of the second phonological word of the NP also affect determiner selection when the second word is not the noun. In this experiment, colour line pictures had to be named with determiner + noun + colour adjective NPs. If the phonological features of the second phonological word (i.e., post-posed adjective) affect determiner selection, no determiner congruency effect should be found (the whole process of determiner selection being too long to produce interference at this stage), as in Experiment 6. In contrast, if there is no influence of the features of the second phonological word on the selection of determiner, a determiner congruency effect should be found (as for determiner + noun NPs) as in Experiments 4 and 5.

2.2   Experiment 7: determiner + noun + adjective NP

2.2.1 Method

Participants
Same participants as in Experiment 6.

Material and Procedure

The same set of stimuli and distractor words as for Experiment 4 were used. Colour line pictures were presented. In French, colour adjectives are post-posed (DET + N + ADJ). Target pictures had to be named with gender marked colour adjectives (e.g., *vert$_{masc}$/verte$_{fem,}$* 'green'*; gris$_{masc}$/grise$_{fem,}$* 'grey'), and fillers with unmarked adjectives (e.g., *rouge$_{masc}$/$_{fem,}$* 'red'*; jaune$_{masc}$/$_{fem,}$* 'yellow'). A list of the materials is presented in Appendix F. The procedure was the same as in Experiment 4.

2.2.2 Results

As in previous experiments, trials were screened for voice-key disfunctioning, disfluencies and incorrect responses. RTs more than 3 standard deviations from the participants' individual mean and those over 1300ms were replaced by the participant's mean (4.3%). Three items had to be excluded, because they generated too many errors (probably due to the uncommon association of the picture with a colour, e.g., *grey strawberry*). ANOVAs were performed on the differences of congruent-control conditions and incongruent-control conditions (means are available in Table 9 and illustrated in Figure 23) and revealed a significant determiner congruency effect (F_1 (1, 17) = 5.12, p < .04; F_2 (1, 44) = 5.19, p < .03), with slower naming latencies for pictures presented with a distractor word that did not share the same gender than for pictures that did. Error rates (1%) analyses did not reveal any effect.

Table 9

Results of Experiment 7 for all Conditions

	Control	Congruent	Incongruent
Means	739	743	785
Standard deviation	111	99	122
Errors	2 (0.7%)	3 (1%)	3 (1%)
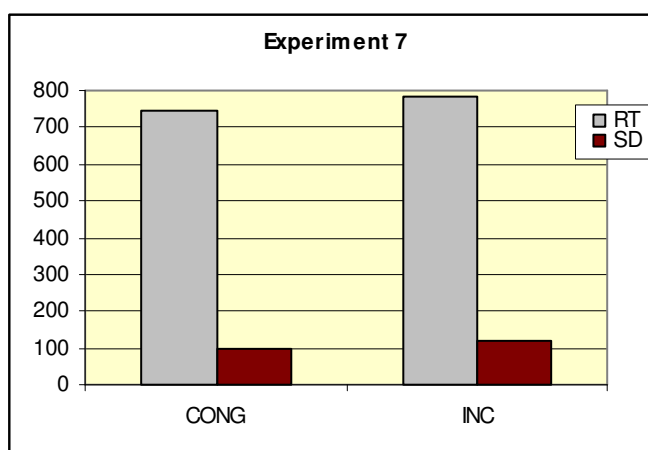
Figure 23: Naming latencies and standard deviations for congruent (CONG) and incongruent (INC) conditions by participants in Experiment 7.

2.2.3 Discussion

In this experiment, we investigated whether the phonological features of the second phonological word of the NP affect determiner selection even if it is an adjective. We presented colour line pictures that participants had to name with determiner + noun + colour adjective NPs. These pictures were associated with a distractor word that was either congruent or incongruent in gender and presented at + 200 SOA. Results revealed a determiner congruency effect, showing longer naming latencies for incongruent picture-word pairs than for congruent pairs. This effect was similar to that obtained for determiner + noun NPs (Exp.4 and 5). In contrast to determiner + adjective + noun NPs, the combination of the determiner and the first phonological word of the NP (i.e., noun) in determiner + noun + adjective is already a full noun phrase. The presence of a post-posed adjective seems to be treated as an extension of the determiner + noun NP. Thus, as soon as the gender of the noun and its phonological features are retrieved, the determiner can be selected. This process is fast enough (despite the slight delay for phonetic adjustment checking), so that when the picture and the distractor are incongruent in gender there is a competition for determiner form selection. Our results seem to show that when the second phonological word of the NP is an adjective, its phonological features do not affect determiner selection. This contrasts with the results previously obtained in Spanish

172

that showed an influence of the phonological features of the adjective on determiner selection when it was the second phonological word of the NP (Costa & Caramazza, 2002). This difference can be accounted for by the fact that they presented adjectives as distractor words, whereas we presented nouns. It is possible that the influence of the phonological features of the adjective is greater when the latter receives additional activation from a phonologically related distractor than when the distractor is a noun.

From Experiments 6 and 7 we argue that the presence of a pre-posed adjective slightly delays the determiner form selection whereas the presence of a post-posed adjective does not. In both types of NP a determiner, a noun and an adjective have to be produced; thus, the difference comes from the order in which the NP is processed up to the articulation stage. In determiner + adjective + noun NP, the determiner cannot be selected until the phonological context of the adjective has been checked; hence it is only when the noun, the adjective and finally the determiner have been selected that articulation can start. So, in determiner + adjective + noun NPs, the determiner is the last element to be selected. In contrast, in determiner + noun + adjective NP, the determiner is selected as soon as the syntactic and phonological features of the noun have been retrieved and the last element to be selected is the adjective. This explains why a determiner congruency effect was found for NPs containing post-posed adjectives but not for those containing a pre-posed adjective. As we suggested, this assumption could be verified in future experiments by delaying the presentation of the distractor so that the phonological features of the adjective would be retrieved soon enough for competition to occur between the picture and the distractor for determiner form selection.

However, our data pose a problem. According to this reasoning, we would expect RTs to be similar for both types of NP (since the same number of elements have to be selected) or shorter for determiner + noun + adjective NP (if articulation can start before the lexical node of the adjective is selected). But in our experiments RTs for determiner + noun + adjective NPs were longer than for determiner + adjective + noun NPs. This difference could be accounted for by the adjectives we used. In Experiment 6, participants had to produce size adjectives (e.g. *big* and *small*)

whereas in Experiment 7, they had to produce colour adjectives (e.g. *green* and *grey* for the stimuli, *red* and *yellow* for the fillers). First, despite our attempt to match frequency across experiments, size adjectives are more frequent than colour adjectives. Second, Experiment 7 involved four colours whereas Experiment 6 had only two sizes. These two experimental parameters may have rendered the retrieval of the adjective costlier in Experiment 7 than in Experiment 6. An experiment in which participants have to simply name complex NPs (with the same number of adjective of similar frequency) could check whether the production of determiner + noun + adjective NPs is incremental. If RTs are shorter for NPs containing post-posed adjectives than for NPs containing pre-posed adjectives, it would suggest that articulation can indeed start as soon as the determiner has been selected and even before the lexical node of the adjective has been selected. On the other hand, if RTs are not significantly different, it would show that the adjective has to be selected before the articulation of the NP can start (even if, as we argue, the determiner is selected as soon as the noun's features have been retrieved).

Experiments 6 and 7 also provide information on grammatical encoding. From our results, we suggest that both the syntactic and phonological features of the noun affect the selection of determiner regardless of the presence and the position of an adjective in the NP. Hence, in line with Pickering and Branigan's (1998) proposal that syntactic information associated with the lemma has to be retrieved for structure building, we argue that the noun is the agreement controller of the NP and its features have to be retrieved for the syntactic structure to be built. Furthermore, the presence of a determiner congruency effect in Experiment 7 suggests that determiner is selected as soon as the syntactic and phonological features of the noun are retrieved, but the longer RTs seem to imply that articulation does not start until the adjective is also selected (further studies are required to verify when articulation actually start as suggested above). Hence, we propose that, in relation to gender, determiner agreement is realised prior to adjective agreement (at least in determiner + noun + adjective NPs).

The investigation of determiner selection in French provided essential information in relation to the main concerns of the present thesis, i.e., the representation and processing of gender. From our results we concluded that gender selection is an automatic and non-competitive process that occurs as soon as a lexical node has been activated. Furthermore, we suggested that determiner agreement is realised before adjective agreement, at least with post-posed adjectives. In the following section, we examine whether in these respects, gender representation and processing are similar in L2 and whether they are influenced by the native language.

3   THE DETERMINER CONGRUENCY EFFECT IN BILINGUALS

In the previous section, we investigated determiner selection in monolinguals. The experiments revealed a determiner congruency effect for certain types of NP, showing that French native speakers are slower to name a picture when the gender of the distractor is incongruent than when it is congruent. The effect was found for simple NPs and NPs that contained a post-posed adjective (i.e., which can be considered as an extension of determiner + noun). We suggested that the absence of effect in determiner + adjective + noun NPs was due to the fact that the features of both the noun and the adjective had to be retrieved before the determiner could be selected, hence provoking a delay in determiner selection that annihilates competition for determiner form selection between the picture and the distractor. From these results, we reached two important conclusions regarding gender representation and processing in L1: first, gender selection is a consequence of the lexical node selection; it is automatic and non-competitive. Second, determiner agreement is realised prior to adjective agreement, at least with post-posed adjectives. This information is essential for the concerns of the present thesis: (i) do L2 speakers process grammatical gender agreement in a similar way to native speakers? (ii) how much of an influence does the native language have on the acquisition of grammatical gender in L2?

To investigate these questions, we replicated the experiments presented in the previous section with bilinguals whose native language is very similar to French with regard to gender agreement (Spanish-French bilinguals) and bilinguals whose native

language differs from French in relation to gender and syntactic structure (English-French bilinguals). We examined whether a determiner congruency effect would be obtained when the gender of a picture and a distractor was incongruent, as for native speakers (for certain types of NP). However, determiner selection in L2 involves more issues than in L1. The conclusions we drew from these experiments were based on the results obtained with highly proficient bilinguals, and may vary depending on the proficiency.

The first issue we were concerned with was the influence of the rules for determiner selection in the native language. We mentioned earlier that in French, the selection of some determiners requires the retrieval of both the gender of the noun and the phonological features of the following word (independently of its grammatical category) for a phonetic adjustment. This is the case for the definite article which is used in the present experiments. However, the monolingual experiments supported the idea that the definite article is selected early in French (see discussion of Experiment 5 for more detail). This phonetic adjustment rule is also present in Spanish and English, but presents some variations. We proposed different assumptions for L2 speakers as a function of the rules of their native language (see below).

The second issue was related to the presence of integrated or separate gender systems in the bilingual mind. Costa et al. (2003, see chapter 4 for details) reached the conclusion that gender retrieval of the language in use is not affected by the gender of the other language of a bilingual. In contrast, recent studies have suggested that the representation of gender feature is shared between L1 and L2 systems (Bordag et al., 2006, Bordag & Pechmann, 2007; Salamoura & Williams, 2007). In our experiments, we made different assumptions for L2 speakers as a function of the presence (i.e., Spanish) vs. absence (i.e., English) of gender in their native language.

The last issue we were interested in concerns the processing of new word orders in L2 (e.g., post-posed adjectives). We assumed that L2 speakers can acquire a new word order in their L2, but the question was whether they process gender agreement within the new structure as they do in a structure that exists in their L1 (if we assume that they process agreement at all). We put forward different assumptions for our two

L2 groups according to the presence (e.g., Spanish) vs. absence (or rare, e.g., English) of that word order in their native language.

Assumptions for Spanish-French bilinguals

Regarding the influence of the determiner selection rule, the case of Spanish-French bilinguals is interesting. Monolingual studies failed to show a determiner congruency effect in Spanish (Costa et al., 1999; Miozzo et al., 2002), arguably because Spanish is a late selection language (but see discussion of Experiment 5 for detail on this hypothesis). Conversely, the experiments reported in the previous section revealed such an effect in French. According to our hypothesis, the definite article in French is selected early because the phonetic adjustment that occurs when the determiner is followed by a vowel concerns both masculine and feminine determiners (i.e., *le/la* become *l'*). In contrast, in Spanish the phonetic adjustment only occurs with the feminine determiner (i.e., *la* becomes *el* when preceding a stressed /a/), making the selection process longer. If Spanish-French bilinguals applied the rule of their L1 to their L2, the selection of determiner should be late and no determiner effect should be found in their L2. On the other hand, if they were sensitive to French phonotactics and used the same rule as native speakers, a determiner congruency effect should be found.

In relation to the question of shared or separate gender systems between languages, we manipulated the language coherency factor in the experiments such that half of the stimuli presented shared the same gender in Spanish and French, and the other half did not. We supposed that if the gender systems of the two languages are indeed autonomous (Costa et al., 2003) no gender interference across languages should be noticed for Spanish-French bilinguals. Thus, if determiner selection in Spanish speakers is affected by the presence of a distractor word and no interaction with the Language Coherency factor occurs, a similar determiner congruency effect to that obtained in native speakers should be found. That is, regardless of shared or different gender across languages, we expected naming latencies to be longer when the picture and the distractor word did not share the same gender as in native speakers. In contrast, we suggested that if there is interference from the gender of the L1 word, longer naming latencies should be found when the name of the picture does not share the same gender across languages. In case of interference with L1, for

example, a gender congruent pair in French (e.g., *la montre_{fem}*, the watch; *la pomme_{fem}*, the apple) would be incongruent in Spanish (e.g., *el reloj_{masc}*; *manzana_{fem}*), thus provoking longer naming latencies. The illustration of separated gender systems in Spanish-French bilinguals is presented in Figure 24.
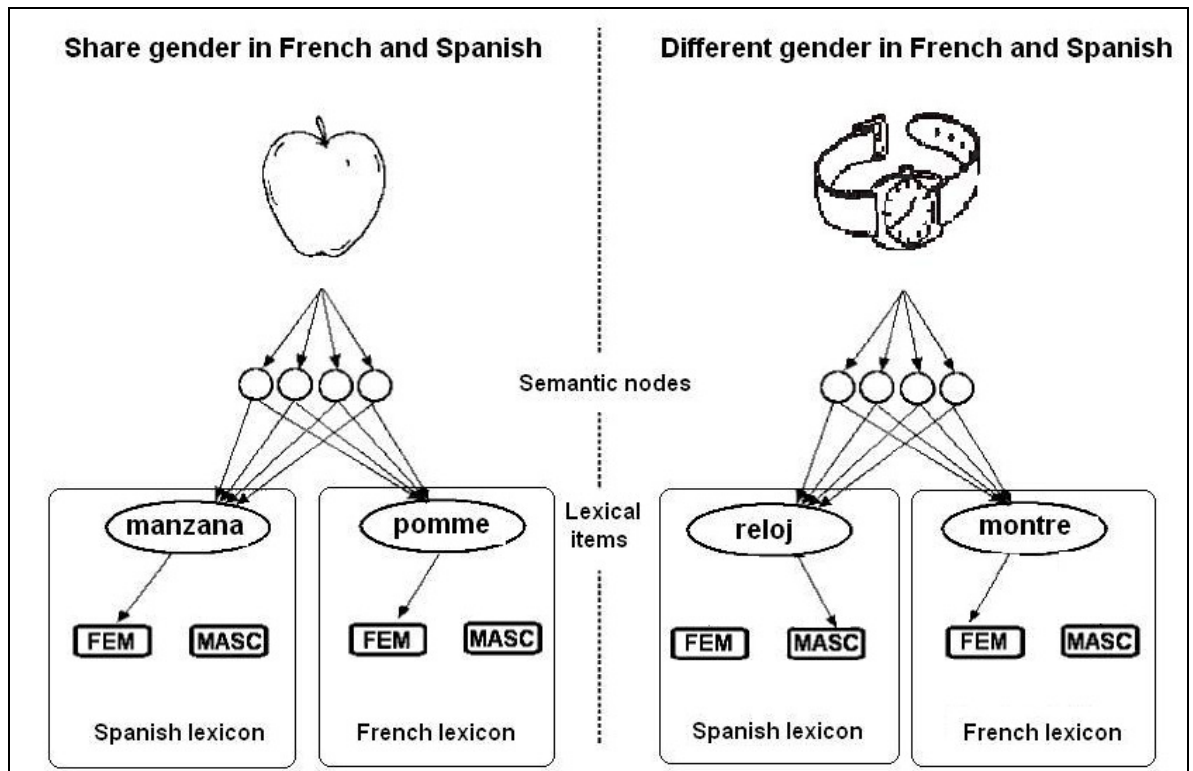
Figure 24: Illustration of the autonomous gender systems in Spanish-French bilinguals (adapted from Costa et al., 2003).

The question of the processing of new word order did not really apply to Spanish speakers since post-posed adjectives are present in their native language. The interesting question concerning the position of the adjective was related to gender processing. We noticed that in L1 determiner agreement is realised prior to adjective agreement with post-posed adjectives. We investigated whether it is also the case for Spanish-French learners since they have an identical structure in their L1.

Assumptions for English-French bilinguals

Regarding the influence of the determiner selection rule, two points have to be addressed. First, it is important to note that in English, as in French, a phonetic

adjustment occurs for determiner selection. In other words, the phonological features of the noun have to be retrieved for determiner selection in some cases, such as the indefinite article (i.e., *a* vs. *an*), where the determiner form is affected by the phoneme at the onset of the following word (i.e., *a chair* but *an apple*). The present experiments involved the definite article, which in English is orthographically invariable (e.g., *the chair*, *the apple*), but phonologically variable depending on whether it is followed by a consonant (e.g., *the /ðə/ chair*) or by a vowel (e.g., *the /ði:/ apple*). Thus, just as in French, the selection of the determiner is a two-step process: selection of determiner and a late phonetic adjustment depending on the local context. Since the selection of determiner seems fairly straightforward in their native language, English-French bilinguals may apply similar rules in their L2. Hence, we expected to find a determiner congruency effect as there was for native speakers. However, the case of English slightly differs from that of French as determiners are not gender marked in English. Determiner selection in L2 does not involve only the ability of applying the phonetic adjustment form; it also involves retrieving gender and processing agreement. This leads us to the issue of the nature of the gender system in L2.

Regarding the representation of gender systems in bilinguals, the question was whether it is possible for L2 speakers to acquire the gender system of their L2 if no system is present in their L1. By *acquiring* a gender system, we do not only mean the ability to assign gender to noun, but also the ability to process agreement in their L2. Recall that this question is a matter of debate: some advocate that L2 learners cannot acquire gender in their L2 if it is not present in their L1 (Carroll, 1989; Hawkins & Franceschina, 2004), whereas other claim that new features such as gender can be acquired in L2 despite their absence in L1 (Schwartz & Sprouse, 1996, White, 1989; see chapter 1 for more detail). If English-French learners are able to acquire the gender system of French, we expected a determiner congruency effect to be found as it is for native speakers. Given the sensitivity to gender agreement violations revealed with ERPs in comprehension (Experiments 1, 2, and 3, chapter 3) for English-French bilinguals who had an equivalent level of proficiency, we supposed that English speakers can acquire a gender system in L2, and we expected them to show longer naming latencies when picture-word pairs were incongruent in gender

than when they were congruent. Conversely, if they are not able to acquire the French gender system, we supposed that no effect would emerge. The illustrations of gender systems in English-French bilinguals are presented in Figure 25 (adapted from Costa et al., 2003).
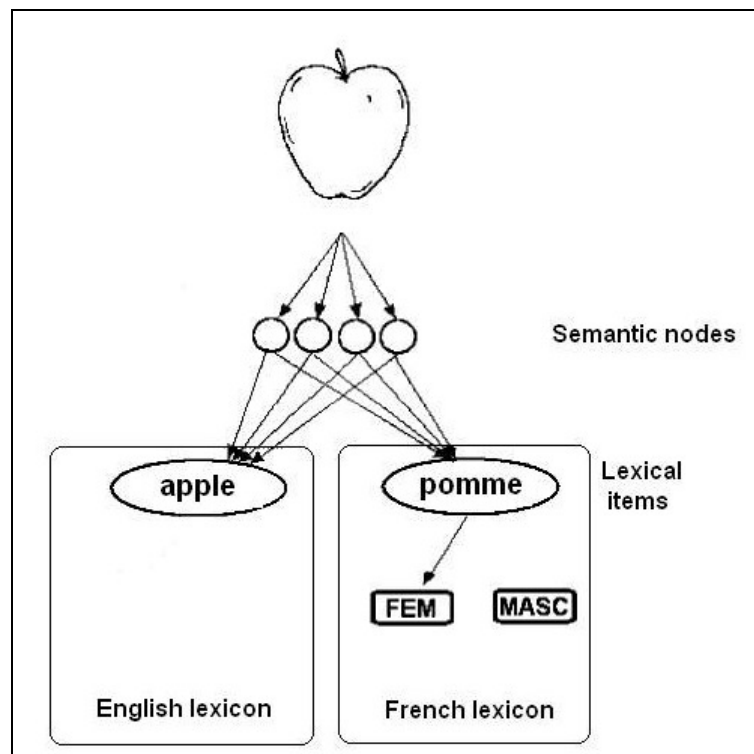
Figure 25: Illustration of the gender systems in English-French bilinguals (adapted from Costa et al., 2003).

Concerning the issue of the processing of new word order, we supposed that English speakers can acquire new grammatical structures such as post-posed adjectives, but we were more concerned about their ability to process agreement within these structures. Thus, if English speakers are able to process gender like native speakers, we expected to find no difference in their naming latencies and/or errors for pre-posed and post-posed adjectives. In contrast, if processing gender in new structure is an additional difficulty for English speakers, we expected a difference in naming latencies and more errors for post-posed adjectives reflecting that they process gender in new structures but to a weaker extent than in structures

that exist in their native language, or that they do not process gender agreement at all in structures that are not similar across languages.

These assumptions were tested in three picture-word interference experiments involving the production of determiner + noun NPs (Exp.8), determiner + adjective + noun NPs (Exp. 9) and determiner + noun + adjective NPs (Exp.10).

3.1 Experiment 8: determiner + noun NP

3.1.1 Method

Participants

Eighteen English-French and Spanish-French learners, Erasmus students at the University of Provence, volunteered for the experiment. The mean age of all participants was 23.4 years (English, 22.8 years; Spanish, 24.1 years). They had normal or corrected-to-normal vision. They all had studied French at school (mean 8.3 years) and passed the required exam to attend courses in a French university (individual results not available). After the experiment, they had to complete an offline test, which consisted in circling the correct article for each of the nouns (stimuli and distractors) presented during the experiment (see Appendix H). Results were approximately similar for English (mean: +/- 5.4 errors, SD: 3.9) and Spanish speakers (mean: +/- 3.8 errors, SD: 4.7; t (34) = 1.3, p = .11). Participants were also asked to self-rate their level of French on a scale from 1 to 6 (1= very poor; 6= excellent) for different aspects of written and spoken language. English speakers estimated their level slightly higher (written comprehension, 4.8; oral comprehension, 4.8; written production, 4.5; oral production, 4.5) than Spanish speakers (written comprehension, 4.2; oral comprehension, 4; written production, 3.3; oral production, 3.5), but no significant differences emerged (written comprehension, t (34) = 1.46, p = .15; oral comprehension, t (34) = 1.53, p = .13; written production, t (34) = 1.6, p = .10; oral production, t (34) = 1.7, p = .10).

Material and Procedure

Materials and procedure were identical to those of Experiment 4. Stimuli were chosen so that half of the noun shared the same gender in French and Spanish (e.g., French, le *couteau$_{masc}$*; Spanish, *el cuchillo$_{masc}$*; 'the knife'), and half did not (e.g., French, le *balai$_{masc}$*; Spanish, *la escoba$_{fem}$*; 'the broom'). Cognates across languages were avoided (French, English and Spanish).

3.1.2 Results

As in previous experiments, trials were screened for voice-key malfunctioning, disfluencies and incorrect responses. RTs farther than 3 standard deviations from the participant mean and those over 1500ms were replaced by the participant's mean (French, 3.3%; English, 8.3%; Spanish, 8.5%). ANOVAs were performed by participants (F_1) and by items (F_2) as a function of Language Coherency (same vs. different gender in French and Spanish), Noun Gender (masculine vs. feminine) and Determiner Congruency (i.e., differences between the means of congruent-control conditions, and incongruent-control conditions). Results for French native speakers obtained in Experiment 4 were reanalysed according to these conditions as a control group. As in Experiment 4, two stimuli (i.e., *bouclier,* 'shield' and *haricot,* 'bean') had to be rejected because they provoke too many errors.

Analysis for the control group and the L2 learners group revealed a significant interaction of Group x Determiner Congruency by participants (F_1 (2, 51) = 3.41, $p <$ .04; $F_2 < 1$). Means are represented in Figure 26 for two conditions, and means for all conditions are available in Appendix I (Table 16). Individual analyses of the different groups showed a significant Determiner Congruency effect for French native speakers (F_1 (1, 17) = 5.26, $p <$ .03; F_2 (1, 42) = 5.59, $p <$ .02). No Determiner Congruency effect was found for English (F_1 and $F_2 < 1$) or Spanish L2 learners (F_1 and $F_2 < 1$), nor did it interact with Language Coherency or Noun Gender. The same analyses were conducted on error rates; no significant effect emerged despite a larger percentage of errors for Spanish speakers (French, 1.2%; English, 2.5%, Spanish, 4.5%).

Figure 26: Naming latencies for congruent (CONG) and incongruent (INC) conditions for French native speakers, English-French and Spanish-French bilinguals in Experiment 8.

3.1.3 Discussion

In this experiment we attempted to replicate the determiner congruency effect found in French native speakers with Spanish-French and English-French late bilinguals. The results showed no difference in naming latencies for gender congruent and incongruent picture-word pairs for these participants. The factor Language Coherency (same vs. different gender across languages) did not reveal any effect either. The absence of any interaction between the gender of French and Spanish words seems to be in line with the hypothesis of separate gender systems for each language (Costa et al., 2003). However, this hypothesis must be considered cautiously being based on a null effect (since Spanish speakers did not reveal the determiner congruency effect found in French monolinguals). In the case of English-French bilinguals, the results of the off-line test as well as the error rates (2.5%) showed that they are able to assign gender to French nouns, however, no conclusion can be drawn from the null effect in relation to the way they process gender on-line in their L2 (i.e., agreement).

The absence of a determiner congruency effect in bilinguals may be accounted for by the time bilinguals need to process their L2. It is worth pointing out that before the experiment proper, participants were presented with the pictures they had to name, thus when they had to name the pictures during the experiment (including both the singular definite determiner and noun), they had recently retrieved the gender features of the nouns. In contrast, the gender features of the distractor words were

retrieved for the first time during the experiment (if, at all, retrieved). It is possible that the retrieval of the distractor's features took longer than for those of the picture. This may not only be due to the fact that pictures were presented beforehand, but may simply reflect the fact that L2 learners focused on the picture (as told) and that the activation of the distractor word was not as automatic as for native speakers. In other words, it is possible that in L2 the retrieval of the features of a word that is not selected for production (e.g., a distractor) is slower than for a word that is to be produced. Hence, by the time the features of the distractor were retrieved, the determiner of the picture was already selected and no competition for selection occurred.

Future research could test this hypothesis by using the same experimental design but with shorter SOAs. If the hypothesis is correct, then an effect should be found at shorter SOA, since the distractor would be presented earlier and its features would be activated soon enough for competition. Or, if determiner selection for the picture is delayed by the presence of an additional element in the NP (e.g., adjective) as we noticed in monolinguals, the features of the distractor may be retrieved in time for competition. In the next two experiments we tested this hypothesis with determiner + adjective + noun and determiner + noun + adjective NPs.

3.2 Experiment 9: determiner + adjective + noun NP

3.2.1 Method

Participants
The same English-French and Spanish-French learners who took part in Experiment 8 volunteered for Experiments 9 and 10, thus reducing variability due to participants' knowledge of their L2.

Material and Procedure
These were identical to those used in Experiment 6 (stimuli were chosen so that half of the noun shared the same gender across language, and half did not), participants had to name pictures with determiner + adjective + noun NPs.

3.2.2 Results

As in previous experiments, trials were screened for voice-key malfunctioning, disfluencies and incorrect responses. RTs greater from 3 standard deviations from the participant mean and those over 1500ms were replaced by the participant's mean (French, 6.3%; English, 8.5%; Spanish, 8.4%). ANOVAs were performed by participants (F_1) and by items (F_2) as a function of Language Coherency (same vs. different gender in French and Spanish), Noun Gender (masculine vs. feminine nouns) and Determiner Congruency (collapsed means of congruent and control conditions, and incongruent and control conditions). Results for French native speakers obtained in Experiment 6 were reanalysed according to these conditions as a control group.

Results for French native speakers and L2 learners showed a main effect of Determiner Congruency (F_1 (1, 51) = 5.85, $p < .02$; F_2 (1, 44) = 5.79, $p < .02$). Means are represented in Figure 27 for congruent and incongruent conditions, and are available for all conditions in Appendix I (Table 17). To confirm whether the Determiner Congruency effect was significant for L2 groups, independent analyses were conducted. Analyses for the control group revealed no main effect (F_1 and $F_2 < 1$). L2 learners data showed a main effect of Determiner Congruency for English speakers (F_1 (1, 17) = 4.61, $p < .05$; F_2 (1, 44) =5.64, $p < .02$), as well as for Spanish speakers (F_1 (1, 17) = 4.67, $p < .04$; F_2 (1, 44) = 4.56, $p < .04$) showing longer naming latencies for gender incongruent than for congruent picture-word pairs. No other main effects or interactions with other factors reached significance. Error rates were slightly higher for Spanish (3.1%) than for French (1%) and English speakers (1.7%) but analyses did not confirm these differences.
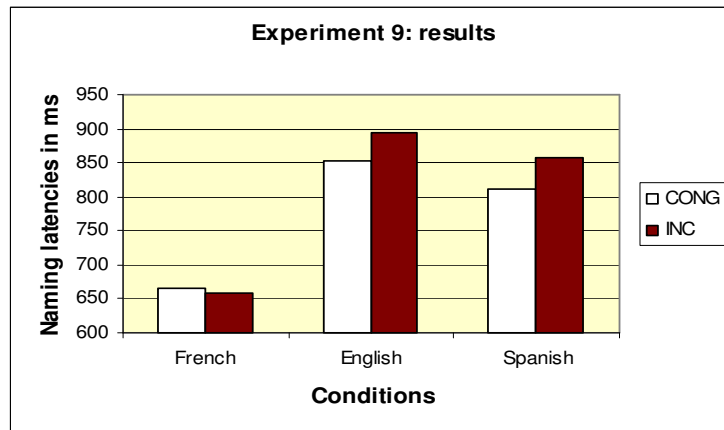
Figure 27: Naming latencies for congruent (CONG) and incongruent (INC) conditions for French native speakers, English-French and Spanish-French bilinguals in Experiment 9.

3.2.3 Discussion

In this experiment, we tested whether the retrieval of the features of a word that is not selected for production (e.g., a distractor) is slower than for a word that is to be produced in L2. The results of our monolingual experiments suggested that the presence of a pre-posed adjective in the NP delays the selection of determiner. In determiner + adjective + noun NPs, the determiner can only be selected once the features of the noun have been retrieved and the phonological context checked for potential adjustment (i.e., the initial phoneme of the adjective). Thus, by the time the determiner is selected the gender conflict provoked by a distractor is already resolved. This accounts for the absence of effect in monolinguals. Unlike monolinguals, bilinguals showed longer naming latencies for gender incongruent pairs than for congruent pairs. This suggests that competition for selection occurs between the picture and the distractor, hence the presence of a determiner congruency effect in L2. This supports our assumption that the retrieval of the distractor features (which is not to be produced) takes longer in L2. However, the determiner congruency effect indicates that the process involved in determiner selection is similar in L1 and L2. Furthermore, the fact that both English and Spanish bilinguals showed this effect implies that gender is processed in the same way regardless the presence or the absence of a complex gender system in L1.

In sum, from this experiment we concluded that the retrieval of the feature of a word that is not to be produced is longer in L2 than in L1. This leads to a determiner congruency effect when the NP contains a pre-posed adjective which delays determiner selection (as in monolinguals, see Experiment 6). In contrast, Experiment 7 has shown that, in monolinguals, the presence of a post-posed adjective does not affect determiner selection. Indeed, it seems that once the features of the noun have been retrieved the determiner can be selected, the adjective being considered as an extension of the determiner + noun NP. If this is also the case in bilinguals, no determiner congruency effect should be found (as for determiner + noun NPs, Exp.8). In contrast, if bilinguals process both the noun and the adjective before the determiner can be selected, selection should be slightly delayed and competition with the gender of the distractor should occur.

3.3   Experiment 10: determiner + noun + adjective NP

3.3.1 Method

Materials and Procedure
The materials and procedure were the same as in Experiment 7 (stimuli were chosen so that half of the noun shared the same gender across language, and half did not). Participants had to name pictures with determiner + noun + adjective NPs.

3.3.2. Results

As in previous experiments, trials were screened for voice-key disfunctioning, disfluencies and incorrect responses. RTs greater than 3 standard deviations from the participant mean and those over 1500ms were replaced by the participant's mean (French, 4.3%; English, 6.6%; Spanish, 8.5%). ANOVAs were performed by participants (F_1) and by items (F_2) as a function of Language Coherency (same vs. different gender in French and Spanish), Noun Gender (masculine vs. feminine nouns) and Determiner Congruency (differences between congruent and control conditions, and incongruent and control conditions). The results for French native

speakers obtained in Experiment 7 were reanalysed according to these conditions as a control group.

Results for French native speakers and L2 learners revealed main effects of Group (F_1 (2, 51) = 3.25, $p < .05$; F_2 (2, 80) = 3.65, $p < .03$) and of Determiner Congruency (F_1 (1, 51) = 17.26, $p < .001$; F_2 (1, 40) = 9.56, $p < .001$). The effect of Group was due to L2 speakers being slower than native speakers. Means are represented in Figure 28 for congruent and incongruent conditions, and are available for all conditions in Appendix I (Table 18). In order to confirm whether the Determiner Congruency effect was significant for L2 groups, independent analyses were conducted. They showed a main effect of Determiner Congruency for French native speakers (F_1 (1, 17) = 6.82, $p < .02$; F_2 (1, 41) = 5.48, $p < .02$). Results for L2 learners showed a significant Determiner Congruency effect for English speakers (F_1 (1, 17) = 6.65, $p < .02$; F_2 (1, 43) = 4.02, $p < .05$; one item was rejected due to excessive error rate), and a tendency for Spanish speakers (F_1 (1, 17) = 4.1, $p < .06$; F_2 (1, 42) = 2.78, $p < .10$; two items were rejected due to error). No other main effects were significant nor did they interact with other factors. Error rates again were larger for Spanish (3.7%) than for French (1%) and English (2.4%), but were not reliable ($F_1 < 1$, $F_2 < 1$).
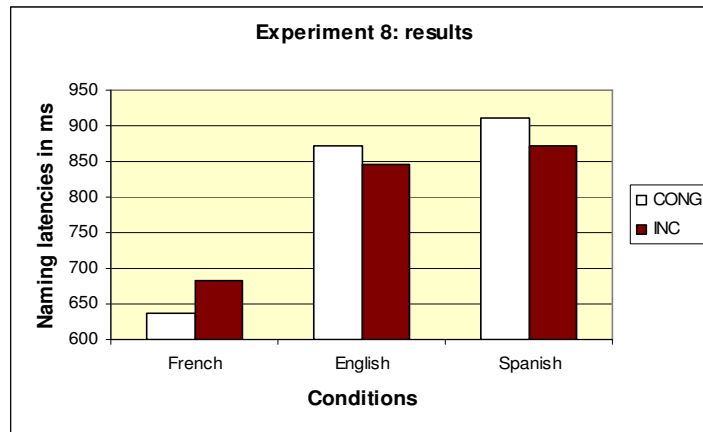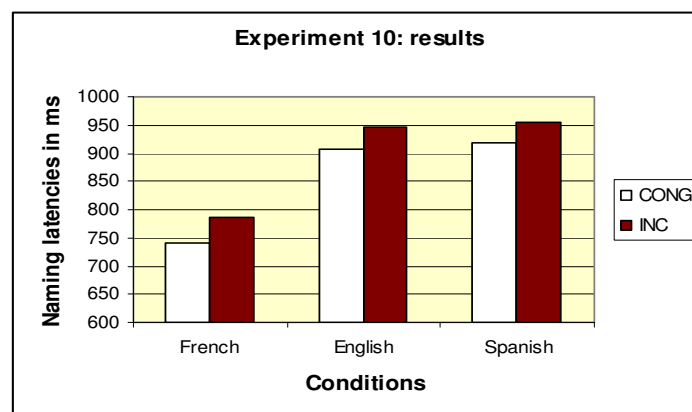

Figure 28: Naming latencies for congruent (CONG) and incongruent (INC) conditions for French native speakers, English-French and Spanish-French bilinguals in Experiment 10.

3.3.3 Discussion

In this experiment we investigated whether bilinguals process the adjective prior to selecting the determiner, in determiner + noun + adjective NPs. Bilinguals had to name pictures with this type of NP while ignoring a distractor word that was either congruent or incongruent in gender with the picture. Results showed a significant determiner congruency effect for English-French bilinguals and a tendency for Spanish-French bilinguals, due to longer naming latencies for gender incongruent picture-distractor pairs than for congruent pairs. These results mirror those obtained for French native speakers. In monolinguals, it seems that the determiner is selected as soon as the features of the noun are retrieved, as in determiner + noun NPs (Experiments 4, 5, and 7). However, this cannot be the case for bilinguals since they did not show any determiner congruency effect for simple NPs (Experiment 8). The existence of an effect for determiner + noun + adjective NPs seems to show that the presence of a post-posed adjective affect determiner selection in bilinguals. It is possible that, unlike in L1 where determiner agreement is realised prior to adjective agreement, bilinguals have to consider all the elements of the NP before processing agreement. We suggest that gender agreement is less automatic in bilinguals than in monolinguals, and the presence of an adjective, regardless its position within the NP, slows down gender processing.

It has been shown that in French native children, determiner agreement is mastered before adjective agreement (Dewaele & Veronique, 2000; Koehn, 1994; Müller, 1990). It would be interesting to compare the performance of L2 speakers with French children at an age where adjective agreement is not yet automatic. We suppose that L2 production becomes more automatic as bilinguals become more proficient, and that highly proficient L2 speakers can achieve native-like production. This assumptions needs to be supported by further research.

We now go back to the three issues we were concerned with in these experiments: the influence of determiner rule of L1 on L2, the presence vs. absence of a gender system in L1, and gender processing in new grammatical structures. As we pointed out in the assumptions we made for both L2 groups, the presence of a

determiner congruency effect has different implications for L2 speakers depending on their native language.

Regarding the influence of the determiner rule, the determiner congruency effect suggests that both groups are sensitive to the French phonotactics and they use the same rule as native speakers with no influence from L1. This conclusion will be further discussed in a theoretical framework in the next chapter.

In relation to the question of shared or separate gender systems, for Spanish speakers, the presence of a determiner congruency effect in Experiments 9 and 10 without any interference from the gender of the nouns in the non-target language shows that gender can be selected during the production of French independently of the properties of these words in Spanish. This is in line with the claim made by Costa et al. (2003) that the gender retrieval of the language in use is not affected by the gender of the other language of a bilingual. They suggested that if one assumes that gender is an automatic consequence of lexical node selection, the only gender value that is selected is the one corresponding to the selected lexical node. As previously mentioned, we adopted the assumption that the effect obtained when pictures are presented with a gender incongruent distractor is not a gender congruency effect but interference at the level of determiner selection (Schiller & Caramazza, 2003). This implies that gender is indeed an automatic process. Thus, the presence of a determiner congruency effect for L2 speakers in the present experiments suggest that, as in L1, gender in L2 is automatically selected once the lexical node is selected. This converges with the assumption made by Costa et al. (2003) that the only gender value that plays a role is that corresponding to the selected node. This proposal accounts for the performance of our participants who were highly proficient bilinguals. In the following chapter, we discuss the evolution of the gender system(s) of bilinguals towards autonomy to account for the absence of gender interference in our experiments in contrast with results obtained in previous studies (Borgad et al., 2006; Bordag & Pechmann, 2007; Foucart & Frenck-Mestre, under revision).

For English-French bilinguals, the presence of a determiner congruency effect (Experiment 9 and 10) demonstrates that not only can they assign gender to French

nouns but they can also process agreement. Thus, as native speakers, English speakers represent gender as a lexical-syntactic property of the noun and are able to correctly compute gender agreement within a syntactic structure. This suggests that English speakers can, with sufficient practice, acquire a gender system in their L2 despite the absence of grammatical gender in their L1. Again, if we assume that gender is automatically selected when the lexical node is selected, when English speakers select the lexical node of a French noun, they automatically select its gender. It is important to note again that this proposal is relevant for the bilinguals we tested who were highly proficient, and could not account for any interference of L1 and L2 genders that may be found in less proficient bilinguals. The results obtained for English-French bilinguals are in line with the assumption that L2 learners are able to acquire new features in their L2 even if they are not present in their L1 (Schwartz & Sprouse, 1996; White, 1989). This question is further discussed in the next chapter.

The issue of processing a new word order in L2 applied only to English speakers since post-posed adjectives are present in Spanish. However, we did not find any difference in how Spanish and English speakers processed gender in French. This implies that processing of new grammatical structures in L2 is not affected by the word order in L1. Furthermore, we noticed some differences between adjective processing in native and non-native speakers, but that was independent of the presence of this grammatical structure in L1 (i.e., post-posed adjectives). Our results suggested that the presence of a post-posed adjective does not affect gender processing in French native speakers, whereas it seems to slow down processing in bilinguals. This implies that gender processing is less automatic in L2 than in L1.

CHAPTER SUMMARY

In this chapter we reported seven picture-word interference experiments that investigated determiner selection in French. The first four experiments involved French native speakers and the other three tested English-French and Spanish-French bilinguals. The aim of examining determiner selection was to characterise gender

representation and production in light of the main questions addressed in the present thesis: are there similarities in gender processing between L1 and L2, and how does the native language influence L2 processing?

From the monolingual experiments, we concluded that gender selection is an automatic and non-competitive process that occurs as soon as the lexical node of the noun has been selected. We also argued that native speakers consider post-posed adjectives as an extension of determiner + noun, and therefore can select determiner even before the lexical node of the adjective has been retrieved. These conclusions were then compared to the performance of L2 speakers. From our results, we suggested that gender representation is similar in L1 and L2 as gender retrieval seems to be an automatic consequence of lexical node selection in L2 as in L1. However, we pointed out some differences in gender processing. The results of both L2 groups (independently of the presence or absence of gender or post-posed adjectives in their L1) suggested that, in contrast to L1 gender processing, L2 processing is slowed down by the presence of an additional element within the NP (e.g., adjective). Regarding the influence of L1 on L2, no interference was found from the Spanish gender system when Spanish-French bilinguals produced NPs in their L2. In line with Costa et al. (2003) we assumed that the gender systems of the two languages are autonomous. English-French bilinguals processed gender in their L2 in the same way as Spanish speakers. Thus, we concluded that late L2 learners can acquire the gender system of their L2 even if this feature is not present in their L1 (Schwartz & Sprouse, 1996; White, 1989). In the next chapter these conclusions are discussed in combination with those drawn from our experiments in comprehension to provide a broad picture of how L2 speakers represent and process gender in French.

CHAPTER 6

CONCLUSIONS

The present thesis investigated whether grammatical gender is represented and processed in a similar manner in L1 and L2. To answer this question we first compared L1 and L2 speakers of French to see whether models of L1 processing could be extended to L2 processing. By using two different groups of L2 speakers, we examined the influence of native language on L2 perception and production of gender. The L1 of our bilinguals either possessed a gender system or did not. To obtain a wide picture of gender representation and processing in L1 and L2, we conducted experiments both in language comprehension and production. In this chapter we first sum up the findings and the conclusions drawn from the experiments, then present their implications, and finally we propose directions for future research regarding gender.

1   SUMMARY OF THE FINDINGS AND CONCLUSIONS

1.1   Experiments 1, 2 and 3: noun-adjective agreement in comprehension

Experiments 1, 2 and 3 investigated gender processing in comprehension. These experiments used ERPs and eye-tracking to compare the performance of French native speakers and bilinguals on gender processing during sentence reading. French

native speakers, English-French and German-French bilinguals read sentences that were either syntactically correct or anomalous. Syntactically anomalous sentences contained gender agreement violations between the noun and the post-posed (Exp.1), pre-posed or predicative adjective (Exp. 2 and 3). The use of various types of adjectives allowed us to examine whether L2 speakers process gender more easily (or indeed if they process gender at all in their L2) within syntactic structures that are similar across languages than within structures that do not exist in their native language (e.g., post-posed adjectives in the present case), and whether agreement rules in L1 affect agreement processing in L2 (e.g. agreement of plural NPs and predicative adjective). The question of the influence of the native language on the L2 was also addressed regarding the presence (e.g., German) or absence (e.g., English) of a grammatical gender system in L1. For English-French learners the question was whether they are able to process grammatical gender in their L2 despite the fact that this feature is not present in their L1. For German-French learners, we introduced a language coherency factor (same vs. different gender across languages) to investigate potential interference from the German gender system when processing gender in French. The presence of a gender system in German allowed us to look at two types of potential interference in L2: lexical and rule-based. In other words, we examined whether German-French bilinguals assign the correct gender to French nouns or whether they use the gender of German nouns, and also whether they apply the agreement rules of the system of their L1 to their L2 or adopt rules specific to French language. Finally, we also tested the assumptions made in Friederici's (2002) model concerning syntactic processing (see the following section).

The results for French native speakers showed sensitivity to gender agreement violations between the noun and the adjective. This effect was found for the three types of adjectives (pre-posed, post-posed, and predicative) with both methodologies we used, i.e., eye-tracking and ERPs. However, the effect obtained for violations on the predicative adjectives suggest that native speakers are less sensitive to violations when agreement is not processed within the NP. This is consistent with the idea that processing is costlier when not 'local' (Barber & Carreiras, 2005). The type of ERP response and the early response in eye-movement record suggest that grammatical

gender is processed at the syntactic level in line with previous studies (Barber & Carreiras, 2005; Hagoort & Brown, 1999; Osterhout & Mobley, 1995).

Results for English-French bilinguals revealed sensitivity to gender agreement violations between the noun and the post-posed adjective. This suggests that English speakers can acquire grammatical gender in their L2 and compute gender agreement online even within structures that do not exist in their native language. They also displayed a pattern similar to that of native speakers for predicative adjectives but only in the eye-tracking experiments. This effect was slightly delayed compared to that found in native speakers, in line with previous reports in the L2 literature using ERP as a method of study (Ardal et al., 1990; Hahne, 2001). The absence of an effect in our ERP experiments may be due to the fact that this methodology requires a larger number of trials, and the number of stimuli we presented may not have been sufficient to allow the effect to emerge for masculine or feminine independently (the effect was only found for masculine nouns with eye-tracking). For pre-posed adjectives, on the other hand, English speakers showed sensitivity to agreement violations (only in the ERP experiment), but displayed a different effect from native speakers. While French native speakers displayed a classic P600 for gender agreement violations, English speakers showed an N400 effect which has been associated with L2 learning in recent studies (Inoue & Osterhout, 2005; Osterhout et al., 2004). In line with these studies and in view of the results for post-posed adjectives, we suggest that processing of pre-posed adjectives may become a native-like with increased proficiency.

German-French bilinguals did not reveal any sensitivity to gender agreement violations on either pre-posed or post-posed adjectives. For predicative adjectives, they showed sensitivity only for masculine nouns, like native speakers, however, only with eye-tracking. Furthermore, at early stages (during the first pass through the sentence), there was an effect of the L1 German gender system: these speakers were sensitive to agreement that was correct in French but incorrect in German. This L1 interference disappeared later in processing. This demonstrates a transitory influence of the L1 on L2. In German, plural masculine and feminine nouns share the same

definite article in the nominative as well as the same agreement with the adjective. Since we used the plural definite article to avoid any gender cue on the determiner (the plural definite article being the same for both masculine and feminine in French, i.e., *les*) it is possible that this affected how German speakers processed gender in their L2. They may have applied the rule of their L1 in L2, and therefore did not realise gender agreement between plural nouns and targets (i.e., determiners and adjectives) in French. Nevertheless, the effect obtained for predicative adjectives in the eye-tracking experiment suggests that German-French learners are, to a certain extent, sensitive to gender agreement violations in their L2. Furthermore, it also suggests that they can adopt rules used by French native speakers since they realised agreement between the noun and the predicative adjective in French even though this type of adjective is invariable in German.

1.2   Language production experiments

1.2.1 Experiments 4 – 7: The determiner congruency effect in monolinguals

In Experiments 4 and 5, we used a picture-word interference paradigm to investigate determiner selection in monolinguals, in French. Participants took longer to name pictures when the superimposed words did not share the same gender. We argued that determiner selection in simple NPs is fairly straightforward: once the gender of the noun has been retrieved and the phonological context checked for a potential phonetic adjustment, determiner form can be selected. To explain the difference between findings for Romance and German languages, we modified the proposal made by Caramazza et al. (2001) that a 'maximum consistency' process is applied for all determiners of a language, and we suggested instead that this process is determiner specific within a language. These assumptions, however, require further examination. We propose some directions for future research in the following section. The investigation of determiner selection provided information regarding gender representation and processing in monolinguals. We concluded that gender selection is an automatic and non-competitive process that occurs upon lexical node selection.

In Experiments 6 and 7, we investigated whether the presence of an additional element within the NP affects determiner selection. We manipulated pre-posed and post-posed adjectives in a picture-word interference paradigm. Participants displayed a determiner congruency effect for incongruent picture-word pairs in determiner + noun + adjective NPs, but not in determiner + adjective + noun NPs. We argued that French speakers treat the post-posed adjective as an extension of determiner + noun, thus, treat determiner + noun + adjective as a simple NP. As the results we obtained for simple NPs suggest, determiner selection is fairly straightforward: our results suggest that the same mechanism holds true for determiner + noun + adjective NPs. In contrast, determiner selection in determiner + adjective + noun NPs is more complex. Since the noun is essential for the construction of the syntactic structure of the NP, we suggested that determiner selection may be delayed because the features of the noun are selected first, and then the features of the adjective are selected and the phonological context checked for phonetic adjustment. We concluded that the presence of a pre-posed adjective slightly delays the determiner form selection whereas the presence of a post-posed adjective does not. Furthermore, in relation to gender agreement, we suggested that determiner agreement is realised prior to adjective agreement (at least with post-posed adjectives). However, our experiment did not allow us to investigate whether articulation can start as soon as determiner is selected or if the adjective has to be selected for articulation to start. To investigate this question, we proposed a simple task of picture-naming for further research.

1.2.2 Experiments 8, 9 and 10: The determiner congruency effect in bilinguals

Experiments 8, 9 and 10 replicated the materials and paradigm used for monolinguals, but with English-French and Spanish-French bilinguals. They showed a determiner congruency effect for NPs containing an adjective (either pre-posed or post-posed), but not for simple determiner + noun NPs. From the presence of a determiner congruency effect, we concluded that L2 speakers apply the same rules as native speakers for determiner selection. Hence, we assumed that gender selection in L2 is also an automatic and non-competitive process that occurs once the lexical

node has been selected. While we argued that gender representation is similar in L1 and L2, we pointed out some differences in gender processing. Our results suggested that, unlike native speakers who selected determiner as soon as the features of the noun have been retrieved (i.e., gender and phonological features) in determiner + noun + adjective NPs, bilinguals seem to consider all the elements of the NP before processing agreement. This implies that gender agreement computation is not as automatic in L2 as it is in L1.

In contrast to the experiments we conducted in comprehension, the production experiments did not show any influence of the native language. No interference was found from the Spanish gender system when Spanish-French bilinguals produced NPs in their L2. This is in line with the assumptions made by Costa et al. (2003) which proposes that the gender systems of the two languages are autonomous, but it conflicts with the studies that revealed interference between L1 and L2 systems (Bordag et al., 2006; Bordag et Pechmann, 2007; see following section for discussion). Furthermore, no difference was found in how English-French and Spanish-French bilinguals processed gender in their L2. Hence, we argue that a gender system can be acquired in L2 even if no such system exists in the native language (Schwartz & Sprouse, 1996; White, 1989). Furthermore, we propose that the development of a gender system may be similar in L2 speakers independently of the presence or absence of such a system in their native language.

2   Implications of our findings

The common aim of these experiments was to examine how L2 speakers represent and process gender. To investigate this question we first examined the architecture and mechanisms present in native speakers. In this section we first report the implications of our findings for monolinguals and then we examine how they can be applied to bilinguals. We also suggest how some questions that our experiments did not clearly answer could be investigated in future research.

2.1 Implications of findings in monolinguals

In comprehension, we looked at native speakers' sensitivity to gender agreement violations. In the ERP experiments, we obtained a classic P600 effect which was never preceded by any (early) negativity. Our results imply that the P600 effect reflects the detection of morpho-syntactic anomalies and not only syntactic reanalysis and repair. In the eye-tracking experiment, gender agreement violations were detected early. When we compare the effects obtained with these methodologies, we can suggest that, like first fixation and first pass reading times, the P600 effect may reflect initial on-line syntactic integration. This assumption, i.e. that the P600 effect is not only associated with syntactic reanalysis and repair, which is supported by our results showing that French native speakers did not display a biphasic process (i.e., LAN + P600 effects) challenges Friederici's three-phase model (Friederici, 2002). Recall that this model proposes a first phase consisting of word category anomaly detection (ELAN), a second phase of morpho-syntactic anomaly detection (LAN), and a third phase where syntactic reanalysis and repair occur (P600). Our results combined with the recent proposal that LAN effects are different types of effects not always generated by syntactical errors (Krott et al., 2006) imply that, at present, the underlying processes reflected by ERP components are still not undeniably defined, and thus, we cannot draw inferences from them about the nature of any putative universal syntactic processing mechanisms. Hence, if Friederici's (2002) model is not relevant for syntactic processing in monolinguals, it cannot be adapted for syntactic processing in bilinguals despite recent proposals of the sort (Rossi et al., 2006). It is important to note, however, that we do not disagree with their proposal that L1 models can be extended to account for L2 processing, as suggested by the conclusions we draw from the production experiments.

The results we obtained in production provided information on gender representation and processing in L1. As proposed by the determiner selection interference hypothesis (Schiller & Caramazza, 2003), a determiner congruency effect reflects competition for determiner form selection, not for gender selection. Hence, longer naming responses are found for incongruent pairs because of competition for the selection of the determiner for the picture name and the

determiner for the distractor word at the level of form selection. A precondition of such competition is the activation of the distractor's gender node and consequent activation of its determiner form. Thus, the word form of the distractor can be selected even if it does not have to be produced and its lexical node is not selected for production. This pattern is incompatible with a discrete serial model such as proposed by Level et al. (1999) but is consistent with a cascaded model such as Caramazza's (1997) IN model. Hence, we adopt Caramazza's (1997) proposal that when a noun is to be produced its semantic representation activates in parallel its phonological and syntactic features (to a lesser extent), and the selection of its syntactic features such as gender is an automatic and non-competitive consequence of lexical node selection.

From our experiments, we also concluded that the presence of a pre-posed adjective slightly delays determiner selection whereas the presence of a post-posed adjective does not. We argue that a post-posed adjective is considered as an extension of the determiner + noun NP and that the determiner can be selected once the noun features have been retrieved and before the adjective is selected. However, our experiments did not allow us to examine whether articulation can start before the adjective has been selected. We suggested that a simple task in which participants have to produce NPs containing either a pre- or post-posed adjective would provide more information. If naming latencies are significantly shorter for determiner + noun + adjective than for determiner + adjective + noun, it would imply that articulation can start before adjective selection.

2.2 Implications of findings in bilinguals

After examining gender representation and processing in monolinguals, we studied the performance of bilinguals in their L2 to investigate whether they treated gender in a native-like fashion and whether their L1 had any influence. The results we obtained in comprehension and production do not always fit together. The differences we observed can have several explanations. First, the methods we used were different (ERPs and eye-tracking vs. picture-word interference). Second, the modality of language differed (i.e., comprehension and production). Finally, the stimuli were more frequent in the production than in the comprehension experiments,

and in production, participants were presented with the pictures before the experiment proper. However, if we compile the conclusions we draw from our experiments with those obtained in previous studies we can make some assumptions regarding the representation and processing of gender in L2.

From the production experiments, we concluded that gender is represented and processed in a similar way in monolinguals and bilinguals. We noticed, however, that gender processing was less automatic in L2 speakers. We also deduced that bilinguals were sensitive to French phonotactics, hence, that L2 speakers seem to adopt the rules used by native speakers (e.g., for determiner selection in our experiments). In relation to the influence of the native language, no interference was found between the two gender systems of Spanish-French speakers, and the absence of a gender system in English did not influence gender processing in L2.

In comprehension, the conclusions were not as straightforward. From the data we obtained for English learners of French, we concluded that English speakers can process gender in a similar way to native speakers, but attaining native-like processing may be faster for certain types of adjectives. In contrast, the absence of effect in the majority of the experiments for German learners of French made us think that there may be an interference with the gender system of their L1 that prevents German speakers from computing gender agreement in French. However, we suggest that this interference may decrease as L2 learners become more proficient. To verify this assumption we could conduct the same experiments with German native speakers whose proficiency is even higher than that of our participants (e.g., German speakers who have spent more time in France and who use French as a daily means of communication).

If we now compare our conclusions with the assumptions made in previous studies, we can propose a theory of the acquisition of gender representation and processing in bilinguals. Recall that to account for the presence (Bordag et al., 2006; Bordag & Pechmann, 2007) vs. the absence (Costa et al., 2003) of interference between L1 and L2 gender systems, Bordag and collaborators suggested the existence of links between the different levels of production (e.g. phonological encoding and grammatical encoding). They proposed that L2 learners, like native children, compute gender on the basis of all the information available (e.g.,

phonological, morphological, semantic information), including information about the gender of the corresponding L1 word. With increasing proficieny, the links gradually become weaker (may even disappear), as is the case for native speakers and highly proficient bilinguals. According to the authors, these links could explain the stages of acquisition which go from a system that involves computation to a system in which gender is stored. This assumption supports cascaded models since they allow interaction between the different processing levels in contrast to serial models that assume that processing must be completed at one level before activation can be sent to the next level. In sum, Bordag and collaborators suggest that the strength of the links accounts for the fact that they found interaction between L1 and L2 gender systems in low/intermediate bilinguals, whereas the results of Costa et al. (2003) supported the assumption of autonomous systems in highly proficient bilinguals.

We adopt the proposal that links are present between the two systems in bilinguals, which may account for the different results we obtained across our groups. However, while Bordag and collaborators focused on language production, we argue that the assumption of links between L1 and L2 systems can be extended to comprehension.

Let us start with the interpretation of the results we obtained in production. As we concluded from our experiments, Spanish and English speakers adopt the rules French native speakers use, and process gender in a similar way. Hence, when they produce an NP, the noun is the agreement controller for structure construction (Pickering & Branigan, 1998). In line with bilingual lexical access models (Costa et al., 1999; Costa & Caramazza, 1999; Roelofs, 1998), we suggest that when bilinguals produce a noun in French, the same amount of activation is sent from the conceptual level to the lexical nodes of both languages. However, only the lexical node tagged for French will be selected. The mechanism involved in lexical node selection is identical to the mechanism used in monolinguals (however slower). Actually, from our results we argue that Caramazza's model can be extended to lexical selection in bilinguals.

The fact that no interference occurred in our Spanish-French bilinguals suggests that the links between L1 and L2 systems were too weak (due to high proficiency)

for L1 gender to affect L2 gender. The results obtained for English-French speakers showed that as in monolinguals, gender is an automatic consequence of lexical node selection. This shows that despite the absence of gender in their L1, English speakers are able to acquire a system with new features.

The results we obtained in comprehension suggest stronger links between the two languages of our English and German learners of French than for English and Spanish speakers who took part in the production experiments. English speakers showed different results depending on the position of the adjective. While they showed a similar P600 effect as native speakers for post-posed adjectives, they showed an N400 for pre-posed adjectives. In line with previous studies (Inoue & Osterhout, 2005; Osterhout et al., 2004), we suggested that the N400 was the reflection that English speakers were still in the process of acquiring gender agreement of pre-posed adjectives in French. It is possible that when L2 learners process pre-posed adjectives in French they unconsciously check the syntactic features of pre-posed adjectives in English. Since adjectives do not agree in gender in English, gender agreement in L2 French is costlier. It may be easier to acquire gender agreement of post-posed adjectives because they do not exist in English and so no interaction is possible with their syntactic features in L1. Once learners become more proficient, the link between L1 and L2 syntactic levels become weaker and agreement can be correctly realised in L2 French since interaction with L1 syntactic features is no longer possible.

The same assumption can be made for German-French speakers who only showed an effect for masculine nouns associated with a predicative adjective. In similar fashion to English speakers, German speakers may check the relevant syntactic features in their L1. For instance, for the noun we noticed an interaction between L1 and L2 gender in early stages of processing with eye-tracking. This interaction was not apparent later in processing (i.e. in second pass reading times). It seems that German speakers first checked gender of their L1 before processing the correct gender in their L2. Moreover, we proposed that the absence of effect for gender agreement between the determiner and pre- and post-posed adjective was due to the fact that German speakers applied the agreement rules of their L1 in their L2. Since determiner and adjective forms are similar for masculine and feminine in

German in plural, it is possible that L2 learners apply the same rule in French and so do not compute the difference between genders in French either. However, the presence of an effect for predicative adjectives shows that our German learners have access to an L2 system but they are not yet proficient enough for their two systems to be autonomous.

In sum, in line with the assumption made by Bordag and collaborators, we suggest that bilinguals have access to two systems, and the interference between the two systems varies with proficiency. Interference is realised via links that are strong at early stages of acquisition but become weaker as proficiency increases. In contrast to Bordag and collaborators who proposed that the links may disappear in highly proficient bilinguals, we suggest that they become weaker but are still present. The same link could then become strong again in case of language attrition, which would explain 'reverse' interference from L2 to L1. The presence of links between the two systems of bilinguals needs to be further investigated; in the next section we give directions for future research. Prior to such, we will briefly return to the linguistic models we presented in chapter 1.

In view of our findings, we can now claim that the assumptions put forward by some linguistic models are erroneous. Recall that the failed functional feature hypothesis (FFFH) proposes that when a language is learned late in life (after a critical period), new parameters required in L2 can no longer be acquired due to UG parameters only being available via L1 and not able to be reset. In contrast, the full transfer full access (FTFA) model claims that parameters can be reset for L2 acquisition via the interlanguage grammar. We can clearly argue that the assumption made by the FFFH model is mistaken. Our conclusion converges with the assumption made by the FTFA model which claims that L2 learners can acquire gender in their L2. However, as we mentioned in chapter 1, these models fail to provide a mechanism to account for L2 speakers' performance. In the present thesis we addressed the same question of gender acquisition in L2 with psycholinguistic methods that provided essential information about how these features are represented and processed in L2. The information we obtained allowed us to make assumptions

on the mechanism involved in gender processing. These assumptions, however, need to be supported by further research.

3   DIRECTIONS FOR FUTURE RESEARCH

This thesis examined grammatical gender processing with an interdisciplinary approach, from linguistic and psychological point of views. It made use of controlled experiments to investigate morpho-syntactic processes in monolingual and bilingual comprehension and production, with different population of bilinguals. Our findings provided a wide picture of the topic and useful information for linguistic and psycholinguistic theories. However, they also raised questions that will have to be investigated in future research.

Our results revealed a determiner congruency effect in French native speakers that had been found only in Germanic languages until now. We proposed some modifications to the early/late language selection theory (Miozzo & Caramazza, 1999), suggesting that early or late determiner selection should not be generalised to the whole language, but should be determiner-specific. In other words, within the same language, a determiner could be selected early or late depending on its selection rule (i.e., definite article in French vs. definite article in Spanish). To test this assumption, it would be interesting to run the same experiment in a language where the definite article follows the same rule as in French, such as Catalan. In Catalan, the masculine singular definite determiner is *el* (e.g., *el got*, 'the glass') and the feminine is *la* (e.g., *la casa*, 'the house') when preceding a consonant. But, as in French, when preceding a vowel, both masculine and feminine determiners become *l'* (e.g., *l'ull*, 'the eye'; *l'ona*, 'the wave'). The presence of a determiner congruency effect with this type of determiner in Catalan would support our hypothesis. In addition, the same experiment could be conducted in French using indefinite articles, which are not affected by the phonetic adjustment rule (a phonetic adjustment is realised for liaison when the determiner is followed by a vowel but does not modify its form). Since the selection of their form does not depend on the phonological context, the indefinite article should be selected early according to our hypothesis.

In relation to bilinguals, we suggested the presence of links between the two language systems. We argued that these links would become weaker in conjunction with increased L2 skills, i.e. in advanced bilinguals, hence reducing interference. It would be interesting to conduct the same experiments we conducted with different groups of bilinguals ranging from low to high proficiency or a longitudinal study investigating grammatical gender acquisition to reveal the different stages of gender acquisition. For example, comparing English-French (impoverished grammatical gender system in L1) and Spanish-French bilinguals (nominal gender agreement in L1) with ERPs, we should observe some differences in gender processing at early stages of acquisition between the groups. Spanish speakers should be sensitive to gender agreement violations like native speakers even at early stages, having the same system and therefore features and mechanisms in their L1. Lexical interference may appear in Spanish learners at early stages of acquisition so that they would assign the gender of Spanish nouns to French nouns even if it is different across languages. In contrast, English speakers should not be sensitive to violations at early stages, but once proficiency increases and they acquire the processing mechanisms of their L2, they should show sensitivity to grammatical gender agreement violations, in like manner to Spanish speakers. This should be reflected by the presence of a P600 effect for Spanish bilinguals from an early stage of acquisition in response to agreement violations. However, this effect should first be found only for nouns sharing the same gender in both language, and would only emerge for nouns of different gender once learners become more proficient. For English bilinguals, the gradual acquisition of the gender system should be reflected by an N400 at early stages (Osterhout et al., 2006), but once they have acquired it, they should show a P600 effect as French native speakers do and Spanish-French bilinguals may do.

In order to test gender processing within new syntactic structures in L2, another study could be realised with the same population examining violations on possessive pronouns. In French, possessive pronouns agree with the syntactic gender of the object (e.g., French, *sa maison,* 'his/her house'; *son stylo*, 'his/her pen'), in Spanish, pronouns are similar for both genders (e.g. *su casa*, 'his/her house'; *su boli*, 'his/her pen'), whereas in English pronouns agree with the natural gender of the subject (e.g.,

206

his house, her house). From the performance of fluent bilinguals in general, we assume that highly proficient bilinguals can process possessive pronouns in French, but the question is whether they are as accurate and as fast as native speakers. At early stages of acquisition, we suppose that interference from the L1 agreement rule could prevent agreement processing in L2. Hence, Spanish speakers would overuse one of the pronouns (either *son* or *sa*) with no gender distinction as in Spanish, and English speakers would agree the pronoun with the subject, not the object. However, in view of our results, we predict that in highly proficient bilinguals, gender processing in the language in use would not be affected by the rule of the language not in use. This study would provide information about agreement processing in bilinguals.

3   CONCLUSION

Studying language processing in bilinguals is not an easy task as it involves influence of parameters such as age of acquisition, proficiency and similarities between L1 and L2. The present thesis shed light on L2 processing by comparing how native and non-native speakers process grammatical gender in French. We have used experimental psychological methods to test assumptions made by linguistic models. Our findings are relevant both for linguistic and psycholinguistic theories, which suggests that these two field should be combined to develop models of language processing.

REFERENCES

Alario, F.-X. & Caramazza, A. (2002). The production of determiners: Evidence from French. *Cognition*, *89*, 179–223.

Altmann, G. T. M., Garnham, A., & Dennis, Y. (1992). Avoiding the garden path: Eye movements in context. *Journal of Memory and Language, 31*, 685-712.

Andersen, R. (1984). What's gender good for anyway? In R. Andersen (Ed.), *Second languages: A cross-linguistic perspective* (pp. 77-100). Rowley, MA: Newbury House.

Ardal, S., Donald, M.W., Meuter, R., Muldrew, S. & Luce, M. (1990). Brain responses to semantic incongruity in bilinguals. *Brain and Language, 39*, 187–205.

Barber, H. & Carreiras, M. (2003). Integrating gender and number information in Spanish word pairs: An ERP study. *Cortex, 39*, 465–482.

Barber, H. & Carreiras, M. (2005). Grammatical gender and number in Spanish: An ERP comparison. *Journal of Cognitive Neuroscience, 17*, 137–153

Bartning, I. (2000). Gender agreement in L2 French: Pre-advanced vs. advanced learners. *Studia Linguistica, 54*, 225-237.

Bernstein, J. (1991). DPs in French and Walloon: Evidence for parametric variation in
nominal head movement. *Probus, 3*, 101-126.

Bloomfield, L. (1933). *Language*. NewYork: Holt, Rinehart and Winston.

Bock, K. (1986). Meaning, sound, and syntax: Lexical priming in sentence production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*, 575-586.

Bock, K. & Levelt, W.J.M. (1994). Language production. Grammatical encoding. In M.A. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 945–984). San Diego: Academic Press.

Boland, J.E. (2004). Linking eye-movements to sentence comprehension in reading and listening. In M. Carreiras & C. Clifton, Jr. (Eds). *The on-line study of sentence comprehension: Eyetracking, ERP, and beyond* (pp. 51-76). Brighton, UK: Psychology Press.

Boland, J.E. & Blodgett, A. (2001). Understanding the constraints on syntactic generation: Lexical bias and discourse congruency effects on eye movements. *Journal of Memory and Language, 45*, 391-411

Bordag, D., Opitz, A., & Pechmann, T. (2006). Gender processing in first and second languages: the role of noun termination. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32*, 1090-1101.

Bordag, D. & Pechmann, T. (2007). Factors influencing L2 gender processing. *Bilingualism: Language and Cognition, 10 (3)*, 299-314.

Bosque, I. & Picallo, C. (1996). Postnominal adjectives in Spanish DPs. *Journal of Linguistics, 32*, 349-385.

Branigan, H. P., Pickering, M. J., & Cleland, A. A. (2000). Syntactic co-ordination in dialogue. *Cognition, 75*, B13-B25.

Brown, C. & Hagoort, P. (1993). The processing nature of the N400: Evidence from masked priming. *Journal of Cognitive Neuroscience, 5*, 34-44.

Bruhn de Garavito, J. & White, L. (2002). L2 acquisition of Spanish DPs: the status of grammatical features. In A. T. Pérez-Leroux & J. M. Liceras (Eds..), *The Acquisition of Spanish Morphosyntax: The L1/L2 Connection* (pp. 151-176). Doradrecht: Kluwer.

Brysbaert, M. & Vitu, F. (1998). Word Skipping: Implications for theories of eye movement control in reading. In G. Underwood (Ed.), *Eye guidance in reading and scene perception* (pp. 125-147). Oxford: Elsevier.

Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology, 14*, 177-208

Caramazza, A. & Miozzo, M. (1997). The relation between syntactic and phonological knowledge in lexical access: Evidence from the "tip-of-the-tongue" phenomenon. *Cognition, 64*, 309-343

Caramazza, A., Miozzo, M., Costa, A., Schiller, N., & Alario, F-X. (2001). A cross-linguistic investigation of determiner production. In E. Dupoux (Ed.), *Language, Brain, and Cognitive Development:Essays in Honor of Jacques Mehler* (pp. 209-226). Cambridge, MA: MIT Press.

Carreiras, M. & Clifton, C, Jr. (1999). Another word on parsing relative clauses: Eye-tracking evidence from Spanish and English. *Journal of Memory and Cognition, 7*, 826-833.

Carreiras, M. & Clifton, C., Jr. (2004). On the on-line study of language comprehension. In M. Carreiras & C. Clifton, Jr. (Eds). *The on-line study of sentence comprehension: Eyetracking, ERP, and beyond* (pp. 1-14). Brighton, UK: Psychology Press.

Carreiras, M. & Perea, M. (2004). Effets de la fréquence du voisinage syllabique dans la reconnaissance des mot écrits et la lecture: Comparisons inter-tâches [Effects of syllable neighborhood frequency in visual word recognition and reading: Cross-task comparisons]. In L. Ferrand & J. Grainger (Eds.), *Psycholinguistique cognitive* (pp. 231-249). Bruxelles: De Boeck.

Carroll, S. (1989). Second Language Acquisition and the Computational Paradigm. *Language Learning, 39*, 535-594.

Carstens, V. (2000). Concord in Minimalist Theory. *Linguistics Inquiry, 31*, 319-355

Chomsky, N. (1995). Categories and transformations. *In The Minimalist Program* (pp. 219–394). Cambridge, Mass.: MIT Press.

Cinque, G. (1994). On the evidence for partial N-movement in the Romance DP. In G. Cinque, J. Koster, J-Y. Pollock, L. Rizzi, and R. Zanuttini (Eds.), *Paths Towards Universal Grammar* (pp. 85-110). Washington DC: Georgetown University Press.

Clahsen, H. & Felser, C. (2006). Grammatical processing in language learners. *Applied*

Psycholinguistics, 27, 3-42.

Clahsen, H. & Muysken, P. (1986). The availability of Universal Grammar to adult and child learners: A study of the acquisition of German word order. *Second Language Research, 2,* 93-119.

Cohen, J. D., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: A new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments, & Computers, 25*, 257-271.

Content, A., Mousty, P., & Radeau, M. (1990). Brulex. Une base de données lexicales informatisée pour le français écrit et parlé. *L'Année Psychologique, 90*, 551-566.

Corbett, G. (1991). *Gender*. Cambridge. Cambridge University Press.

Costa, A. (2005). Lexical Access in Bilingual Production. In J. F. Kroll & A. M. de Groot, (Eds.), *Handbook of Bilingualism: Psycholinguistic Approaches* (pp. 308-325). Oxford University Press.

Costa, A. & Caramazza, A. (1999). Is lexical selection language specific? Further evidence from Spanish-English bilinguals. *Bilingualism: Language and Cognition, 2*, 231-244.

Costa, A. & Caramazza, A. (2002). The production of Noun Phrases in English and Spanish: Implications for the scope of phonological encoding in speech production. *Journal of Memory and Language, 46*, 178-198.

Costa, A., Kovacic, D., Franck, J., & Caramazza, A. (2003). On the autonomy of the grammatical gender systems of the two languages of a bilingual. *Bilingualism: Language and Cognition, 6*, 181-200.

Costa, A., Mahon, B., Savova, V., & Caramazza, A. (2003). Level of categorization effect: a novel effect in the picture-word interference paradigm. *Language and Cognitive Processes, 18*, 205-233.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual.s two lexicons compete for selection? *Journal of Memory and Language, 41*, 365-397.

Costa, A., & Santesteban, M. (2004). Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners. *Journal of Memory and Language, 50*, 491-511.

Costa, A., Sebastian-Galles, N., Miozzo, M., & Caramazza, A. (1999). The gender congruity effect: Evidence from Spanish and Catalan. *Language and Cognitive Processes, 14*, 381–391.

Coulson, S., King, J.W. & Kutas, M. (1998). Expect the unexpected: event-related brain response to morphosyntactic violations. *Language and Cognitive Processes, 13*, 21–58.

Crystal, D. (1987). *The Cambridge Encyclopaedia of Language*. Cambridge: Cambridge University Press.

Cubelli, R., Lotto, L., Paolieri, D., Girelli, M., & Job, R. (2005). Grammatical gender is selected in bare noun production: Evidence from the picture-word interference paradigm. *Journal of Memory and Language, 53*, 42-59.

De Bot, K. (1992). A bilingual production model: Levelt's speaking model adapted. *Applied Linguistics, 13*, 1-24.

De Bot, K. & Schreuder, R. (1993). Word production and the bilingual lexicon. In R. Schreuder & B. Weltens (Eds.), *The bilingual lexicon* (pp. 191-214). Amsterdam: John Benjamins.

Dell, G. S. (1986). A spreading activation theory of retrieval in sentence production. *Psychological Review, 93*, 283-321.

Desmet, T. & Declercq, M. (2006). Cross-linguistic priming of syntactic hierarchical configuration information. *Journal of Memory and Language, 54*, 610-632.

Deutsch, A. & Bentin, S. (2001). Syntactic and semantic factors in processing gender agreement in Hebrew: Evidence from ERPs and eye movements. *Journal of Memory and Language, 45*, 200-224

Dewaele, J.M. & D.Véronique (2001). Gender assignment and gender agreement in advanced French interlanguage: a cross-sectional study. *Bilingualism: Language and Cognition, 4*, 275-97.

Dijkstra, T. & van Heuven, W. J. B. (2002). The architecture of the bilingual word recognition system: From identification to decision. Bilingualism: Language and *Cognition, 5*, 175-197.

Elston-Gütler, K., Paulmann, S., & Kotz, S. (2005). Who's in control? Proficiency and L1 influence on L2 processing. *Journal of Cognitive Neuroscience, 17,* 1593-1610

Foucart, A. & Frenck-Mestre, C. (under revision). Processing of grammatical gender in French as a first and second language: Evidence from lexical decision and ERPs. *Bilingualism: Language & Cognition*.

Franceschina, F. (2001). Morphological or syntactic deficits in near-native speakers? An assessment of some current proposals. *Second Language Research, 17*, 213-247

Francis, W. S. (2005). Bilingual semantic and conceptual representation. In J. F. Kroll, & A. M. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 251-268). New York: Oxford University Press.

Frazier, L. & Rayner, K. (1982). Making and correcting errors during sentence comprehension: Eye movements in the analysis of structurally ambiguous sentences. *Cognitive Psychology, 14*, 178-210.

Frenck-Mestre, C. (2002). An on-line look at sentence processing in a second language. In R. Herida and J. Altarriba (Eds.), *Bilingual Sentence Processing* (pp. 217-236). Elsevier, Amsterdam

Frenck-Mestre, C. (2004). Ambiguities and anomalies: What can eye-movements and event-related potentials reveal about second language sentence processing? In J. Kroll & A. M. de Groot (Eds.), *Hanbook of Bilingualism* (pp. 268-284)

Frenck-Mestre, C. (2005). Eye-movement as a tool for studying syntactic processing in a second language: A review of methodologies and experimental findings. *Second Language Research, 21*, 175-198

Frenck-Mestre, C. & Pynte, J. (1997). Syntactic ambiguity resolution while reading in second and native languages. *Quarterly J. of Experimental Psychology, 50*, 119-148.

Friederici, A.D. (2002). Towards a neural basis of auditory sentence processing. *Trends in Cognitive Sciences, 6*, 78–84.

Friederici, A. D., Hahne, A., & Mecklinger, A. (1996). Temporal structure of syntactic parsing: Early and late event-related brain potential effects. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*, 1219–1248.

Garrett, M. F. (1980). Levels of processing in sentence production. In B. Butterworth (Ed.), *Language production: speech and talk* (pp. 177-220). London: Academic Press.

Gouvea, A., Phillips, C., Kazanina, N., & Poeppel, D. (submitted). The Linguistic Processes Underlying the P600. *Language and Cognitive Processes*.

Green, D. W. (1986). Control, activation and resource: A framework and a model for the control of speech in bilinguals. *Brain and Language, 27*, 210-223.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition, 1*, 67-81.

Greenhouse, S.W. & Geisser, S. (1959). On methods in the analysis of profile data. *Psychometrika, 24*, 95-111.

Grosjean, F. (2000). Processing mixed language: Issues, findings and models. In A. M. de Groot & J. Kroll (Eds), *Tutorials in Bilingualism: Psycholinguistic Perspectives*. Mahwah, NJ: LEA, 1997.

Grosjean, F. (2001). The bilingual's language modes. In J. Nicol (Ed.). *One Mind, Two Languages: Bilingual Language Processing* (pp. 1-22). Oxford: Blackwell.

Guillelmon, D. & Grosjean, F. (2001). The gender marking effect in spoken word recognition: The case of bilingual. *Memory & Cognition, 29* (3), 503-511.

Gunter, T. C., Friederici, A. D., & Schriefers, H. (2000). Syntactic gender and semantic expectancy: ERPs reveal early autonomy and late interaction. *Journal of Cognitive Neuroscience, 12*, 556-568.

Hagoort, P. & Brown, C. M. (1999). Gender electrified: ERP evidence on the syntactic nature of gender processing. *Journal of Psycholinguistic Research, 28*, 715–728.

Hagoort, P., Brown, C. M., & Groothusen, J. (1993). The syntactic positive shift (SPS) as an ERP-measure of syntactic processing. *Language and Cognitive Processes, 8*, 439–483.

Hagoort, P., Brown, C. M., & Osterhout, L. (1999). The neurocognition of syntactic processing. In C. M. Brown & P. Hagoort (Eds.), *The neurocognition of language* (pp. 273–316). Oxford, UK: Oxford University Press.

Hahne, A. (2001). What's different in second language processing? Evidence from event-related brain potentials. *Journal of Psycholinguistic Research, 30*, 251–66.

Hahne, A. & Friederici, A.D. (2001). Processing a second language: late learners' comprehension mechanisms as revealed by event-related brain potentials. *Bilingualism: Language and Cognition, 4*, 123–41.

Hahne, A., Mueller, J., & H. Clahsen (2006). Morphological processing in a second language: Behavioural and event-related potential evidence for storage and decomposition. *Journal of Cognitive Neuroscience, 18,* 121-134.

Hartsuiker, R. J., Pickering, M. J., & Veltkamp, E. (2004). Is syntax separate or shared between languages? Cross-linguistic syntactic priming in Spanish/English bilinguals. *Psychological Science, 15*, 409-414.

Hawkins, R. (1998). Explaining the Difficulty of French Gender Attribution for Speakers of English. Paper presented at the EUROSLA conference, Paris.

Hawkins, R. & Chan, C. (1997). The partial availability of Universal Grammar in second language acquisition: the 'failed functional features hypothesis'. *Second Language Research, 13*, 187-226

Hawkins, R. & F. Franceschina (2004). Explaining the acquisition and non-acquisition of determiner-noun gender concord in French and Spanish. In P. Prevost & J. Paradis (Eds), *The acquisition of French in different contexts. Focus on functional categories* (pp. 175-207). Amsterdam: John Benjamins.

Hermans, D. (2004). Between-language identity effects in picture-word interference tasks: A challenge for language-nonspecific or language-specific models of lexical access? *International Journal of Bilingualism, 8*, 115-125.

Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent interference from their first language? Bilingualism: Language and Cognition, 1, 213-229.

Hockett, Charles F. (1958). A Course in Modern Linguistics. New York: Macmillan.

Holmes, V.M. & Dejean De La Battie, B. (1999). Assignment of grammatical gender by native speakers and foreign learners of French. *Applied Psycholinguistics, 20*, 479-506.

Holmes, V. M. & Segui, J. (2004). Sublexical and lexical influences on gender assignment in French. *Journal of Psycholinguistic Research, 33*, 425-457.

Hoover, M.L. & Dwivedi, V.D. (1998). Syntactic processing by skilled bilinguals. *Language Learning, 48*, 1-29.

Hulk, A. & Tellier, C. (1999). Conflictual agreement in Romance nominals. In J.-M. Authier, B. E. Bullock, & L. A. Reed, (Eds.), *Formal Perspectives on Romance Linguistics* (pp. 179-195). Amsterdam: John Benjamins.

Inoue, K. & Osterhout, L. (2005). Honorifics in Japanese: An ERP study. Annual CUNY Sentence Processing Conference, Tucson, March 2005.

Jasper, H. H. (1958). The ten twenty electrode system of the International Federation. *Electroencephalography and Clinical Neurophysiology, 5*, 196-214

Juffs, A. & Harrington, M. (1996). Garden path sentences and error data in second language sentence processing. *Language Learning, 46*, 283-326.

Just, M.A. & Carpenter, P.A. (1980). A theory of reading: From eye-fixations to comprehension. *Psychological Review, 87*, 329-354.

Karmiloff-Smith, A. (1979). *A functional approach to child language*. Cambridge, UK: Cambridge University Press.

King, J.W. & Kutas, M. (1995). Who did what and when? Using word- and clause-related ERPs to monitor working memory usage in reading. *Journal of Cognitive Neuroscience, 7*, 378–397.

Kluender, R. & Kutas, M. (1993). Subjacency as a processing phenomenon. *Language and Cognitive Processes, 8*, 573–633.

Koehn, C. (1994). The acquisition of gender and number morphology within NP. In J.M. Meisel (Ed.), *Bilingual first language acquisition: French and German grammar development* (pp. 29-51). Amsterdam: Benjamins.

Köpcke, K.M. & Zubin, D.A. (1984). Sechs Prinzipien für die Genuszuweisung im Deutschen : Ein Beitrag zur natürlichen Klassifikation. *Linguistische Berichte, 93*, 26-50.

Kotz, S.A. (2001). Neurolinguistic evidence for bilingual language representation: a comparison of reaction times and event-related brain potentials. *Bilingualism: Language and Cognition, 4*, 143–54

Kotz, S. A. & Elston-Guettler, K. (2004). The role of proficiency on processing categorical and associative information in the L2 as revealed by reaction times and event-related brain potentials. *Journal of Neurolinguistics, 17*, 215–35.

Krott, A., Baayen, R.H., & Hagoort, P. (2006). The nature of anterior negativities caused by misapplications of morphological rules. *Journal of Cognitive Neuroscience, 18*, 1616-1630.

Kutas, M. & Hilyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science, 207*, 203–205.

Kutas, M. & van Petten, C. (1988). Event-related brain potential studies of language. In: P.K. Ackles, J.R. Jennings & M.G.H. Coles (Eds.), *Advances in Psychophysiology*, Vol. 3 (pp 139-187). Greenwich, Connecticut: JAI Press.

Laenzlinger, C. (2005). French adjective ordering: perspectives on DP-internal movement types. *Lingua, 115*, 645-689

La Heij, W., Mak, P., Sander, J., & Willeboordse, E. (1998). The gender congruency effect in picture–word tasks. *Psychological Research, 61*, 209–219.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation.* Cambridge, Massachusetts: The MIT Press.

Levelt, W. J. M. (1999). Producing spoken language: A blueprint of the speaker. In C. M. Brown & P. Hagoort (Eds.), *The neurocognition of language* (pp. 83–122). Oxford, UK: Oxford University Press.

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioural and Brain Sciences, 22*, 1-38.

Loebell, H. & Bock, K. (2003). Structural priming across languages. *Linguistics, 41*, 791-824.

Longobardi, G. (1994). Reference and proper names: A theory of N-movement in syntax and logical form. *Linguistic Inquiry, 25*, 609-665.

MacNamara, J. & Kushnir, S. (1971). Linguistic independence of bilinguals: The input switch. *Journal of Verbal Learning and Verbal Behavior, 10*, 480-487.

MacWhinney, B. (1978). The acquisition of morphophonology. *Monographs of the Society for Research in Child Development, 43*, 1-23.

McLaughlin, J., Osterhout, L., & Kim, A. (2004). Neural correlates of second-language word learning: minimal instruction produces rapid change. *Nature Neuroscience, 7*, 703-704.

Mel'cuk, I.A. (1958). Statisctics and the relationship between the gender of French nouns and their endings. In V. Ju. Rozencvejg (Ed.) 1974 *Essays on Lexical Semantics*, I, (pp.11-42). Stockholm: Skriptor.

Meuter, R. & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language, 40*, 25-40

Meuter, R., Donald, M.W., & Ardal, S. (1987). A comparison of first and second-language ERPs in bilinguals. *Current Trends in Event-Related Potential Research (EEG supplement), 40*, 412-416.

Mills, A. E. (1986). *The acquisition of gender: A study of English and German.* Berlin: Springer-Verlag.

Miozzo, M. & Caramazza, A. (1999). The selection of determiners in noun phrase production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25*, 907–922.

Miozzo, M., Costa A., & Caramazza, A. (2002) The gender congruency effect in Romance languages: A matter of stimulus onset asynchrony? *Journal of Experimental Psychology: Learning, Memory and Cognition, 28*, 388-391

Mirković, J., MacDonald, M. C., & Seidenberg, M. S. (2005). Where does gender come from? Evidence from a complex inflectional system. *Language and Cognitive Processes, 20*, 139-168

Mirković, J., Seidenberg, M. S., & Joanisse, M. F. (2004). Statistical nature of inflectional structure : Insight from a highly inflected language. (Manuscript in preparation)

Müller, N. (1990). Gender and number agreement within DP. In J.M. Meisel (Ed.), *Bilingual first language acquisition: French and German grammar development* (pp. 53-88). Amsterdam: Benjamins.

Müller, O. & Hagoort, P. (2006). Access to Lexical Information in Language Comprehension : Semantics before Syntax. *Journal of Cognitive Neuroscience, 18*, 84-96.

Münte, T. F., Heinze, H. J., & Mangun, G. R. (1993). Dissociation of brain activity related to syntactic and semantic aspects of language. *Journal of Cognitive Neuroscience, 5*, 335-344.

Myers-Scotton, C. (1992). Constructing the frame in intrasentential code-switching. *Multilingua, 11*, 101-127

Neville, H.J., Mills, D.J., & Lawson, D.S. (1992). Fractionating language: different neural subsystems with different sensitive periods. *Cerebral Cortex, 2*, 244-258.

Neville, H.J., Nicol, J.L., Barss, A., Forster, K.I. & Garrett, M.F. (1991). Syntactically based sentence processing classes – evidence from event-related brain potentials. *Journal of Cognitive Neuroscience 3*, 151–65.

Oliphant, K. (1998). Acquisition of Grammatical Gender in Italian as a Foreign Language. *Canadian Modern Language Review, 54,* 239-262

Osterhout, L., Bersick, M., & McKinnon, R. (1997). Brain potentials elicited by words: word length and frequency predict the latency of an early negativity. *Biological Psychology, 46*, 143-168.

Osterhout, L. & Hagoort, P. (1999). A superficial resemblance does not necessarily mean you are part of the family: Counterarguments to Coulson, King, and Kutas (1998) in the P600/SPS-P300 debate. *Language and Cognitive Processes, 14*, 1-14.

Osterhout, L. & Holcomb, P. J. (1992). Event-related brain potentials elicited by syntactic anomaly. *Journal of Memory and Language, 31*, 785–806.

Osterhout, L. & Holcomb, P. J. (1995). Event-related brain potentials and language comprehension. In M. D. Rugg & M. G. H. Coles (Eds.), *Electrophysiology of mind: Event-related brain potentials and cognition*. Oxford: Oxford University Press.

Osterhout, L., McKinnon, R., Bersick, M., & Corey, V. (1996). On the language-specificity of the brain response to syntactic anomalies: Is the syntactic positive

shift a member of the P300 family? *Journal of Cognitive Neuroscience, 8*, 507-526.

Osterhout, L., McLaughlin, J., Kim, A., & Inoue, K. (2004). Sentences in the brain: Event-related potentials as real-time reflections of sentence comprehension and language learning. In M. Carreiras & C. Clifton, Jr. (Eds.), *The on-line study of sentence comprehension: Eyetracking, ERP, and beyond* (pp. 271-308). Psychology Press.

Osterhout, L., McLaughlin, J., Pitkanen, I., Frenck-Mestre, C., & Molinaro, N. (2006). Novice learners, longitudinal designs, and event-related potentials: A paradigm for exploring the neurocognition of second-language processing. *Language Learning, 56*, 199-230.

Osterhout, L. & Mobley, L. A. (1995). Event-related brain potentials elicited by failure to agree. *Journal of Memory and Language, 34*, 739-773.

Paradis, M. (1987). *The assessment of bilingual aphasia*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Perea, M. & Pollatsek, A. (1998). The effects of neighborhood frequency in reading and lexical decision. *Journal of Experimental Psychology: Human Perception & Performance, 24*, 767-779.

Perez-Pereira, M. (1991). The acquisition of gender: What Spanish children tell us. *Journal of Child Language, 18*, 571-590.

Pickering, M. J. & Branigan, H. P. (1998). The representation of verbs: Evidence from syntactic priming in language production. *Journal of Memory and Language, 39*, 633-651.

Pickering, M. J. & Traxler, M. (1998). Plausibility and the recovery from garden paths: An eyetracking study. *Journal of Experimental Psychology: Learning, Memory and Cognition, 24*, 940-961.

Pollatsek, A., Hyona, J., & Bertram, R. (2000). The role of morphological constituents in reading Finnish compound words. *Journal of Experimental Psychology: Human Perception & Performance, 26*, 820-833

Poulisse, N. (1997). Language production in bilinguals. In A. M. de Groot & J. F. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 201-223). Mahwah, NJ: Lawrence Erlbaum Publishers.

Poulisse, N. & Bongaerts, T. (1994). First language use in second language production. *Applied Linguistics, 15*, 36-57.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin, 124*, 372-422.

Rayner, K., Cook, A.E., Juhasz, B.J., & Frazier, L. (2006). Immediate disambiguation of lexically ambiguous words during reading: Evidence from eye movements. *British Journal of Psychology, 97,* 467-482

Rayner, K. & Pollatsek, A. (1989). *The psychology of reading*. Englewood Cliffs, N.J.: Prentice Hall.

Rayner, K., Pollatsek, A., & Binder, K.S. (1998). Phonological codes and eye movements in reading. *Journal of Experimental Psychology : Learning, Memory, and Cognition, 24*, 476-497.

Ritchie, W. C. & Bhatia, T. K. (1996). *Handbook of Second Language Acquisition.* Academic Press.

Roelofs, A. (1998). Lemma selection without inhibition of languages in bilingual speakers. *Bilingualism: Language and Cognition, 1*, 94-95.

Rossi, S., Gugler, M.F., Friederici, A.D., & Hahne, A. (2006). The impact of proficiency on syntactic second-language processing of German and Italian: evidence from event-related potentials. *Journal of Cognitive Neuroscience, 18*, 2030-2048.

Sabourin, L. (2003). Grammatical gender and second language processing: an ERP study. Unpublished doctoral dissertation, University of Groningen.

Sabourin, L. L. & Haverkort, M. (2003). Neural substrates of representation and processing of a second language. In R. van Hout, A. Hulk, F. Kuiken and R. J. Towell (Eds.), *The Lexicon Syntax Interface in Second Language Acquisition* (pp. 175195). Amsterdam: John Benjamins.

Sabourin, L. Stowe, L. A. & de Haan, G. J. (2006). Transfer effects in learning a second language grammatical gender system. *Second Language Research, 22*, 1-29

Salamoura, A. & Williams, J.N. (2007). The representation of grammatical gender in the bilingual lexicon: Evidence from Greek and German. *Bilingualism: Language and Cognition, 10 (3)*, 257-275

Scheepers, C. (2003). Syntactic priming of relative clause attachments: Persistence of structural configuration in sentence production. *Cognition, 89*, 179-205.

Schiller, N. O., & Caramazza, A. (1999). Gender interference in speech production: The case of German. Abstracts of the Psychonomic Society, 4, 45.

Schiller, N. O. & Caramazza, A. (2003). Grammatical feature selection in noun phrase production: Evidence from German and Dutch. *Journal of Memory and Language, 48*, 169-194.

Schoonbaert, S., Hartsuiker, R.J., & Pickering, M.J. (2007). The representation of lexical and syntactic information in bilinguals: Evidence from syntactic priming. *Journal of Memory and Language, 56*, 153-171.

Schriefers, H. (1993). Syntactic processes in the production of noun phrases. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 841–850.

Schriefers, H.J. & Jescheniak, J.D. (1999). Representation and processing of grammatical gender in language production. *Journal of Psycholinguistic Research, 28*, 575-600

Schriefers, H.J. & Teruel, E. (1999). The production of noun phrases: A cross-linguistic comparison of French and German. Proceedings of the 21st Annual Conference of the Cognitive Science Society, 1999, 637-642.

Schriefers, H. & Teruel, E. (2000). Grammatical gender in noun phrase production: The gender interference effect in German. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 1368–1377.

Schwartz, B.D. & R.A. Sprouse. (1994). Word order and Nominative Case in nonnative language acquisition: A longitudinal study of (L1 Turkish) German Interlanguage. In T. Hoekstra & B.D. Schwartz, (Eds.), Language Acquisition Studies in Generative Grammar. Amsterdam: John Benjamins. pp. 317-68.

Tucker, G.R., Lambert, W.E., & Rigault, A. (1977). *The French speaker's skill with grammatical gender: An example of rule-governed behavior*. The Hague: Mouton.

van Berkum, J. J. A. (1997). Syntactic processes in speech production: The retrieval of grammatical gender. *Cognition, 64*, 115–152.

van Berkum, J.J.A., Hagoort, P., & Brown, C.M. (1999). Semantic integration in sentences and discourse: Evidence from the N400. *Journal of Cognitive Neuroscience, 11*, 657-671.

van Turennout, M.I., Hagoort, P., & Brown, C.M. (1998). Brain activity during speaking: From syntax to phonology in 40 milliseconds. *Science, 280* , 572-574

Vigliocco, G., Antonini, T., & Garrett, M. F. 1997. Grammatical gender is on the tip of Italian tongues. *Psychological Science, 8*, 314–317

Weber-Fox, C.M. & Neville, H.J. (1996). Maturational constraints on functional specializations for language processing: ERP and behavioural evidence in bilingual speakers. *Journal of Cognitive Neuroscience, 8*, 231–56.

White, L. (1989). *Universal grammar and second language acquisition*. Amsterdam: John Benjamins.

White, L. (2003). *Second language acquisition and universal grammar*. Cambridge: Cambridge University Press.

White, L., Valenzuela, E., Kozlowska-Macregor, M., & Leung, Y. I. (2004). Gender and number agreement in non-native Spanish. *Applied Psycholinguistics, 25*, 105-133

APPENDIX A

EXPERIMENTS 1, 2, AND 3:
OFF-LINE TEST

Bilingual participants were asked to circle the correct gender of the nouns used in Experiments 1, 2, and 3.

le/la	bague	le/la	balai	le/la	biscotte
le/la	brume	le/la	cendre	le/la	chagrin
le/la	chaise	le/la	chaleur	le/la	chapeau
le/la	choix	le/la	clef	le/la	cloche
le/la	combat	le/la	corbeille	le/la	couette
le/la	dépit	le/la	dos	le/la	falaise
le/la	fleche	le/la	fraise	le/la	frein
le/la	fromage	le/la	jambon	le/la	marmite
le/la	marteau	le/la	matelas	le/la	moitié
le/la	neige	le/la	nez	le/la	nuage
le/la	paysage	le/la	péniche	le/la	piqûre
le/la	plafond	le/la	plage	le/la	pneu
le/la	pointe	le/la	pomme	le/la	pont
le/la	prairie	le/la	raisin	le/la	repas
le/la	repos	le/la	retard	le/la	savon
le/la	sentier	le/la	sortie	le/la	tableau
le/la	talon	le/la	tambour	le/la	tempête
le/la	tige	le/la	tiroir	le/la	titre
le/la	torche	le/la	trêve	le/la	trompe
le/la	tuile	le/la	ventre	le/la	verger
le/la	violon	le/la	volet	le/la	voyelle

APPENDIX B

EXPERIMENTS 1, 2, AND 3:
EXPERIMENTAL MATERIALS (STIMULI)

Stimuli are presented in French (singular form) with their translation in German according to gender (same vs. different across languages), and in English.

Nouns masculine in French - feminine in German

FRENCH	GERMAN	ENGLISH
haricot	Bohne	bean
savon	Seife	soap
raisin	Traube	grape
tambour	Trommel	drum
tiroir	Lade	drawer
plafond	Zimmerdecke	ceiling
repas	Malhzeit	meal
pont	Brücke	bridge
repos	Ruhe	rest
tableau	Tafel	board
frein	Bremse	brake
matelas	Matratze	mattress
violon	Mühle	mill
talon	Ferse	heel
retard	Verspatung	delay
nuage	Wolke	cloud
paysage	Landschaft	landscape
choix	Wahl	choice
nez	Nase	noise

Nouns feminine in French – masculine in German

French	German	English
biscotte	Zwieback	toast
péniche	Schleppkahn	barge
trompe	Rüssel	snout
piqûre	Stich	sting
tuile	Ziegel	tile
fleche	Pfeil	arrow
tempête	Sturm	storm
brume	Nebel	mist
clef	Schlüssel	key
chaise	Stuhl	chair
voyelle	Vokal	vowel
marmite	Kochkessel	pot
corbeille	Korb	basket
bague	Ring	ring
tige	Stiel	stem
plage	Strand	beach
pomme	Apfel	apple
sortie	Ausgang	exit
neige	Schnee	snow

Nouns masculine in French – masculine in German

French	German	English
jambon	Schinken	ham
balai	Besen	broom
verger	Obstgarten	orchard
fromage	Käse	cheese
volet	Fensterladen	shutter
chagrin	Kummer	sarrow
fleuve	Fluss	river
dépit	Verdruss	pique
titre	Titel	title
chapeau	Hut	hat
pneu	Reifen	pneumatique
placard	Wandschrank	cupboard
marteau	Hammer	hammer
sucre	Zucker	sugar
sentier	Pfad	path
quai	Bahnsteig	platform
ventre	Bauch	belly
sable	Sand	sand

French	German	English
combat	Kampf	fight
dos	Rücken	back

Nouns feminine in French – feminine in German

French	German	English
couette	Bettdecke	duvet
fraise	Erdbeere	strawberry
flaque	Pfütze	puddle
falaise	Klippe	cliff
boucle	Schnalle	loop
prairie	Wiese	meadow
bêtise	Dummheit	something silly
cendre	Asche	ash
peau	Haut	skin
chaleur	Wärme	heat
cible	Zielscheibe	target
torche	Fackel	torch
caverne	Höhle	cave
trêve	Waffenruhe	respite
dette	Schuld	debt
cloche	Glocke	bell
montre	Uhr	watch
pointe	Spitze	tip
durée	Dauer	duration
moitié	Hälfte	half

APPENDIX C

EXPERIMENT 1:
EXPERIMENTAL MATERIALS (SENTENCES)

SYNTACTIC SENTENCES (critical adjectives are underlined)

Masculine French – Feminine German

1. Les haricots <u>secs</u> sont dans la cuisine.
   Pulse beans are in the kitchen.
2. Les savons <u>glissants</u> sont difficiles à attraper.
   Slippery soaps are hard to catch.
3. Souvent les raisins <u>secs</u> sont dans les céréales.
   Usually raisins are in cereal.
4. Les tambours <u>bruyants</u> sont très désagréables.
   Loud drums are very unpleasant.
5. Les tiroirs <u>ouverts</u> sont à ranger.
   The open drawers have to be tidied.
6. Souvent les plafonds <u>hauts</u> sont dans les anciennes maisons.
   Usually high ceilings are in old houses.
7. Les repas <u>chauds</u> sont à prendre le soir.
   Hot meals should be eaten in the evening.
8. Les ponts <u>droits</u> sont de cette région.
   Straight bridges are found in this region.
9. Les repos <u>légers</u> sont très agréables.
   Light naps are very pleasant.
10. Les tableaux <u>anciens</u> sont à l'école du village.
    Old boards are in the school of the village.
11. Les repas <u>froids</u> sont à prendre le midi.
    Cold meals should be eaten at lunch time.

12. Les haricots <u>ronds</u> sont dans la casserole.
    Round-shaped beans are in the saucepan.
13. Les freins <u>neufs</u> sont sur la voiture.
    New brakes are on the car.
14. Les matelas <u>fins</u> sont sur les lits.
    Thin mattresses are on the beds.
15. Les violons <u>lents</u> sont au fond de l'orchestre.
    Slow fiddles are at the back of the orchestra.
16. Les moulins <u>lents</u> sont dans le village.
    Slow mills are in the village.
17. Les talons <u>plats</u> sont à la mode.
    Flat shoes are fashion.
18. Les retards <u>fautifs</u> sont sans excuse.
    Intentional delays have no excuse.
19. Les nuages <u>blancs</u> sont très bas.
    White clouds are very low.
20. Les paysages <u>plats</u> sont dans le nord.
    Flat landscape are found in the North.
21. Parfois les choix <u>prudents</u> sont difficiles à prendre.
    Sometimes wise choices are difficult to make.
22. Les nez <u>parfaits</u> sont assez rares.
    Perfect noses are quite rare.
23. Les moulins <u>anciens</u> sont hors d'usage.
    Old mills are unusable.
24. Les nuages <u>ronds</u> sont au-dessus de la mer.
    Round-shaped clouds are above the sea.

Feminine French – Masculine German

25. Les biscottes <u>croquantes</u> sont à manger rapidement.
    Crunchy toasts have to be eaten soon.
26. Les péniches <u>lentes</u> sont sur la rivière.
    Slow barges are on the river.
27. Les trompes <u>courtes</u> sont très pratiques.
    Short snout are really handy.
28. Souvent les piqûres <u>profondes</u> sont sur les bras.
    Usually stings are deep on arms.
29. Les tuiles <u>plates</u> sont à remplacer rapidement.
    Flat tiles have to be replaced soon.
30. Les flèches <u>courtes</u> sont vers la droite.
    Short arrows are towards the right side.
31. Les tempêtes <u>brèves</u> sont les plus terribles.
    Brief storms are the most dreadful.
32. Le matin les brumes <u>légères</u> sont sur le lac.
    In the morning the light mist is all over the lake.
33. Les clefs <u>rondes</u> sont dans la serrure.
    Round-shaped keys are in the keyhole.
34. Tous les étés les chaises <u>blanches</u> sont dans le jardin.

Every summer the white chairs are in the garden.
35. Les clefs <u>plates</u> sont sur le porte-clefs.
    The flat keys are on the keyring.
36. Les chaises <u>neuves</u> sont dans le salon.
    The new chairs are in the garden.
37. Souvent les voyelles <u>longues</u> sont après une consonne.
    Usually unstressed vowels are found after a consonant.
38. Les marmites <u>pleines</u> sont dans la cuisine.
    Full cooking pots are in the kitchen.
39. Déjà les corbeilles <u>pleines</u> sont à vider.
    Full baskets already have to be emptied.
40. Parfois les bagues <u>brillantes</u> sont en diamant.
    Sometimes shiny rings are made of diamond.
41. Les tiges <u>fines</u> sont en fer.
    Thin rods are made of iron.
42. Tous les étés les plages <u>gratuites</u> sont pour les touristes.
    Every summer the free beaches are for the tourists.
43. Maintenant les pommes <u>vertes</u> sont de saison.
    Now green apples are in season.
44. Les sorties <u>étroites</u> sont vers le parc.
    Narrow exits go to the park.
45. Chaque hiver les neiges <u>blanches</u> sont sur les montagnes.
    Every winter the white snow is on the mountains.
46. Chaque année les pluies <u>fraiches</u> sont le signe de l'automne.
    Every year cold rains announce the autumn.
47. En été les pluies <u>fines</u> sont agréables.
    In summer thin rains are very pleasant.
48. Les sorties <u>secrètes</u> sont dans le château.
    Secret exits are in the castle.

Masculine in French and German

---

49. Parfois les jambons <u>cuits</u> sont au menu.
    Sometimes cooked hams are on the menu.
50. Les balais <u>verts</u> sont dans la cave.
    The green brooms are the cellar.
51. Les vergers <u>clos</u> sont au voisin.
    Close orchards belong to the neighbour.
52. Les fromages <u>ronds</u> sont dans le réfrigérateur.
    Round-shaped cheese is in the fridge.
53. Les volets <u>ouverts</u> sont au premier étage.
    Open shutters are on the first floor.
54. Depuis les chagrins <u>secrets</u> sont dans son cœur.
    Since then secret sarrows are in his heart.
55. Depuis toujours les fleuves <u>puissants</u> sont en Europe.
    Powerful rivers have been in Europe forever.
56. Les dépits <u>lourds</u> sont à oublier rapidement.
    Heavy pique feelings have to be forgotten rapidely.

57. Souvent les titres <u>brefs</u> sont en première page.
    Usually brief titles are in front page.
58. Tous les soirs les chapeaux <u>ronds</u> sont sur le porte-manteaux.
    Every evening round-shaped hats are on the coat-hanger.
59. Les balais <u>courts</u> sont dans le grenier.
    The short brooms are in the attic.
60. En hiver les chapeaux <u>chauds</u> sont pour skier.
    In winter warm hats are for skiing.
61. Depuis une semaine les pneus <u>neufs</u> sont au garage.
    The new tyres have been in the garage for a week.
62. Les placards <u>ouverts</u> sont à vider.
    The open cupboards have to be emptied.
63. Les marteaux <u>plats</u> sont dans la caisse.
    Flat hammers are in the box.
64. Les sucres <u>lents</u> sont dans les pâtes.
    Carbohydrates are found in pasta.
65. Les sentiers <u>étroits</u> sont dans la montagne.
    Narrow paths are in the mountains.
66. Les quais <u>glissants</u> sont à l'exterieur.
    Slippery platforms are outside.
67. Souvent les ventres <u>plats</u> sont tout en muscle.
    Usually flat stomachs have strong muscles.
68. Les sables <u>fins</u> sont sur la plage.
    Thin sand is on the beach.
69. Les combats <u>sanglants</u> sont sans limites.
    Bloody fights have no limits.
70. Parfois les dos <u>ronds</u> sont à redresser.
    Round backs have to be corrected.
71. Les pneus <u>étroits</u> sont pour les vélos.
    Narrows tyres are for bikes.
72. D'habitude les sables blancs sont dans le sud.
    Usually white sand is found in the south.

Feminine in French and German

73. En hiver les couettes <u>chaudes</u> sont sur les lits.
    In winter warm duvet covers are on the beds.
74. Les fraises <u>fraiches</u> sont dans le panier.
    Fresh strawberries are in the basket.
75. Les flaques <u>profondes</u> sont dans les trous.
    Deep puddles are in holes.
76. Les falaises <u>blanches</u> sont en Bretagne.
    White cliffs are in Britany.
77. Les boucles <u>parfaites</u> sont magnifiques.
    Perfect curls are beautiful.
78. Au printemps les prairies <u>vertes</u> sont dans la vallée.
    In spring green meadows are in the valley.
79. Parfois les bêtises <u>naïves</u> sont des erreurs.

Usually naive silly things are mistakes.
80. Les cendres froides sont dans la cheminée.
    Cold ashes are in the fireplace.
81. En hiver les peaux sèches sont très fragiles.
    In winter dried skins are very sensitive.
82. Les chaleurs sèches sont souvent dans le désert.
    Dry heats are usually in the deserts.
83. Les fraises rondes sont dans les bois.
    Round strawberries are in the woods.
84. Les cendres chaudes sont dans le barbecue.
    Hot ashes are in the barbecue.
85. Les cibles rondes sont sur la gauche.
    Round targets are on the left side.
86. Depuis toujours les torches éteintes sont dans la boîte.
    Torches have been in the boxes forever.
87. Les cavernes secrètes sont dans la forêt.
    Secret caves are in the forest.
88. Cependant les trêves récentes sont encore fragiles.
    However recent respites are still fragile.
89. Les dettes secrètes sont des problèmes.
    Secret debts are problems.
90. Les cloches rondes sont dans le clocher.
    Round bells are in the tower.
91. D'habitude les montres précises sont faciles à utiliser.
    Usually accurate watches are easy to use.
92. Les pointes fines sont au bout du crayon.
    Thin tips are at the end of the pencil.
93. Maintenant les durées brèves sont à exploiter.
    Brief durations have to be exploited.
94. Souvent les moitiés pleines sont au-dessous.
    Usually full halves are on the top.
95. Cette année les montres rondes sont très tendance.
    This year round watches are fashion.
96. Les cavernes étroites sont difficiles à visiter.
    Narrow caves are difficult to visist.

SEMANTIC SENTENCES (critical nouns are underlined)

1. Les haricots secrets sont dans la casserole.
   Secret beans are in the saucepan.
2. Les savons hauts sont sur le lavabo.
   High soaps are on the sink.
3. Souvent les raisins fautifs sont très bons.
   Guilty grapes are very tasty.
4. Les tambours frais sont dans l'orchestre.
   Fresh drums are in the orchestra.
5. Souvent les ponts lents sont en fer.

Usually slow bridges are made of iron.
6. Depuis toujours les tableaux <u>cuits</u> sont au musée.
   Cooked boards have been in the museum forever.
7. Les freins <u>ouverts</u> sont à l'avant.
   Open brakes are at the front.
8. Les matelas <u>precis</u> sont dans la chambre.
   Accurate mattresses are in the bedroom.
9. Les violons <u>cuits</u> sont sur la scène.
   Cooked fiddles are on stage.
10. Les moulins <u>croquants</u> sont dans le champs.
    Crunchy mills are in the fields.
11. Les nuages <u>prudents</u> sont dans le ciel.
    Careful clouds are in the sky.
12. Les nez <u>éteints</u> sont très jolis.
    Switched off noses are very nice.
13. Souvent les jambons <u>profonds</u> sont très chers.
    Usually deep hams are very expensive.
14. Les balais <u>naïfs</u> sont à la cave.
    Naive brooms are in the cellar.
15. Les fromages <u>précis</u> sont sur la table.
    The accurate cheese is on the table.
16. Souvent les volets <u>lents</u> sont faciles à fermer.
    Usually slow shutters are easy to close.
17. Les chapeaux <u>cuits</u> sont dans le hall.
    Cooked hats are in the hall.
18. D'habitude les fleuves <u>neufs</u> sont dans le nord.
    Usually news flowers are in the north.
19. Les placards <u>naïfs</u> sont difficiles à ouvrir.
    Naive cupboards are difficult to open.
20. Les marteaux <u>croquants</u> sont dans le garage.
    Crunch hammers are in the garage.
21. Les sucres <u>verts</u> sont dans la boîte.
    Green sugars are in the box.
22. Les sables <u>neufs</u> sont vers l'océan.
    The new sand is towards the ocean.
23. Les combats <u>ronds</u> sont magnifiques.
    Round fights are beautiful.
24. Souvent les dos <u>gratuits</u> sont douloureux.
    Usually free backs are painful.
25. Maintenant les tuiles <u>fautives</u> sont sur le toit.
    Now guilty tiles are on the roof.
26. Les flèches <u>fraiches</u> sont avec l'arc.
    The fresh arrows are with the bow.
27. Les tempêtes <u>plates</u> sont dangereuses.
    Flat storms are dangerous.
28. En septembre les brumes <u>éteintes</u> sont féquentes.
    In September the switched off mist is frequent.
29. Souvent les clefs <u>prudentes</u> sont sur la porte.

Usually careful keys are on the door.
30. En juin les chaises <u>fraiches</u> sont dans le jardin.
    In June the fresh chairs are in the garden.
31. Souvent les bagues <u>brèves</u> sont en or.
    Usually brief rings are made of gold.
32. Les tiges <u>lentes</u> sont efficaces.
    Slow rods are efficient.
33. Les plages <u>légères</u> sont les plus belles.
    Light beaches are the most beautiful.
34. Les pommes <u>plates</u> sont très bonnes.
    Flat apples are really good.
35. En hiver les neiges <u>chaudes</u> sont fréquentes.
    In winter hot snows are frequent.
36. En mars les pluies <u>rondes</u> sont de saison.
    In March round rains are in season.
37. Maintenant les couettes <u>puissantes</u> sont sur le lit.
    Now powerful duvet covers are on the bed.
38. Les fraises <u>blanches</u> sont dans les bois.
    White strawberries are in the woods.
39. Les falaises <u>bruyantes</u> sont près de la mer.
    Loud cliffs are by the sea.
40. Les boucles <u>droites</u> sont dans les cheveux.
    Straight curls are in the hair.
41. Les peaux <u>étroites</u> sont très fragiles.
    Narrow skins are very sensitive.
42. En été les chaleurs <u>vertes</u> sont très fortes.
    In summer green heats are very heavy.
43. Les cibles <u>cuites</u> sont très faciles.
    Cooked tragets are very easy.
44. Depuis longtemps les torches <u>bruyantes</u> sont dans le grenier.
    Loud torches have been in the attic for a long time.
45. Les cavernes <u>plates</u> sont très sombres.
    Flat caves are very dark.
46. Les cloches <u>glissantes</u> sont à l'église.
    Slippery bells are in the church.
47. Souvent les montres <u>prudentes</u> sont très chères.
    Usually careful watches are very expensive.
48. Les pointes <u>cuites</u> sont fragiles.
    Cooked tips are fragile.

APPENDIX D

EXPERIMENT 2 AND 3:
EXPERIMENTAL MATERIALS (SENTENCES)

POST-POSED ADJECTIVES (critical nouns are underlined)

Masculine French – Feminine German

1. Les bons <u>haricots</u> sont dans la casserole.
   The good beans are in the saucepan.
2. Souvent les doux <u>savons</u> sont dans la douche.
   Usually soft soaps are in the shower.
3. Au printemps les premiers <u>raisins</u> sont dans les vignes.
   In spring the first grapes are in the vineyard.
4. Maintenant les lourds <u>tambours</u> sont en rythme.
   Now the heavy drums are in rhythm.
5. Les profonds <u>tiroirs</u> sont sous l'armoire.
   Deep drawers are underneath the wardrobe.
6. En Provence les hauts <u>plafonds</u> sont très communs.
   In Provence high ceilings are very common.
7. De nos jours les bons <u>repas</u> sont rares.
   Nowadays good meals are rare.
8. En France les hauts <u>ponts</u> sont un symbole.
   In France high bridges are a symbol.
9. Les courts <u>repos</u> sont une récompense.
   Short rests are a reward.
10. Depuis toujours les grands <u>tableaux</u> sont à l'école du village.
    The large boards have been in the school of the village forever.
11. Les longs <u>repas</u> sont ennuyeux.
    Long meals are boring.

12. Les gros <u>haricots</u> sont dans la soupe.
    The big beans are in the soup.
13. Depuis une semaine les mauvais <u>freins</u> sont en réparation.
    The bad brakes have been being repaired for a week.
14. Souvent les fins <u>matelas</u> sont de mauvaise qualité.
    Usually thin mattresses are of poor quality.
15. Depuis toujours les grands <u>violons</u> sont sa passion.
    Big fiddles have been his passion forever.
16. Depuis ce matin les grands <u>moulins</u> sont en marche.
    Big mills have been working since this morning.
17. Cette année les hauts <u>talons</u> sont à la mode.
    This year high heels are fashion.
18. Les longs <u>retards</u> sont en raison des grèves.
    Long delays are due to strikes.
19. Les petits <u>nuages</u> sont dans le ciel.
    Small clouds are in the sky.
20. D'habitude les lointains <u>paysages</u> sont dans les livres.
    Usually faraway landscapes are in books.
21. Les parfaits <u>choix</u> sont peu fréquents.
    Perfect choices are very unusual.
22. En Egypte les longs <u>nez</u> sont un symbole de beauté.
    In Egypt long noses are a sign of beauty.
23. Souvent les hauts <u>moulins</u> sont plus efficaces.
    Usually high mills are more efficient.
24. En automne les épais <u>nuages</u> sont signe de pluie.
    In autumn thick clouds are sign of rain.

Feminine French – Masculine German

---

25. D'habitude les petites biscottes sont plus fragiles.
    Usually small toasts are more fragile.
26. Les grandes péniches sont sur la rivière.
    Big barges are on the river.
27. Les longues trompes sont très pratiques.
    Long snouts are very handy.
28. Souvent les grosses piqûres sont douloureuses.
    Usually big stings are painful.
29. Les grandes tuiles sont sur le toit.
    Large tiles are on the roof.
30. D'habitude les longues flèches sont très précises.
    Usually long arrows are very precise.
31. En hiver les violentes tempêtes sont redoutables.
    In winter violent storms are formidable.
32. Le matin les épaisses brumes sont sur le lac.
    In the morning the thick mist is on the lake.
33. Les lourdes clefs sont sur la porte.
    The heavy keys are on the door.
34. Les lourdes chaises sont dans le salon.

The heavy chairs are in the living-room.
35. Souvent les diverses clefs sont dans la boîte.
    Usually divers keys are in the box.
36. Depuis toujours les anciennes chaises sont au grenier.
    The old chairs have been in the attic forever.
37. Souvent les brèves voyelles sont après les consonnes.
    Usually stressed vowels are after consonants.
38. Les chaudes marmites sont dans la cuisine.
    The hot cooking pots are in the kitchen.
39. Déjà les lourdes corbeilles sont à vider.
    The heavy baskets already have to be emptied.
40. Parfois les grosses bagues sont en plastique.
    Sometimes big rings are made of plastic.
41. Les fines tiges sont en fer.
    Thin rods are made of iron.
42. Depuis toujours les lointaines plages sont un rêve.
    Faraway beaches have always been a dream.
43. Maintenant les bonnes pommes sont dans le panier.
    Now the good apples are in the baskets.
44. Les dernières sorties sont disponibles en magasin.
    The latest releases are available in store.
45. En décembre les premières neiges sont sur les pistes.
    In December the first snowfalls are on the slopes.
46. En été les fines pluies sont agréables.
    In summer thin rains are pleasant.
47. En mars les violentes pluies sont terribles.
    In March violent rains are dreadful.
48. Les étroites sorties sont dans le jardin.
    Narrow exits are in the garden.

Masculine in French and German

---

49. Souvent les bons jambons sont très chers.
    Usually good hams are very expensive.
50. Les grands balais sont dans la cave.
    The big brooms are in the cellar.
51. Souvent les anciens vergers sont moins productifs.
    Usually old orchards are less productive.
52. Les bons fromages sont dans le frigo.
    The good cheese is in the fridge.
53. La nuit les grands volets sont fermés.
    At night the big shutters are closed.
54. Depuis les lourds chagrins sont dans son cœur.
    Heavy sorrows have been in his hearts since then.
55. Les profonds fleuves sont très dangereux.
    Deep rivers are very dangerous.
56. Parfois les profonds dépits sont pénibles.
    Sometimes deep piques are painful.

57. Toutes les semaines les gros titres sont dans les magazines.
    Every week headlines are in magazines.
58. Les hauts chapeaux sont sur le porte-manteau.
    High hats are on the coat hanger.
59. Les divers balais sont dans le garage.
    Various brooms are in the garage.
60. Les anciens chapeaux sont dans le coffre.
    The old hats are in the boot.
61. Depuis une semaine les mauvais pneus sont en morceaux.
    Bad brakes have been in pieces for a week.
62. Les profonds placards sont très pratiques.
    Deep cupboards are very handy.
63. Les lourds marteaux sont dans la caisse.
    The heavy hammers are in the box.
64. Les petits sucres sont dans le pot.
    Small sugar lumps are in the pot.
65. En forêt les longs sentiers sont agréables.
    In the forest long paths are pleasant.
66. Les longs quais sont dans la gare.
    Long platforms are in the station.
67. Souvent les gros ventres sont peu musclés.
    Usually big bellies do not have strong muscles.
68. Les parfaits sables sont sur la plage.
    The perfect sand is on the beach.
69. D'habitude les longs combats sont sans limites.
    Usually long fights do not have limits.
70. Souvent les longs dos sont plus souples.
    Usually long backs are suppler.
71. Maintenant les bons pneus sont sur la voiture.
    Now good tyres are on the car.
72. Les hauts placards sont dans la cuisine.
    High cupboards are in the kitchen.

Feminine in French and German

73. Souvent les épaisses couettes sont en plume.
    Usually thick duvet covers are made of feather.
74. Les bonnes fraises sont sur le gâteau.
    Good strawberries are on the cake.
75. Les profondes flaques sont sur le chemin.
    Deep puddles are on the path.
76. Les hautes falaises sont loin de la plage.
    High cliffs are far from the beach.
77. Maintenant les parfaites boucles sont démodées.
    Now perfect curls are no longer fashion.
78. Au printemps les grandes prairies sont pour les moutons.
    In spring large meadows are for sheep.
79. Les grosses bêtises sont toujours punies.

Big silly mistakes are always punished.
80. Les chaudes cendres sont dans la cheminée.
    Hot ashes are in the fireplace.
81. Les douces peaux sont agréables à toucher.
    Soft skins are pleasant to touch.
82. D'habitude les grandes chaleurs sont au mois d'août.
    Usually big heats are in August.
83. Au printemps les petites fraises sont dans les bois.
    In spring small strawberries are in the woods.
84. Les fines boucles sont difficiles à coiffer.
    Thin curls are hard to brush.
85. Les petites cibles sont en hauteur.
    Small targets are high.
86. Maintenant les grandes torches sont dans le grenier.
    Now the big torches are in the attic.
87. Souvent les profondes cavernes sont très sombres.
    Usually deep caves are very dark.
88. Maintenant les courtes trêves sont à prévoir.
    Now short respites have to be expected.
89. Les lourdes dettes sont à payer.
    Big debts have to be paid.
90. Les grandes cloches sont en haut de l'église.
    Bells are at the top of the church.
91. Les anciennes montres sont très rares.
    Old watches are very expensive.
92. Les fines pointes sont très précises.
    Thin tips are very precise.
93. Maintenant les courtes durées sont en augmentation.
    Now short durations are increasing.
94. Maintenant les petites moitiés sont en trop.
    Now small halves are useless.
95. Cette année les grosses montres sont à la mode.
    This year big watches are fashion.
96. Les étroites cavernes sont difficiles d'accès.
    Narrow caves are difficult to reach.

PREDICATIVE ADJECTIVES (critical adjectives are underlined)

Masculine French – Feminine German

1. Les haricots sont secs maintenant.
   Beans are dry now.
2. Les savons sont glissants dans l'eau.
   Soaps are slippery in water.
3. D'habitude les raisins sont secs dans les céréales.
   Usually raisins are dry in cereal.
4. Les tambours sont bruyants en concert.

Drums are loud live.
5. D'habitude les tiroirs sont ouverts dans cette maison.
   Usually drawers are open in this house.
6. Les plafonds sont hauts dans la maison.
   Ceilings are high in the house.
7. Souvent les repas sont chauds le soir.
   Usually meals are hot for dinner.
8. Les ponts sont droits sur la Seine.
   Bridges are straight on the Seine.
9. Les repos sont courts en ce moment.
   Rests are short at the moment.
10. Les tableaux sont anciens au musée.
    Old pictures are at the museum.
11. Les repas sont froids le midi.
    Meals are cold for lunch.
12. Les haricots sont ronds en Asie.
    Beans are round in Asia.
13. Depuis une semaine les freins sont neufs sur la voiture.
    New brakes have been on the car for a week.
14. Les matelas sont fins dans cet hôtel.
    Mattresses are thin in this hotel.
15. Les violons sont lents dans ce concerto.
    Fiddles are slow in this concerto.
16. Les moulins sont lents sans vent.
    Mills are slow without wind.
17. Les talons sont plats cette année.
    Heels are flat this year.
18. Les retards sont longs pour les trains.
    Delays are long for trains.
19. Parfois les nuages sont blancs dans le ciel.
    Sometimes clouds are white in the sky.
20. Les paysages sont plats dans le nord.
    Landscapes are flat in the north.
21. D'habitude les choix sont prudents dans sa vie.
    Usually choices are careful in his life.
22. Les nez sont parfaits sur ce dessin.
    Noses are perfect on this drawing.
23. Souvent les moulins sont anciens en Hollande.
    Usually mills are old in Holland.
24. Les nuages sont ronds sur cette photo.
    Clouds are round on this picture.

Feminine French – Masculine German

25. Les biscottes sont croquantes au petit déjeuner.
    Toasts are crunchy at breakfast.
26. Souvent les péniches sont lentes sur cette rivière.
    Usually barges are slow on the river.

27. Les trompes sont longues chez les éléphants.
    Elephants have long snouts.
28. Les piqûres sont profondes sur son bras.
    Stings are deep on his arm.
29. D'habitude les tuiles sont plates dans cette région.
    Usually tiles are flat in this region.
30. Les flèches sont courtes mais fragiles.
    Arrows are short but fragile.
31. Les tempêtes sont brèves au printemps.
    Storms are brief in spring.
32. Les brumes sont légères le matin.
    The mist is thin in the morning.
33. Les clefs sont rondes pour cette porte.
    Keys are round for this door.
34. Maintenant les chaises sont blanches et rouges.
    Now chairs are white and red.
35. Les clefs sont plates en général.
    Keys are flat in general.
36. Les chaises sont neuves sur la terrasse.
    Chairs are new on this terrace.
37. Souvent les voyelles sont longues devant une consonne.
    Usually vowels are stressed before a consonant.
38. Les marmites sont pleines avant le repas.
    Cooking pots are full before the meal.
39. Les corbeilles sont pleines le soir.
    Baskets are full in the evening.
40. Les bagues sont brillantes dans la vitrine.
    Rings are shiny in the window.
41. Les tiges sont fines avec des épines.
    Stems are thin with thorns.
42. Chaque année les plages sont gratuites tout l'été.
    Every year beaches are free all summer.
43. Les pommes sont vertes sur cet arbre.
    Apples are green on this tree.
44. Les sorties sont étroites dans ce parking.
    Exits are narrow in this car park.
45. Chaque hiver les neiges sont blanches sur la montagne.
    Every winter snow is white on the mountains.
46. En automne les pluies sont fraiches le soir.
    In autumn rains are cold in the evening.
47. Les pluies sont fines en été.
    Rains are thin in summer.
48. Les sorties sont secrètes dans le château.
    Exits are secret in the castle.

49. Les jambons sont cuits au four.
    Hams are cooked in the oven.
50. Les balais sont verts et jaunes.
    Brooms are green and yellow.
51. Dans cette région les vergers sont clos mais immenses.
    In this region orchards are close but huge.
52. Les fromages sont ronds dans cette région.
    Cheese is round in this region.
53. Parfois les volets sont ouverts dans la journée.
    Sometimes shutters are open during the day.
54. Depuis toujours les chagrins sont secrets et pénibles.
    Sorrows have been secret and painful forever.
55. Les fleuves sont puissants à cette saison.
    Rivers are powerful in this season.
56. Les dépits sont lourds et pénibles.
    Piques are heavy and painful.
57. Souvent les titres sont brefs dans ce journal.
    Usually headlines are brief in this newspaper.
58. D'habitude les chapeaux sont ronds en Bretagne.
    Usually hats are round in Brittany.
59. En Afrique les balais sont courts et fragiles.
    In Africa brooms are short and fragile.
60. D'habitude les chapeaux sont chauds pour l'hiver.
    Usually hats are warm for winter.
61. Depuis une semaine les pneus sont neufs sur la moto.
    New tyres have been on the motorbike for a week.
62. Les placards sont ouverts dans la cuisine.
    Cupboards are open in the kitchen.
63. Les marteaux sont plats pour ce travail.
    Hammers are flat for this job.
64. Souvent les sucres sont lents à fondre.
    Usually sugar lumps take a long time to melt.
65. Parfois les sentiers sont étroits dans la forêt.
    Sometimes paths are narrow in the forest.
66. Les quais sont glissants sous la pluie.
    Platforms are slippery in the rain.
67. Après l'exercice les ventres sont plats et fermes.
    After this exercise stomachs are flat and firm.
68. Les sables sont fins sur cette plage.
    The sand is thin on this beach.
69. Les combats sont sanglants dans ce film.
    Fights are bloody in this film.
70. Les dos sont ronds pendant l'exercice.
    Backs are round during this exercise.
71. Les pneus sont étroits sur les vélos.

Tyres are narrow on the bike.
72. Les sables sont blancs dans le désert.
Sand is white in the desert.

Feminine in French and German

---

73. Les couettes sont chaudes dans cet hôtel.
Duvet covers are warm in this hotel.
74. En général les fraises sont fraîches au marché.
Usually strawberries are fresh at the market.
75. Les flaques sont profondes sur le terrain.
Puddles are deep on the pitch.
76. Les falaises sont blanches en Normandie.
Cliffs are white in Normandy.
77. Les boucles sont parfaites sur les photos.
Curls are perfect on the pictures.
78. Au printemps les prairies sont vertes en Provence.
In spring meadows are green in Provence.
79. Les bêtises sont naïves à cet âge.
Silly mistakes are naïve at this age.
80. Le matin les cendres sont froides dans le barbecue.
In the morning ashes are cold in the barbecue.
81. Les peaux sont sèches en hiver.
Skins are dry in winter.
82. Les chaleurs sont sèches en Afrique.
Heat is dry in Africa.
83. Les fraises sont rondes cette année.
Strawberries are round this year.
84. Les cendres sont chaudes dans la cheminée.
Ashes are hot in the fireplace.
85. Les cibles sont rondes et jaunes.
Targets are round and yellow.
86. Chaque fois les torches sont éteintes par le vent.
Each time torches are blown out by the wind.
87. Les cavernes sont secrètes dans cette forêt.
Caves are secret in this forest.
88. Les trêves sont récentes et fragiles.
Respites are recent and fragile.
89. Depuis toujours les dettes sont secrètes dans la famille.
Debts have been secret forever in this family.
90. En Normandie les cloches sont rondes et sonores.
In Normandy bells are round and loud.
91. En Suisse les montres sont précises en général.
In Switzerland watches are usually precise.
92. Les pointes sont fines mais solides.
Tips are thin but strong.
93. Maintenant les durées sont brèves pour les pauses.
Now durations are brief for breaks.

94. En général les moitiés sont pleines ou vides.
    Usually halves are full or empty.
95. Les montres sont rondes dans cette collection.
    Watches are round in this collection.
96. Souvent les cavernes sont étroites et humides.
    Usually caves are narrow and humid.

EXPERIMENTS 3: TABLES OF MEANS

RESULTS FOR NOUN / PREDICATIVE ADJECTIVE AGREEMENT

Table 10

Means for first fixation of all regions as a function of Group (French, English and German speakers), Language coherency (different vs. same gender in French and German), Noun Gender (masculine vs. feminine nouns) and Agreement (correct vs. incorrect)

| | | Different | | | | Same | | | |
| | | Masculine | | Feminine | | Masculine | | Feminine | |
		Cor.	Inc.	Cor.	Inc	Cor.	Inc	Cor.	Inc
Initial (R1)	French	454	420	443	468	502	463	408	457
	English	425	458	434	498	451	442	492	456
	German	427	399	415	390	403	412	417	413
Noun (R2)	French	256	260	283	304	247	277	281	259
	English	273	277	311	282	274	293	304	301
	Ger.	273	287	283	299	264	263	291	285
Adjective (R4)*	French	269	285	274	267	265	308	290	281
	English	293	304	254	306	286	278	281	267
	German	282	287	283	264	281	312	273	274
Final (R5+R6)	French	299	309	309	294	337	312	416	262
	English	346	345	291	305	380	343	298	311
	German	313	336	316	328	309	335	307	307

Note. R3 is not reported as the copula was skipped on 80% of trials
* Main region of interest.

Table 11

Means for gaze duration of all regions as a function of Group (French, English and German speakers), Language coherency (different vs. same gender in French and German), Noun Gender (masculine vs. feminine nouns) and Agreement (correct vs. incorrect)

		Different				Same			
		Masculine		Feminine		Masculine		Feminine	
		Cor.	Inc.	Cor.	Inc	Cor.	Inc	Cor.	Inc
Initial (R1)	French	788	759	761	881	773	732	728	747
	English	663	706	681	917	741	697	773	776
	German	743	708	696	745	645	651	761	760
Noun(R2)	French	320	297	336	327	311	335	333	323
	English	407	392	369	354	374	386	432	359
	Ger.	320	297	336	327	311	335	333	323
Adjective (R4)*	French	334	365	342	352	316	366	357	326
	English	379	420	346	384	363	436	363	350
	German	339	394	385	322	351	436	335	329
Final (R5+R6)	French	338	332	416	395	448	440	393	350
	English	434	384	384	463	508	478	489	356
	German	378	434	434	452	430	453	359	501

Note. R3 is not reported as the copula was skipped on 80% of trials
* Main region of interest.

Table 12

Means for total reading time of all regions as a function of Group (French, English and German speakers), Language coherency (different vs. same gender in French and German), Noun Gender (masculine vs. feminine nouns) and Agreement (correct vs. incorrect)

		Different				Same			
		Masculine		Feminine		Masculine		Feminine	
		Cor.	Inc.	Cor.	Inc	Cor.	Inc	Cor.	Inc
Initial (R1)	French	805	698	809	887	785	767	755	822
	English	754	750	786	898	789	788	896	860
	German	930	942	921	1026	824	889	976	1032
Noun(R2)	French	372	381	481	470	448	460	469	423
	English	619	609	553	580	613	649	644	623
	Ger.	574	662	606	698	651	686	656	675
Adjective (R4)*	French	470	569	536	585	486	664	575	582
	English	536	755	618	630	627	699	557	571
	German	674	725	676	620	638	812	649	639
Final (R5+R6)	French	615	655	633	657	675	634	728	708
	English	699	828	795	763	836	716	830	808
	German	830	740	817	823	688	754	714	742

Note. R3 is not reported as the copula was skipped on 80% of trials
* Main region of interest.

Table 13

Means for first fixation of all regions as a function of Group (French, English and German speakers), Language coherency (different vs. same gender in French and German), Noun Gender (masculine vs. feminine nouns) and Agreement (correct vs. incorrect)

		Different				Same			
		Masculine		Feminine		Masculine		Feminine	
		Cor.	Inc.	Cor.	Inc	Cor.	Inc	Cor.	Inc
Initial (R1)	French	486	432	463	411	431	470	464	397
	English	467	475	480	504	492	435	425	467
	German	582	530	512	533	546	533	518	500
Adjective (R2)	French	257	262	265	278	243	265	262	264
	English	281	287	287	300	274	264	293	315
	Ger.	269	274	270	275	275	273	286	271
Noun (R3)*	French	280	296	288	284	279	292	276	322
	English	330	315	328	323	307	323	344	324
	German	311	309	307	328	311	317	344	341
(R5)	French	295	285	315	276	279	298	304	266
	English	303	307	300	292	291	298	289	306
	German	269	298	284	296	290	303	289	301
(R6)	French	358	331	303	300	405	337	299	337
	English	305	398	358	336	366	394	382	420
	German	345	371	335	351	353	359	371	369

Note. R4 is not reported as the copula was skipped on 80% of trials
* Main region of interest.

Table 14

Means for gaze duration of all regions as a function of Group (French, English and German speakers), Language coherency (different vs. same gender in French and German), Noun Gender (masculine vs. feminine nouns) and Agreement (correct vs. incorrect)

		Different				Same			
		Masculine		Feminine		Masculine		Feminine	
		Cor.	Inc.	Cor.	Inc	Cor.	Inc	Cor.	Inc
Initial (R1)	French	850	750	812	694	705	791	795	737
	English	787	824	679	746	733	685	674	776
	German	753	749	693	644	668	735	807	739
Adjective (R2)	French	293	283	323	300	265	323	342	335
	English	324	385	389	367	306	344	382	382
	Ger.	321	376	425	372	311	338	413	338
Noun (R3)*	French	324	335	337	351	320	335	313	367
	English	414	363	377	399	415	399	441	383
	German	400	386	401	411	403	430	411	403
(R5)	French	345	309	401	311	327	330	358	308
	English	380	406	381	327	314	338	335	381
	German	317	377	362	330	324	334	375	380
(R6)	French	389	496	425	460	551	523	414	460
	English	561	608	512	588	634	630	610	606
	German	625	470	562	564	584	542	537	483

Note. R4 is not reported as the copula was skipped on 80% of trials
* Main region of interest.

Table 15

Means for total reading time of all regions as a function of Group (French, English and German speakers), Language coherency (different vs. same gender in French and German), Noun Gender (masculine vs. feminine nouns) and Agreement (correct vs. incorrect)

		Different				Same			
		Masculine		Feminine		Masculine		Feminine	
		Cor.	Inc.	Cor.	Inc	Cor.	Inc	Cor.	Inc
Initial (R1)	French	908	763	759	778	755	793	827	773
	English	850	937	763	781	834	715	812	911
	German	896	1036	867	890	806	859	912	939
Adjective (R2)	French	415	458	447	452	423	547	535	520
	English	498	656	657	611	471	562	640	655
	Ger.	567	670	810	748	523	737	798	658
Noun (R3)*	French	455	463	419	493	432	487	455	580
	English	659	616	595	612	617	599	611	649
	German	652	718	739	748	687	746	717	745
(R5)	French	532	435	568	597	483	524	491	425
	English	690	582	665	627	509	487	566	613
	German	692	687	658	636	594	623	614	656
(R6)	French	688	688	599	670	692	686	638	696
	English	920	778	797	1080	766	828	903	925
	German	969	850	992	916	1015	740	853	717

Note. R4 is not reported as the copula was skipped on 80% of trials
* Main region of interest.

APPENDIX F

EXPERIMENTS 4, 6-10:
PICTURE-WORD INTERFERENCE PARADIGM
EXPERIMENTAL MATERIALS

Stimuli (pictures) and distractor words are presented in French with their translation in Spanish according to gender (same vs. different across languages), and in English.

PICTURES

Nouns masculine in French - feminine in Spanish

French	Spanish	English
balai	escoba	broom
chou	col	cabbage
drapeau	bandera	flag
genou	rodilla	knee
haricot	judia	bean
nez	nariz	nose
nuage	nube	cloud
panier	cesta	basket
sourcil	ceja	eyebrow
stylo	boli	pen
tableau	pizarra	board
tapis	alfombra	carpet

Nouns feminine in French – masculine in Spanish

French	Spanish	English
brosse	cepillo	brush
casserole	cazo	saucepan
chaussette	calcetin	sock
chaussure	zapato	shoe
dent	diente	tooth
fourchette	tenedor	fork
fumee	humo	smoke
glace	helados	ice-cream
montre	reloj	watch
poubelle	balde/cubo	bin
robe	vestido	dress
voiture	coche	car

Nouns masculine in French – masculine in Spanish

French	Spanish	English
bouclier	escudo	shield
chapeau	sombrero	hat
collier	collar	necklace
couteau	cuchillo	knife
fauteuil	sillon	armchair
gant	guante	glove
nœud	nudo	node
pinceau	pincel	paintbrush
pont	puente	bridge
pouce	pulgar	thumb
sapin	pino	pine tree
seau	balde	bucket

Nouns feminine in French – feminine in Spanish

French	Spanish	English
baignoire	bañera	bathtub
bouteille	botella	bottle
chaise	silla	chair
clef	llave	key
cloche	campana	bell
couronne	corona	crown
neige	nieve	snow
niche	perrera	doghouse
pelle	pala	shovel
poire	pera	pear
pomme	manzana	apple
saucisse	salchicha	sausage

DISTRACTOR WORDS
(distractors always shared the same gender across languages).

Masculine nouns

French	Spanish	English
bras	brazo	arm
chemin	camino	path
ciel	cielo	sky
coeur	corazón	heart
doigt	dedo	finger
feu	fuego	fire
jardin	jardín	garden
jeu	juego	game
papier	papel	paper
pied	pie	foot
reve	sueňo	dream
soleil	sol	sun
train	treno	train
vent	viento	wind
village	pueblo	village
voyage	viaje	journey

Feminine nouns

French	Spanish	English
bouche	boca	mouth
fenêtre	ventana	window
fleur	flora	flower
jambe	pierna	leg
lettre	letra	letter
ligne	linea	line
lumiere	luz	light
main	mano	hand
maison	casa	house
nuit	noche	night
porte	puerta	door
rue	calle	street
table	mesa	table
terre	tierra	earth
tete	caveza	head
ville	cuidad	town

APPENDIX G

EXPERIMENTS 5:

PICTURE-WORD INTERFERENCE PARADIGM

EXPERIMENTAL MATERIALS

Stimuli (pictures) and distractor words are presented in French with their translation in English.

PICTURES

Masculine nouns		Feminine nouns	
French	English	French	English
bateau	boat	boîte	box
bol	bowl	bombe	bomb
bouton	button	bouee	buoy
briquet	lighter	bougie	candle
bureau	desk	carotte	carrot
cadeau	present	cassette	tape
camion	lorry	cerise	cherry
cendrier	ashtray	chemise	shirt
chateau	castle	cible	target
citron	lemon	cravate	tie
clou	nail	cuillere	spoon
disque	record	feuille	leaf
domino	domino	guitare	guitar
four	oven	lampe	lamp
gateau	cake	loupe	magnifying glass
jambon	ham	palme	flipper
masque	mask	pipe	pipe

Masculine nouns			Feminine nouns	
French	English		French	English
parapluie	umbrella		plume	feather
peigne	comb		raquette	racket
piano	piano		roue	wheel
savon	soap		tasse	cup
sifflet	whistle		tomate	tomato
telephone	telephone		trompette	trumpet
verre	glass		valise	suitcase

DISTRACTOR WORDS

Masculine nouns			Feminine nouns	
French	English		French	English
bras	arm		bouche	mouth
journal	newspaper		chambre	bedroom
livre	book		fenêtre	window
papier	paper		fleur	flower
pied	foot		mer	sea
soleil	sun		route	road
train	train		table	table
visage	face		ville	town

APPENDIX H

EXPERIMENTS 8, 9, AND 10:
OFF-LINE TEST

Bilingual participants were asked to circle the correct gender of the nouns used in Experiments 8, 9, and 10.

le/la	baignoire	le/la	fauteuil	le/la	nuit	le/la	terre
le/la	balai	le/la	fenêtre	le/la	panier	le/la	tête
le/la	bouche	le/la	feu	le/la	papier	le/la	train
le/la	bouclier	le/la	fleur	le/la	pelle	le/la	vent
le/la	bouteille	le/la	fourchette	le/la	pied	le/la	village
le/la	bras	le/la	fumée	le/la	pinceau	le/la	ville
le/la	brosse	le/la	gant	le/la	poire	le/la	voiture
le/la	casserole	le/la	genou	le/la	pomme	le/la	voyage
le/la	chaise	le/la	glace	le/la	pont		
le/la	chapeau	le/la	haricot	le/la	porte		
le/la	chaussette	le/la	jambe	le/la	poubelle		
le/la	chaussure	le/la	jardin	le/la	pouce		
le/la	chemin	le/la	jeu	le/la	rêve		
le/la	chou	le/la	lettre	le/la	robe		
le/la	ciel	le/la	ligne	le/la	rue		
le/la	clef	le/la	lumière	le/la	sapin		
le/la	cloche	le/la	main	le/la	saucisse		
le/la	coeur	le/la	maison	le/la	seau		
le/la	collier	le/la	montre	le/la	soleil		
le/la	couronne	le/la	neige	le/la	sourcil		
le/la	couteau	le/la	nez	le/la	stylo		
le/la	dent	le/la	niche	le/la	table		
le/la	doigt	le/la	nœud	le/la	tableau		
le/la	drapeau	le/la	nuage	le/la	tapis		

APPENDIX I

EXPERIMENTS 8, 9 AND 10: TABLES OF MEANS

Table 16

Results for Experiment 8 (article + noun NPs) for all conditions and the three group.

			French		English		Spanish	
			Mean	SD	Mean	SD	Mean	SD
Same	Masculine	Control	623	107	863	212	916	196
		Congruent	654	141	827	159	895	190
		Incongruent	616	126	892	149	864	215
	Feminine	Control	648	90	885	222	882	159
		Congruent	682	99	837	186	760	204
		Incongruent	661	124	818	147	840	171
Different	Masculine	Control	675	110	912	156	1005	181
		Congruent	756	143	882	190	869	232
		Incongruent	641	145	848	160	894	154
	Feminine	Control	605	94	825	128	846	196
		Congruent	640	146	841	93	962	169
		Incongruent	616	106	817	94	875	151

Table 17

Results for Experiment 9 (article + adjective+ noun NPs) for all conditions and the three group.

			French		English		Spanish	
			Mean	SD	Mean	SD	Mean	SD
Same		Control	643	103	830	104	775	209
	Masculine	Congruent	646	132	900	152	848	204
		Incongruent	621	106	847	149	832	196
		Control	700	149	869	175	836	139
	Feminine	Congruent	705	129	875	231	805	180
		Incongruent	705	103	885	158	795	174
Different		Control	709	152	910	221	844	212
	Masculine	Congruent	679	133	967	123	954	167
		Incongruent	660	140	876	146	775	157
		Control	610	139	805	127	788	126
	Feminine	Congruent	604	94	837	129	822	146
		Incongruent	613	141	799	160	782	164

Table 18

Results for Experiment 10 (article + noun+ adjective NPs) for all conditions and the three group.

			French		English		Spanish	
			Mean	SD	Mean	SD	Mean	SD
Same		Control	721	125	941	154	879	157
	Masculine	Congruent	744	145	943	149	936	167
		Incongruent	758	138	881	148	792	173
		Control	754	119	890	129	981	169
	Feminine	Congruent	823	117	947	115	946	147
		Incongruent	723	79	857	172	856	171
Different		Control	773	107	922	143	929	174
	Masculine	Congruent	775	149	951	166	979	175
		Incongruent	750	149	862	156	827	225
		Control	714	139	875	94	884	162
	Feminine	Congruent	806	150	942	116	955	134
		Incongruent	724	125	916	98	874	187