Is *le maison* acceptable?:
The representation and processing of grammatical gender in French speakers

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ABSTRACT

Grammatical gender is a complex classification system and is often referred to as one of the most difficult grammatical categories for second language (L2) speakers to master. Previous research has focused on anticipatory processing of grammatical gender cues in first language (L1) speakers of various gendered languages (French, Spanish, Dutch, etc.) and has found that speakers use gender information from a preceding determiner to facilitate access to a gender-congruent noun (e.g., Dussias et al., 2013; Lew-Williams & Fernald, 2010). These findings have been consistently found among speakers of various languages when they were presented with congruent vs. incongruent determiner phrases (DPs), subsequently collapsing across grammatical genders (e.g., congruent: *la maison* and *le bateau* vs. incongruent: **le maison* vs. **la bateau*). Responses to individual genders cues in Spanish has been teased apart (masculine vs. feminine) as well as the effect of inhibitory control on gender processing (Beatty-Martínez, et al., 2020). A correlation between grammatical gender error recovery and increased inhibitory control was found. The current dissertation aims to dissect the processing and underlying neural mechanisms associated with masculine and feminine grammatical gender in L1 French, simultaneous French-English, and L1 English-L2 French speakers.

A series of three experiments were conducted. The first two experiments used a masked priming lexical decision task where participants were presented with congruent (e.g., *la maison*) and incongruent (**le maison*) DPs. The first experiment employed a behavioural version of the task and the second experiment focused on event-related brain potentials (ERPs). At a behavioural level, there was no indication of grammatical gender cue use. However, ERP results show that L1 speakers employ distinct processing mechanisms for feminine (P200; **le maison*) incongruencies compared to feminine congruencies (*la maison*). The final experiment consisted of a self-paced reading task, where participants read sentences with congruent and incongruent DPs and an AX-CPT task as a measure of inhibitory control. L1 French and simultaneous French-English speakers exhibit processing difficulties with the incongruent feminine condition (**le maison*) compared to the congruent feminine condition (*la maison*), as well as with the incongruent masculine condition (**la bateau*) compared to the congruent masculine condition (*le bateau*). On the other hand, L2 speakers only show difficulty with the incongruent feminine condition in relation to the congruent feminine condition. Further, there was no relationship between inhibitory control and grammatical gender processing across groups.

Overall, the results reflect an intricate picture of grammatical gender processing in French speakers. At a lexical level, L1 French speakers likely process incongruent feminine DPs as a lexical clash, potentially implementing further cognitive resources during processing. At a syntactic level, L1 French and simultaneous French-English speakers show processing difficulties behaviourally to gender incongruencies. L2 speakers seem to employ the use of masculine grammatical gender cues, implying that it is perhaps the presence of a feminine noun causing processing difficulty due to a feature mismatch. These results indicate that masculine and feminine genders employ distinct processing mechanisms and may be accessed in a contrasting manner.

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"I don't know what lies around the bend, but I'm going to believe that the best does. It has a fascination of its own, that bend."

- Anne Shirley, Anne of Green Gables
L.M. Montgomery

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LIST OF ABBREVIATIONS

ADJ-N	Adjective – Noun
AoA	Age of Acquisition
AoI	Age of Immersion
AX-CPT	AX continuous performance task
CF	Core French
D-N	Determiner – Noun
DP	Determiner Phrase
EEG	Electroencephalography
EF	Executive function
EFI	Early French Immersion
ERP	Event-related brain potentials
FF	All French School
L1	First language
L2	Second language
LAN	Left anterior negativity
LBQ	Language Background Questionnaire
LC	Left-central
LD	Lexical decision
LF	Left-frontal
LFI	Late French Immersion
LMM	Linear mixed effect model
LN	Left negativity
LP	Left-parietal
MC	Mid-central
MF	Mid-frontal
MoA	Manner of Acquisition
MP	Mid-parietal
RC	Right-central
RF	Right-frontal

ROI	Region of interest
RP	Right-parietal
RT	Reaction Time
SD	Standard deviation
SPR	Self-paced reading
VF	Verbal fluency
VWP	Visual world paradigm

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Grammatical gender is an arbitrary noun classification system and is often referred to as one of the most difficult grammatical categories to master, especially for second language (L2) speakers (e.g., Cornips & Hulk, 2008; Dewaele & Véronique, 2001; Scherag et al., 2004). This makes it an ideal tool to investigate how grammatical concepts are acquired, stored, and accessed in the mental lexicon of both native and bilingual speakers. To this end, several studies have focused on native language (L1, e.g., Valdés Kroff et al., 2017; Lew-Williams & Fernald, 2010; Bates et al., 1996) and L2 acquisition and processing (e.g., Guillelmon & Grosjean, 2001; Hopp, 2013) using various online techniques investigating spoken word recognition (e.g., Dussias et al., 2013) and written language comprehension (e.g., Beatty-Martínez et al., 2020). Commonly, it is found that L1 speakers can use grammatical gender as an anticipatory cue during processing, whereas L2 speakers do under certain conditions.

Theoretical properties that accompany grammatical gender are often investigated (e.g., distribution of grammatical gender, default/markedness status; Atkinson, 2015; Ihsane & Sleeman, 2016), however, they are rarely explored in conjunction with online experimental data. Interestingly, Beatty-Martínez et al. (2020) focused on grammatical gender processing in native Spanish speakers based on the distributional properties of masculine and feminine nouns. The researchers found that L1 speakers make use of grammatical gender cues during processing. Specifically, electrophysiological responses (in particular, the LAN and P600; see section 1.5.1 for more details) to masculine and feminine were found to be correlated with general cognitive

abilities and lexical knowledge respectively. This suggests that nouns of masculine and feminine gender are potentially acquired, represented, and accessed differently in the lexicon.

Apart from a small number of studies, differences between genders of a specific language (e.g., potential differences in processing between masculine and feminine in Spanish) are not considered, and instead findings are collapsed across genders. The investigation of grammatical gender processing with a specific focus on the separation of the genders is especially absent in languages containing more opaque gender systems, such as French. French is considered an opaque language, due to the lack of transparency between the phonological and morphological properties of the language and the grammatical gender assigned to a given noun. Additionally, grammatical gender in French is argued to consist of a low communicative load, meaning that other factors such as attention and memory may play a large role in grammatical gender acquisition (Ayoun, 2007). Therefore, further investigation into general cognitive abilities and grammatical gender processing may prove to be beneficial and insightful.

Previous studies focusing on L2 acquisition show that factors, such as proficiency, Age of Immersion (AoI), and the environment in which a participant learns their language (Manner of Acquisition - MoA) are important for L2 speakers to reach a level of processing similar to that of native speakers (e.g., Sabourin, Brien, & Burkholder, 2014; Sabourin, Leclerc, Burkholder, & Brien, 2014). How each language is learned can greatly differ from person to person. For instance, some individuals learn both languages from birth, whereas others learn one as an L2. In fact, a large portion of Canadian speakers learn French as an L2 through a French language requirement in schools across the country. These programs vary in several aspects, including, the amount and type of French exposure, the age at which a child begins to learn the language, and the language goals of the program. These factors play a role in a child's French knowledge and communicative

ability, which in turn can potentially influence their processing abilities and grammatical gender acquisition.

1.1 Research questions and chapter overview

This dissertation focuses on whether L1 and L2 French speakers use available grammatical gender cues from determiners to facilitate the processing of an upcoming noun, as well as which factors influence processing. More specifically, the following questions are investigated:

1. Do native French speakers utilize grammatical gender cues from determiners anticipatorily during online processing to facilitate processing?
    - Are masculine and feminine cues used in the same way and to the same degree during processing, or are there any differences?
2. Do L2 speakers use grammatical gender cues in a similar manner to that of native speakers? Is how they use (or do not use) cues related to the environment in which they learned or acquired their language?
3. What are the neural underpinnings associated with the predictive use of grammatical gender processing?
4. Is there a relationship between gender processing and individual differences in cognitive abilities and/or lexical knowledge?

The organization of this dissertation is as follows: the remainder of Chapter 1 will provide an overview of grammatical gender, the French gender system, and will summarize previous literature on grammatical gender processing. In addition, an overview of various L2 French school programs in relation to MoA will be discussed. Chapter 2 will present an examination of how L1 and L2 speakers use grammatical gender cues during online processing via a masked priming lexical decision task using determiner phrases (DPs). Chapter 3 will analyze the neural underpinnings associated with anticipatory processing using an ERP version of the same lexical

decision task implemented in Chapter 2. The relationship between cognitive abilities and grammatical gender processing in L1 and L2 speakers is discussed in Chapter 4. Finally, Chapter 5 will summarize the findings from each experiment and provide concluding remarks.

1.2 Gender overview

Gender is a noun classification system and is often comprised of grammatical gender (also referred to as arbitrary or lexical gender) and semantic gender (also referred to as natural gender). Languages can consist of only semantic gender (e.g., English), semantic and grammatical gender (e.g., French, Spanish, Dutch, German), or neither (e.g., Farsi). Semantic gender is the assignment of gender to a noun based on its semantic properties, such as animacy and an individual's natural gender. For example, the word *mother* possesses feminine gender cross-linguistically, as the word is associated with an animate female entity (1). In contrast, grammatical gender is an arbitrary noun classification system with little to no formal basis for the gender assignment of a particular noun (2). The grammatical gender property of the noun is reflected in agreement processes between two or more syntactic elements (articles, adjectives, etc.; Corbett, 1991). For instance, in (3), the noun *table* is assigned feminine grammatical gender in French, thus feminine gender is required to be marked on corresponding syntactic elements, such as the determiner (*la*) and the adjective (*verte*). Gender assignment and gender agreement can be acquired and accessed in different ways. L1 speakers of a gendered language may access gendered features during assignment and agreement processes indicating which gender to assign to the noun and supporting syntactic elements. However, depending on the manner and age at which an L2 speaker learned their language, they may not access specific gender information during these processes, instead relying more on memorization and metalinguistic knowledge of the gender of the noun.

(1) a. la madre$_F$ French
b. die Mutter$_F$ German
c. matka$_F$ Czech

(2) a. le château$_M$ French
'the castle'
b. la casa$_F$ Spanish
'the house'
c. crkva$_F$ Croatian
'the church'

(3) la$_F$ table$_F$ est verte$_F$ French
'the table is green'

Despite the grammatical gender of a noun in one language, gender is not consistent cross-linguistically. For instance, the word *table* in Spanish possesses feminine gender (4a), whereas in German it is masculine. Additionally, languages can be comprised of a 2-gender (e.g., French; Atkinson, 2015), 3-gender system (e.g., German; Kürschner & Nübling, 2011), or more, increasing the amount of variability in gender congruency cross-linguistically.

(4) a. la mesa$_F$ Spanish
b. der Tisch$_M$ German
'the table'

In some languages, grammatical gender is reflected at a morphological level where gender classes are marked on the noun via inflectional suffixes. Suffixes are then associated with a particular grammatical gender class. For instance, in Spanish, nouns ending with *-o* tend to be masculine, whereas nouns ending with *-a* tend to be feminine, however, there are instances of

opaque nouns in Spanish that do not possess the regular association (e.g., *torre*$_{F}$, "tower"). In contrast, other languages, such as German or Dutch, possess few (or no) morphophonological associations with the gender of the noun, rendering the grammatical gender system more opaque. Languages can range from being highly transparent to highly opaque (Sá-Leite et al., 2020), with Spanish and Dutch residing at opposite ends of the spectrum. In some cases, such as with French, the grammatical gender system is comprised of phonological gender cues that are not as straightforwardly associated with gender but also consist of a number of transparent nouns (see section 1.3 below). Thus, these types of systems fall somewhere in the middle the transparency-opaque spectrum, with French leaning more towards opaque.

1.3 The French gender system

The grammatical gender system in French is comprised of two genders, masculine and feminine. These genders are marked on singular definite and indefinite determiners (e.g., *la*$_{F}$*/une*$_{F}$, *le*$_{M}$*/un*$_{M}$, 'the/a'), possessive articles (e.g., *ma*$_{F}$*, mon*$_{M}$, 'my'), demonstratives (e.g., *ce*$_{M}$*/cette*$_{F}$, 'this/that'), and the interrogative words (e.g., *quel*$_{M}$*.quelle*$_{F}$, 'what'). Each of these syntactic elements must agree in gender with their respective noun (5a -d; note that *ce* is followed by a masculine noun beginning with a vowel or h, it becomes *cet* to avoid a hiatus). Additionally, French consists of semantic gender, where the gender of a noun corresponds to the referent (Séguin, 1969). Specifically, semantic gender typically refers to animate nouns, where the gender aligns with natural sex, as seen in (5e) and (5f) which refers to a male and female singer respectively (Atkinson, 2015). On the other hand, grammatical gender is arbitrarily assigned to the noun and does not possess any semantic motivation (Deutsch & Dank, 2009). For example, *chaise*$_{F}$ ('chair') is feminine in French, but there is nothing that is inherently "feminine" about the noun.

(5) a. le mouton$_{M}$
‘the sheep’

b. ma maison$_{F}$
‘my house'

c. ce livre$_{M}$
‘this book’

d. Quelle chaussure$_{F}$?
‘what shoe?

e. le chanteur$_{M}$
‘the (male) singer’

f. la chanteuse$_{F}$
‘the (female) singer’

In contrast to languages such as Spanish, the phonological forms of French nouns are not as strongly correlated with grammatical gender, as French is traditionally referred to as having an opaque system (Ayoun, 2007). However, researchers have proposed gender assignment rules based on phonological and orthographic properties (e.g., Tucker, Lambert, Rigault, & Segalowitz, 1977; Lyster, 2006). For example, the suffix *-ette* is typically associated with feminine gender, making it a highly predictable suffix. Despite this level of predictability, French is still considered an opaque language, as speakers are required to have a good base knowledge of suffixal information, as some suffixes may appear to correspond with a particular gender when it is not the case (e.g., *-tion*, is used for both masculine (*bastion*, ‘bastion’) and feminine (*conversation* ‘conversation’) (Presson, MacWhinney, & Tokowicz, 2014).

The Default masculine notion

In French, masculine grammatical gender is often referred to as the default gender. One reason for this assumption is that masculine, as opposed to feminine, is considered to be syntactically unmarked [-FEM] in some syntactic models (Atkinson, 2015), therefore it is assumed to be simpler to process. Further evidence comes from the distributional properties and situations in which the masculine gender is used (Ayoun, 2007). For instance, all colour words are masculine (e.g., *le vert*$_{M}$*, le bleu*$_{M}$*,* "green, blue") unless paired with a feminine noun (*e.g., la maison*$_{F}$ *verte*$_{F}$*,* 'the green house'). When there is a conflict between the gender of various syntactic elements, the masculine counterparts are used in adjective agreement (e.g., *un*$_{M}$ *cousin*$_{M}$ *et une*$_{F}$ *cousine*$_{F}$ *amusants*$_{M}$ as opposed to **un*$_{M}$ *cousin*$_{M}$ *et une*$_{F}$ *cousine*$_{F}$ *amusantes*$_{F}$; Ayoun, 2018).

Additional evidence stems from the gender assignment for words that are borrowed into French - these words are often assigned masculine gender (e.g., *le camping*; Violin-Wignet, 2006)[1], as well as the overgeneralized use of the masculine gender during production with nonce nouns (Boloh & Ibernon, 2010). L1 speakers have been shown to use masculine determiners when they are unfamiliar with a noun and its gender. Ayoun (2018) found that native French-speaking adults were more accurate with gender assignment of masculine nouns (82.4%) versus feminine nouns (73.8%) and were more likely to assign the correct gender to common nouns than uncommon. French-speaking children also exhibit the use of a masculine default notion. Royle and Valois (2010) studied the speech of 32 French-speaking children (3-8 years old) and found that the production of feminine forms was inconsistent in relation to masculine forms. In particular, children showed difficulty with producing feminine variable adjectives, instead relying on the

[1] There are exceptions to this process, where nouns are assigned feminine gender, such as *une job.* The study by Violin-Wignet (2006) found that French monolingual speakers assigned masculine gender to English borrowed words 64% of the time, and native French bilingual speakers 74.7% of the time. In contrast, French monolinguals assigned feminine gender 32 % of the time and bilinguals 17.3%.

masculine counterpart (la$_F$ petite$_F$ maison$_F$ *vert$_M$, “the small green house”). The researchers argue that masculine forms are more frequent and the default form, thus a higher number of errors occur with feminine structures. Further, L2 learners are also more likely to overgeneralize the use of masculine definite determiners (e.g., **le*$_M$ *culture*$_F$*;* Bartning, 1999). During production, learners have been shown to utilize the masculine form of adjectives over the correct feminine counterpart (e.g., *je suis *satisfait*$_M$ *Yvonne;* Bartning, 2000).

1.4 Methods used in the current thesis

Research on grammatical gender spans comprehension and production, in which various experimental paradigms are implemented. Studies focusing on production often use methods that either elicit target items or natural speech from speakers (e.g., elicited production tasks, recording speech during a typical day, etc.). Studies focusing on the comprehension side of language use offline tasks, online tasks, or a combination of the two. Offline tasks tap into a speaker’s metalinguistic knowledge, conscious use of language, and competence. Tasks are often administered in the form of grammaticality judgements, where speakers provide judgements and intuitions about language structure. Crucially, offline techniques cannot tap into any form of processing, as the responses take place post-processing routines. In contrast, online techniques investigate processing and processing mechanisms, allowing researchers to answer questions related to speakers’ performance. Further, researchers can use behavioural, eye-tracking, electrophysiological, or neurological techniques. Behavioural tasks require participants to take explicit action when responding during a task – this is measured by reaction time (RT) button press data in tasks such as lexical decision (see section 1.4.1). Other online measures allow for the investigation of processing in real time. Some techniques provide good temporal data (e.g., eye-

tracking, electrophysiology), while others provide spatial information, highlighting where language processes occur (e.g., functional neuroimaging). This dissertation includes the use of behavioural and electrophysiological techniques. The following five sub-sections will provide a brief overview of each technique used.

1.4.1 Lexical decision

Visual lexical decision (LD) tasks consist of participants reading a string of letters on a screen and responding via a button press as to whether it is a real word in the language of interest. RT and response accuracy are measured. LD tasks can consist of a masked priming paradigm (Foster & Davis, 1984), where a prime stimulus is presented for a short time (e.g., 52 ms) prior to the target word. The prime can be masked, by the presence of symbols (e.g., #######) before (forward mask; Figure 1.1), after (backward mask), or before and after (sandwich mask; Royle et al, 2012; 2019) the presentation of the prime. The idea is that the masked prime can unconsciously influence participants' responses to target items when it is related or unrelated. The target appears until participants provide a response or the screen times out after a pre-determined amount of time.

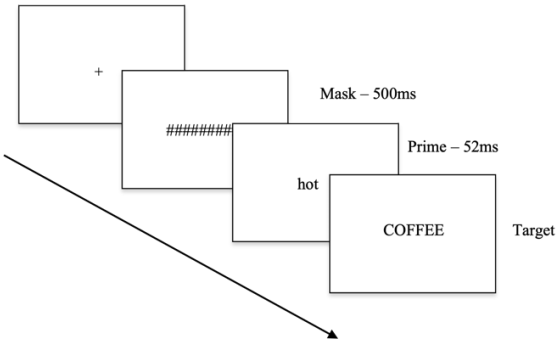

Figure 1.1. Example of a masked priming lexical decision paradigm with a semantically associated prime and target.
The line indicates the direction of the trial. The trial begins with a fixation cross and ends with the presentation of the target.

The use of this task allows researchers to explore lexical representation, access, and storage. Included in the task alongside real-word targets are pseudowords of the language being tested, which are fake words following the phonotactics of the target language. Pseudowords are often used as filler items in lexical decision tasks to ensure that participants are paying attention during the task. This task has been used to look at concepts such as semantic activation (Taikh & Lupker, 2020), the influence of cognate and homophone primes (Lim & Christianson, 2023), and the integration of the bilingual mental lexicon (Sabourin et al., 2014). In the current dissertation, this LD task will be used to investigate whether French speakers use grammatical gender cues from determiners to facilitate access to an upcoming noun.

1.4.2 Self-paced reading

In self-paced reading (SPR) tasks, participants read sentences in chunks – either by word or by phrase. The name of the task stems from the fact that the speed at which participants read the provided sentences is self-paced and their RT for each element is recorded. The primary thought behind SPR is that the amount of time that it takes to read a sentence or an element in a sentence is reflective of processing ease or difficulty. Sentences can be presented in a cumulative or noncumulative manner (Jegerski, 2014). Cumulative presentation is when segments are presented as participants click through a sentence and the read segments remain on the screen. A noncumulative display shows one element at a time while the others are not visible – each segment disappears as participants make their way through the sentence. Noncumulative presentations can be linear or centered. In a linear display, segments that have already been read and those that have not yet been seen are often masked by a non-language-related symbol, such as dashes (----). When

sentences are centered, each word or phrase will appear in the middle of the screen (Figure 1.2). Centered word-by-word presentation is used in this dissertation.

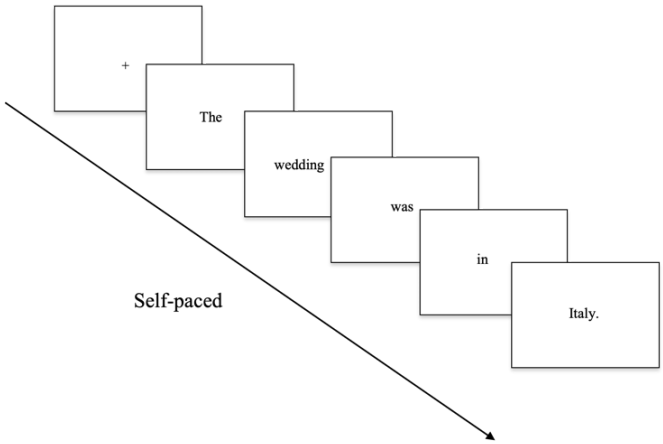

Figure 1.2. Example of a centered word-by-word SPR paradigm.
The line indicates the direction of the trial. The trial begins with a fixation cross and ends with the presentation of the final word.

SPR has been used in L1 and L2 research to investigate various linguistic phenomena, such as number agreement (e.g., Foote, 2011), garden path ambiguities (e.g., Trueswell & Kim, 1998), and grammatical gender processing (e.g., Sagarra & Herschensohn, 2011). Thus, it is an ideal tool to explore grammatical gender processing at a syntactic level, as it can highlight when processing difficulty is encountered.

1.4.3 AX continuous performance task

The AX continuous performance task (AX-CPT) is a measure of cognitive control, which focuses on participants' ability to suppress irrelevant information. More specifically, it is a measure of proactive and reactive control (Cohen et al., 1999; Paxton et al., 2008). Proactive control requires participants to hold onto relevant information prior to a cognitively demanding event to use it at a later stage. Thus, proactive control is referred to as an anticipatory control

strategy. Reactive control refers to resolving interference when it is encountered (Braver, 2012). Proactive and reactive control is required for optimal cognitive performance (Wagner et al., 2023). During the distractor version of this task, participants are presented with a visual cue in red (either A or B) followed by three distractor letters in black (e.g., D, T, E), and finally a red probe (either X or Y). Each letter is presented one at a time for a pre-determined amount of time (Figure 1.3). Participants are required to respond *yes* to all cue-probe combinations that result in AX and *no* to any other combination. RT and accuracy to the probe are measured. The cue serves as the relevant information that speakers must maintain, and the distractors are the interference. In the current dissertation, the AX-CPT task is used to investigate the relationship between grammatical gender processing and inhibitory control.

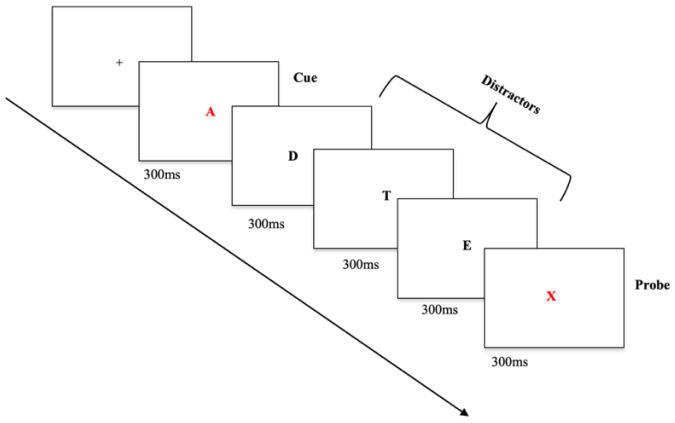

Figure 1.3. Example of the distractor version of the AX-CPT task.
The line indicates the direction of the trial. The trial begins with a fixation cross and ends with the presentation of the probe.

1.4.4 Verbal fluency

The verbal fluency (VF) task is a measure of lexical knowledge (Pekkala, 2012), and requires participants to name as many items as possible based on a given cue within a pre-determined amount of time. These cues can be phonological, individual letters, or a semantic category. Semantic categories are used in the current dissertation. In the semantic categorization version, participants will see the name of the category, such as animals, on a screen, and have 30 seconds to audibly name as many animals as they can think of. Participants are asked to refrain from repetitions. Typically, a minimum of four categories are tested. The total number of unique exemplars is calculated as their VF score. A speaker's level of VF has been shown to correlate with neural indices during grammatical gender processing (Beatty-Martínez et al., 2020), which was the motivation behind including this task in the current dissertation. It should be noted despite the implementation of the VF task, any results obtained were not used in the analysis due to experimental issues (see Chapter 4, Section 4.3 for further discussion).

1.4.5 EEG/ERP

The Event-Related brain Potential (ERP) technique can be used to see how the brain reacts to certain stimuli and conditions and can be used to investigate how language is processed in real time. This is an online measure that reflects implicit processing. To measure ERPs, the ongoing electroencephalograph (EEG) is recorded and then averaged to specific events. The EEG provides a continuous stream of data that allows us to look at processing as a stimulus is encountered, as opposed to solely the end result. While the EEG provides a large portion of surface brain activity that is occurring at a certain point in time, ERPs are associated with a response to a particular event. Certain components are sensitive to certain linguistic variables (Luck, 2014). For example,

one component associated with language processing, specifically the grammaticality of a sentence, is the P600, which is an increase in positivity to ungrammatical sentences that is maximal at 600 ms after the onset of the critical event. ERP waves appear in positive and negative components and are associated with the time at which the waves shift post-stimulus onset in reaction to a particular stimulus. Often the naming convention includes N (negative) or P (positive) followed by the timing that the effect is typically observed (e.g., 400ms). The ERP components of interest for the proposed study are the N400, P600, and the Left-Anterior Negativity (LAN).

N400

The N400 is thought to reflect the semantic integration of words into a particular context (e.g., Kutas & Hillyard, 1980). This component is a negative deflection in the brain waves that is maximal around 400 ms and ranges between 300-500 ms post-stimulus onset. It is slightly right lateralized and typically largest over central and parietal electrodes (Luck, 2014; Figure 1.4). The N400 effect can be found in isolated word contexts, as well as sentence contexts.

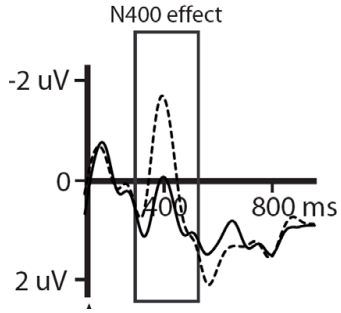

Figure 1.4. Example of an N400 effect (Nieuwland, 2006). The waveform illustrates neural responses to semantically expected and unexpected words. The solid line is in response to the noun *cake* in the sentence "He ate the *cake*". The dashed line is in response to the noun *cloud* in the sentence "He ate the *cloud*".

Interestingly, in sentence contexts, the N400 is seen for each word in a sentence, however, the effect is larger when semantic integration appears to be more difficult. Words that are less frequent or are relatively unexpected based on the context of the sentence show a larger peak, whereas words with higher frequency and/or a higher degree of predictability in the context of the sentence show smaller effects (Van Petten & Kutas, 1990).

P600

The P600 is typically found in sentence contexts and at a later stage in processing, with a positive peak around 600 ms post-stimulus onset (Luck, 2014; Figure 1.5). Due to its late occurrence, it is thought to reflect syntactic integration (Kaan et al., 2000), as well as sentence reanalysis (e.g., Steinhauer & Connolly, 2008). Typically, the effect is more pronounced around central and parietal electrode regions. It should be noted that the P600 time-window is not used for analysis in the current dissertation. However, it is important to understand this effect to interpret previous literature.

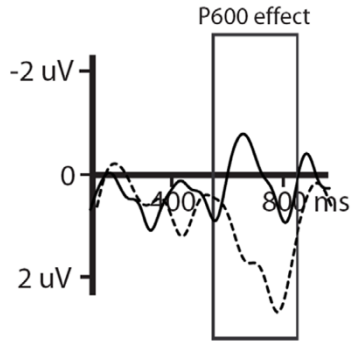

Figure 1.5. Example of a P600 effect (Nieuwland, 2006). The waveform illustrates neural responses to syntactic congruencies and incongruencies. The solid line is in response to the verb *laugh* in the sentence "He did not *laugh*". The dashed line is in response to the verb *laughed* in the sentence "He did not *laughed*".

LAN

Contrary to the P600, the LAN is thought to reflect more automatic processing of morphosyntactic violations. This negativity is typically more pronounced over left anterior electrode regions and similar to the N400, appears around 400 ms post-stimulus onset (Figure 1.6). Often, this effect is followed by the presence of a P600, which indicates the syntactic reanalysis stage of processing. It is important to note that the LAN is often only found in L1 speaker processing and tends to be absent in the L2 findings. The presence of the LAN has been questioned in grammatical gender research in relation to morphosyntactic processing, as it is not consistently found among L1 speakers, resulting in the reliability of the effect being challenged (e.g., Molinaro et al., 2015; Caffarra, Mendoza, & Davidson, 2019). However, it has been found across several studies in on grammatical gender, and alongside other effects, such as the P600 and the N400 (e.g., Caffarra et al., 2015; Popov et al., 2020).

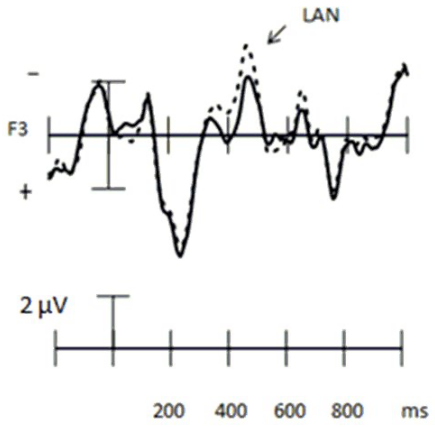

Figure 1.6. Example of a LAN effect (Meulman et al., 2015; figure adapted from Gunter et al., 2000). The waveform illustrates neural responses to gender agreement and disagreement. The solid line is in response to the noun *land* in the sentence: *Sie bereist das*$_{NEU}$ *Land*$_{NEU}$ *auf einem kräftigen Kamel,* 'She travels the land on a strong Camel'. The dashed lined is in response to the noun *land* in the sentence: **Sie bereist den*$_{M}$ *Land*$_{NEU}$ *auf einem kräftigen Kamel.*

Summary of components

In summary, the N400, the P600, and the LAN are ERP components that are typically associated with grammatical gender processing at the lexical and syntactic levels. The N400 reflects semantic integration at an earlier stage of processing, whereas the P600 occurs at a later point, reflecting syntactic integration and reanalysis. The LAN occurs in response to morphosyntactic violations and can occur prior to a P600 effect. A large focus of the proposed study is to investigate whether L1 and L2 French speakers use available grammatical gender cues during online processing. Using ERPs can provide insight into the processes occurring at a neurophysiological level.

1.5 Grammatical gender processing

1.5.1 L1 processing

Several studies have solely focused on native speakers' processing of grammatical gender, in particular how they utilize gender cues to facilitate processing. L1 speakers have the ability to use gender information that is available from a preceding determiner (i.e., *la*$_{F}$ in French, 'the') or adjective (*petite*$_{F}$ in French, 'small') to anticipate an upcoming noun (i.e., *maison*$_{F}$ in French 'house'). Evidence supporting these claims has been found across several languages, including French (Grosjean, et al., 1994), Italian (Bates et al., 1996), Spanish (e.g., Dussias, et al., 2013), and Dutch (Brouwer et al., 2017) in both children (Lew-Williams & Fernald, 2007; Melançon & Shi, 2015; Van Heughten & Christophe, 2015; Van Heughten & Shi, 2009) and adults. These findings have been consistently observed in real-time processing through the use of online measures, such as eye-tracking (e.g., Lew-Williams & Fernald, 2010) and ERPs (e.g., Foucart, & Frenck-Mestre, 2012). Many previous studies emphasize differences between congruent and

incongruent[2] determiner-noun in a DP or adjective-noun (ADJ-N) combinations embedded in syntactic context.

Eye-tracking

Seminal research on anticipatory processing and grammatical gender centers around spoken word recognition and the visual world paradigm (VWP). Dahan et al. (2000) studied whether L1 French speakers make use of grammatical gender cues anticipatorily during spoken word recognition. Speakers saw a visual scene with four images: the target (e.g., *bouton*$_{M}$, 'button'), the competitor (e.g., *bouteille*$_{F}$, 'bottle') and two unrelated distractors, one masculine and one feminine. The important distinction between images is that the target and distractor are of opposite genders, but consist of the same phonological onset, therefore, any effects observed should be due to the differentiation between genders. Participants would then hear a sentence instructing them to click on the target image (e.g., *cliquez sur le*$_{M}$ *bouton*$_{M}$, 'click on the button'), consisting of a congruent DP. Upon hearing the determiner in the sentence (e.g., *le*), participants were quicker to fixate on the image of the same gender (e.g., *bouton*). The researchers discuss the possibility that speakers are using grammatical gender cues that are marked on the article to restrict the possibilities of the upcoming noun. In other words, when they hear a masculine determiner, the realm of possible nouns is restricted to masculine to create a grammatical sentence. Another possibility that is discussed is that these findings are reflective of co-occurrence dependencies. In French (as well as other gendered languages), co-occurrence between determiner and noun is high, in that nouns almost always occur alongside a corresponding determiner; therefore, speakers may limit their possibilities to those that are statistically probable based on frequency of occurrence. In

[2] Congruent and incongruent are often used interchangeably in the literature with match/mismatch and agree/disagree.

other words, due to the high level of co-occurrence between congruent D-N combinations, speakers will likely know that the probability of a masculine noun following a masculine determiner is high.

Similar to the previous study, Lew-Williams and Fernald (2010) tested whether L1 Spanish speakers process grammatical gender information online using the VWP. Speakers saw two images on a screen that were either of the same gender (e.g., *la pelota*$_{F}$ and *la galleta*$_{F}$, 'ball' and 'cookie') or different genders (e.g., *la pelota*$_{F}$ and *el zapato*$_{F}$, 'ball' and 'shoe'). They would then hear a sentence such as *¿Dónde está/Encuentra la pelota*? ('Where is/Find the ball'). When the images were different genders, speakers were faster to identify the referent of the noun upon encountering the determiner. The results are thought to reflect the use of grammatical gender in real time processing – when gender cues are informative, they facilitate processing.

ERP research

The use of ERPs in grammatical gender research aims to explore the neural underpinnings associated with processing. Similar to studies that implement other online techniques, much of the previous research focuses on DPs and ADJ-N combinations in a greater syntactic context. ERP findings have been relatively consistent in that a LAN is observed to incongruencies, reflecting morphosyntactic violations, followed by a P600, displaying syntactic reanalysis (Barber & Carreiras, 2005; Caffarra et al., 2015; Popov et al., 2020). Seminal ERP research on grammatical gender agreement between D-N was conducted on Dutch speakers (Hagoort & Brown, 1999). Speakers read active sentences containing D-N agreement or disagreement. Half of the sentences were constructed of sentence initial agreement (*De*$_{COM}$ *kapotte paraplu*$_{COM}$ *staat in da garage* vs. **Het*$_{NEUT}$ *kapotte paraplu*$_{COM}$ *staat in da garage*, 'The broken umbrella is in the garage') and half

in sentence final position (*Cindy sliep slecht vanwege de*$_{COM}$ *griezelige droom*$_{COM}$ vs. **Cindy sliep canwege het*$_{NEUT}$ *griezielige droom*$_{COM}$, 'Cindy slept badly due to the scary dream'). A P600 was observed to incongruent conditions regardless of sentence position, however, when the incongruency was in sentence-final position an N400 preceded the P600. The researchers argue that the P600 is reflective of syntactic processing sensitivity to gender incongruencies, and the N400 is a product of syntactic wrap-up effects.

Grammatical gender agreement processing with ERPs has been an area of investigation among child speakers. Courteau et al. (2013) tested French-speaking children (ages 4-8) on a visual-auditory task. Participants saw an image on the screen (e.g., a brown shoe on a table) and were presented with auditory sentences with determiner gender agreement/disagreement (*Je vois un*$_{M}$ *soulier*$_{M}$ *brun*$_{M}$ *sur la table* vs. *Je vois *une*$_{F}$ *soulier*$_{M}$ *brun*$_{M}$ sur la table, 'I see a brown shoe on the table'). A statistical trend towards significance was found, with incongruent conditions eliciting a larger positivity than congruent conditions over left electrode regions in an early time-window (250-500 ms). Although the finding was not statistically significant, the trend is interpreted as an "immature" counterpart to a LAN that is typically found in adults and that agreement may be at an automatic processing stage.

Interestingly, sensitivity to gender incongruencies has been recognized with mixed modality testing. Wicha et al. (2003) tested native Spanish speakers as they listened to sentence pairs (e.g., Caperucita Roja cargaba la comida para su abuela en *una*$_{F}$ *... muy bonita. Pero el lobo llegó antes que ella*.', 'Red Riding Hood carried the food for her grandmother in a ... [very pretty]. But the wolf arrived before she did'). While listening, participants were visually presented with an image that depicted the noun in the sentence which agreed (*corona*$_{F}$, 'crown') or disagreed (*canasta*$_{M}$, 'basket') in gender with the article in the auditory sentence. An increased negativity with a

distribution and latency later than the classic N400 effect was observed to the image when there was an incongruency between D-N. Thus, speakers are sensitive to grammatical gender violations, even when the noun is implicitly presented, as they create predictions about syntactic elements during processing.

Emphasis in previous studies on grammatical gender processing has been related to noun transparency and the effect of overt cues provided by transparent nouns. Caffarra et al. (2015) embedded transparent and irregular Italian DPs into syntactic contexts. The gender of the determiner either agreed (*il*$_{M}$ *cucchiaio*$_{M}$, 'the spoon') or disagreed (*il*$_{F}$ *cucchiaio*$_{M}$) with the gender of the noun. Determiners included definite (*il*$_{M}$, "the") and indefinite (*un*$_{M}$, "a") articles, as well as prepositions (e.g., *nel*$_{M}$, 'in the'; *del*$_{M}$, 'of the'). Transparent nouns elicited a larger frontal negativity than irregular nouns in early time-windows (350-500 ms, 550-750 ms), followed by an increased positivity in the later time-window (750-950 ms). These results were interpreted as the gender system's sensitivity to reliable formal gender cues. Namely, transparent nouns provide overt grammatical gender cue information, which is regularly co-occurring, and this is realized during the early stages of processing. Incongruencies across all transparent and irregular nouns resulted in a biphasic LAN-P600 effect. Similarly, De Resende et al. (2018) tested Brazilian Portuguese speakers on DP congruencies and incongruencies with regular (*O paciente interrompeu o*$_{M}$ *tratamento*$_{M}$ *de saúde*, 'The patient interrupted the health treatment' vs. *As fotos revelaram *o*$_{M}$ *natureza*$_{F}$ *do caso*, 'The photos showed the nature of the case') and irregular (*Os trabalhadores receberam a*$_{F}$ *metade*$_{F}$ *das férias,* 'Workers received the half of the vacation (payment)' vs. *Os atletas controlaram *os*$_{M}$ *fontes*$_{F}$ *de energia,* 'The athletes controlled the sources of energy') noun forms in sentences. Both regular and irregular incongruencies elicited a biphasic LAN-P600, however, the P600 for regular forms was more positive than for irregular

forms. The latter finding was attributed to differences in the repair and reanalysis process due to structural differences between transparent/regular and non-transparent/irregular nouns.

Based on findings related to transparent gender systems, Popov et al. (2020) looked at grammatical[3] and semantic gender processing, emphasizing the difference in repair mechanisms when speakers encounter an incongruency. To highlight grammatical gender processing, they proposed a scheme of access and retrieval (Figure 1.7a), and a repair scheme when incongruences are met (Figure 1.7b). What the model of access and retrieval illustrates is that when DPs (here in the case of the masculine Italian transparent noun *il treno* – 'the train'), speakers will carry gender information obtained from the determiner forward and check it against gender information from the lemma (*tren*-) and phonological gender marker (-*o*). Accessing gender information from the lemma and the gender marker is thought to be done simultaneously. If the information between determiner-lemma-gender marker is congruent, the computation is successful. If there is a mismatch or incongruency (e.g., *[4]*la treno*), then reanalysis occurs. In this case, the speaker must backtrack to the determiner and repair it to the correct gender. The thought is the incongruency between determiner and noun will result in a LAN and the re-analysis will result in a P600. Participants read congruent and incongruent DPs (grammatical and semantic) embedded in sentences and what was found was that both grammatical and semantic gender violations elicited a LAN across left anterior and central regions, followed by a P600, however, the amplitude of the LAN was larger for grammatical gender incongruencies in particular. The researchers attribute the grammatical finding to the purely morphosyntactic nature of grammatical gender dependencies.

[3] Grammatical gender was referred to as syntactic gender in this article. As previously mentioned, these terms are often used interchangeably.
[4] "*" here refers to a mismatch between the gender of the determiner and the gender of the noun.

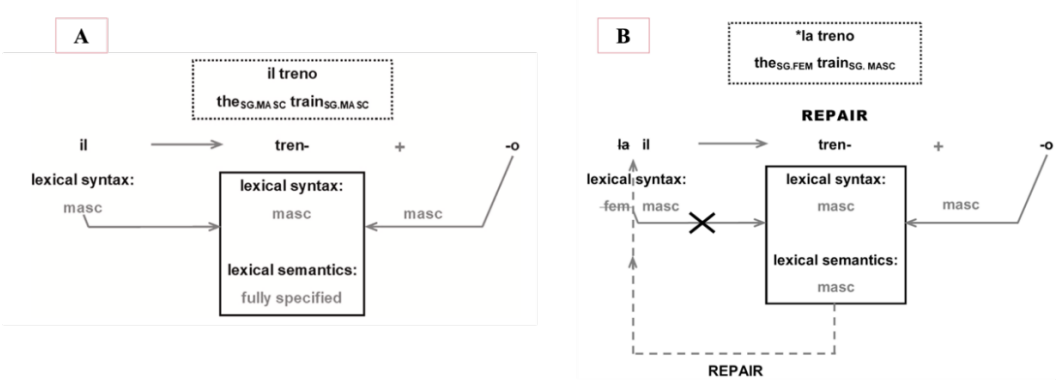

Figure 1.7. Schemes for grammatical gender processing (from Popov et al. (2020)). Figures 1 and 3 on pg. 2 and 5). A) the process of congruent gender checking. B) the repair process for incongruencies.

LAN effects to grammatical gender incongruencies have been found in word pairs outside of syntactic contexts. Barber and Carreiras (2005) observed a LAN to incongruent N-ADJ (e.g., **faro*$_{M}$-*alta*$_{F}$, 'lighthouse-high') combinations in Spanish, as well as an N400 to incongruent DPs (e.g., **la*$_{F}$ *piano*$_{M}$, 'the piano) across central and posterior electrode regions during an agreement judgement task. The presence of the N400 in the DPs is argued to be caused by the inherent representations of determiners and nouns. The researchers speculate that due to determiners (function words) and nouns (and other content words) belonging to distinct vocabulary classes, they may activate different neural networks. However, a follow-up study was conducted, where DPs were inserted into sentences (e.g., **La*$_{F}$ *piano*$_{M}$ *estaba viejo y desafinado*; 'the piano was old and off-key'), and a biphasic LAN-P600 effect was found, without the presence of an N400. The presence of a P600 in the sentence condition is thought to be due to the fact that when speakers encounter the same incongruencies embedded in a syntactic context, they can immediately render a sentence incorrect upon reading the incongruency, resulting in re-analysis.

In the same vein, Foucart and Frenck-Mestre (2012) investigated grammatical gender congruency/incongruency between ADJ-N in L1 French speakers. They found a P600 to both the noun in pre-posed ADJ-N (e.g., *De nos jours, les *anciens*$_{M}$ *montres*$_{F}$ *sont rares*, 'Nowadays old

watches are rare') and the adjective in post-posed ADJ-N (e.g., *Depuis une semaine, les *chaises*$_{F}$ *verts*$_{M}$ *sont dans le jardin*) grammatical gender incongruencies. Indicating that speakers access relevant gender information on the adjective or noun during processing and expect a congruent element to follow. Despite the robustness of previous findings, studies have not typically teased apart how separate genders (e.g., masculine vs. feminine) influence processing. Nor have studies explored how differences in default status and markedness between genders influence how grammatical gender is accessed, stored, and processed.

Gosselin & Sabourin (2021) tested habitual and non-habitual code-switchers on code-switched D-N combinations embedded in sentences between English and French, however, as a control, they included a unilingual French condition. Although the difference between masculine and feminine gender processing was not their primary point of investigation, they looked at the effect of gender congruency between the determiner and the noun collapsed across genders and disentangling each gender. For non-habitual code-switchers (speakers who tend not to switch between English and French regularly), a broadly distributed negativity was found for incongruent feminine (**le*$_{M}$ *maison*$_{F}$, "the house") conditions versus congruent feminine (*la*$_{F}$ *maison*$_{F}$) conditions. This finding is attributed to the markedness of the feminine gender. Due to marked items being more difficult to process, the effect is only observed for feminine nouns and not masculine. A study by Beatty-Martínez et al. (2020), took these general findings from native speakers a step further and investigated the differences between masculine and feminine gender cues in Spanish speakers using ERPs. Of particular interest were the distributional properties of masculine and feminine nouns in Spanish and their impact on processing. The study consisted of sentences across four conditions: congruent masculine (e.g., *La mujer compró* <u>*el*$_{M}$ *vestido*$_{M}$</u> *en la tienda*, 'The woman bought the dress at the store'), incongruent masculine (e.g., *La mujer compró*

**la*$_{F}$ *vestido*$_{M}$ *en la tienda*), congruent feminine (e.g., *La mujer compró la*$_{F}$ *cartera*$_{F}$ *en la tienda*, 'the woman bought the purse at the store'), and incongruent feminine (e.g., *La mujer compró * el*$_{M}$ *cartera*$_{F}$ *en la tienda*). An important point about the stimuli items is that only nouns with transparent endings were utilized. Meaning that all nouns ended with *-o* or *-a*, which are highly correlated with the gender of the noun. Findings were time-locked to the onset of the noun, which showed the presence of a P600 effect to incongruent feminine conditions (when a masculine determiner was paired with a feminine noun). This effect was also found to be correlated with higher lexical knowledge among participants, as measured by a verbal fluency task. Therefore, speakers with a higher verbal fluency score showed a larger P600. The researchers argue that because feminine nouns share more phonological similarities than masculine nouns (the category of masculine nouns consists of more irregular nouns, which do not possess the typical phonological suffix), they provide more consistent grammatical information. Thus, feminine violations, when a masculine determiner is followed by a feminine noun, evoke a more robust neurophysiological response. Therefore, the observed P600 reflects the representational strength of masculine and feminine gender categories and can be used as an indicator of noun gender classification. Conversely, a LAN effect – in conjunction with a P600 – was found to incongruent masculine conditions (when a feminine determiner was paired with a masculine noun). Taken together, these findings indicate that when a LAN was present – followed by a P600 – gender incongruency was interpreted as a morphosyntactic error. Whereas when only a P600 was observed, the incongruency was interpreted as a grammatical error. Hence, masculine and feminine genders do not seem to be processed in the same manner among native speakers.

1.5.2 L2 processing

Often, studies investigating L2 speakers have been conducted with late learners of the gendered language, specifically, learners who have acquired the language after childhood (e.g., Guillelmon & Grosjean, 2001; Lew-Williams & Fernald, 2010; Dussias et al., 2013; Hopp, 2013; Foucart et al., 2014). These studies provide mixed results as to whether grammatical gender cues are used anticipatorily in L2 processing. Dussias et al. (2013) studied highly proficient late L2 speakers of Spanish using an eye-tracking visual-world paradigm with a two-picture array. The study consisted of same-gender trials, where both images were masculine or both feminine (e.g., *pera*$_{F}$, 'pear' and *bufanda*$_{F}$, 'scarf') and different gender trials, where one image was masculine and the other was feminine (i.e., *reloj*$_{M}$, 'watch' and *bufanda*$_{F}$, 'scarf'). Participants heard a sentence including the target noun/image (i.e., *el estudiante estaba dibujando el*$_{M}$ *reloj*$_{M}$ *que vio ayer,* 'the student was drawing the clock that he saw yesterday') and eye gaze to the target was measured. The researchers found that participants were quicker to fixate on the target image in the different gender trials, as they used available gender cues from the preceding determiner to anticipate the upcoming noun. This is shown by a change point estimate, it was 375 ms for feminine nouns and 366 ms for masculine nouns in different gender trials. Same-gender trials had a change point estimate of 466 ms for feminine nouns and 532 ms for masculine nouns. Importantly, the later change point estimate for same-gender trials indicates that speakers considered both images as viable options for longer, as both images corresponded with the information provided by the determiner. Taken together, the results show that highly proficient late L2 speakers only exploit gender cues when they are informative.

In another study, Guillelmon and Grosjean (2001) studied highly proficient late L2 speakers of French (speakers began learning French in school and regularly using it as adults) using a

repetition task. Participants listened to either congruent (i.e., *le*$_{M}$ *joli*$_{M}$ *bateau*$_{M}$, 'the pretty boat'), incongruent (i.e., **la*$_{F}$ *joli(e)*$_{F}$ *bateau*$_{M}$, 'the pretty boat', note that in this example, the feminine version of the adjective is homophonous with its masculine counterpart), or neutral sentences (i.e., *leur*$_{neutral}$ *joli*$_{neutral}$ *bateau*$_{M}$, 'their pretty boat'). Participants were asked to repeat the word following the adjective as quickly as possible. Late L2 speakers had similar reaction times for incongruent, congruent, and neutral trials, whereas monolingual speakers showed a congruency effect in that they were quicker on correct trials vs. neutral trials and slower on incongruent vs. neutral trials. Therefore, the researchers argue that late L2 speakers did not use masculine or feminine cues provided by the preceding determiner during processing. Although few studies have directly investigated early L2 speakers, Guillelmon and Grosjean (2001) show that they use gender cues to the same extent as native speakers. In their study, they included a group of early L2 French speakers, who used both their L1 and L2 frequently during childhood, as well as a group of French monolingual speakers. Following the same procedure, both groups of speakers were quicker to name the noun in the congruent condition than the incongruent and neutral conditions. Illustrating that they used the provided gender cues to anticipate a matching upcoming noun. The only difference between the early L2 and monolingual groups was that the monolingual speakers appeared to be slightly more sensitive to congruency effects.

Fowler & Jackson (2017) studied L1 English - late L2 German speakers who were exposed to German between the ages of 11-21 and varied in proficiency. The researchers explored whether semantic and/or morphosyntactic information in a prime sentence is used to anticipate an upcoming image. Participants saw two prime images on a screen (the target image and a foil) that either matched or mismatched in grammatical gender. Under each image was a sentence in German with information pertaining to what the image was depicting. Each sentence consisted of the name

of the object in the image, as well as a gendered determiner (e.g., *ein*[5]$_{M}$ *Tisch*$_{M}$, 'a table') *or* a determiner and adjective carrying gender information (e.g., *ein*$_{M}$ *roter*$_{M}$ *Tisch*$_{M}$, 'a red table'). Participants then read another sentence one word at a time and were presented with the target image, where they had to audibly name the object. The results show that L2 speakers were able to use grammatical gender cues in a predictive manner when presented with the most amount of gender information possible (determiner and adjective), thus concluding that speakers require multiple gender cues.

Despite the robustness of findings from the aforementioned studies, the focus has been primarily placed on whether grammatical gender cues are used as a whole. In other words, grammatical gender categories are collapsed in studies conducted with L2 speakers. Therefore, the proposed studies attempt to tease apart genders and examine whether there are any differences between these cues.

1.6 Inhibition and language processing

In everyday life humans implement the use of top-down controlled processes to help regulate behaviours – these are referred to as executive functions (EF; Diamond, 2013). There are three primary EFs: working memory, cognitive flexibility, and inhibitory and interference control. The bridge between language and cognition is increasingly studied. For instance, previous studies focus on bilingual cognitive control (Morales et al., 2013; Morales et al., 2015) regarding language entropy (Gullifer & Titone, 2021), and proficiency (Bonfieni et al., 2019), and the effect of working memory capacity on language learning (Linck & Weiss, 2015; Rivera et al., 2023). Inhibition and interference suppression are of particular interest for the current dissertation.

[5] Note that *ein* is used with masculine and neuter nouns for nominative and accusative case in German. However, in this study, the determiner was used as a masculine determiner, and it was found that it was used predictively during processing. The researchers discuss this in more detail in the discussion section of the article.

Inhibition requires us to control or "inhibit" our impulses, attention, behaviour, thoughts, emotions, etc. In relation to language processing, speakers can use inhibition to control linguistic competition (Ibbotson & Kearvell-White, 2015) or ungrammatical encounters. Often this relationship is tested with linguistic tasks such as the Stroop task, and non-linguistic tasks such as Flanker and the AX-CPT. For example, research shows that L2 speakers immersed in the environment of their L2 (vs. their L1) perform better on an AX-CPT task, showing a greater use of proactive control (Zhang et al., 2021).

Concerning grammatical gender processing specifically, speakers who are better at inhibiting unrelated or incorrect information in non-linguistic related domains may be more likely to show quicker recovery when presented with grammatical gender incongruencies. This was seen in the finding that the LAN to masculine nouns found by Beatty-Martínez et al. (2020; discussed above) was correlated with participants' performance on an AX-CPT task for L1 speakers. The researchers argue that when there are greater expectations for an upcoming noun, higher inhibitory control mediates any observable response. In this case, speakers were expecting a feminine noun to follow the feminine determiner, but when a masculine noun was presented, speakers with greater inhibitory control did not show a LAN. These speakers were able to mediate the conflict between what they were expecting and the incongruency that was encountered. Although this is an interesting finding, further investigation regarding inhibition and grammatical processing is required to evaluate whether the relationship spans different languages and whether it plays a role in L2 acquisition.

1.7 Manner of Acquisition and Age of Immersion

MoA and AoI are crucial factors to take into consideration when teasing apart language groups. The two factors go hand-in-hand, in the sense that the age at which they are immersed in

the language can influence how a speaker learns a language. Further, an earlier AoI can lead to a more naturalistic MoA, as learning a language as a child can be intrinsically more natural. It has been said that speakers who begin to learn a language at a young age are more likely to attain native-like abilities (Birdsong, 1992). This observation leads to the importance of including the age at which a speaker is immersed in their language when investigating language processing, as it focuses on when the language was initially encountered. Previously, age of acquisition (AoA) has been referred to as the age of onset of a language, the age of first exposure, or the age at which a speaker is significantly immersed in an environment where the primary language is the one being learned. For the purposes of this dissertation, AoI will represent the age of immersion in the language environment. An earlier AoI or AoA has been seen to influence the organization of the bilingual mental lexicon, as well as the child's ability to learn a second language at a young age (Meisel, 2018). Therefore, it is crucial to separate language groups accordingly.

MoA can be defined as *naturalistic* or *instructional* (Sabourin, Leclerc, Burkholder, & Brien, 2014). A *naturalistic* MoA has been referred to as speakers who either learn a language with minimal explicit teaching of the language (Crezee, 2012) or those who receive a significant amount of language input from both passive learning and explicit teaching (Ellis, 1994). On the other hand, an *instructional* environment is one where speakers primarily learn a language by means of being explicitly taught. For this dissertation, these types of environments will be referred to as *naturalistic* and *formalistic*, where *formalistic* refers to a more formal or instructional language learning environment.

Although understudied, the effects of MoA have been found for L2 speakers of both English and French. A series of studies from Sabourin et al. (Sabourin, Brien, & Burkholder, 2014; Sabourin, Leclerc, Burkholder, & Brien, 2014; Sabourin et al., 2016) investigated the integration

of the bilingual mental lexicon using a masked priming lexical decision task with translation primes from English to French (e.g., prime = fox, target = *RENARD* 'fox') or French to English (e.g., prime = *renard*, target = FOX). The researchers tested early and late (L1 English-L2 French and L1 French-L2 English) bilinguals. The L2 French speakers were grouped based on their completion of a French Immersion school program, with early speakers beginning before the age of 6 and late speakers beginning after the age of 6. These programs are thought to be more *formalistic*, as the language of instruction is French. On the other hand, the late L2 English (with L1 French) speakers were *naturalistically* immersed in the language between 7-16 years old, as they were in an environment where the majority language was English, therefore they were not explicitly taught the language. Interestingly, the results suggested that only the early L2 French group and the late L2 English group patterned similarly in displaying translation priming effects. The researchers conclude that that these two groups demonstrate priming effects due to their MoA, whereas the early L2 French group exhibited a *naturalistic* learning environment, where they were not explicitly taught the language (Sabourin, Sabourin, Leclerc, Burkholder, & Brien,2014; Sabourin et al., 2016). Although the early L2 French group completed a French language program, early versus late school programs may be intrinsically more natural, as children are relying less on their established L1 to learn the L2. Therefore, it may be the case that these types of language programs appear to be represented as a spectrum from *naturalistic* to *formalistic*. Early programs may fall closer to the middle of this spectrum, as they technically occur in a formal language learning environment, but due to the early AoI, they appear to be learning their L2 in a *naturalistic* manner.

Incidentally, based on these findings, a speaker's MoA and AoI/AoA are not only relevant to their language background but can in turn influence their language processing. These findings

are particularly relevant for the current study, as there is a strong focus on how differing MoAs and AoIs influence the grammatical gender processing in the L2.

1.7.1 French language programs

Within Canada, particularly Ontario, there exists a wide range of school-implemented programs for students to learn French as an L2 beginning in elementary school. As French is one of the two official languages of Canada, it is mandatory for students attending school in the English Public School Board to complete a certain amount of French language learning by the time they have graduated from high school[6]. According to *Ontario Schools Policy and Guideline Requirements* (2016), this is implemented in an effort to create a bilingual environment throughout the country. Each program aims to have students reach different levels of French language abilities. Contrarily, French-Public School Boards consist of schools that are taught primarily in French with minimal English requirements. Although several second language French programs (FLS) are offered across the country, only a subset of those are available in Ontario. The programs of interest for the current study offered via the English School Boards include Core French (CF) and French Immersion (FI). Each program differs depending on the amount of French instruction received and the age at which student begins learning French[7]. Additional programs are offered elsewhere across the country, such as Extended French and Intensive French (Lazaruk, 2007). The following subsections outline the various French language programs of interest for the current

[6] Apart from students who choose to study an Aboriginal language. These students are then exempt from minimum required French courses (*Framework for French as a Second Language in Ontario Schools,* 2013).
[7] Keep in mind that this is a baseline of general information that schools are required to follow for the French programs discussed in Ontario. Anything above and beyond the minimum is up to the discretion of different school boards and individual schools.

dissertation. It is important to note that more precise information regarding French language exposure in school was collected during testing and may vary from the baseline information below.

Core French[8]

The sole mandatory FLS program within the English Public School Board in Ontario is CF. CF is designed for students to obtain a basic level of French proficiency, purely through French language classes. Teaching primarily focuses on French grammar, word learning, and communicative skills (*Framework for French as a Second Language in Ontario Schools,* 2013[9]). All students from grades 4-8 complete, on average, 20-40 minutes of French language learning per day. Additionally, once students begin high school, it is mandatory to complete 1 CF course in grade 9 to fulfill their Ontario Secondary School Diploma requirements. Due to the minimal amount of French requirement, these students are not fully immersed in the French language, contrary to FI programs.

French Immersion

Parents are given the choice to enroll their children in FI programs, where they will be provided with further French instruction. FI is aimed to extend beyond the fundamentals of the French language learned in CF. Therefore, in addition to French language classes, students are taught various other subjects in French (e.g., math, social studies, history, geography), resulting in French as the primary language of instruction throughout the day (Turnball, Lapkin, & Hart, 1998). Individual school boards in Ontario have the flexibility to decide in which grades they would like

[8] Information on Core French programs is included here for contextual purposes, however, participants who completed this type of language program are not included in the current dissertation.
[9] The Framework for French as a Second Language is re-evaluated every 10 years, thus the information provided here may differ from changes that are in the process of being implemented.

FI to begin, as well as which courses will be offered in French, resulting in Early French Immersion (EFI) and Late French Immersion (LFI)[10] (as seen in Table 1.1). EFI typically begins in kindergarten or grade 1, with all subjects (apart from English) taught in French up until the point of grade 3 or 4. Regardless of the onset of FI, all students are expected to receive the same amount of French instruction by the end of elementary school. According to the *Framework for French as a Second Language in Ontario Schools* (2013), by the end of elementary school (grade 8), all FI students must have completed a minimum of 3800 hours of school time in French. Additionally, at least 50% of all school instruction must be in French, although individual schools have the choice to exceed this minimum.

Table 1.1. *French Immersion program requirements.*

Level of Schooling	French Program	Start Age (years)	Minimum Amount of French Instruction
Elementary	Early French Immersion	3/4	3800 hours
	Late French Immersion	11/12	
Secondary	Students from EFI and LFI	N/A	- 4 French language courses - 6 additional courses taught in French

Regardless of the age of onset FI in elementary school, students in secondary school are required to complete the same number of compulsory courses. These are comprised of 10 courses, 4 focusing on the French language and 6 additional courses taught in French. Similar to classes taught in French in elementary school, Ontario School Boards have the opportunity to establish which courses are taught in French (e.g., math, science, history, etc.).

[10] Information on Late French Immersion is included here for contextual purposes, however, participants who completed this type of language program are not included in the current dissertation.

Full French Schools

Contrary to FLS programs in English School Boards, French School Boards in Ontario are comprised of schools that operate in the opposite manner. These schools are taught completely in French, with the exception of English language courses, which begin in grade 4. According to *Ontario's Aménagement Linguistique Policy for French-Language Education* (2005), French schools are intended to promote and reinforce bilingualism, as well as enhance student's connection with their Franco-Ontarian communities, aiding in the development of their cultural French identity. Often students enrolled in French schools are native speakers of the language, but occasionally, L2 students attend and complete their school within an environment with a primary focus on French.

CHAPTER 2

STUDY 1: USE OF GENDER CUES

As discussed in Chapter 1, studies traditionally emphasize congruent versus incongruent gender conditions, without considering how any variation in gender may result in distinct findings. Current studies on L2 gender processing studies seem to show conflicting results as to whether these speakers can facilitatively use gender cues (e.g., Guillelmon & Grosjean, 2001; Hopp, 2013; Lew-Williams & Fernald, 2010). Moreover, MoA in natural language processing has not been directly included as a factor that can influence processing. For these reasons, this chapter focuses not only on whether grammatical gender cues are used to facilitate access during processing by L1 and L2 speakers but also to tease apart cues provided by each gender. More specifically, the following questions are investigated: (1) Do L1 French speakers utilize grammatical gender cues anticipatorily during online processing to facilitate processing? (2) Are masculine and feminine cues used in the same way and to the same degree during processing, or are there any differences? (3) Do L2 speakers use grammatical gender cues in a similar manner to that of native speakers? (4) Is how L2 speakers use (or do not use) cues related to the environment they learned and acquired their language?

It is anticipated that L1 speakers will show the use of gender cues during processing, as this has been shown across various gendered languages for L1 speakers in previous research (e.g., Dahan et al., 2000; Dussias et al., 2013). More specifically, when the gender of a preceding determiner is congruent with the following noun, participants will respond quicker than with incongruent combinations. However, it is not expected that the degree of use for these cues will be the same across genders. It is expected that feminine gender cues will be used to a higher degree

than masculine cues. In other words, speakers are anticipated to respond quicker when a feminine noun is preceded by a feminine determiner than any other condition.

Due to the default masculine notion that is present in French, the masculine determiner, which provides grammatical gender information, can be used with a much wider range of nouns. When there is a large inventory of nouns to choose from, it may take speakers longer to access the relevant word. Whereas, in the case of feminine cues, the determiner is strongly associated with feminine nouns, as it is quite rare for L1 speakers to allow incongruent combinations of feminine determiners and masculine nouns. Therefore, the range of nouns available for access when speakers encounter a feminine determiner is much smaller, which may result in a stronger use of this cue. Figure 2.1 illustrates the scope of all nouns that masculine and feminine gender cues from gendered determiners (e.g., le, la, un, une) theoretically cover. Additionally, there is overlap in the feminine nouns that can be accessed with both masculine and feminine determiners, creating a situation where a larger number of nouns are more easily accessible when presented following a masculine determiner.

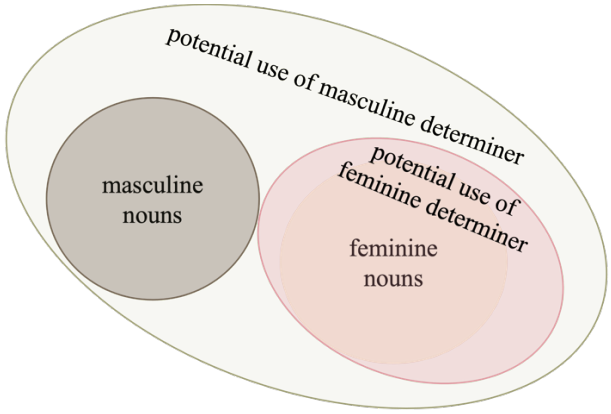

Figure 2.1. Allowable use of gendered determiners with nouns. As masculine is argued to be the default gender in French, masculine determiners (le, un) are theoretically allowed to be used in conjunction with feminine nouns. However, feminine determiners (la, une) can only be used with feminine nouns. Note that this scheme does not take semantic gender into account and is only representative of inanimate nouns and their associated grammatical gender, as well as definite articles.

It is hypothesized that L2 speakers will use grammatical gender cues during processing, but to different degrees depending on their MoA. Speakers who learned their L2 in a full French (FF) school (see Chapter 1 (Section 1.7) for a breakdown of the relevant French language school programs in Canada) are expected to pattern the same as L1 speakers, in that they will use gender cues from both masculine and feminine cues, but they will show stronger use of the feminine cue. Thus, they are expected to respond to both masculine and feminine congruent gender conditions quicker than a control pseudo condition, with the feminine condition resulting in the fastest RTs. These results are expected because the environment in which FF speakers acquired their language lands closer to the naturalistic end of the MoA spectrum (as discussed in Chapter 1, Section 1.7). On the contrary, EFI speakers are hypothesized to only use feminine gender cues facilitatively, resulting in faster RTs in the congruent feminine condition. EFI speakers land on the more formal end of the MoA spectrum, meaning that they did not receive as much natural and informal language exposure as FF and L1 speakers. Formal language instruction can place emphasis on specific grammatical constructions, such as grammatical gender, resulting in higher conscious awareness of noun genders. As masculine is argued to be the default gender in French and feminine the marked gender, there may be a strong emphasis on feminine nouns in particular in educational contexts to ensure that learners are aware of which nouns are feminine.

The remainder of this chapter includes two experiments. Section 2.1 discusses Experiment 1, where grammatical gender cues are individually explored in a masked priming paradigm. Experiment 1 served as a pilot study for Experiment 2 (section 2.2). The second experiment considers methodological issues that arose during the administration and data analysis of the pilot study. A general conclusion is presented in section 2.3.

2.1 Experiment 1: Facilitation from gender cues

2.1.1 Participants

16 L1 French speakers (*Mage* = 18.6) and 16 L2 speakers (*Mage* = 19.1) were included in the analysis of this study. An additional 2 L1 participants were excluded due to speaking an L1 other than French (i.e., Somali). All participants were recruited through the University of Ottawa Psychology participant pool for partial class credit. Participants had no visual impairments or history of speech and language disorders. Caution was taken to ensure that participants had little or no previous knowledge (e.g., very low proficiency) of another gendered language.

The L2 group was further sorted into one of two groups depending on their completion of a French language program during their elementary school years (Table 2.1). If the participant was a native English speaker and attended a full French language school beginning in kindergarten or grade 1 ($n = 6$), they were placed in the *Full French* (FF) group. Those in the *Early French Immersion* (EFI) group completed a French Immersion program offered in a primarily English school beginning in kindergarten or grade 1 ($n = 10$). The MoA of the L2 groups is represented on a spectrum from *naturalistic* to *formalistic.* Those who attended a completely FF school are considered to have been immersed in an environment reflecting *naturalistic* learning, as the majority of their day was completed in French. EFI participants were immersed in an environment between *naturalistic* and *formalistic*, with approximately half of their school day completed in French. This percentage of time is based on the average amount of time per day participants reported spending in French during their early school years. L1 French speakers were classified as acquiring their language in a completely naturalistic manner, as they did not attend any form of formal schooling to learn the language.

Table 2.1. *Breakdown of participant information*

Language Group	School Program	N	Manner of Acquisition	Average Age of Immersion in French	Approx. percentage of French per school day	Average cloze score
L1 French	-	16	Naturalistic	0	-	-
L1 English–L2 French	All French Schooling	6	↓	4.2 years	95	27.5
	Early French Immersion	10	Formalistic	4.7 years	50	25.5

All L2 participants completed a French fill-in-the-blank cloze task, a measure of reading and comprehension proficiency (Tremblay, 2011 – see Appendix A). The task involves reading a story and completing it with any word that is considered the best fit. All speakers were classified as high/very highly proficient, meaning that they correctly completed a minimum of 21 out of 40 responses.

2.1.2 Stimuli and design

Stimuli consisted of one hundred and twenty French nouns (60 feminine) and an equal amount of French pseudowords. French pseudowords are non-words that follow French phonotactics and are therefore highly similar to real French nouns. There were no English-French cognates or vowel initial words included to account for elision in French, which reduces the vowel in a determiner that preceded a vowel initial noun. Noun frequency for each real word item was obtained from Lexique3, a lexical database consisting of 140,000 French words (New et al., 2001). Specifically, this database provides information that is pulled from various corpora and reports on different levels of lexical information such as the frequency of occurrence of words, phonological representations, and syllable count. Although there was variation in frequency across all nouns,

there was no difference in frequency between masculine and feminine nouns (p=.79). Three L1 French speakers and three L2 French speakers verified that the nouns used were high-frequency and should be familiar to L2 participants.

Each noun and pseudoword was then paired with a prime. Primes consisted of the masculine definite determiner (*le*), the feminine definite determiner (*la*), and a pseudoprime (*lu*). Three experimental lists were created, and the prime-target pairing varied across lists; therefore, the French noun was not always paired with its correct determiner. For instance, in one list, the masculine word BATEAU ("boat") was paired with the masculine prime *le*, creating a congruent condition. Whereas in another list, BATEAU was paired with the feminine prime *la* (incongruent condition) or the pseudoprime *lu* (pseudo-prime condition). Table 2.2 illustrates the various conditions and the number of trials that each participant completed per condition. There were six experimental conditions: congruent masculine, incongruent masculine, congruent feminine, incongruent feminine, pseudo masculine, pseudo feminine. French pseudo words were paired with masculine, feminine, and pseudo determiners.

Table 2.2. *Breakdown of conditions*

Condition	Prime	Prime gender	Target (example)	Target gender	Number of trials
Congruent masculine	le	Masculine	bateau ("boat")	Masculine	20
Incongruent masculine	la	Feminine	bateau ("boat")	Masculine	20
Pseudo masculine	lu	N/A	bateau ("boat")	Masculine	20
Congruent feminine	la	Feminine	bouche ("mouth")	Feminine	20
Incongruent feminine	le	Feminine	bouche ("mouth")	Feminine	20
Pseudo feminine	lu	N/A	bouche ("mouth")	Feminine	20
Masculine pseudoword	le	Masculine	plave	N/A	40
Feminine pseudoword	la	Feminine	plave	N/A	40
Pseudo pseudoword	lu	N/A	plave	N/A	40

Participants were randomly assigned to one of three lists and saw each target noun and pseudoword once. Within each list, there were four blocks of 60 words. An additional four French nouns were included at the beginning of each block as opening stimuli items and were later filtered out, and there were six practice items (four French nouns and two pseudowords) used for training purposes. A complete list of stimuli items and their frequency can be found in Appendix B.

2.1.3 Procedure

Participants first completed the consent form and Language Background Questionnaire (LBQ; Sabourin et al., 2016 – see Appendix C). Participants were then seated in a sound-attenuated room and completed a lexical decision task using a forward masking paradigm (adapted from Forster & Davis, 1984; Sabourin et al., 2014; Wang & Forster, 2010) administered on Presentation (Neurobehavioral Systems, version 17). Words were presented in black on a white background. Instructions for the task were presented on the screen in French. The prime was presented between the forward mask (##########) and the target word. The forward mask was presented for 500 ms, followed by the prime (*le, la* or *lu*) for 52 ms, followed by the target word for 500 ms in uppercase letters (Figure 2.2). After the presentation of each target word, participants were asked to respond to whether the word presented in uppercase letters was a real word in French or not as quickly and accurately as possible. Participants were given 1720 ms to make their lexical decision. Once a response was provided or the screen timed out and there was a 100 ms blank screen prior to the beginning of the next trial. Responses were made on a computer keyboard using the "Z" and "/" buttons as fixed responses.

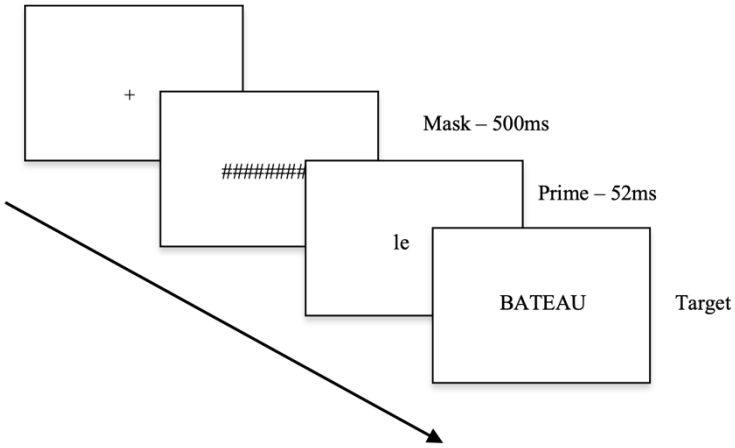

Figure 2.2. Sequence of the lexical decision task procedure.

Participants were provided with the opportunity for a self-paced break after each block. Before the lexical decision task, participants completed 6 practice trials where the experimenter remained in the testing room to answer questions or address any concerns. Following the lexical decision task, L2 participants completed the French cloze task. Overall, the study took approximately 45 to 60 minutes to complete.

2.1.4 Statistical design

Prior to statistical analysis, the data was cleaned to remove outliers. Participants below a 70% accuracy threshold based on previous studies that used a similar procedure and design (see Sabourin et al., 2014) were excluded from the analysis (n = 1 L1 participant). Trials with reaction times (RT) below 300 ms and above 1200 ms were excluded. Standard deviations (SD) for each participant were calculated and RTs above or below 2.5 the SD were excluded, which resulted in approximately 0.06% of the data being excluded.

Linear Mixed Models (LMM) were conducted in R (R Core Team, 2022) using the lme4 package (Bates et al., 2015). The first model included Noun gender (masculine or feminine),

Congruency (congruent, incongruent, pseudo determiner), and Group (L1, L2) as fixed effects, and participant and item were included as random effects. Fixed effects were deviation coded (i.e., sum-to-zero contrasts). The continuous dependent variable was the mean RT to each word. If there was a significant main effect or interaction including congruency and/or noun gender with language group, planned pairwise comparisons (confidence level (CI) = 0.95) were conducted by examining estimated marginal means with the emmeans package in R (Lenth, 2022). Only significant interactions including the factor of congruency and/or noun gender are discussed in the results to investigate differences between conditions. To investigate if there is an influence of MoA a separate model was run with only L2 speakers. The model included Noun gender (masculine or feminine), Congruency (congruent, incongruent, pseudo determiner), and MoA (FF, EFI) as fixed effects, and participant and item were included as random effects. Fixed effects were deviation coded (i.e., sum-to-zero contrasts). The continuous dependent variable was the mean RT to each word. Due to the contrast coding scheme, the models include two contrasts for the fixed factor of Congruency. This contrast compares a factor level with the grand mean of all levels of that specific factor. Thus, contrast 1 for Congruency compares the level of congruent to the grand mean of Congruency, and contrast 2 compares the level of incongruent to the grand mean.

2.1.5 Results

Language group results

Table 2.3 includes a summary of the RT and SD data for each group and condition and the complete model output is presented in Table 2.4. Significant effects are bolded. Visual depictions of the congruency conditions are presented in Figures 2.3 (L1 speakers) and 2.4 (L2 speakers). Graphs for individual gender conditions can be found in Appendix D.

Table 2.3. *Lexical decision, experiment 1 RT and SD summary for each group and condition.*

Group	Condition	*Mean* RT (ms)	RT *SD*
L1	Congruent masculine	608.49	167.67
	Incongruent masculine	618.23	159.14
	Pseudo masculine	629.93	172.64
	Congruent feminine	616.90	168.84
	Incongruent feminine	617.57	156.42
	Pseudo feminine	622.69	167.37
L2	Congruent masculine	629.58	149.97
	Incongruent masculine	633.72	144.91
	Pseudo masculine	648.34	160.51
	Congruent feminine	634.71	145.67
	Incongruent feminine	646.64	155.88
	Pseudo feminine	643.83	153.68

Table 2.4. *Lexical decision experiment 1, model 1 output.*

Predictors	Estimates	95% CI	*t*-value	*p*-value
(Intercept)	631.5656	596.76 – 666.38	35.57	**<0.001**
Congruency [1]	-6.77	-12.41 – -1.14	-2.36	**0.02**
Congruency [2]	-0.68	-6.36 – 5.01	-0.23	0.82
Noun gender	0.47	-7.82 – 8.77	0.11	0.91
Group	10.00	-24.05 – 44.04	0.58	0.57
Congruency [1]*Noun gender	2.09	-3.54 – 7.72	0.73	0.47
Congruency [2]*Noun gender	1.78	-3.90 – 7.46	0.62	0.54
Congruency[1]*Group	-1.09	-6.73 – 4.54	-0.38	0.70
Congruency [2]*Group	0.93	-4.76 – 6.61	0.32	0.75
Noun gender*Group	1.25	-2.75 – 5.25	0.61	0.54
Congruency [1]*Noun gender *Group	-2.21	-7.85 – 3.43	-0.77	0.44
Congruency [2]*Noun gender *Group	1.97	-3.72 – 7.66	0.68	0.50

Marginal $R^2 = 0.006$, Conditional $R^2 = 0.432$

An effect of Congruency contrast 1 was found ($\beta = -6.77, t = 2.38, p = 0.02$). Pairwise comparisons highlight a significant difference between congruent and pseudo conditions, with congruent conditions yielding faster RTs ($\beta = -14.22, t = -2.86, p = 0.01$). Thus, speakers were performing faster on congruent DPs across language groups. Congruency did not interact with any other factor.

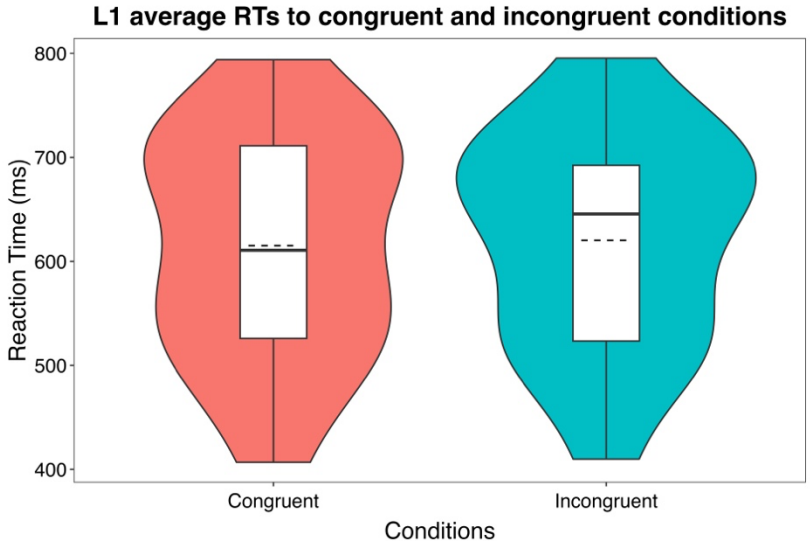

Figure 2.3. L1 speakers' average RT to congruent, incongruent, and pseudo conditions (collapsed across masculine and feminine nouns). Dotted line = mean, solid line = median.

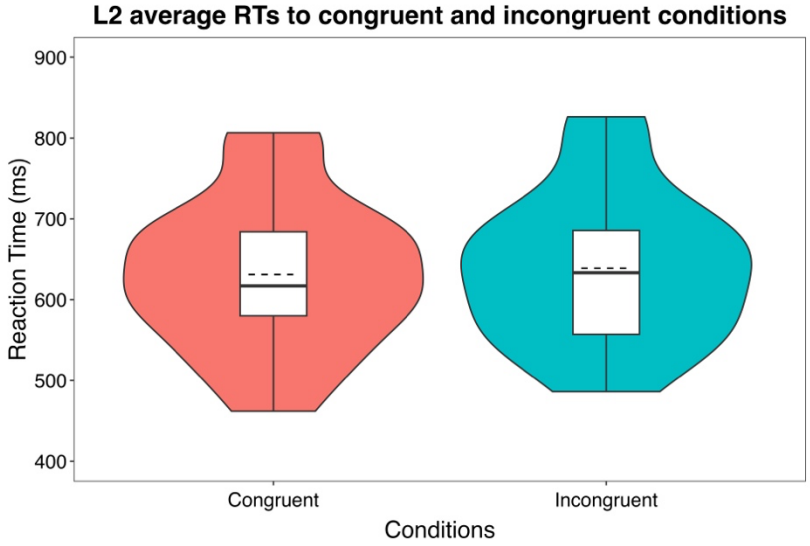

Figure 2.4. L2 speakers' average RT to congruent, incongruent, and pseudo conditions (collapsed across masculine and feminine nouns). Dotted line = mean, solid line = median.

Influence of MoA

Table 2.5 includes a summary of the RT and SD data for each group and condition and the complete model output is presented in Table 2.6. Visual depiction of congruency is presented in Figure 2.5. The graph for individual gender conditions can be found in Appendix D.

Table 2.5. *Lexical decision, experiment 1 RT and SD summary by MoA and condition.*

Group	Condition	*Mean* RT (ms)	RT *SD*
Full French School	Congruent masculine	622.47	133.28
	Incongruent masculine	625.56	130.92
	Pseudo masculine	642.36	131.77
	Congruent feminine	633.79	120.25
	Incongruent feminine	635.88	140.94
	Pseudo feminine	631.05	146.27
Early French Immersion	Congruent masculine	634.04	159.73
	Incongruent masculine	638.87	153.25
	Pseudo masculine	651.87	175.53
	Congruent feminine	635.28	159.86
	Incongruent feminine	653.56	164.81
	Pseudo feminine	651.72	157.97

Table 2.6. *Lexical decision experiment 1, model 2 output.*

Predictors	Estimates	95% CI	*t*-value	*p*-value
(Intercept)	639.75	591.36 – 688.15	25.93	**<0.001**
Congruency [1]	-7.00	-15.04 – 1.04	-1.71	0.09
Congruency [2]	-0.42	-8.55 – 7.72	-0.10	0.92
Noun gender	2.01	-7.34 – 11.35	0.42	0.67
MoA	-4.77	-52.59 – 43.06	-0.20	0.85
Congruency [1]*Noun gender	-0.24	-8.29 – 7.80	-0.06	0.95
Congruency [2]*Noun gender	3.66	-4.48 – 11.80	0.88	0.38
Congruency [1]*MoA	1.75	-6.60 – 10.09	0.41	0.68

Congruency [2]*MoA	-0.96	-9.39 – 7.47	-0.22	0.82
Noun gender *MoA	0.03	-5.64 – 5.69	0.01	0.99
Congruency [1]*Noun gender*MoA	0.80	-7.55 – 9.15	0.19	0.85
Congruency [2]*Noun gender*MoA	-1.05	-9.48 – 7.37	-0.25	0.81

Marginal R^2 = 0.011, Conditional R^2 = 0.249
Marginal R^2 = 0.003, Conditional R^2 = 0.434

No effects of Congruency, Noun gender, MoA or any interactions were observed. This indicates that none of the fixed factors influenced participants' RTs.

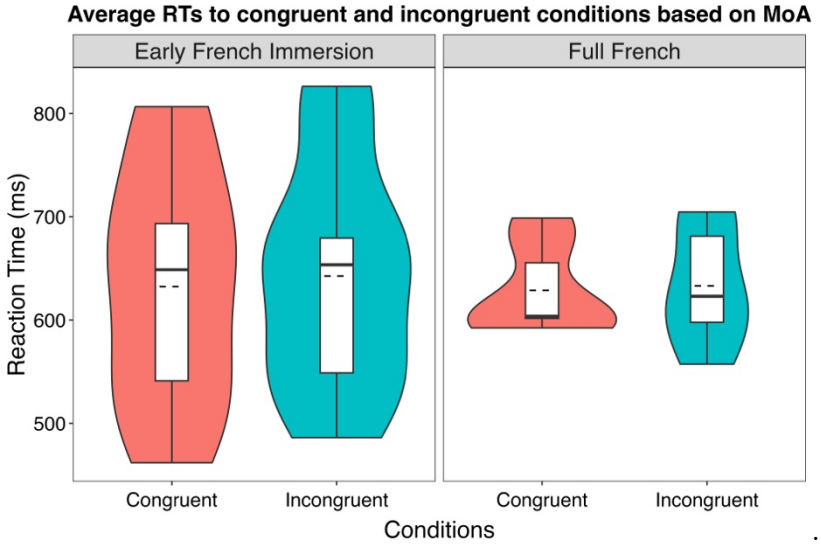

Figure 2.5. L2 speakers' average RT to congruent and incongruent conditions by MoA (FF, EFI). Dotted line = mean, solid line = median.

2.1.6 Discussion

The current study aimed to investigate whether L1 and L2 French speakers use grammatical gender cues during online processing to facilitate processing if there are differences in the strength and use of masculine and feminine gender cues. Of interest was also whether the language learning environment influences cue use. Overall, the results indicate that L1 and L2 speakers do not use gender information available on determiners to facilitate the processing of an upcoming noun. This

is shown by the lack of difference between congruent, incongruent, and pseudo conditions across both masculine and feminine nouns between groups. Additionally, the language learning environment did not have an impact on participants' grammatical gender cue use. Congruent conditions were found to have faster RTs than pseudo conditions collapsed across noun gender and language groups, however, there was no difference between congruent and incongruent conditions. Thus, it is likely the case that speakers are using relevant congruent information to facilitate processing.

L1 speakers

L1 speakers are often studied when investigating anticipatory processing and are typically included as a baseline comparison group in studies focusing on L2 acquisition and processing. This group of speakers typically provides consistent findings in that they demonstrate the ability to use gender cues facilitatively during online processing across various languages (e.g., Bates et al., 1996; Lew-Williams & Fernald, 2010). Notably, L1 French speakers fall within these findings (Grosjean, et al., 1994). Yet, data from the present L1 speakers in the current study do not align with these findings. Although an unanticipated result, several factors may have contributed to this outcome.

The experimental design is such that nouns are primed with their corresponding gendered determiner (e.g., *la*$_{\text{fem}}$ *maison*$_{\text{fem)}}$, an incongruent gendered determiner (e.g., *le*$_{\text{masc}}$ *maison*$_{\text{fem)}}$, or a pseudo determiner (*lu*$_{\text{paeudo}}$ *maison*$_{\text{fem}}$) an equal amount. Therefore, nouns only appear with the correct congruently gendered prime 33% of the time across the duration of the experiment. In other words, participants were only provided with reliable gender cues from congruent conditions one-third of the time. The minimal number of reliable trials may have hindered participants' ability to

render gender information as informative, as more often than not, any information that can be gathered from the determiner is not beneficial. This has been explored in previous research, in particular investigating semantic priming. Bodner and Masson (2003) conducted a study where participants completed a masked priming lexical decision task, where the primes were semantically related or unrelated to the target (e.g., *related condition:* bread-BUTTER, *unrelated condition*: robin-BUTTER). Half of the participants completed a version of the task with a *low relatedness proportion* of 0.2, and the other half with a *high relatedness proportion* or 0.8, resulting in 20% of trials providing useful semantic information about the noun in the *low* condition and 80% of trials providing useful semantic information in the *high* condition. It was found that semantic priming increased when related proportion increased. In other words, when a higher amount of related information was provided, participants benefitted from it to access the target noun quicker[11].

In addition to the French target nouns, participants saw an equal amount of French pseudo-words that served as filler targets. Pseudowords were treated the same as French nouns in the design of the study. Thus, pseudowords were paired with the three prime items (le, la, lu) to an equal degree, resulting in each prime + pseudoword combination being seen 50% of the time by participants (as pseudowords compose half the total number of trials). In conjunction with the 33% of incongruent or gender uninformative primed real French nouns, participants only experience 17% of trials with useful gender information (see Table 2.7 for a complete breakdown of trials and informative cues). Due to the proportion of pseudowords lessening the proportion of relevant gender information, the overall distribution of conditions may have further enhanced participants' sense of prime unreliability. Therefore, participants may be rendering any congruent/informative gender information useless and uninformative.

[11] See Basnight-Brown & Altarriba (2007) for a review where the researchers discuss how a high RP may result in conscious awareness and strategic processing during priming tasks.

Table 2.7. *Distribution of information and informative/uninformative gender cues.*

Condition	Prime gender	Target gender	Number of trials	Informative cue?
Congruent masculine	Masculine	Masculine	20	✓
Incongruent masculine	Feminine	Masculine	20	✗
Pseudo masculine	N/A	Masculine	20	✗
Congruent feminine	Feminine	Feminine	20	✓
Incongruent feminine	Masculine	Feminine	20	✗
Pseudo feminine	N/A	Feminine	20	✗
Masculine pseudo	Masculine	N/A	40	✗
Feminine pseudo	Feminine	N/A	40	✗
Pseudo pseudo	N/A	N/A	40	✗

L2 speakers

It was hypothesized that since FF speakers acquired their L2 in a more naturalistic environment than EFI speakers, placing them closer to L1 speakers on the spectrum of *naturalistic* learning to *formalistic* learning, they would perform similarly to L1 speakers. Analogous to L1 speakers, FF speakers did not show the use of gender cues during processing. Arguably this can be reflective of the type of environment that the FF group was exposed to during L2 acquisition. By virtue of being immersed in French for a large portion of their day, perhaps the more informal teaching of French at a young age is comparable to the language environment L1 speakers are exposed to. However, this interpretation is lightly stated due to the aforementioned methodological issues.

It was hypothesized that EFI speakers would heavily rely on feminine gender cues due to the nature of their language learning environment. Increased formal language learning results in the emphasis placed on specific structures of the language. According to the *Framework for French as a Second Language in Ontario Schools* (2013), emphasis is placed on a combination of explicit

and implicit learning in L2 French school programs in Ontario. Therefore, it is likely the case that students are explicitly told when a noun is masculine and feminine and corrected when using the incorrect form, creating a higher metalinguistic awareness of noun categorization. However, this is not found for the EFI speakers in the current study, instead, it is observed that these speakers are performing in the same way as L1 and FF speakers.

General discussion

A general limitation of the current study is the minimal number of participants included in the analysis. A total of 16 L1 and 16 L2 speakers may not be sufficient to obtain enough statistical power, in particular, when the L2 group is classified based on MoA, there are less than 10 participants in the FF group. Previous research implementing techniques such as eye-tracking or EEG may require a similar number of participants as the current study to find effects. However, the behavioural task implemented here does not measure fine-tuned processing, thus a larger number of participants may be required. Further, language background (e.g., L1 French vs. simultaneous bilingual) and environmental factors, such as which region of the country participants learned their language in (e.g., French present in the environment vs. French absent from the environment) should be built into the model. Of particular interest is whether speakers learned French alongside another language (namely English) from birth in the case of simultaneous bilinguals, or whether they learned an L2 at a later age (e.g., after the age of 6). It may be that there are differences between these groups of speakers, as simultaneous bilinguals can be argued to have a more integrated lexicon with their second language, which can influence their processing in French, even if there is little to no overlap in target nouns and no presence of a grammatical gender feature in their other language. The inclusion of these factors will provide for a more fine-tuned

analysis of any potential confounding factors. To tease apart the concerns, a modified follow-up study was conducted and is discussed in the following section.

2.2 Experiment 2: Increased gender cues

Based on the limitations of Experiment 1, a follow-up study was conducted to further investigate whether L1 French speakers use grammatical gender cues during processing and whether they exploit one gender more than the other. In Experiment 2, the number of reliable gender cues was increased from 33% to 58% when focusing solely on noun targets, meaning that a higher number of congruent gender trials were included. This was achieved by using French-English non-identical cognates that were only presented with a preceding *congruent* determiner.

Furthermore, information pertaining to L1 speaker background was collected to determine whether they learned one or two languages from birth. Speakers who acquired one language only French from birth, with no other language prior to the age of 8, are referred to as L1 for the purpose of this dissertation. Speakers who acquired more than one language from birth as their L1s, in this case, English and French, are referred to as simultaneous bilinguals[12]. Disentangling these groups based on language experience may provide insight into the organization and access to grammatical gender-related items in the lexicon. It is hypothesized that all speakers will use grammatical gender cues and that L1 speakers will respond quicker to feminine nouns preceded by feminine determiners than any other condition. However, since simultaneous speakers may place less importance on utilizing gender cues due to the fact that the feature is only present in one of their two languages (in this case, French), it is hypothesized that they will use masculine and feminine

[12] Note that both groups of speakers are L1 speakers of French. However, for the purpose of disentangling these groups based on language experience and knowledge, those who learned one language from birth are referred to as L1 speakers.

cues to the same degree, responding equally as fast to congruent conditions versus pseudo conditions.

The hypotheses for L2 speakers are the same as for Experiment 1 – it is anticipated that L2 speakers will use grammatical gender cues during processing, but to different degrees depending on their MoA. Speakers who learned their L2 in an FF school are expected to pattern similarly to the simultaneous speakers, in that they will use gender cues from both masculine and feminine cues, but they will show stronger use of the feminine cue. FF speakers are expected to behave more similarly to simultaneous speakers due to their high level of knowledge of the two languages. In other words, both groups are bilinguals, thus their processing may be more similar than L2 speakers and monolingual French speakers. Thus, they are expected to respond to both masculine and feminine congruent gender conditions quicker than the pseudo condition, with the feminine condition resulting in the fastest RTs.

2.2.1 Participants

72 native French speakers completed the study, 48 of which are L1 speakers (*Mage* = 19.7) and 24 are simultaneous bilinguals (*Mage* = 18.8). An additional 15 L1 English-L2 speakers (*Mage* = 18.9) were included for analysis. L1 speakers are classified as acquiring only French from birth, with no other language prior to the age of 8 (*MAoA* of L2 = 10.3). Simultaneous bilinguals are classified as speakers who learned both English and French before the age of 2 (*MAoA* of English = 0.8, *MAoA* of French = 0.05).

L2 speakers were categorized based on their MoA, namely, whether they learned their L2 in an FF ($n = 4$) or EFI ($n = 11$) program (Table 2.8). For the purpose of this study, is placed on FF and EFI speakers, however, all L2 speakers will be included as a single group in the overall

analysis that does not factor in MoA. Speakers fall on a spectrum of naturalistic to formalistic language learning, with an FF MoA being the most naturalistic and EFI the most formal. All L2 participants completed a French cloze task and were classified as high/very highly proficient.

Table 2.8. *Breakdown of participant information.*

Language Group	School Program	N	Manner of Acquisition	Average Age of Immersion in French	Approx. percentage of French per school day	Average cloze score (/40)
L1 French	-	48		0	-	-
Simultaneous bilingual	-	24	Naturalistic	0	-	-
L1 English–L2 French	All French Schooling	4	↓	4.2 years	95	31.25
	Early French Immersion	11	Formalistic	2.3 years	50	24.45

All participants were recruited through the University of Ottawa Psychology participant pool for partial class credit. Participants had no visual impairments or history of speech and language disorders. Caution was taken to ensure that participants had little or no previous knowledge (e.g., very low proficiency) of another gendered language. Thirty-two additional speakers were excluded due to having an L1 other than English or French.

2.2.2 Stimuli and design

Stimuli consisted of the same one hundred and twenty French nouns as Experiment 1. An additional 48 French pseudowords and 48 French-English non-identical cognates (24 feminine, e.g., famille, “family”) were included. There was no difference in frequency between masculine

and feminine cognates (p = 0.97; Lexique3). Each noun and pseudoword was paired with the same primes used in Experiment 1 and counterbalanced across 3 lists. The sole difference is that the cognates were intended to serve as reliable cue fillers (increasing the relatedness proportion of gender cues to 58%), so they were always paired with a congruent determiner to increase the reliability of correct gender cues (see Table 2.9). This means that each participant saw the same cognate conditions across all lists.

Table 2.9. *Cognate filler conditions.*

Condition	Prime	Prime gender	Target (example)	Target gender	Number of trials
Cognate masculine	le	masculine	nombre (“number”)	masculine	24
Cognate feminine	la	feminine	famille (“family”)	feminine	24

Participants were randomly assigned to one of three lists and saw each target noun and pseudoword once. Within each list, there were four blocks of 84 words. An additional four French nouns were included at the beginning of each block as opening stimuli items and were later filtered out, and there were six practice items (four French nouns and two pseudowords) used for training purposes. A complete list of cognate items can be found in Appendix B.

2.2.3 Procedure

Participants completed the study via Gorilla Experiment Builder (www.gorilla.sc), an online testing platform (Anwyl-Irvine et al., 2020). Conducting psycholinguistic studies online has been shown to provide reliable and good-quality results (Eerola et al., 2021). The use of the masked priming paradigm in particular has been administered online and yielded precise and positive

findings (Angele et al., 2023[13]). Before completing the experiment and associated online paperwork, participants were asked whether their first language was English or French. The response to this question dictated the language in which the consent form and the same LBQ from Experiment 1 were presented to them. This resulted in the majority of L1 French speakers completing the paperwork in French, with the exception of a number of speakers who were simultaneously bilingual and chose to complete the study with the English paperwork. Following the completion of the paperwork, participants completed the same lexical decision task as in Experiment 1. Words were presented in black on a white background. L2 speakers completed the French cloze task after the lexical decision task. Overall, the study was approximately 1 hour long.

2.3.4 Statistical design

Prior to statistical analysis, the data was cleaned to remove outliers. Participants below a 70% accuracy threshold across all conditions were excluded (n = 6). Trials with RTs below 300 ms and above 2000 ms were excluded[14]. No participants were removed due to data removal from RT cut-offs. The SD for each participant and condition was calculated and RTs above or below 2.5 the SD, no participants were excluded based on this criteria.

When visualizing the raw RTs, the data was positively skewed, thus resulting in a non-normal distribution. Positively skewed data is common in psycholinguistic research, particularly when with RT data, as many of the measures that are implemented are often associated with how

[13] Angele, Baciero, Gómez, and Perea (2023) were interested in whether online testing platforms yielded comparable results to in-lab administration of a task using masked priming lexical decision. Due to the sensitive nature of prime duration, it is important that timing is precise and accurate during the task to obtain satisfactory results. The researchers found similar results between online and in-lab testing, indicating the validity of online measures.

[14] Note the high end of the RT cut-off threshold. Due to this study being conducted online and not in a lab setting, a decision was made to increase this number to account for any individual differences in technological lag on the participants' end.

fast a participant can respond during a given trial. Therefore, RTs tend to be clustered in the low range of scores (Winter, 2019). When data is not normally distributed, it can potentially result in violations of regression assumptions, causing certain RTs to have a skewed influence on the model outcome (Baayen, 2008). To adjust this, a non-linear log transformation was applied to the raw RTs, creating a normal distribution of the data. The process of log transformation "takes large numbers and shrinks them. The exponential function takes small numbers and grows them. The logarithm and the exponential function are each other's 'inverses', which is a mathematical term for two functions that reverse each other's effects." (Winter, 2019:91). Most importantly, log transforming does not change the data in a way that alters the findings.

Linear Mixed Models (LMM) were conducted in R (R Core Team, 2022) using the lme4 package (Bates et al., 2015). The first model included Noun gender (masculine or feminine), Congruency (congruent, incongruent, pseudo determiner), and Group (L1, simultaneous, L2) as fixed effects, and participant and item were included as random effects. Fixed effects were deviation coded (i.e., sum-to-zero contrasts). The continuous dependent variable was the mean RT to each word. If there was a significant main effect or interaction including congruency and/or noun gender with language group, planned pairwise comparisons (confidence level (CI) = 0.95) were conducted by examining estimated marginal means with the emmeans package in R (Lenth, 2022). Only significant interactions including the factor of congruency and/or noun gender are discussed in the results to investigate differences between conditions. To investigate if there is an influence of MoA a separate model was run with only L2 speakers. The model included Noun gender (masculine or feminine), Congruency (congruent, incongruent, pseudo determiner), and MoA (FF, EFI) as fixed effects, and participant and item were included as random effects. Fixed effects were deviation coded (i.e., sum-to-zero contrasts). The continuous dependent variable was

the mean RT to each word. Due to the contrast coding scheme, the models include two contrasts for the fixed factors of Congruency (model 1 and 2) and Group (model 1). These contrasts compare a factor level with the grand mean of all levels of that specific factor. Thus, contrast 1 for Congruency compares the level of congruent to the grand mean of Congruency, and contrast 2 compares the level of incongruent to the grand mean. Group contrast 1 compares L1 speakers to the grand mean, and contrast 2 is simultaneous speakers.

2.2.5 Results

Language group results

Table 2.10 includes a summary of the RT and SD data for each group and condition and the complete model output is presented in Table 2.11. There was no significant effect of Congruency or Noun gender, or any interaction between factors. There was a significant effect of Group contrast 1, however, pairwise comparisons did not identify any significant interaction between groups. Thus, the fixed effects do not appear to influence participants' RT. Visual depictions of congruency are presented in Figures 2.6 (L1 speakers), 2.7 (simultaneous), and 2.8 (L2 speakers). Graphs for individual gender conditions can be found in Appendix D.

Table 2.10. *Lexical decision, experiment 2 RT and SD summary for each group and condition.*

Group	Condition	***Mean* RT (ms)**	**RT *SD***
L1	Congruent masculine	674.34	175.15
	Incongruent masculine	662.99	164.66
	Pseudo masculine	678.55	195.57
	Congruent feminine	665.35	179.36
	Incongruent feminine	661.61	181.64
	Pseudo feminine	670.32	178.58
Simultaneous	Congruent masculine	711.88	204.63
	Incongruent masculine	720.01	232.77
	Pseudo masculine	699.82	194.63
	Congruent feminine	702.53	200.60

	Incongruent feminine	706.60	206.27
	Pseudo feminine	725.60	194.92
L2	Congruent masculine	706.34	184.53
	Incongruent masculine	706.75	198.44
	Pseudo masculine	707.74	200.25
	Congruent feminine	709.72	216.60
	Incongruent feminine	706.17	184.34
	Pseudo feminine	715.86	210.39

Table 2.11. *Lexical decision experiment 2, model 1 output.*

Predictors	**Estimates**	**95% CI**	***t*-value**	***p*-value**
(Intercept)	6.51	6.48 – 6.53	501.683	**<0.001**
Congruency [1]	0.00	-0.01 – 0.01	-0.165	0.87
Congruency [2]	0.00	-0.01 – 0.00	-0.68	0.50
Noun gender	0.00	-0.01 – 0.01	-0.253	0.8
Group [1]	-0.03	-0.06 – -0.00	-2.037	**0.04**
Group [2]	0.02	-0.01 – 0.05	1.172	0.24
Congruency [1]*Noun gender	0.00	-0.01 – 0.00	-1.075	0.28
Congruency [2]*Noun gender	0.00	-0.01 – 0.01	-0.465	0.64
Congruency [1]*Group [1]	0.00	-0.00 – 0.01	0.94	0.35
Congruency [2]*Group [1]	-0.01	-0.01 – 0.00	-1.506	0.13
Congruency [1]*Group [2]	0.00	-0.01 – 0.01	-0.877	0.38
Congruency [2]*Group [2]	0.00	-0.00 – 0.01	0.977	0.33
Noun gender*Group [1]	0.00	-0.01 – 0.00	-1.405	0.16
Noun gender*Group [2]	0.00	-0.00 – 0.01	0.628	0.53
Congruency [1]*Noun gender*Group [1]	0.00	-0.01 – 0.01	0.421	0.67
Congruency [2]*Noun gender*Group [1]	0.00	-0.01 – 0.01	0.767	0.44
Congruency [1]*Noun gender*Group [2]	0.00	-0.01 – 0.01	-0.821	0.41
Congruency [2]*Noun gender*Group [2]	-0.01	-0.01 – 0.00	-1.1	0.27

Marginal $R^2 = 0.011$, Conditional $R^2 = 0.249$

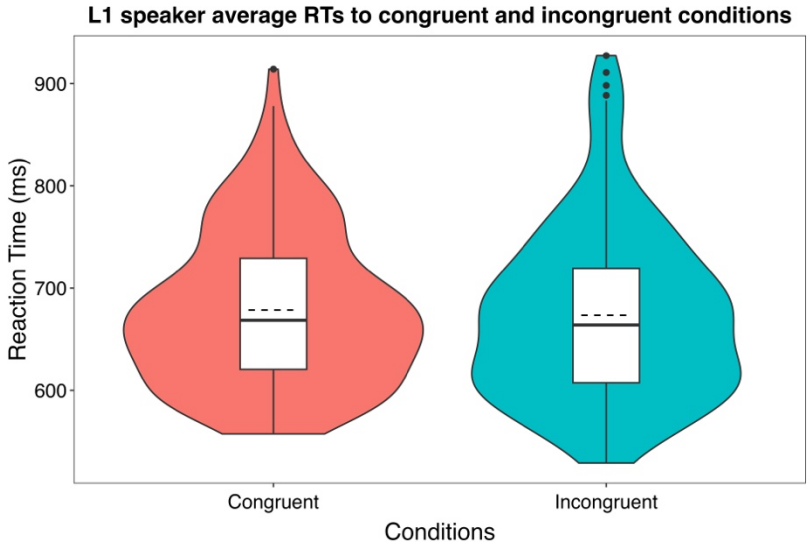

Figure 2.6. L1 speakers' average RT to congruent and incongruent conditions. Dotted line = mean, solid line = median.

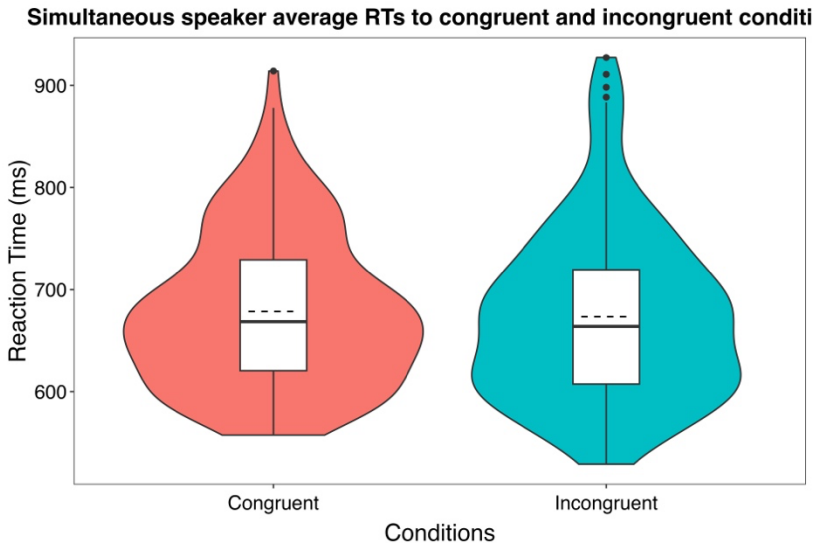

Figure 2.7. Simultaneous speakers' average RT to congruent and incongruent conditions. Dotted line = mean, solid line = median.

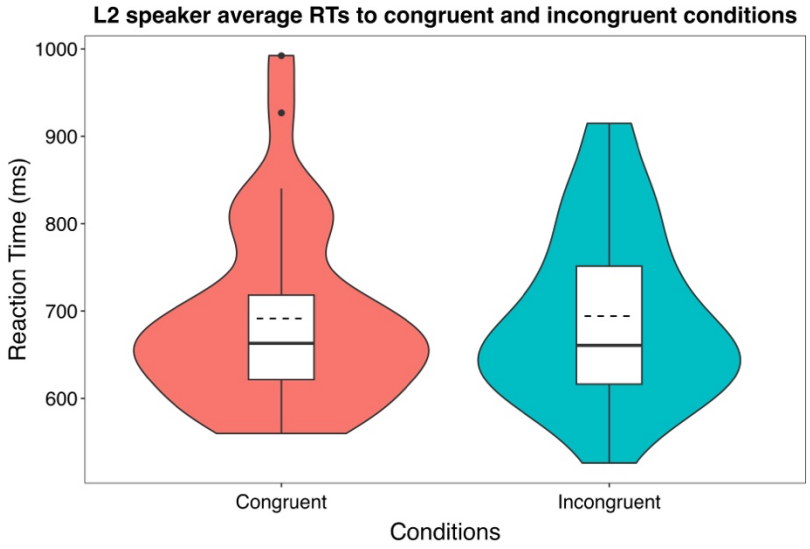

Figure 2.8. L2 speakers' average RT to congruent and incongruent conditions. Dotted line = mean, solid line = median.

Influence of MoA

Table 2.12 includes a summary of the RT and SD data for each group and condition and the complete model output is presented in Table 2.13. There was no significant effect of Congruency, Noun gender, MoA, or any interaction between factors. Thus, the fixed effects do not influence participants' RT. Visual depiction of congruency is presented in Figure 2.9, the graph for individual gender conditions can be found in Appendix D.

Table 2.12. *Lexical decision, experiment 2 RT summary by MoA and condition.*

Group	Condition	*Mean* RT (ms)	RT *SD*
Full French School	Congruent masculine	660.41	159.75
	Incongruent masculine	637.83	119.75
	Pseudo masculine	646.99	159.22
	Congruent feminine	662.35	173.69
	Incongruent feminine	627.21	120.05
	Pseudo feminine	677.31	169.43
Early French Immersion	Congruent masculine	723.76	190.63
	Incongruent masculine	734.23	216.45

Pseudo masculine	731.16	209.70
Congruent feminine	730.11	230.11
Incongruent feminine	737.20	195.88
Pseudo feminine	730.54	222.73

Table 2.13. *Lexical decision experiment 2, model 2*

Predictors	Estimates	95% CI	*t*-value	*p*-value
(Intercept)	6.51	6.45 – 6.57	197.067	**<0.001**
Congruency [1]	0.00	-0.02 – 0.02	0.10	0.92
Congruency [2]	0.00	-0.02 – 0.01	-0.25	0.80
Noun gender	0.00	-0.02 – 0.02	0.19	0.85
MoA	-0.05	-0.12 – 0.01	-1.67	0.12
Congruency [1]*Noun gender	0.00	-0.01 – 0.02	0.45	0.66
Congruency [2]*Noun gender	-0.01	-0.02 – 0.01	-0.64	0.53
Congruency [1]*MoA	0.01	-0.01 – 0.02	0.88	0.38
Congruency [2]*MoA	-0.01	-0.03 – 0.01	-1.32	0.19
Noun gender*MoA	0.00	-0.01 – 0.01	-0.01	0.99
Congruency [1]*Noun gender*MoA	0.01	-0.01 – 0.02	0.61	0.54
Congruency [2]*Noun gender*MoA	-0.01	-0.03 – 0.01	-1.04	0.30

Marginal R^2 = 0.041, Conditional R^2 = 0.321

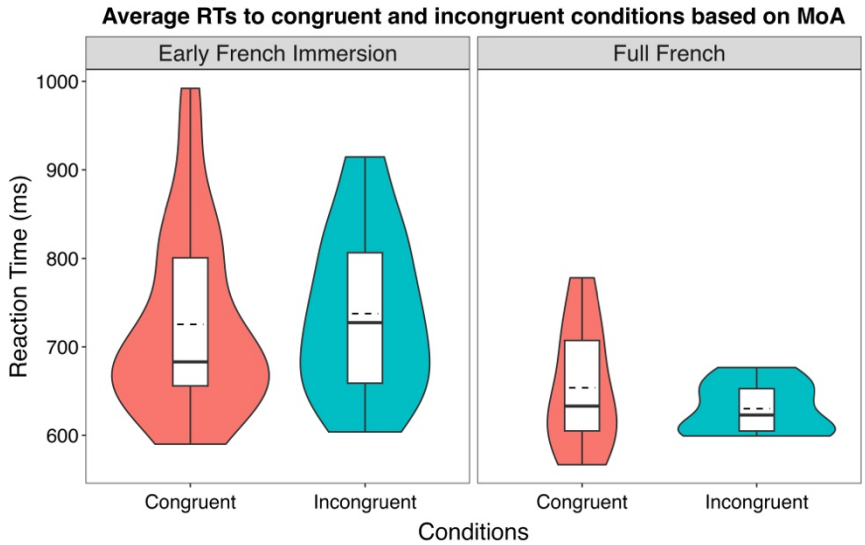

Figure 2.9. L2 speakers' average RT to congruent and incongruent conditions by MoA (FF, EFI). Dotted line = mean, solid line = median

2.2.6 Discussion

The goal of Experiment 2 was to further study the use of grammatical gender cues in French speakers. Methodological changes were made to increase the number of gender congruent trials, increasing the RP of reliable gender cues. Native speakers were also analyzed as separate groups of speakers (L1 and simultaneous bilinguals) to explore potential variation in processing. Overall, it was found that French speakers do not use grammatical gender cues during processing, this is evident by the lack of congruency effects. This lack of distinction is apparent for all speakers.

L1 speakers and simultaneous speakers

Despite the lack of difference between congruent and incongruent conditions, it is important to discuss the anticipated results in relation to previous literature. If there were a difference between congruency, it would not necessarily reflect that grammatical gender cues facilitate lexical access. Instead, variation in congruency may be indicative of co-occurrence dependencies (e.g., vanHeugten & Shi, 2009). In French, article-noun combinations are highly co-occurring, as it is rare for a noun to be spoken, written, or referred to in isolation in the absence of a determiner or quantifier. In contrast to English, the article and noun are used almost as one unit or chunk, because the language dictates the inclusion of an article. In English, you can drop articles in certain situations and the utterance will remain grammatical, whereas this is not admissible in French. For instance, when pointing at an object and labelling it, in English you can say “table”, however in French you must say “la table” (see Rozendaal & Baker, 2008 for a discussion on the frequency of article-noun combinations in French speech). Thus, nouns are infrequently encountered without a corresponding article that either carries gender marking (le, la, un, une) or does not (les, des).

When the incorrect determiner precedes a noun, there is a violation of the co-occurrence dependency, resulting in differences between congruent and incongruent conditions.

Due to the nature of co-occurrence cues in French, it is difficult to tease apart whether studies are tapping into grammatical gender use during processing. Although the disentanglement of co-occurrence and gender cues was not a primary aspect of the current study, it can be argued that there is a distinct difference that can be made between the two types of cues. The inclusion of a pseudo-prime preceding French masculine and feminine nouns allowed for the comparison of articles that carry gender information versus one that does not. If gender cues were being used to any extent, congruent conditions would be quicker than the pseudo condition. Additionally, incongruent conditions may also show faster RTs, due to the presence of a real determiner versus a pseudo-determiner, however, neither of these situations is observed. Therefore, it is plausible that the observed effect of congruency is a co-occurrence effect.

L2 speakers

Previous studies on L2 grammatical gender are inconsistent (see Chapter 1 for more detail), in that mixed results have been reported regarding whether speakers exploit gender cues during online processing (e.g., Dussias et al., 2013; Guillelmon & Grosjean, 2001). The current study found that L2 speakers do not use grammatical gender cues during processing and that this does not vary based on the speaker's language learning environment. It should be noted that there is a similar drawback to what was present in Experiment 1. The number of L2 speakers analyzed for the study was quite low (n=15), resulting in poor statistical power. The number of participants further decreases when investigating the effects of MoA, as they are categorized into separate groups. This results in groups of 4 (FF schooling) and 11 (EFI schooling), which may be too few

participants to observe effects. Future research should focus on collecting data from a larger sample size.

2.3 General discussion

It is perhaps the case that L1, simultaneous, and L2 speakers do not make use of grammatical gender cues in French, however, this does not align with previous findings. There are two explanations for the lack of observable significant differences. First, it is possible that participants are performing at a ceiling behaviourally, and differences will only be observed with a more sensitive measure, such as EEG (see Chapter 3). Second, gender cues may not be used as strongly when there is no associated syntactic context. When determiner-noun combinations are presented within sentences, the surrounding context is impacted by their grammaticality (as seen in studies investigating grammatical gender cues within sentence contexts Beatty-Martinez et al., 2020; Foucart & Frenck-Mestre, 2012). So, there will likely be a higher reliance on gender information syntactically (see Chapter 4). During a lexical decision task, participants may be ignoring gender information as there is no consequence as to whether it is correct or incorrect.

2.4 Conclusion

This chapter focused on whether L1 and L2 speakers use grammatical gender cues to facilitate the processing of an upcoming noun and if there are differences between genders over two experiments. Experiment 1 found that French speakers do not rely on grammatical gender cues during processing, however, several methodological issues arose which may have impacted the results. Experiment 2 made modifications to the task with an increased number of reliable gender trials. Despite this change, speakers continue to show no use of gender cues. It is perhaps the case that French speakers perform at ceiling at a lexical level with grammatical gender processing, thus more sensitive measures are required for further investigation.

CHAPTER 3

STUDY 2: THE NEURAL COGNITIVE UNDERPINNINGS OF GENDER PROCESSING

In the previous chapter, it was found that native French speakers do not make use of grammatical gender cues at a behavioural level during processing. More specifically, there are no differences in RTs between masculine and feminine congruencies and incongruencies when investigating lexical access. This finding is interesting, but perhaps not surprising, as behavioural tasks require participants to respond after neural processing has occurred. Thus, it is possible that grammatical gender cues at the lexical level to aid in recognition are subtle, and a behavioural masked priming paradigm cannot capture their use. Much of the previous research on grammatical gender processing has implemented more sensitive online measures that track processing in real-time, such as eye-tracking and EEG (e.g., Caffarra et al., 2015; de Resende et al., 2018; Wicha et al., 2003). These measures allow researchers to measure implicit processing and see what occurs as soon as the stimulus of interest is encountered, as opposed to post-processing responses which are observed after the response has been made. These types of techniques can provide more precise accounts of *when* there are any processing difficulties or deviations and what mechanisms may be implemented.

The current study seeks to investigate the following question: What (if any) are the neural underpinnings associated with the predictive use of grammatical gender processing? Particular focus is placed on whether masculine and feminine genders rely on similar or distinct neural mechanisms. Based on previous research on grammatical gender processing in French (Gosselin

& Sabourin, 2021) and with DPs in isolation (Barber & Carreiras, 2005), it is hypothesized that congruent and incongruent conditions collapsed across gender will yield different effects. Incongruent conditions are expected to show an N400 effect compared to congruent conditions. Separating the genders, the incongruent masculine condition (*la_{F} $bateau_{M}$, 'the boat') is expected to elicit the largest N400 effect, followed by the incongruent feminine condition (*le_{M} $maison_{F}$, 'the house'). The incongruent masculine condition is expected to show the largest effect, as feminine determiners in conjunction with a masculine noun are not permissible (see Chapter 2 for further discussion). However, incongruent feminine combinations are thought to be allowable, as masculine determiners can be used with a wider range of nouns (see Chapter 2 for further discussion). Although incongruent feminine combinations are more accepted, the incongruency will likely result in an N400, albeit of a smaller amplitude than incongruent masculine combinations. Congruent feminine and masculine conditions are expected to show similar decreased N400s. An alternative hypothesis is that speakers will show a LAN effect to incongruent conditions collapsed across gender and to incongruent masculine conditions when disentangled, as opposed to an N400, as the LAN is typically associated with morphosyntactic violations in agreement (Beatty-Martínez et al., 2020). Often in gender processing, a biphasic LAN-P600 is found for incongruencies, however, this is not expected to occur due to the nature of the task. The stimuli items are not presented in a larger syntactic context, but instead as DPs in isolation. These combinations are arguably noun phrases (NP), in which case it is possible that a syntactic processing can occur and be reflected as a P600. However, previous research investigating Spanish DPs found an N400/LAN effect when they were presented without a greater syntactic context and a LAN-P600 when further context was provided (see Chapter 1 for more information; Barber & Carreirass, 2005).

The remainder of the chapter is structured as follows: section 3.1 discusses the methodology of the current study (participants, stimuli and design, procedure, EEG recording, and statistical design). Section 3.2 reports the results, followed by the discussion in section 3.3 and concluding remarks in section 3.4.

3.1 Methodology

3.1.1 Participants

Twenty-four L1 French speakers are included in the analysis for this study (20 female, 1 non-binary, *M*=18.47). All participants were recruited through the University of Ottawa Psychology participant pool for partial class credit. Participants were all right-handed and had no visual impairments or history of speech and language disorders. Caution was taken to ensure that participants had little or no previous knowledge (e.g., very low proficiency) of another gendered language. Six additional participants were tested and excluded due to their L1 being another language ($n = 4$) and poor EEG recording data ($n = 2$).

3.1.2 Stimuli and design

Stimuli consisted of the same 120 French nouns (60 feminine), 48 non-identical French-English cognates (24 feminine) and 48 French pseudowords used in Chapter 2 - Experiment 2 (see section 2.3.2 for more detailed information). In particular, the version of the lexical decision task with a higher cue validity and cognate fillers.

3.1.3 Procedure

Prior to the experimental task, participants completed the LBQ and were fitted with an EEG cap. Participants were then seated in a sound-attenuated room approximately 1 m away from a 20-

inch (31.5 x 38 cm) computer screen. Participants completed a masked priming lexical decision task (the same task used in Chapter 2-Experiments 1 & 2, see section 2.2.3 for more information) administered through Presentation (Neurobehavioral Systems, version 17.2). Words were presented in black on a white background. At the beginning of the experiment, participants completed 4 practice trials where the experimenter remained in the room with the participant to address any questions or concerns. Throughout the experiment, participants were provided two self-paced breaks to limit eye strain.

3.1.4 EEG recording and analysis

Scalp voltages were collected using a 64-electrode Compumedics Quik-Cap with a 10-20 electrode placement system. Four facial electrodes were placed on the temples (hEOGr, hEOGl) and above and below the left eye (vEOGu, vEOGl) to capture ocular movement. An additional two external electrodes were placed on the right and left mastoids (M1, M2). All impedances were kept below 10kΩ and ERPs were recorded at 1000Hz. An online low-pass filter of 200Hz was applied (SynAmps amplifier) and no online high-pass filter was utilized. Online reference was recorded from the original reference electrode (REF) located at a central location between Cz and CPz. The data was re-referenced offline to the average of the mastoids.

Data pre-processing was conducted in Brain Vision Analyzer version 2.2.0 (Brain Products, GmbH, Herrsching, Germany). A low-pass filter of 30 Hz and a high-pass filter of 0.01 Hz was applied offline. Vertical and horizontal eye movements were corrected using ocular correction, which eliminates or reduces movement using the Gratton and Coles method (Gratton et al., 1983). Semi-automatic artifact rejection was conducted where peaks above ±100 μV were rejected. Epochs were time-locked to the onset of the noun or pseudoword and established according to a

100ms pre-stimulus corrected baseline[15] and ended 800 ms post-noun onset. The data was analyzed in the specified time-windows (see section 3.1.5 below) post-noun onset. Pre-processing resulted in approximately 0.4% of the data being excluded, with no differences across conditions ($p = 0.35$).

Forty-three electrodes, separated into nine regions of interest (ROIs) were included in the analysis. The ROIs and analysis were adapted from what was used in a similar study by Barber & Carreiras (2003). The value of each ROI includes values for each of the electrodes in the region for each condition. A map of the ROIs is presented in Figure 3.1. The regions are as follows: left-frontal (LF; F5, F3, FC5, FC3), mid-frontal (MF; F1, FZ, F2, FC1, FCZ, FC2), right-frontal (RF; F4, F6, FC4, FC6), left-central (LC; C5, C3, CP5, CP3), mid-central (MC; C1, CZ, C2, CP1, CPZ, CP2), right-central (RC; C4, C6, CP4, CP6), left-parietal (LP; P5, P3, P05, 01), mid-parietal (MP; P1, PZ, P2, PO3, POZ, PO4, OZ), and right-parietal (RP; P4, P6, PO6, 02).

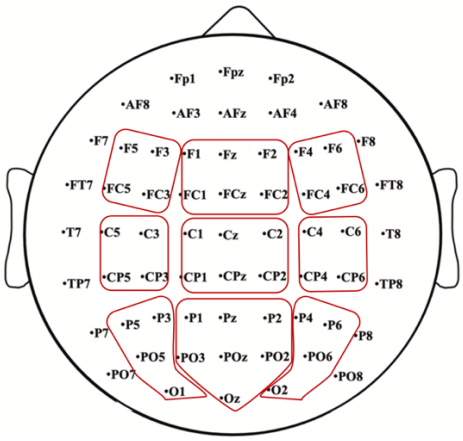

Figure 3.1. Map of ROIs included for analysis.

[15] A 100 ms baseline was chosen based on the use of a lexical decision task. Due to the nature of the task, the presentation of the prime is included in the baseline. To account for the effects that may influence the baseline, a shorter than average baseline for ERP studies was chosen according to previous studies implementing the same type of task (see Barber & Carreiras (2003) for similar methods).

3.1.5 Statistical design

Two time-windows were included in the analysis. Upon visual investigation of the waves, the first time-window looks for a potential P200 effect (100 - 300 ms). This effect was unexpected, however, upon visual inspection of the waves, a positive deflection was observed around 200 ms. Typically, this early effect is found in non-linguistic tasks, associated with attention and visual change (e.g., Arbell et al., 2011; Conely et al., 1999), and is often more pronounced over anterior and central electrode sites (Luck, 2014). Linguistic studies have observed similar effects in the location and timing of a P200 (e.g., Guo et al., 2012; Lui et al., 2003; see the P200 discussion section 3.3). The second time-window investigates an N400/LAN (300 - 500 ms), based on similar studies focusing on grammatical gender processing (e.g., Barber & Carreiras, 2003). The following models were run on both time-windows.

Linear Mixed Models (LMM) analyses were conducted in R (R Core Team, 2022) using the lme4 package (Bates et al., 2015). Models were run for each time-window. Both models included Noun gender (masculine or feminine), Congruency (congruent or incongruent determiner), Laterality, (left, mid, right), and Anteriority (frontal, central, parietal) as fixed effects, and participant and individual electrode channel[16] were included as a random effects[17]. Fixed effects were deviation coded (i.e., sum-to-zero contrasts). The continuous dependent variable was the mean amplitude in each condition across averaged electrodes. If there was a significant main effect or interaction in the models including congruency and/or noun gender, planned pairwise comparisons (confidence level (CI) = 0.95) were conducted by examining estimated marginal means with the emmeans package in R (Lenth, 2022). Only significant interactions including the

[16] Researchers that have used LMMs to explore ERP data have included electrode channel as a random effect to account for variability in the data (e.g., Volpert-Esmond et al., 2021).
[17] Note that stimuli item is not included as a random effect. Originally, analyses of variance were intended to be conducted with this data, and the EEG setup did not allow for item-specific information to be extracted.

factor of congruency and/or noun gender are discussed in the results to investigate differences between conditions. Due to the contrast coding scheme, the models include two contrasts for each of the fixed factors of Laterality and Anteriority. These contrasts compare the presented factor level with the grand mean of all levels of that specific factor. Thus, contrast 1 for Laterality compares the level of left to the grand mean of laterality, and contrast 2 compares the level of mid to the grand mean. For Anteriority, contrast 1 and 2 compare the levels of frontal and central to the grand mean respectfully.

3.2 Results

3.2.1 Accuracy

Participants' accuracy in response to whether the target was a real French word or not ranged between 70 - 97% ($M = 90\%$, $SD = 8\%$). This indicates that participants were consistently attending to the task. There was no difference between the number of correct responses to masculine nouns versus feminine nouns ($p = 0.22$). All trials were included in the ERP analysis.

3.2.2 ERP results

The following section presents visual and statistical analyses of the grand average ERP waveforms. These results are organized by time-window. All waveforms have negative plotted up. A summary of the statistical results from the full model outputs is presented in Table 3.1 (100-300ms) and Table 3.2 (300-500ms). Complete model outputs can be found in Appendix E.

3.2.2. 100 – 300 ms time-window

A main effect Congruency ($\beta = -0.19$, $t = -4.82$, $p < 0.001$) was found, with incongruent conditions being more positive than incongruent across the scalp (Figure 3.2). Noun gender

interacted with Laterality contrast 1 ($\beta = 0.14$, $t = 2.45$, $p = 0.01$), however, pairwise comparisons did not indicate any significant relationship between the variables/regions of interest. There was an interaction between Noun gender, Congruency, and Laterality contrast 1 ($\beta = 0.12$, $t = 2.14$, $p = 0.03$). Pairwise comparisons highlight that incongruent feminine conditions are significantly more positive than congruent feminine conditions over left ($\beta = -10.7$, $t = -3.43$, $p = 0.03$) and mid ($\beta = -0.55$, $t = -3.4$, $p = 0.03$) ROIs, indicative of a P200 (Figure 3.3). There were no interactions with masculine nouns (waveforms for masculine noun conditions can be found in Appendix E).

Table 3.1. *Reduced liner mixed model output for the 100-300 ms time-window.*

Predictors	Estimates	95% CI	*t*-value	*p*-value
Intercept	4.05	2.81 – 5.29	6.408	**<0.001**
Noun gender	-0.06	-0.13 – 0.02	-1.47	0.14
Congruency	-0.19	-0.26 – -0.11	**-4.818**	**<0.001**
Noun gender*Congruency	0.06	-0.01 – 0.14	1.583	0.11
Noun gender*Laterality [1]	0.14	0.03 – 0.25	**2.451**	**0.01**
Noun gender*Laterality [2]	-0.04	-0.14 – 0.06	-0.77	0.44
Congruency*Laterality [1]	0.02	-0.09 – 0.13	0.383	0.70
Congruency*Laterality [2]	-0.02	-0.12 – 0.08	-0.309	0.76
Noun gender*Anteriority [1]	-0.07	-0.18 – 0.03	-1.331	0.18
Noun gender*Anteriority [2]	-0.02	-0.13 – 0.09	-0.34	0.73
Congruency*Anteriority [1]	-0.01	-0.12 – 0.10	-0.141	0.89
Congruency*Anteriority [2]	-0.04	-0.15 – 0.07	-0.742	0.46
Noun gender * Congruency * Laterality [1]	0.12	0.01 – 0.23	**2.143**	**0.03**
Noun gender * Congruency * Laterality [2]	0.01	-0.09 – 0.11	0.207	0.84
Noun gender * Congruency * Anteriority [1]	0.04	-0.07 – 0.15	0.76	0.45
Noun gender * Congruency * Anteriority [2]	-0.01	-0.12 – 0.09	-0.261	0.79
Noun gender*Laterality [1]*Anteriority [1]	0	-0.16 – 0.16	0.023	0.98
Noun gender*Laterality [2]*Anteriority [1]	0.03	-0.12 – 0.17	0.366	0.71
Noun gender*Laterality [1]*Anteriority [2]	0.04	-0.12 – 0.20	0.487	0.63

Noun gender*Laterality [2]*Anteriority [2]	-0.01	-0.15 – 0.13	-0.148	0.88
Congruency*Laterality [1]*Anteriority [1]	-0.08	-0.24 – 0.08	-0.961	0.34
Congruency*Laterality [2]*Anteriority [1]	0.01	-0.13 – 0.16	0.172	0.86
Congruency*Laterality [1]*Anteriority [2]	0	-0.15 – 0.16	0.058	0.95
Congruency*Laterality [2]*Anteriority [2]	0	-0.14 – 0.14	-0.014	0.99
Noun gender*Congruency*Laterality [1]*Anteriority [1]	0.03	-0.13 – 0.19	0.381	0.70
Noun gender*Congruency*Laterality [2]*Anteriority [1]	-0.02	-0.16 – 0.12	-0.28	0.78
Noun gender*Congruency*Laterality [1]*Anteriority [2]	0.03	-0.13 – 0.19	0.376	0.71
Noun gender*Congruency*Laterality [2]*Anteriority [2]	0.01	-0.13 – 0.16	0.172	0.86

Marginal R^2 = 0.099, **Conditional R^2** = 0.663

3.2.2.2 300 – 500 ms time-window

A main effect Congruency ($\beta = 0.14$, $t = 3.03$, $p = 0.002$) was found, with incongruent conditions being more negative than incongruent across the scalp, indicating an N400 effect (Figure 3.2). Congruency did not interact with any other factors.

Table 3.2. *Reduced liner mixed model output for the 300-500 ms time-window.*

Predictors	**Estimates**	**95% CI**	***t*-value**	***p*-value**
Intercept	4.05	2.50 – 5.60	5.123	**<0.001**
Noun gender	0.02	-0.07 – 0.12	0.506	0.61
Congruency	0.14	0.05 – 0.23	**3.03**	**0.002**
Noun gender*Congruency	0.02	-0.07 – 0.11	0.465	0.64
Noun gender*Laterality [1]	0.13	-0.01 – 0.26	1.867	0.06
Noun gender*Laterality [2]	-0.05	-0.17 – 0.07	-0.782	0.43
Congruency*Laterality [1]	-0.01	-0.14 – 0.13	-0.081	0.94
Congruency*Laterality [2]	0.01	-0.11 – 0.13	0.097	0.92
Noun gender*Anteriority [1]	-0.02	-0.15 – 0.11	-0.339	0.73
Noun gender*Anteriority [2]	-0.05	-0.18 – 0.08	-0.815	0.42

Congruency*Anteriority [1]	0.06	-0.07 – 0.19	0.902	0.37
Congruency*Anteriority [2]	0	-0.13 – 0.13	-0.06	0.95
Noun gender * Congruency * Laterality [1]	0.12	-0.01 – 0.26	1.822	0.07
Noun gender * Congruency * Laterality [2]	-0.03	-0.15 – 0.09	-0.421	0.67
Noun gender * Congruency * Anteriority [1]	-0.03	-0.16 – 0.10	-0.454	0.65
Noun gender * Congruency * Anteriority [2]	-0.06	-0.19 – 0.07	-0.86	0.39
Noun gender*Laterality [1]*Anteriority [1]	-0.07	-0.26 – 0.12	-0.711	0.48
Noun gender*Laterality [2]*Anteriority [1]	0.08	-0.10 – 0.25	0.866	0.39
Noun gender*Laterality [1]*Anteriority [2]	0	-0.19 – 0.19	0.014	0.99
Noun gender*Laterality [2]*Anteriority [2]	-0.02	-0.19 – 0.16	-0.177	0.86
Congruency*Laterality [1]*Anteriority [1]	-0.09	-0.28 – 0.10	-0.965	0.33
Congruency*Laterality [2]*Anteriority [1]	0.01	-0.16 – 0.18	0.151	0.88
Congruency*Laterality [1]*Anteriority [2]	-0.03	-0.22 – 0.16	-0.277	0.78
Congruency*Laterality [2]*Anteriority [2]	0.02	-0.16 – 0.19	0.175	0.86
Noun gender*Congruency*Laterality [1]*Anteriority [1]	-0.03	-0.22 – 0.16	-0.354	0.72
Noun gender*Congruency*Laterality [2]*Anteriority [1]	-0.01	-0.18 – 0.17	-0.067	0.95
Noun gender*Congruency*Laterality [1]*Anteriority [2]	0.05	-0.14 – 0.24	0.488	0.63
Noun gender*Congruency*Laterality [2]*Anteriority [2]	0	-0.17 – 0.17	-0.017	0.99

Marginal R^2 = 0.054, **Conditional R^2** = 0.662

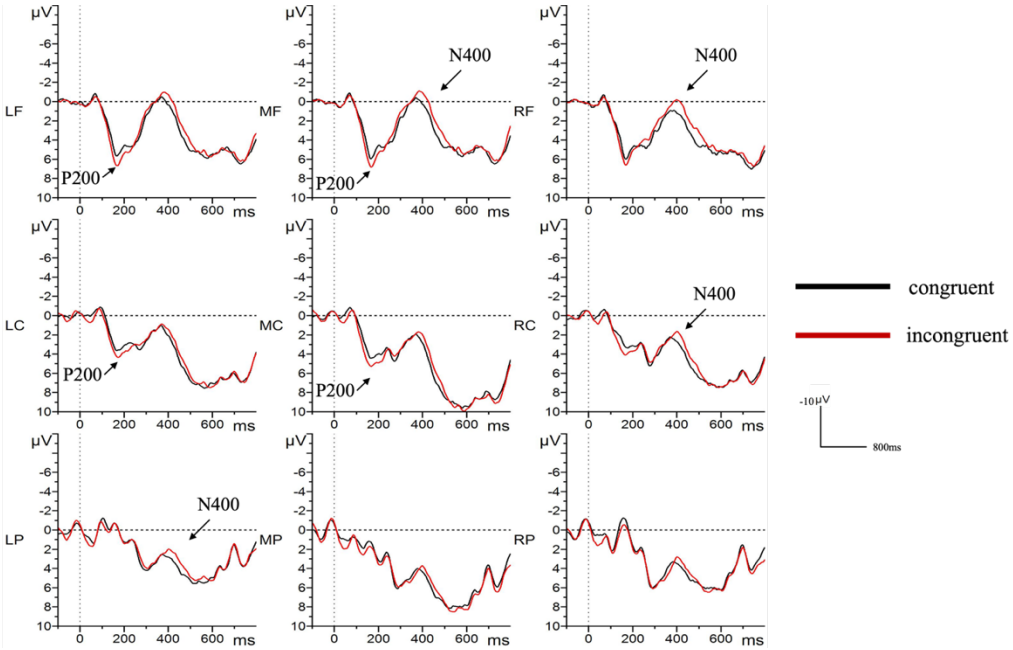

Figure 3.2. Grand average ERPs time-locked to the onset of target nouns in congruent and incongruent conditions for each ROI.

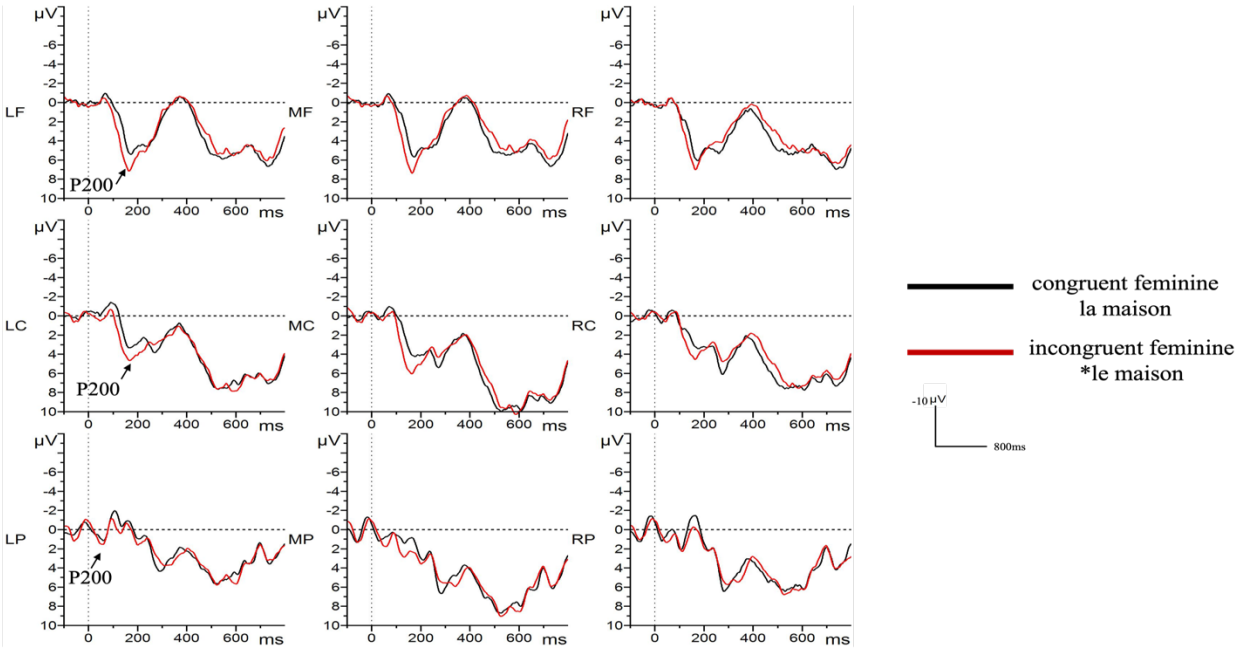

Figure 3.3. Grand average ERPs time-locked to the onset of feminine nouns in congruent and incongruent conditions for each ROI.

3.3 Discussion

The goal of the current study was to identify the neural underpinnings associated with grammatical gender processing. Moreover, focus was placed on examining whether there are

differences between the processing of masculine and feminine nouns when preceded by informative and uninformative gender cues. It was found there are indeed differences in the processing mechanisms that are employed. The expected outcome was to observe an N400 effect to incongruent conditions across the scalp. Interestingly, a disparity between genders was found, in that feminine nouns elicit a P200 when the preceding determiner is incongruent (**le maison*).

P200

Incongruent conditions collapsed across gender, as well as incongruent feminine noun conditions, showed an increased positivity around 200 ms post-noun onset over left ROIs. This finding was unexpected, as early positivities are seldom explored in grammatical gender processing. Often when found in language-related studies, the P200 is related to lexical processing, specifically the effects of orthographic form (e.g., Barnea & Breznitz, 1998; Guo et al., 2012; Lui et al., 2003) and semantic monitoring and judgement (e.g., Misra & Holcomb, 2003; Thierry & Wu, 2007). Guo et al. (2012) studied Chinese-English bilinguals' access to translated word meanings. Participants were presented with English-Chinese word pairs which consisted of correct and incorrect translations. Among the incorrect translations were *translation form distractors*, which were comprised of English words (e.g., sugar) paired with a different Chinese word that is pronounced similarly to the Chinese translation of the English word and partially overlaps in orthography with the translation equivalent. A P200 was found for these items, suggesting participants had to implement additional resources when deciding if the translation was correct.

In relation to grammatical gender, Courteau et al. (2013) observed a statistical trend for an early positivity in children which lasted over multiple time-windows. This finding was attributed to immature gender representation in children; however, this does not seem to be the case with the

current findings. The current study investigates adults with a mature and established gender system; thus the observed positivity cannot be related to a system that is not completely acquired.

Gosselin and Sabourin (2021) analyzed an early time-window (200 – 300 ms) with the anticipation and discovery of an N400 or LAN. Contrary to the current study, they found a broadly distributed negativity to incongruent French DPs compared to congruent conditions. This negativity was also observed for incongruent feminine conditions in relation to congruent feminine conditions. The discrepancy between these results and the results of the current study may be due to the contextual environment in which the stimuli were presented. Gosselin and Sabourin provided participants with congruent and incongruent conditions embedded in a syntactic context. The incongruencies were presented near the end of the sentence, at which point, the participant had already begun parsing and interpreting the sentences they were reading. It is likely due to the ongoing parsing and contextualization of the DP that participants show a negativity reflective of the integration of incongruencies into the syntactic context. In contrast, the P200-like effect observed in the current study may be related to the use of additional cognitive resources. As previously discussed, when speakers are presented with a feminine determiner, they narrow their noun possibilities to include only feminine nouns, resulting in ease of processing for congruent feminine conditions. When a masculine determiner precedes a feminine noun, they begin with a wider scope of possible nouns, and to access the correct noun they must narrow in on only the feminine nouns. It is important to note that speakers begin with the same scope of possibilities when presented with a congruent masculine DP. However, in the case of the incongruent masculine determiner and feminine noun, speakers are required to narrow in on a noun of the opposite gender from the determiner. Thus, they are likely relying on additional cognitive resources to re-evaluate their lexical access and eliminate the irrelevant congruent possibilities.

Another possibility is that the P200 is reflective of a lexical clash that remains permissible, thus there is no difficulty in processing. Despite masculine determiners being argued to be acceptably used with both feminine and masculine nouns, the mismatch between determiner and noun is recognized in the earlier stages of processing. Due to the broad usage of masculine determiners, there is no later effect of processing difficulty.

Broad negativity

Many previous studies have analyzed grammatical gender DP processing by collapsing across genders and evaluating congruent versus incongruent conditions. Often, a LAN, N400, or a combination of the two distributions are found for incongruent DPs collapsed across genders (e.g., Barber & Carreiras, 2005; Molinaro et al., 2008; Wicha et al., 2004). The results of the current study contribute to this literature, in that a wide-spread negativity was found to incongruent conditions collapsed across gender in the 300 – 500 ms time-window. Here the effect is referred to as an N400-like effect, similar to that of Gosselin & Sabourin (2020). The observed effect falls in line with a more classic N400 observed over central parietal regions, however, it is also frontal, thus, the N400-like effect is argued to reflect a mismatch in prediction expectancies and integration difficulty when speakers are expecting a gender-matching noun to follow the correct determiner. When a speaker's predictions are met, there is no difficulty in processing the congruent conditions. However, when these predictions fail, speakers show difficulty with morphosyntactic integration.

Results among previous studies exhibit a discrepancy in observed effects to congruent and incongruent conditions. Molinaro, Barber, & Carreiras (2011), discuss various studies in relation to predictive processing and speculate that the differences between studies that have found a LAN (e.g., Barber & Carreiras, 2005; Caffarra et al., 2015) and those that have found a negativity that

blurs the line between a LAN and an N400 (e.g., Molinaro et al., 2008), is due to the experimental task. Barber & Carreiras solely utilized transparent Spanish nouns, whereas Molinaro and co-workers included irregular Italian nouns but manipulated phonological determiner regularity. French consists of an opaque gender system, with minimal association between gender and phonological suffixes, and it is seen that the results more closely align with the N400-like effect observed for irregular Italian determiners with correct/incorrect nouns. Due to the lack of association between the gender of the noun and the composition of the noun itself, this finding is likely due to the reliability of gender cues. When incongruencies arise, the cue that was provided is rendered unreliable and incorrect, resulting in a processing error where participants have difficulty integrating the incongruent noun. As discussed in Chapter 1, French has a high level of co-occurrence between determiners and nouns, therefore, the observed effect may be reflective of a co-occurrence violation. When the D-N is of opposite genders, co-occurrence expectancies are violated, and require additional processing.

The absence of an N400 for separate genders

An N400-like effect was found for incongruent conditions collapsed across genders, however, an N400 was expected for incongruent masculine and feminine conditions but was not found. The lack of an effect upon disentangling gender is perhaps not surprising, as researchers have argued that there is little evidence in favour of the N400 being reflective of processing costs associated with prediction errors. Further, the N400 is often associated with processing of semantic context that facilitates or inhibits processing. However, when the context is not semantically related, an N400 is less likely to occur (Van Petten & Luka, 2012). For instance, a misleading semantically unrelated context, which can elicit effects pertaining to prediction errors (e.g., a

feminine determiner preceding a masculine noun). Yet, as discussed in Chapter 1, the N400 can be found with words in isolation or pairs of words outside of a greater syntactic and semantic context. Perhaps a traditional N400 will only be observed across and between genders when DPs are integrated into a syntactic framework with additional preceding semantic information, which would be in line with previous grammatical gender findings (e.g., Wicha et al., 2004).

The default masculine

The current results provide do not provide evidence in support of the default masculine notion in French, however, it does provide evidence for processing differences between genders with the presence of a P200 to the incongruent feminine condition. As previously mentioned, this effect is thought to be reflective of lexical clash or narrowing in on the relevant noun. Due to the unmarked nature of the masculine gender, it is more flexible in its use in a variety of situations (see Chapter 1-section 1.2 for further discussion). The lack of processing difficulty for incongruent feminine combinations is expected, as it is more acceptable to use masculine determiners with masculine and feminine nouns. Thus, speakers are likely expecting either a masculine *or* feminine noun to follow the determiner. When it is an incongruently marked noun, there is a clash.

The lack of effect to the incongruent masculine condition is required to be discussed here, as negativity was expected due to the presence of a masculine noun following a feminine determiner, which would provide evidence for a default masculine system. Interestingly, Gosselin and Sabourin also did not find an effect for the incongruent masculine condition. These findings may be related to the noun itself and the idea that the masculine noun is syntactically unmarked. Previous studies argue that marked items require more processing effort, as shown in behavioural (e.g., Domínguez et al., 1999; Deutsch & Bentin, 2001), and ERP studies (e.g., Deutsch & Bentin,

2001; Aleman Banon & Rothman, 2016). Thus, perhaps, speakers are not showing use (or lack thereof) of grammatical gender information from the determiner but showing effects of markedness on the feminine noun when it is preceded by an unmarked determiner. Another possibility is that masculine nouns are highly expected in general due to their default notion and speakers are not relying on the relationship between the presented D-N. In this case, there is no observable N400 to the incongruent masculine condition due to the expectancy and processing of the noun itself.

3.4 Conclusion

The current study aimed to explore the underlying neural mechanisms associated with predictive grammatical gender processing. It was found that incongruent conditions regardless of gender elicited a P200 as well as a widespread negativity around 400 ms post-noun onset, consistent with previous studies on gender congruency. Incongruent feminine conditions elicited a P200, which is thought to be reflective of lexical processing. While incongruent masculine conditions did not show any effect. These findings demonstrate that there are distinct processing mechanisms employed for feminine nouns among native speakers. Therefore, it is important to keep these differences in mind when studying processing and grammatical gender. The possibility of speakers using additional cognitive resources is an avenue for further research, as general cognitive abilities may interact with linguistic processing (see Chapter 4).

CHAPTER 4

STUDY 3: GENDER PROCESSING AND INHIBITION

In Chapter 2 of this dissertation, L1 and L2 French speakers were shown to not exhibit any use of grammatical gender cues behaviourally at a lexical level. As discussed, this was an unexpected finding, but perhaps not entirely surprising due to the nature of the task. Much of the previous research on grammatical gender processing where effects of congruency have been found embeds DPs or ADJ-N into a larger syntactic context. Sentential stimuli are more reflective of the language used in speakers' day-to-day lives, thus making it a more ecologically valid approach to investigate processing mechanisms. Further, researchers are increasingly including non-linguistic cognitive methods alongside linguistic-based tasks to investigate potential correlations between general cognitive abilities and language processing and production. In particular, inhibition suppression and lexical knowledge have been shown to correlate with neural responses in grammatical gender congruencies and incongruencies in L1 speakers (Beatty-Martínez et al., 2020) and other aspects of linguistic competition (Ibbotson & Kearvell-White, 2015). Thus, the combination of contextual information and lexical knowledge may provide insight into if or how grammatical gender cues are used.

The current study aims to explore the following question: Is there a relationship between grammatical gender processing and individual differences in cognitive abilities and/or lexical knowledge in L1 and L2 French speakers? Emphasis is placed on how responses to both genders correspond with inhibition suppression on an AX-CPT and lexical performance in a VF task, and whether there is a difference between L1 and L2 processing. Based on the relationship between grammatical gender comprehension performance and inhibitory control (Beatty-Martínez et al.,

2020), it is expected that speakers who show better inhibition (quicker RTs) on an AX-CPT will have faster RTs for incongruent masculine DPs (e.g., *la*$_{F}$ *bateau*$_{M}$). This is anticipated for the incongruent masculine condition specifically because there is a high level of prediction for a feminine noun to follow a feminine determiner in French. When this is violated, speakers must re-evaluate and remedy the error. If speakers have better inhibitory control in non-linguistic contexts, they can likely implement those same mechanisms when faced with a linguistic prediction error. In contrast, speakers with lower inhibitory control are expected to show longer RTs, reflective of increased processing difficulty.

Participants with a lower lexical knowledge, measured via a VF task, are expected to show shorter RTs to feminine incongruencies (e.g., *le*$_{M}$ *maison*$_{F}$). As masculine is argued to be the default gender, it is likely the case that speakers who have a low level of lexical knowledge will rely more on this default notion and accept incongruencies quicker than those with high lexical knowledge. Therefore, speakers with a higher lexical knowledge will show slower RTs as they re-evaluate the incongruency. Overall, L2 speakers are expected to show slower RTs than their L1 counterparts.

The remainder of the chapter is structured as follows: section 4.1 includes methodological information (participants, stimuli and design, procedure, and statistical design). Section 4.2 reports the results, followed by the discussion in section 4.3. Concluding remarks are presented in section 4.4.

4.1 Methodology

4.1.1 Participants

Seventy-three (51 female, 1 non-binary) participants were included in the final analysis. This population was comprised of 31 L1 French speakers, 16 simultaneous French-English bilinguals,

and 26 L1 English-L2 French speakers. All L2 speakers acquired French before the age of 11 and learned the L2 in a school environment. As emphasis is placed on inhibition and verbal fluency, there was no threshold for L2 speaker proficiency. All L2 speakers that were above the accuracy thresholds for each task were included in the analysis (see section 4.1.4). Proficiency was not included as a factor in the statistical analysis, as the majority of participants did not complete the administered cloze proficiency measure. Despite this, each speaker provided self-rated proficiency for both English and French, resulting in a range of French proficiency. Participants were asked to rate themselves on a scale of 0–5 (very low – native proficiency) for reading, writing, oral, pronunciation, and comprehension for both languages[18]. The average of their responses resulted in a score for each participant out of 5 (see Table 4.1 for a complete participant breakdown). All participants were recruited through the University of Ottawa psychology participant pool for partial class credit. Aside from French, speakers included for analysis had little to no knowledge of another gendered language. An additional 26 participants were excluded due to their L1 being a language other than French or English.

Table 4.1. *Complete participant breakdown.*

Self-rated proficiency was calculated based on participants' responses to their level of proficiency in reading, writing, oral, pronunciation, and comprehension.

Group	N	*M* age	*M* self-rated French proficiency (/5)	*M* self-rated English proficiency (/5)	*M* Age of Immersion (L2)
L1 French	31	19.72	4.9	4.2	N/A
Simultaneous bilinguals	16	18.86	4.7	4.8	N/A
L2 French	26	19.24	3.8	4.8	3.1

[18] Self-rated proficiency is common in L2 research. In particular, previous studies on grammatical gender processing among L2 speakers have implemented this type of proficiency threshold (e.g., Lew-Williams & Fernald, 2010).

4.1.2 Stimuli and design

Self-paced reading

Two hundred semantically low-constrained sentences were created using a subset of the masculine and feminine French nouns (50 masculine, 50 feminine) from the experiment in Chapter 2 and sentences from Burkholder (2018; also used in Gosselin & Sabourin, 2021). Each noun was paired with a masculine (*le*) and feminine (*la*) definite determiner, resulting in four experimental conditions; congruent masculine, incongruent masculine, congruent feminine, and incongruent feminine (see Table 4.2). Nouns varied in frequency (2.26 - 727.26 parts per million) according to Lexique 3, a lexical database of French words (New et al., 2001). Despite frequency variation, there was no difference between masculine and feminine nouns ($p = 0.64$). No cognates or animate nouns were included as experimental items. Forty filler sentence pairs were created. Each pair was comprised of the syntactically correct sentence and its counterpart containing syntactic/morphosyntactic violations unrelated to grammatical gender. Comprehension questions related to the context of the sentence (e.g., *Eric a-t-il acheté un livre en juin?,* "Did Eric buy a book in June?") followed 60% of trials.

Table 4.2. *Example of experimental and filler conditions*. The target nouns and determiners are bolded in example sentences.

Condition	Determiner gender	Noun gender	Example sentence	English translation
Congruent masculine	Masculine	Masculine	Eric a acheté trois livres pendant **le mois** de mai.	Eric bought three books during the month of May.
Incongruent masculine	Feminine	Masculine	Eric a acheté trois livres pendant **la mois** de mai.	
Congruent feminine	Feminine	Feminine	Dominic a vu le village par **la fenêtre** de l'autobus.	Dominic saw the village from

Incongruent feminine	Masculine	Feminine	Dominic a vu le village par **le fenêtre** de l'autobus.	the window of the bus.
Filler – grammatical	-	-	Xavier a lavé ses mains avant de manger son souper.	Xavier washed his hands
Filler - ungrammatical	-	-	Xavier a lavé ses **main** avant de manger son souper.	before eating his dinner.

Participants were randomly assigned to one of two lists and saw one sentence from each sentence pair across experimental and filler conditions for a total of 140 sentences (25 congruent feminine, 25 congruent masculine, 25 incongruent feminine, 25 incongruent masculine, 20 grammatical fillers, 20 ungrammatical fillers). Within each list, there were four blocks of 35 sentences. Sentences were pseudorandomized with no more than 3 iterations of the same condition in a row, and an additional 4 practice sentences were included as practice trials. A complete list of stimuli items can be found in Appendix F.

AX-CPT

Uppercase letters of the alphabet were used in the AX-CPT. The letters A, B (cues), X, and Y (probes) were displayed in red with all other letters in black. Each participant saw a total of 100 trials. Each trial consisted of a red cue (e.g., A) followed by 3 randomized black letter distractors (e.g., I, W, H) and a red probe (e.g., X). 80% of trials were comprised of an A cue, and 70% of trials were constructed of an AX cue-probe combination. This distribution is intended for the A cue to serve as a predictive function. The remaining 30% of trials (10 each) consisted of AY, BX, and BY cue-prob combinations. Trials were randomized and split across 2 blocks. An additional 6 practice trials were included.

Verbal fluency

The VF task consisted of 8 semantic categories: animals, parts of the body, clothing, colours, musical instruments, vegetables, fruits, and tools. Participants completed 1 of 4 lists, which contained a total of 4 distinct categories. Categories were randomized across lists and were written on the screen to prompt the participant to respond verbally.

4.1.3 Procedure

Participants completed the study via Gorilla Experiment Builder (www.gorilla.sc; Anwyl-Irvine et al., 2020). Prior to completing the experiment and questionnaires, participants were asked whether their first language was English or French. The response to this question dictated the language in which the consent form and LBQ were presented to them. The majority of L1 French speakers completed the paperwork in French, with the exception of a number of speakers who were simultaneously bilingual and chose to complete the English paperwork. All L2 speakers completed the English paperwork. Participants then completed each task with self-timed breaks in between (Figure 4.1 illustrates each task and the overall procedure). The first task completed was the AX-CPT, where they saw a series of letters appear on the screen one at a time. Each trial began with a red letter cue (A or B), followed by 3 random black letters (e.g., I, W, H) and ended with a red letter prob (X or Y). Each letter appeared on the screen for 300 ms. When the probe was presented, participants were instructed to respond based on whether the two red letters were an AX combination (yes) or any other combination of letters (no). After the AX-CPT, participants completed the SPR task where they read sentences one word at a time in a self-paced manner via a button press. At the end of 60% of the sentences, they were prompted to respond to a comprehension question. Next, participants did the VF task, which began with a microphone

calibration procedure to ensure that auditory responses were being recorded. Each trial consisted of a screen with an image of a microphone and a semantic category written out. The microphone prompted participants to begin naming as many items as possible within the relevant semantic category. The screen disappeared after 35 seconds, and a blank screen was presented for 3 seconds before the next trial. Participants then completed the French cloze task.

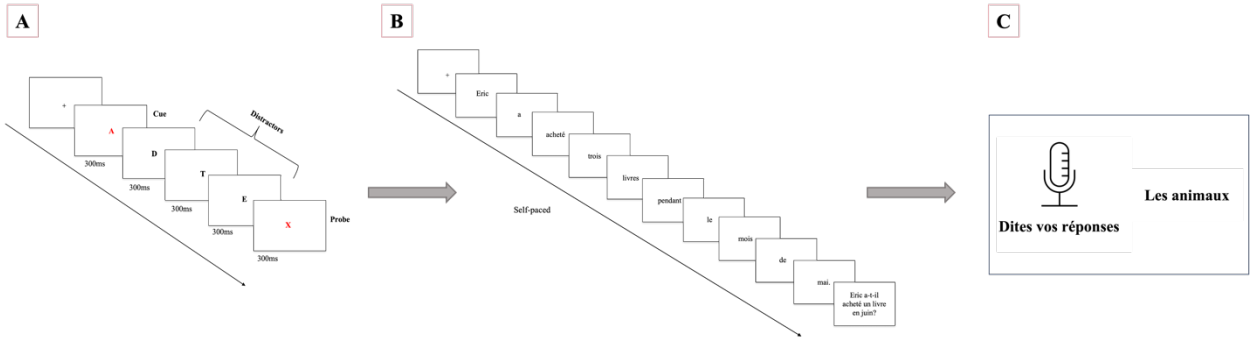

Figure 4.1. The procedure of the experimental tasks. A) Sequence for the AX-CPT. B) Trial sequence for the SPR task. C) Example screen for one semantic category in the VF task.

4.1.4 Statistical design

Data filtering and cleaning

Absolute RT thresholds were implemented for the AX-CPT. Trials below 100 ms and above 1200 ms were excluded. Twenty-one participants (4 L1, 6 simultaneous, 11 L2) were excluded from the AX-CPT analysis due to very high error rates (>45%) across all conditions and/or no correct trials in one or more conditions, suggesting that they did not accurately complete the task or misunderstood the instructions. An additional 2 participants (L2) were excluded from the AX-CPT, as they were excluded from the SPR analysis due to low accuracy rates. All participants who were included in the final analysis completed both the AX-CPT and the SPR tasks. The criteria were put in place to accurately reflect potential correlations between inhibition and predictive processing. Participants who were below 70% accurate on the comprehension questions during the

SPR task were excluded overall – these participants overlapped with those who did poorly on the AX-CPT task, therefore, no additional participants were excluded.

The VF task was not included in the analysis due to overall incompleteness. Over 80% of participants either did not complete the task, or it was completed incorrectly. For these reasons, a decision was made to not include the few data points that were collected, as there was not enough data to make an accurate comparison between lexical knowledge and predictive processing.

RTs for each word in the SPR task were measured, however, only the critical word (CW) and the word preceding (PreCW) and following (PostCW) the CW are included in the analysis (illustrated in Table 4.3). The PreCW is consistently the determiner associated with the noun. The PostCW word is included to investigate any potential spill-over effects, which refers to the idea that comprehension difficulty can "spill-over" to the element following the critical item, resulting in slower RTs on the PostCW (Jegerski, 2014). Trials with RTs below 100 ms and above 3000 ms to each word were excluded from the analysis. Means for each condition for each participant were calculated and responses that were 2.5 SDs from the mean were excluded. Approximately 10% of the data was excluded based on this criterion.

Table 4.3. *Example sentences highlighting the three words used in the analysis.*

Condition	Example sentence	PreCW	CW	PostCW	English translation
Congruent masculine	Eric a acheté trois livres pendant **le mois de** mai.	le	mois	de	Eric bought three books during the month of May.
Incongruent masculine	Eric a acheté trois livres pendant **la mois de** mai.	la	mois	de	
Congruent feminine	Dominic a vu le village par **la fenêtre de** l'autobus.	la	fenêtre	de	Dominic saw the village from the window of the bus.
Incongruent feminine	Dominic a vu le village par **le fenêtre de** l'autobus.	le	fenêtre	de	

SPR analysis

A Linear Mixed Model (LMM) analysis was conducted in R (R Core Team, 2022) using the lme4 package (Bates et al., 2015). The model included Noun gender (masculine or feminine), Congruency (congruent or incongruent determiner), Group (L1, simultaneous, L2), and Word (PreCW, CW, PostCW) were included as fixed effects, and participant and item were included as random effects. Fixed effects were deviation coded (i.e., sum-to-zero contrasts). The continuous dependent variable was the mean RT to each word. If there was a significant main effect or interaction including congruency and/or noun gender with language group or word, planned pairwise comparisons (confidence level (CI) = 0.95) were conducted by examining estimated marginal means with the emmeans package in R (Lenth, 2022). Only significant interactions including the factor of congruency and/or noun gender are discussed in the results to investigate differences between conditions. Due to the contrast coding scheme, the models include two contrasts for each of the fixed factors of Group and Word. These contrasts compare the present factor level with the grand mean of all levels of that specific factor. Thus, contrast 1 for Group compares the level of L1 to the grand mean of Group, and contrast 2 compares the level of simultaneous to the grand mean. For Word, contrast 1 and 2 compare the levels of CW and PostCW to the grand mean respectfully. Due to technical issues with recording RTs, four trials were excluded from the analyses for all participants (one incongruent feminine, two congruent masculine trials, and one incongruent masculine trial from each participant).

Correlation between AX-CPT and SPR

Prior to conducting the correlation analyses, an LMM was run to investigate any differences between conditions and language groups for the AX-CPT. The model included Group (L1,

simultaneous, L2), and Condition (AX, AY, BX, BY) as fixed effects, with RT to the probe as the dependent variable. Participant was included as a random effect. Fixed factors were contrast coded, thus, Group consisted of two contrasts (contrast 1 = L1 compared vs. mean, contrast 2 = simultaneous vs. mean) and Condition three contrasts (contrast 1 = AX vs. mean, contrast 2 = AY vs. mean, contrast 3 = BX vs. mean). Focus is placed on the AY versus AX conditions to evaluate prediction errors. AY versus BY conditions are investigated using BY as a baseline to analyze cue bias. More specifically, to see whether the A impacts inhibition of the Y probe (Beatty-Martínez et al., 2020; Zirnstein et al., 2018). To investigate the correlation between participants' inhibition performance and grammatical gender processing, emphasis was placed on participants' average RT to the AY condition. The AY condition is reflective of prediction recovery, as participants are expecting an X due to the distributional properties of the task – similar to the allowable use of the masculine determiner with masculine and feminine nouns. Thus, the relationship between participants' average RT to the AY condition and the average RT to incongruent masculine and incongruent feminine conditions was explored. Analyses for each group (L1, simultaneous, and L2) were conducted.

4.2 Results

4.2.1 Self-paced reading

Table 4.4 includes a summary of the RT and SD data for each group, word, and condition and a subset of the complete model output is presented in Table 4.5 and the complete model can be found in Appendix G.

Table 4.4. *SPR RT summary for each group, language, and word position.*

Group	Condition	Word position	*Mean* RT (ms)	RT *SD*
L1	Congruent masculine	PreCW	325.88	111.95
		CW	337.55	122.64
		PostCW	337.45	113.11
	Incongruent masculine	PreCW	332.05	116.90
		CW	345.01	141.20
		PostCW	378.68	144.07
	Congruent feminine	PreCW	321.57	116.58
		CW	332.28	124.63
		PostCW	335.45	111.19
	Incongruent feminine	PreCW	340.24	115.75
		CW	369.41	165.62
		PostCW	383.02	144.23
Simultaneous	Congruent masculine	PreCW	342.74	110.64
		CW	344.12	113.17
		PostCW	343.40	103.64
	Incongruent masculine	PreCW	340.86	104.87
		CW	354.01	134.45
		PostCW	376.40	131.07
	Congruent feminine	PreCW	325.84	93.52
		CW	332.28	97.62
		PostCW	342.82	106.88
	Incongruent feminine	PreCW	350.21	106.51
		CW	365.39	133.52
		PostCW	396.16	143.16
L2	Congruent masculine	PreCW	340.70	105.68
		CW	344.60	127.51
		PostCW	353.31	107.49
	Incongruent masculine	PreCW	350.50	108.57
		CW	353.50	140.33
		PostCW	358.79	121.12
	Congruent feminine	PreCW	337.61	101.87
		CW	344.56	115.29
		PostCW	347.28	113.19

Incongruent feminine	PreCW	356.49	117.15
	CW	361.70	134.02
	PostCW	364.66	119.66

Table 4.5. *Reduced SPR linear mixed model output.*

Predictors	Estimates	95% CI	*t*-value	*p*-value
(Intercept)	351.60	329.24 – 374.00	30.80	**<0.001**
Congruency	-11.06	-12.25 – -9.87	-18.21	**<0.001**
Noun gender	1.04	-6.10 – 8.18	0.29	0.78
Group [1]	-3.99	-31.91 – 23.92	-0.28	0.78
Group [2]	2.65	-30.31 – 35.61	0.16	0.88
Congruency*Noun gender	-4.54	-5.73 – -3.35	-7.47	**<0.001**
Congruency*Group [1]	-2.07	-3.65 – -0.50	-2.59	**0.01**
Congruency*Group [2]	-3.10	-4.95 – -1.25	-3.29	**0.001**
Congruency*Word [1]	0.88	-0.81 – 2.56	1.02	0.30835
Congruency*Word [2]	-5.93	-7.61 – -4.25	-6.91	**<0.001**
Congruency*Noun gender*Word [1]	-0.88	-2.57 – 0.80	-1.03	0.30
Congruency*Noun gender*Word [2]	1.56	-0.12 – 3.24	1.82	0.07
Congruency*Group [1]*Word [1]	0.48	-1.74 – 2.70	0.42	0.67
Congruency*Group [2]*Word [1]	0.61	-2.00 – 3.22	0.46	0.65
Congruency*Group [1]*Word [2]	-2.54	-4.75 – -0.32	-2.25	**0.02**
Congruency*Group [2]*Word [2]	-2.85	-5.45 – -0.24	-2.14	**0.03**
Noun gender*Group [1]*Word [1]	1.91	-0.31 – 4.12	1.68	0.09
Noun gender*Group [2]*Word [1]	-1.25	-3.86 – 1.36	-0.94	0.35
Noun gender*Group [1]*Word [2]	-1.70	-3.92 – 0.51	-1.51	0.13
Noun gender*Group [2]*Word [2]	3.28	0.68 – 5.89	2.47	**0.01**
Congruency*Noun gender*Group [1]*Word [1]	-2.42	-4.64 – -0.20	-2.14	**0.03**
Congruency*Noun gender*Group [2]*Word [1]	0.22	-2.38 – 2.83	0.17	0.87
Congruency*Noun gender*Group [1]*Word [2]	1.36	-0.86 – 3.57	1.20	0.23
Congruency*Noun gender*Group [2]*Word [2]	-0.30	-2.90 – 2.31	-0.22	0.82

Marginal R^2 = 0.017, **Conditional R^2** = 0.583

An effect of Congruency (β = -11.06, t = -18.21, p <0.001) was found with congruent conditions showing faster RTs than incongruent conditions collapsed across all word positions and language groups. Congruency interacted with Language contrast 1 and Word contrast 2 (β = -2.54, t = -2.25, p = 0.02), as well as with Language contrast 2 and Word contrast 2 (β = -2.85, t = -2.14, p = 0.03). Pairwise comparisons indicate that L1 speakers were significantly faster on congruent conditions versus incongruent conditions (Figure 4.2) at the PreCW (β = -12.05, z = -3.85, p = 0.01), CW (β = -23.57, z = -7.53, p <.0001) and PostCW (β = -43.21, z = -13.83, p <.0001). Simultaneous speakers were quicker on congruent conditions compared to incongruent (Figure 4.3) at the CW (β = -25.36, z = -5.87, p <.0001) and PostCW (β = -45.89, z = -10.66, p <.0001). The L2 speakers were quicker on congruent conditions compared to incongruent (Figure 4.4) at the CW (β = -12.20, z = -3.57, p = 0.04) and PostCW (β = -12.86, z = -3.81, p = 0.02).

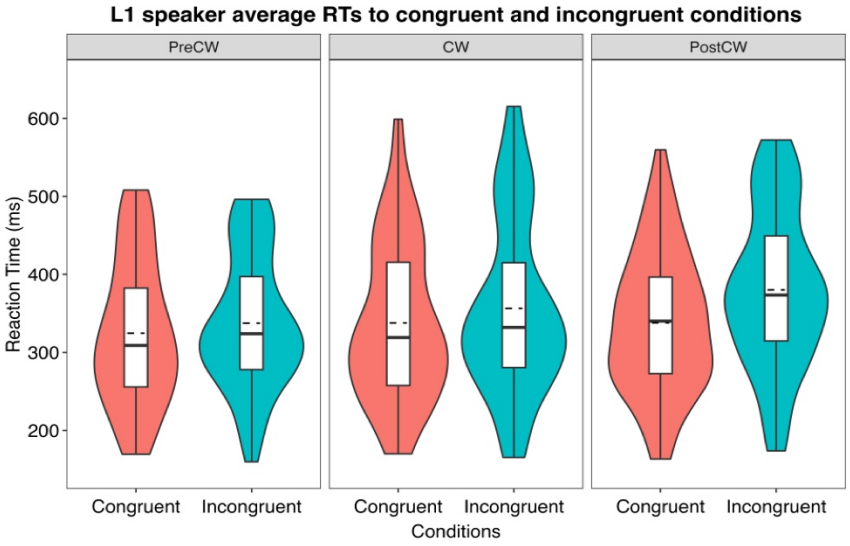

Figure 4.2. L1 speakers average RT to congruent and incongruent conditions. Dotted line = mean, solid line = median.

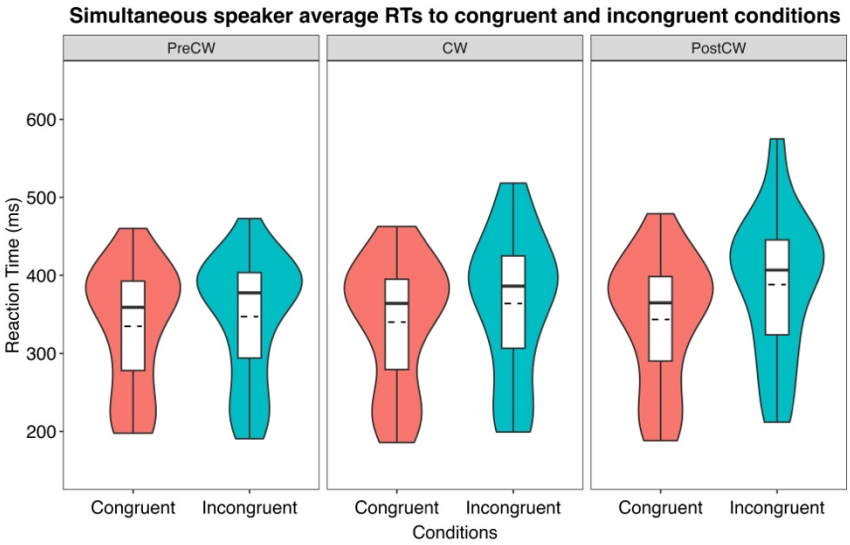

Figure 4.3. Simultaneous speakers average RT to congruent and incongruent conditions. Dotted line = mean, solid line = median.

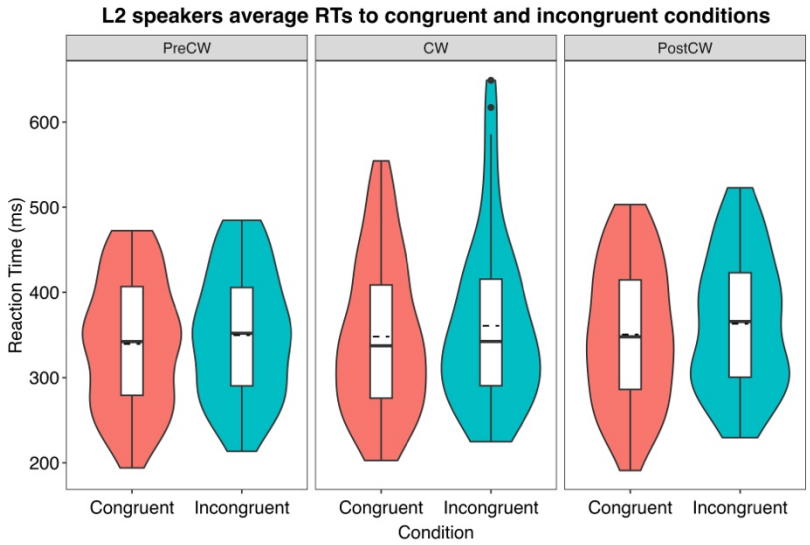

Figure 4.4. L2 speakers average RT to congruent and incongruent conditions. Dotted line = mean, solid line = median.

Noun gender interacted with Language contrast 2 and Word contrast 2 ($\beta = 3.28, z = 2.47, p = 0.01$), however, post-hoc comparisons did not highlight any significant differences between relevant conditions.

An interaction between Congruency, Noun gender, Group contrast 1, and Word contrast 1 was found ($\beta = -2.42$, $z = -2.14$, $p = 0.03$). Pairwise comparisons indicate that L1 speakers exhibited faster RTs to congruent feminine conditions versus incongruent feminine at the PreCW ($\beta = -20.27$, $z = -4.60$, $p = 0.002$), CW ($\beta = -39.19$, $z = -8.92$, $p < .0001$), and PostCW ($\beta = -46.38$, $z = -10.57$, $p < .0001$), as well as quicker RTs to congruent masculine compared to incongruent masculine conditions at the PostCW ($\beta = -40.03$, $z = -9.01$, $p < .0001$). The masculine result is indicative of potential spill-over effects with slower RTs to the incongruent masculine condition (Figure 4.5).

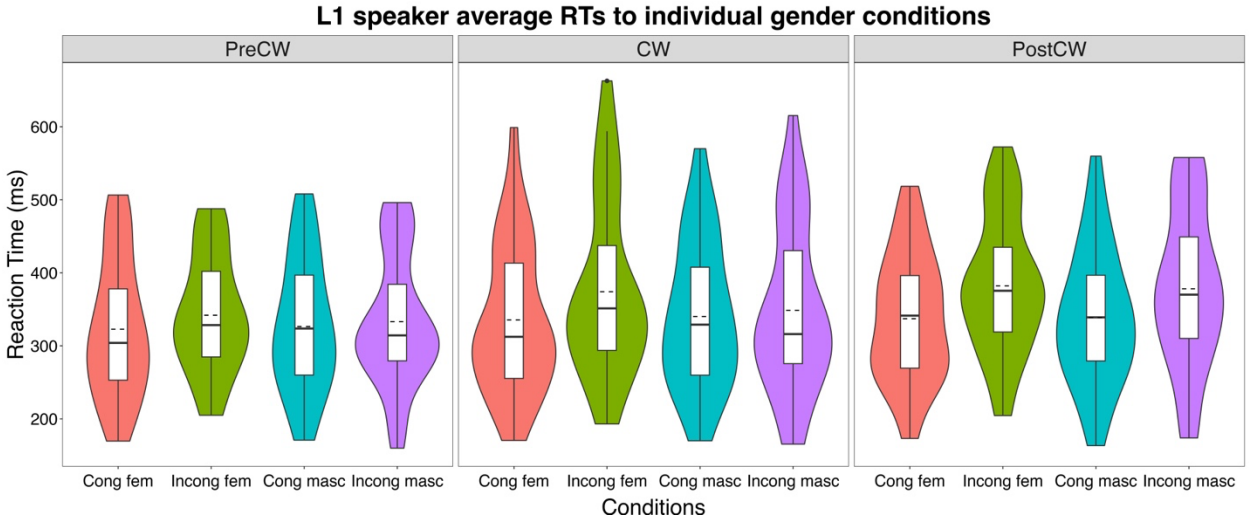

Figure 4.5. L1 speakers average RT to individual gender conditions. Cong fem = congruent feminine, Incong fem = incongruent feminine, Cong masc = congruent masculine, Incong masc = incongruent masculine. Dotted line = mean, solid line = median.

Simultaneous speakers showed quicker RTs to congruent feminine conditions versus incongruent feminine at the PreCW ($\beta = -26.39$, $z = -4.37$, $p = 0.006$), CW ($\beta = -38.11$, $z = -6.27$, $p < .0001$), and PostCW ($\beta = -54.80$, $z = -9.06$, $p < .0001$), as well as quicker RTs to congruent masculine compared to incongruent masculine conditions at the PostCW

(β = -36.97, z = -6.04, p <.0001). Similar to L1 speakers, the masculine result is indicative of potential spill-over effects with slower RTs to the incongruent masculine condition (Figure 4.6).

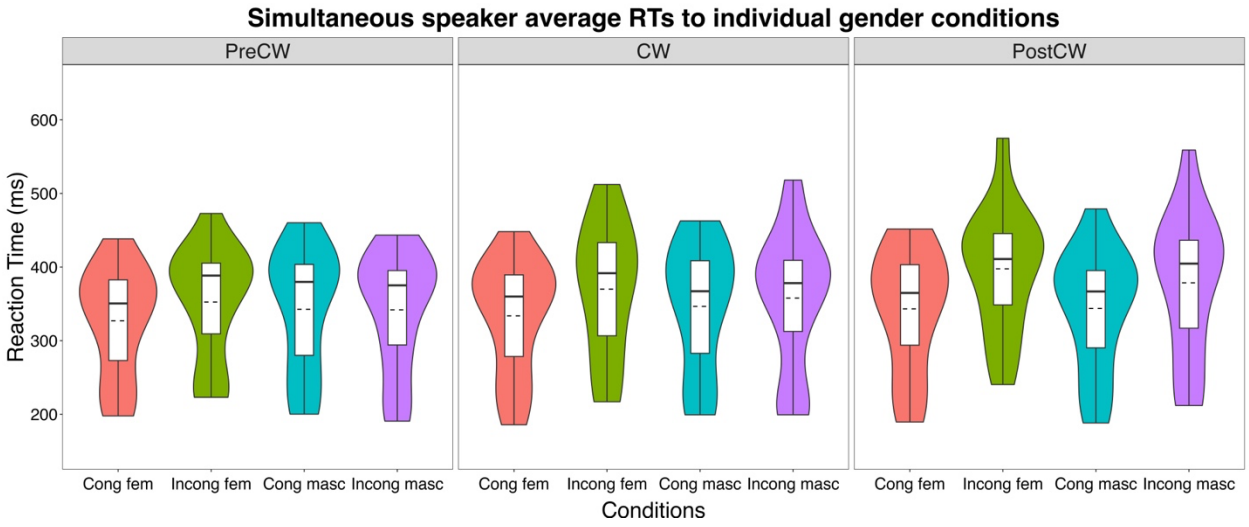

Figure 4.6. Simultaneous speakers average RT to individual gender conditions. Cong fem = congruent feminine, Incong fem = incongruent feminine, Cong masc = congruent masculine, Incong masc = incongruent masculine. Dotted line = mean, solid line = median.

L2 speakers show faster RTs to congruent versus incongruent feminine conditions at the PreCW (β = -20.69, z = -4.35, p = 0.007), and PostCW (β = -18.68, z = -3.93, p = 0.04; Figure 4.7).

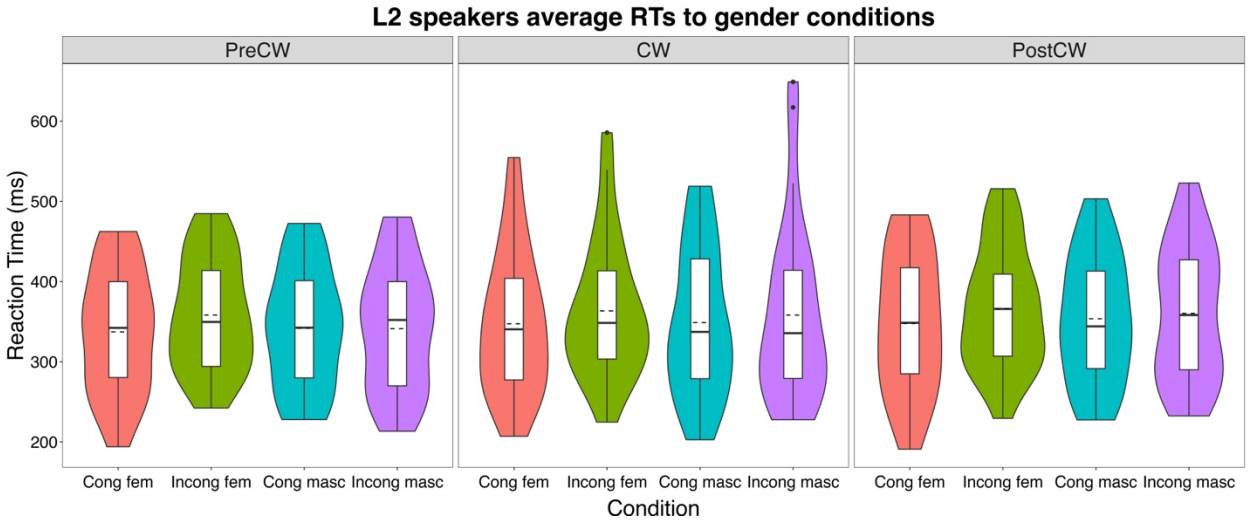

Figure 4.7. L2 speakers average RT to individual gender conditions. Cong fem = congruent feminine, Incong fem = incongruent feminine, Cong masc = congruent masculine, Incong masc = incongruent masculine. Dotted line = mean, solid line = median.

4.2.2 AX-CPT results

Table 4.6 presents the mean RT, mean error rate, and overall associated SDs for each group and condition of the AX-CPT. A complete LMM output can be found in Appendix G. Interactions between the Group and Condition contrasts were observed (Condition 1*Language 1: $\beta = 13.93$, $t = 3.21$, $p = 0.001$; Condition 2*Language 1: $\beta = 14.45$, $t = 2.07$, $p = 0.04$; Condition 3*Language 1: $\beta = -16.59$, $t = -2.4$, $p = 0.02$). Pairwise comparisons indicate that AY conditions are significantly longer than AX conditions for all language groups (L1: $\beta = -146.09$, $z = -14.44$, $p < .0001$; simultaneous: $\beta = -152.78$, $z = -11.02$, $p < .0001$; L2: $\beta = -137.81$, $z = -12.63$, $p < .0001$). AY RTs were also slower than BY for all groups (L1: $\beta = 171.76$, $z = 13.09$, $p < .0001$; simultaneous: $\beta = 145.29$, $z = 8.10$, $p < .0001$; L2: $\beta = 119.51$, $z = 8.40$, $p < .0001$).

Table 4.6. *Mean RT, mean error rate, and SD for each group and each condition of the AX-CPT*

Group	Condition	***Mean*** **RT (ms)**	**RT *SD***	***Mean*** **error rate**	**Error rate *SD***
L1	AX	535.46	113.97	0.03	0.05
	AY	682.50	128.84	0.09	0.11
	BX	481.88	134.88	0.09	0.11
	BY	509.25	128.49	0.03	0.06
Simultaneous	AX	504.55	73.42	0.02	0.03
	AY	660.41	108.85	0.10	0.11
	BX	517.24	141.89	0.08	0.14
	BY	514.23	113.81	0.01	0.03
L2	AX	551.81	94.0	0.03	0.03
	AY	694.74	124.84	0.11	0.14
	BX	535.49	110.86	0.13	0.19
	BY	570.95	115.33	0.05	0.09

4.2.3 Correlation analysis

The correlation analyses between the average AY RTs and responses to the CW in incongruent masculine conditions showed no significant relationship for all language groups (L1: $r = -0.03$, $p = 0.88$; simultaneous: $r = -0.03$, $p = 0.92$; L2: $r = -0.19$, $p = 0.36$) or the PostCW (L1: $r = 0.05$, $p = 0.77$; simultaneous: $r = -0.04$, $p = 0.88$; L2: $r = -0.11$, $p = 0.58$). Similarly, there was no significant relationship between AY and the CW RTs to the incongruent feminine conditions (L1: $r = -0.01$, $p = 0.96$; simultaneous: $r = 0.02$, $p = 0.93$; L2: $r = -0.15$, $p = 0.46$) or the PostCW (L1: $r = 0.05$, $p = 0.79$; simultaneous: $r = 0.05$, $p = 0.87$; L2: $r = -0.16$, $p = 0.43$).

4.3 Discussion

The current study aimed to investigate whether there is a relationship between grammatical gender processing and individual differences in inhibitory control and/or lexical knowledge. It was anticipated that there would be a positive correlation between participants' average RT on the AX

task – in particular, the AY condition – and their performance on incongruent masculine DPs. More specifically, speakers with quicker RTs on the AX task would show faster RTs on the noun of the incongruency, illustrating increased inhibitory control. The results show that there is no correlation between the processing of congruent and incongruent determiner-noun combinations and inhibition across all groups of speakers. However, the individual SPR results highlight a difference between genders for all speakers.

Self-paced reading

Congruent conditions collapsed across genders are responded to quicker than incongruent conditions for all groups. In particular, L1 speakers show faster RTs at each word, simultaneous speakers at the noun and the following word, and L2 speakers on the noun and the word following the noun. This finding is not surprising, as previous studies consistently find differences between congruent and incongruent gender conditions (e.g., Barber & Carreiras, 2005; Bates et al., 1996; Brouwer et al., 2017; Caffarra et al., 2015; Dussias, et al., 2013; Lew-Williams & Fernald, 2010). Differences between congruent and incongruent masculine and feminine conditions yield interesting results. L1 and simultaneous speakers were quicker at the point of the determiner, the noun, and the word following the noun in congruent feminine (*la maison*) sentences versus incongruent feminine (**le maison*) sentences. Faster responses to the feminine determiner are perhaps due to the feminine determiner acting as a more reliable cue due to its restrictive nature. Thus, speakers read the feminine determiner at a faster rate. The effect that was observed on the noun is thought to reflect the speaker's requirement to narrow in on a noun of the opposite gender, resulting in increased processing difficulty when the noun is encountered. Alternatively, speakers acknowledge that the feminine noun is a marked element that was preceded by an unmarked

determiner (see Chapter 3 discussion for further discussion). This may result in an increased cognitive load when processing the feminine noun. In contrast, the congruent masculine (*le bateau*) is seen to be quicker in response to the PostCW in comparison to the incongruent masculine condition (**la bateau*) for both L1 and simultaneous speakers. As discussed in Chapters 2, and 3, masculine is considered to be the default gender in French, and because of this, it is permissible for a masculine determiner to precede both masculine and feminine nouns (e.g., $le_M\ bateau_M$ and $*le_M\ maison_F$), whereas it is less acceptable for a feminine determiner to precede a masculine noun (**la beateau*).[19] Thus, when presented with a feminine-masculine D-N combination, speakers are anticipating a feminine noun. When the expectations are not met, speakers must search for the masculine noun by expanding the number of lexical possibilities and re-evaluating the information to process the sentence. In return, a longer processing route is required, resulting in an increase in processing time, which is then reflected in the RTs on the word following the noun in the sentence.

L2 speakers only demonstrated a difference for individual gender congruency with feminine nouns, where the incongruent feminine condition (**le maison*) is slower than the congruent feminine condition (*la maison*). This effect is significantly seen on the PreCW and the PostCW, however, it is not observed on the CW. The PreCW observation with L2 speakers reinforces the potential for feminine determiners being processed differently than masculine, due to the lack of effect on the CW. Further investigation into this notion is required to tease apart the root cause of this difference. The PostCW effect is likely not an indication of spill-over effects, but conscious processing, where speakers show awareness of the ungrammaticality. This finding is interesting considering the default masculine notion discussed in Chapter 2. It would be expected that the

[19] It is important to note that the acceptability of incongruent feminine combinations (*le maison*) is not necessarily considered grammatical. Arguably, speakers still acknowledge that these occurrences are incorrect, however, they are more lenient with interpretation during comprehension.

incongruent feminine condition would not pose added processing difficulty compared to the incongruent masculine condition, as the masculine determiner is prone to be more tolerable in its use with feminine nouns. A possible explanation for these results is that speakers are more accepting of masculine nouns in general, even when they are incorrectly paired with a feminine determiner. By the time the masculine noun is read, there is no difficulty with integrating it into the sentence at a behavioural level, however, speakers may be using different processing mechanisms, which would need to be further investigated with more fine-tuned measures. For instance, regarding EEGs, speakers may show a LAN-P600 to masculine incongruencies highlighting the initial incorrect nature of the DP followed by the repair that is shown behaviourally. In contrast, when the incongruent feminine noun is read, it is difficult to parse without the highly correlated feminine determiner which regularly accompanies the noun.

There may be alternative reasons as to why there were no effects shown for the incongruent masculine condition in L2 speakers. The first is the possibility that the group of participants included did not possess high enough proficiency for these effects to be seen. However, based on the L2 speaker's average self-rated proficiency in French (3.7/5), participants were considered intermediate to highly proficient. Therefore, their French knowledge should not be the cause of the lack of gender use. Further, there may be other factors, such as the environment in which the L2 was learned, current use of the L2, or language immersion, that play a role in cue use. Lastly, it may be that more sensitive measures are required to investigate this speaker population. Previous studies have implemented techniques such as eye-tracking, which allows researchers to distinguish when difficulties are encountered, as opposed to an after-the-fact response time (e.g., Guillelmon & Grosjean, 2001).

The lack of a relationship between processing and inhibition

Before conducting the correlation analysis between grammatical gender processing and inhibition effects, the AX-CPT was independently analyzed. The results show that all groups performed similarly across all conditions. Within language groups, the AX condition was quicker than the AY condition. This result was expected, as the majority of the trials were composed of AX cue-probe combinations, resulting in a bias for an X probe to follow an A cue. Likewise, each language group showed faster RTs to BY versus AY trials. Again, this was anticipated, as participants were specifically asked to focus on trials beginning with an A cue. When a B cue was presented, they were able to quickly respond to the probe, as the response would consistently be no. Overall, these findings are consistent with previous studies (e.g., Beatty-Martínez, Navarro-Torres, et al., 2020; Zirnstein et al., 2018) and indicate that participants rely on contextual information and show difficulty with inhibiting incongruent expectations.

No relationship between inhibitory control and grammatical gender processing was found among all groups of speakers. A potential reason for the lack of correlation is that inhibition is not related to grammatical gender processing in French, thus there is no advantage in possessing a high level of inhibitory control. It may be the case that other factors, such as linguistic environment, dominance, and amount of use of the language, are better indicators of gender processing. Another possibility is that all participants performed exceptionally well on the AX-CPT. Therefore, there were too few data points for there to be a correlation between inhibition performance and processing.

Verbal fluency limitations

As previously mentioned, the verbal fluency task had to be excluded from the analysis due to a large number of incomplete participations and audio recordings. These issues included participants not completing this portion of the experiment, and poor audio quality. A correlation between high levels of verbal fluency and grammatical gender processing has been found in native Spanish speakers (Beatty-Martínez et al., 2020). Therefore, future research further investigating the potential relationship is beneficial. This task is likely better conducted in an in-lab setting or synchronously online (e.g., via Zoom) to ensure optimal participation and quality audio recording.

4.4 Conclusion

This chapter explored the relationship between grammatical gender processing and inhibitory control in native French speakers and L2 French speakers. No such relationship was observed, but there was an interesting finding highlighting the use of grammatical gender cues among French speakers. Variations in responses to congruent and congruent masculine and feminine conditions provide implications for how different genders are accessed and processed by L1 and simultaneous speakers. Specifically, access to feminine nouns is more restricted, as indicated by the delayed processing of incongruent masculine sentences, where speakers likely had to expand their lexical search from solely feminine nouns to include masculine nouns. Whereas incongruent feminine conditions show initial processing difficulty. L2 speakers show a delayed difficulty when processing feminine nouns following an incongruently gendered determiner. Suggesting potential distinct underlying processing for feminine versus masculine nouns when co-dependency relations are not met. Despite the absence of a correlation involving these findings, the possible link between cognition and language processing remains a relevant research avenue and requires more precise measures.

CHAPTER 5

GENERAL DISCUSSION AND CONCLUSION

The current dissertation aimed to provide a well-rounded picture of grammatical gender processing between in DPs in L1, simultaneous, and L2 French speakers, including the potential impact of extra-linguistics factors. The following overarching research questions were asked: 1) Do native French speakers utilize grammatical gender cues anticipatorily during online processing to facilitate processing? Are masculine and feminine cues used in the same way and to the same degree during processing, or are there any differences? 2) Do L2 speakers use grammatical gender cues in a similar manner to that of native speakers? Is how they use (or do not use) cues related to the environment in which they learned or acquired their language? 3) What are the neural underpinnings associated with the predictive use of grammatical gender processing? and 4) Is there a relationship between gender processing and individual differences in cognitive abilities and/or lexical knowledge?

A large majority of previous literature on grammatical gender processing collapses across their findings across gender categories, particularly in Spanish which possesses a transparent gender system. This dissertation combats these notions by focusing on French, which consists of a more opaque system, placing less emphasis on phonological suffix cues associated with gender. Moreover, the disentanglement of processing mechanisms associated with masculine and feminine gender cues is taken into consideration. This is especially important when considering the way the French gender system is composed. Masculine is argued to be the default gender, implying that syntactic elements associated with masculine grammatical gender should be simpler to process compared to the feminine. In addition, L2 research largely focuses on late language learners,

leaving a gap with early L2 bilingualism and processing, making this another focus of the current dissertation. Lastly, the relationship between cognitive abilities and language processing is being increasingly studied and can provide important implications for gender processing.

The remainder of the chapter summarizes the findings of the dissertation in relation to each research question and situates the findings in previous research on grammatical gender. A general scheme for grammatical gender processing in relation to a more opaque gender system is proposed, and finally, limitations and future directions are discussed.

5.1 Summary of results

5.1.1 Grammatical gender cue use

The first two research questions focused on whether native and L2 French speakers make use of grammatical gender cues during language processing and if the degree of use differed for masculine and feminine. Further, emphasis was placed on whether L2 MoA influenced processing. These questions were answered with the results from the first study, which investigated whether grammatical gender cues are used to facilitate processing in L1, simultaneous bilingual, and L2 speakers using a masked priming lexical decision task, and with the SPR results in the final study, which includes grammatical gender cue use when integrated into a syntactic context. At the lexical decision level, there were no differences in processing found for congruent versus incongruent DPs across all groups. Additionally, there was no difference in congruency overall, and the MoA of L2 participants did not appear to play a role in processing. The congruency finding in particular is in stark contrast to what has been found among L1 and L2 speakers in previous studies (Dussias, et al., 2013), where speakers have been shown to possess processing difficulty with incongruencies. The SPR results highlight that L1 and simultaneous speakers show difficulty in processing incongruent feminine sentences from the determiner onwards. Speakers exhibited a

delayed processing cost to the word following the noun in incongruent masculine conditions. In the latter case, it is thought that upon encountering the noun, speakers are under the assumption that a feminine noun has followed a feminine determiner. Once they realize that the noun is masculine, they must expand their lexical entries to correctly process the sentence. In contrast, L2 speakers only exhibit difficulty with the incongruent feminine condition at the determiner and the word immediately following the noun. Indicating that when the feminine noun is encountered, speakers may be using more conscious processing of the syntactically marked noun. The L2 results thus continue to be unclear and inconsistent among the literature (e.g., Guillelmon & Grosjean, 2001; Lew-Williams & Fernald, 2010; Hopp, 2013; Foucart et al., 2014).

The SPR results that highlight processing difficulty with incongruent conditions are consistent with previous research on L1 processing (e.g., Bates et al., 1996; Grosjean, et al., 1994), implying that congruencies require less processing power. As previous studies have mentioned (e.g., Dahan et al., 2000), it is difficult to distinguish whether these findings are reflective of actual gender information being accessed and implemented during processing, or co-occurrence cues. The two concepts are deeply intertwined and difficult to disentangle, as a high level of co-occurrence is associated with congruent gender pairs.

Contrary to the results of the lexical decision task, variation between conditions was found at a behavioural level during sentence reading (evidence of cue use without syntactic context was found in the ERP counterpart to the behavioural lexical decision task - see section 5.1.2 for further discussion on neural underpinnings). The reason for this discrepancy is likely two-fold. First, speakers have more time to respond as they read each syntactic element, as the nature of the SPR task is self-paced, allowing for the possibility of re-evaluating what has been read. Second, a broader syntactic context helps situate the DP into a more realistic frame of reference, resulting in

processing differences. Previous studies analyzing the processing of words in isolation versus embedded in a syntactic context have found a discrepancy between task results (e.g., Barber and Carreiras, 2005). In the context of the current results, the findings may indicate that grammatical gender cues are only accessed and actively used during processing at a syntactic level behaviourally.

5.1.2 Neural underpinnings

The lack of differences observed at a behavioural level in the lexical decision task is not necessarily indicative of a lack of gender use during processing. In psycholinguistic research, participants can perform at ceiling during behavioural tasks. This means that the task may not be suited to disentangle subtle differences at the level of collecting RT data post-processing mechanisms. Thus, more precise, and fine-tuned measures are beneficial to investigate underlying mechanisms associated with processing, leading to the third research question. This question is investigated with the ERP counterpart of the same behavioural lexical decision task. Native French speakers (L1 and simultaneous speakers) showed a P200 to incongruent feminine conditions (**le maison*) and incongruent conditions collapsed across gender. The P200 is interpreted as a marker of lexical processing due to the default masculine notion, which would make it acceptable (although not necessarily grammatical) for feminine nouns to be accompanied by a masculine determiner. However, due to the incongruency between the D-N, the P200 reflects the requirement to restrict lexical possibilities to only feminine nouns. Unlike previous studies investigating gender processing with ERPs (e.g., Barber & Carreiras, 2005; Caffarra et al., 2015; Popov et al., 2020), there does not appear to be processing difficulty with incongruent conditions. Overall, the data

suggests that French speakers implement distinct processing mechanisms for different genders at a neural level.

One of the only other studies that has disentangled grammatical genders is Beatty-Martínez et al. (2020) in Spanish. Both the current study and their study found that masculine and feminine are distinctly processed, however, there was a disparity between the two genders, which may account for the variation in findings. Firstly, Beatty-Martínez et al. used sentential stimuli items, providing speakers with more contextual information (this is discussed in relation to the behavioural results obtained in the current dissertation in Subsection 5.1.1). Second, Spanish is comprised of a transparent gender system, with a high level of association between the gender of a noun and its suffix (-o is typically masculine and -a feminine), whereas French is largely opaque with minimal suffixal correlation. Thus, French speakers may be implementing different processing mechanisms when presented with word pairs at a lexical level than Spanish speakers at the syntactic level.

5.1.3 Inhibition and gender processing

Research question 4 aimed to examine the possible relationship between cognitive abilities/lexical knowledge and grammatical gender processing. This was done by implementing a sentential SPR task that was administered alongside an AX-CPT and a VF task for L1, simultaneous, and L2 speakers. Unfortunately, the results of the VF task were not usable, however a correlation was conducted between performance on the AX-CPT and gender processing of incongruent DPs. No significant correlation was found, and this was the case across all participant groups.

5.2 Retrieval and repair scheme

As discussed in Chapter 1, Popov et al. (2020) proposed a scheme of grammatical gender retrieval and repair when speakers are exposed to incongruencies in Italian (repeated in Figure 5.1). In summary, the researchers state that speakers carry forward the gender information available on the determiner and check it against the gender marking of the noun. In the case of Italian, checking occurs with the gender-associated suffix (e.g., -o is associated with masculine). When the features are congruent, the computation is successful and processing proceeds without issue. However, when there is an incongruency, a re-analysis and repair process occurs, resulting in an increased processing load.

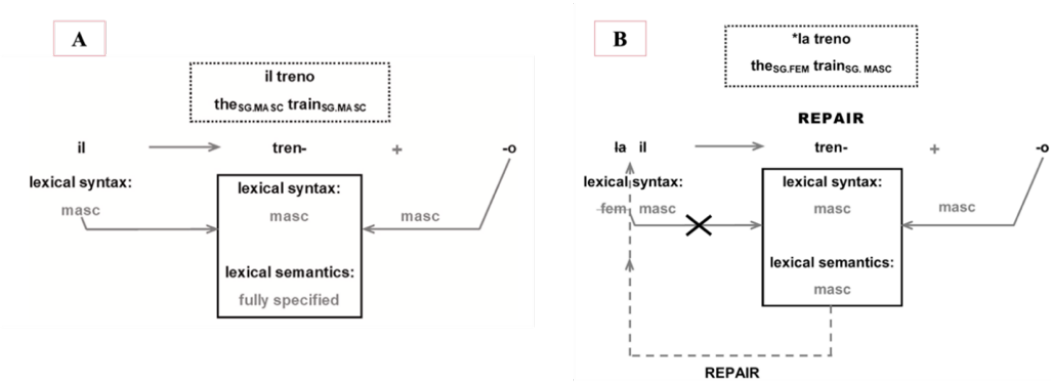

Figure 5.1. Schemes for grammatical gender processing (from Popov et al. (2020). Figures 1 and 3 on pg. 2 and 5). A) the process of congruent gender checking. B) the repair process for incongruencies.

Based on the Popov et al. scheme, I propose a modified version that considers two additional conditions: The marked nature of feminine elements, and an opaque gender system. It should be noted that the modification of this model is primarily based on native speaker results from the ERP and SPR tasks, further research on L2 processing is required to fully incorporate the findings into the scheme. For the additional conditions to be met, a modification to the gender checking is made. As French does not have a transparent system with consistent suffixal-gender correlation, the

gender feature (+FEM, -FEM) carried on the determiner is checked against the feature on the noun. A gender feature being present on the noun aligns with formal linguistic accounts for grammatical gender in French (e.g., Atkinson, 2015). The modification of the access model with congruent conditions is illustrated in Figure 5.2a. This shows that the +FEM feature on the feminine determiner (*la*) is brought forward and checked against the +FEM feature on the noun (*maison*). The computation is fully specified, and processing is completed. When the default masculine determiner is used with a feminine noun (e.g., **le maison*, Figure 5.2b), the masculine -FEM feature is first checked against the noun, resulting in an unsuccessful computation. This process results in an immediate processing cost due to the encounter with the feminine noun. The marked noun may require more cognitive resources in general, difficulty arises immediately when it follows an unmarked determiner, and not only at the point of needing to re-process. This is evidenced by the slower RTs to the noun this condition in Chapter 4 and the P200 in Chapter 3. The cycle then restarts and re-processes/re-pairs with the +FEM feature on the determiner being brought forward for the computation to be fully specified. This only occurs when the incongruency is embedded in a syntactic context as speakers are required to re-evaluate the incongruency to accurately process the sentence. This is evidenced by slower RTs to the word following the noun in the SPR task to the incongruent feminine conditions. The initial increased cognitive load does not occur with congruent feminine conditions, due to the marked noun immediately following the correct determiner. When a masculine determiner (*le*) is used with a masculine noun (*bateau*), computation is complete on the first round. When there is an inadmissible incongruency (e.g., *la bateau*, Figure 5.2c), the +FEM feature from the determiner is checked against the -FEM of the noun. Once the incongruency is met, the repair process begins by going back to the determiner and replacing it with the correct article carrying the congruent feature. In the case of *la bateau, la*

would be changed to *le* for the features to become congruent. Upon reaching the incongruent feature on the noun, processing difficulty arises – this is illustrated by the delayed processing difficulty exhibited to the incongruent masculine condition in Chapter 4 (slower RTs to the word immediately following the noun). The primary difference between incongruent feminine and masculine conditions is that the feminine condition exhibits an additional processing cost due to the properties of the noun.

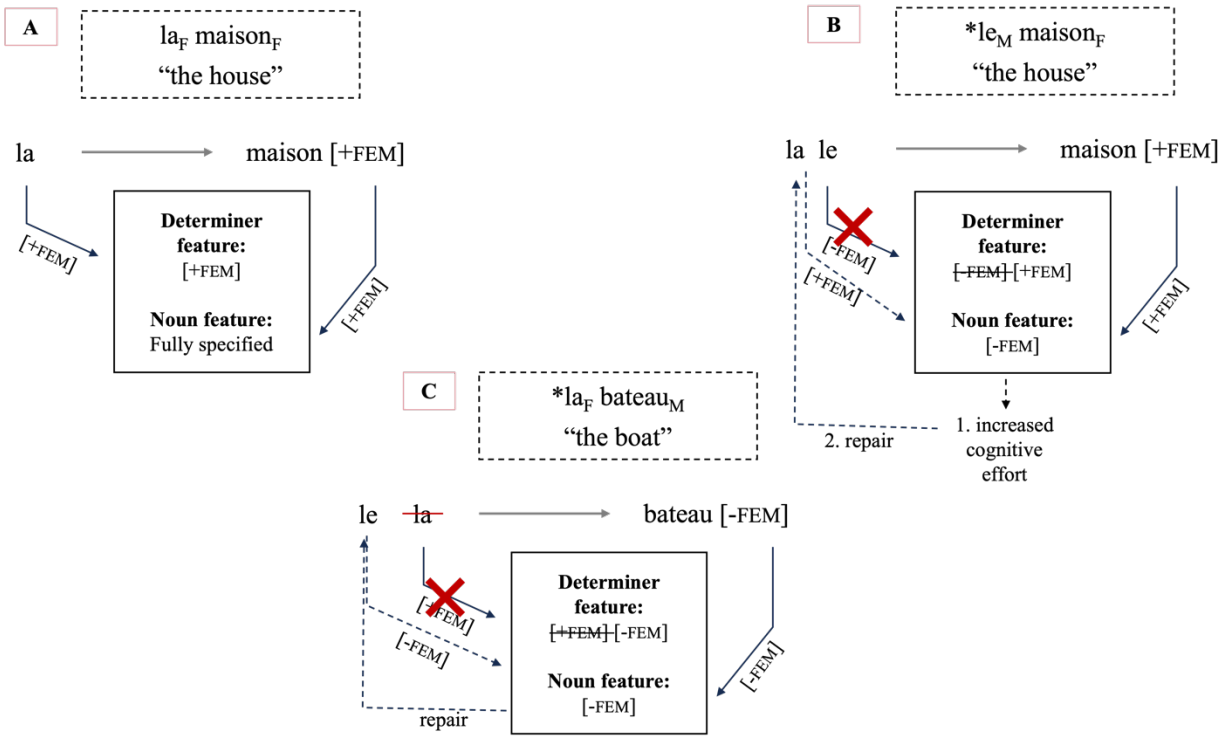

Figure 5.2. Modified scheme for grammatical gender processing (adapted from Popov et al. (2020)). A) the process of congruent gender checking. B) the process for incongruencies with a default masculine notion. C) the repair process for inadmissible incongruencies.

Up until recently, gender processing has been collapsed across all genders in a particular language. Due to the differences between masculine and feminine gender processing in French and Spanish, it is important to highlight these differences in models related to processing. The

modifications implemented in the above model can also be used for languages with a transparent gender system, as it is reliant on the gender feature itself.

5.3 Limitations and future directions

With the completion of this dissertation came a number of limitations. Due to testing limitations, there were no L2 speakers included in the ERP study, therefore, it is not known whether the underlying neural mechanisms implemented during grammatical gender processing are different from those of native speakers. There was also a small number of participants included when attempting to investigate the effects of MoA, which made it difficult to examine whether language environment has an impact on language processing. Additionally, the lack of usable verbal fluency data in Chapter 4 resulted in the inability to investigate any potential correlation between lexical knowledge and processing. Lastly, the ability to test in an online manner allows researchers to reach a larger number of participants, however, this came with a large amount of unusable data due to incomplete or incorrect participation.

Despite the aforementioned limitations, there is a wide range of possibilities for future research. It would be interesting to study whether the underlying neural mechanisms implemented during grammatical gender processing that were found in Chapter 3 would be the same at a syntactic level and to expand this to L2 speakers. Perhaps the results would align more similarly with previous studies using stimuli with more contextual information. The studies conducted in this dissertation focused on visual language comprehension, which only accounts for a small portion of language processing. Future research can focus on spoken-word recognition. Specifically, whether speakers are accepting of incongruencies that follow a default masculine notion and if the level of acceptability would differ if they were listening to a native speaker or an L2 speaker of the language. Additionally, the P200 observed in Chapter 3 is interesting in that it

may be related to more general cognitive mechanisms that are implemented during the processing of certain incongruencies. Further research can delve deeper into the connection between grammatical gender processing and cognition to see what types of mechanisms are used. Lastly, it would be interesting to investigate similar questions as in the current dissertation with language pairs both consisting of grammatical gender and/or a different more than two gender classifications. There may be variation in the results due to potential transfer effects.

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APPENDICES

APPENDIX A: FRENCH CLOZE TASK

French cloze task implemented in the experiments in Chapters 2 and 4.

"Le taux de CO2 dans l'atmosphère augmente plus vite que prévu"

La croissance économique mondiale (1) provoqué un accroissement de (2) teneur en dioxyde de (3) (CO2) dans l'atmosphère beaucoup (4) rapidement que prévu, selon une étude (5) lundi dans les comptes rendus de l'Académie (6) des sciences des États-Unis.

Cette étude (7) que la concentration des émissions (8) gaz carbonique dans l'atmosphère a (9) de 35 % en 2006, entre le début (10) années 1990 et les (11) 2000-2006, passant de 7 à 10 milliards de tonnes (12) an, alors que le protocole de Kyoto prévoyait (13) en 2012, ces émissions responsables (14) réchauffement climatique devaient (15) baissé de 5 % par (16) à 1990. « Les améliorations dans l'intensité carbonique de l'économie (17) stagnent depuis 2000, après trente (18) de progrès, ce qui a provoqué cette (19) inattendue de la concentration de CO2 (20) l'atmosphère », indique dans (21) communiqué le British Antarctic Survey, (22) a participé à cette étude.

(23) les chercheurs, les carburants polluants (24) responsables de 17 % de cette augmentation, (25) que les 18 % restant sont (26) à un déclin de la capacité des « puits » naturels comme (27) forêts ou les océans (28) absorber le gaz carbonique. « (29) y a cinquante ans, pour chaque tonne de CO2 émise, 600 kg (30) absorbés par les puits naturels. (31) 2006, seulement 550 kg par tonne ont été (32) , et cette quantité continue à baisser », explique (33) auteur principal de l'étude, Pep Canadell, du Global Carbon Project. « La baisse de l'efficacité (34) puits mondiaux laisse (35) que la stabilisation de cette (36) sera encore plus (37) à obtenir que ce que l'on pensait jusqu'à (38) », indique pour sa (39) le British Antarctic Survey.

Ces (40) obligent à une révision à la hausse (41) prévisions du

APPENDIX B: LEXICAL DECISION STIMULI

This appendix consists of the nouns and pseudowords used in Chapters 2 and 3.

Type of word	Gender	French word	Frequency	English translation
Target	Masculine	cerveau	28.23	brain
		bateau	41.94	boat
		beurre	24.48	butter
		bonbon	23.45	candy
		bras	290.89	arm
		bruit	139.52	noise
		bureau/pupitre	99.77	desk
		cadeau	18.65	gift
		camion	18.19	truck
		chapeau	42.48	hat
		cheval	76.77	horse
		chien	69.68	dog
		ciel	212.65	sky
		ciseaux	7.42	scissors
		coeur	274.94	heart
		coin	95.81	corner
		clou	7.79	nail
		doigt	46.87	finger
		dos	119.81	back
		drapeau	15.16	flag
		fantôme	16.84	ghost
		feu	156.29	fire
		foulard	8.23	scarf
		fromage	12.52	cheese
		gâteau	55.19	cake
		jardin	88.42	garden
		lait	44.9	milk
		lapin	10.42	rabbit
		lit	184.27	bed
		livre	144.29	book
		magasin	27.53	store
		manteau	36.29	coat
		matin	210.29	morning
		mur	100.87	wall
		billet	41.47	ticket
		nez	95.94	nose
		nuage	19.29	cloud
		pain	62.94	bread

	panier	16.32	basket
	pied	169.65	foot
	plafond	29.58	ceiling
	poisson	30.03	fish
	poulet	9	chicken
	repas	46.84	meal
	rideau	30.23	curtain
	roi	106.61	king
	sac	124.6	bag
	singe	10.39	monkey
	stylo	5.68	pen
	sucre	26.71	sugar
	tapis	39.94	rug
	verre	155.29	glass
	ver	727.26	worm
	vin	64.97	wine
	visage	270.74	face
	cochon	9.06	pig
	papillon	13.03	butterfly
	mouton	11.1	sheep
	seau	7.84	bucket
	pinceau	8.81	paintbrush
Feminine	maison	299.65	house
	bibliothéque	33.32	library
	bouche	150.68	mouth
	ceinture	20.87	belt
	chaise	48.45	chair
	chaleur	82.52	heat
	chambre	231.23	room
	chanson	23.52	song
	chaussette	2.26	sock
	chemise	38.71	shirt
	clé	22.61	key
	corde	22.1	rope
	couverture	25.94	blanket
	croix	57.81	cross
	cuisine	68.45	kitchen
	douche	10.39	shower
	femme	400.52	woman
	fenêtre	70.2	window
	fête	50.45	party
	pluie	35.23	leaf/sheet
	plume	6.49	feather
	glace	49.58	ice
	guerre	320.86	war

		jambe	36.68	leg
		jupe	18.13	skirt
		langue	105.42	tongue
		lune	52.45	moon
		neige	48.23	snow
		nuit	404.42	night
		peau	107.26	skin
		phrase	57.55	sentence
		plage	42.23	beach
		pluie	69.74	rain
		pomme	26.45	apple
		porte	426.48	door
		poubelle	5.68	garbage
		poupée	27.59	doll
		reine	37.9	queen
		roche	13.77	rock
		roue	22.58	wheel
		rue	260.97	street
		santé	50.55	health
		semaine	68.71	week
		soeur	103	sister
		sorcière	54.09	witch
		souris	26.03	mouse
		tasse	14.61	cup
		tête	475.87	head
		vache	18.45	cow
		valise	23.77	suitcase
		viande	33.84	meat
		ville	227.16	city
		voiture	123.13	car
		cloche	15.06	bell
		bague	9.1	ring
		serrure	9.58	lock
		planche	10.81	board/wood/floor
		boucle	9.1	loop/buckle
		chaussure	5	shoe
		vis	95.48	screw
Cognates	Masculine	bouton	21.29	button
		cercle	17.77	circle
		chat	57.71	cat
		corde	28.89	cord
		cylindre	0.62	cylinder
		dauphin	1.76	dolphin
		désastre	12.26	disaster
		diamant	7.97	diamond

		dinosaure	2.32	dinosaur
		gaz	36.33	gas
		gorille	3.55	gorilla
		groupe	90.16	group
		kilomètre	3.73	kilometer
		mécanisme	3.79	mechanism
		micro-ondes	2.45	microwave
		moteur	26.31	motor
		musée	18.59	museum
		nez	75.18	nose
		nombre	36.57	number
		papier	56.32	paper
		parc	31.02	park
		parfum	24.44	perfume
		pingouin	2.29	penguin
		prisme	0.1	prisim
		problème	391.2	problem
	Feminine	banane	6.09	banana
		batterie	10.61	battery
		bicyclette	7.34	bicycle
		bouteille	42.31	bottle
		brosse	7.29	brush
		cabine	17.65	cabin
		côte	25.86	coast
		famille	357.75	family
		fleur	25.2	flower
		fourrure	5.56	fur
		galaxie	8.29	galaxy
		girafe	2.71	giraffe
		guitare	12.78	guitar
		leçon	29.24	lesson
		ligne	69.42	line
		magie	25.58	magic
		médaille	14.44	medal
		musique	168.89	music
		planète	55.29	planet
		plante	9	plant
		pratique	7.6	practice
		fraise	5.28	strawberry
		tomate	7.88	tomato
		tornade	2.13	tornado
		trompette	5.71	trumpet
Pseudowords				
Amunt	Foide	Lagume	Pagle	Seqs
Barueu	Fren	Langeir	Palt	Soued

Bere	Frure	Larvu	Pamoun	Souve
Blagder	Gaf	Lavor	Pank	Sruine
Boll	Ganc	Lawer	Paos	Tabeau
Borve	Gaws	Levior	Papan	Tacile
Boupe	Geneaux	Liag	Pelpe	Talle
Bourger	Gianier	Lonret	Pemle	Tamin
Bouver	Gorde	Lorge	Pighon	Tanvier
Brospe	Goter	Mamen	Pimde	Thun
Buignet	Grus	Mandiat	Pione	Toste
Cantide	Guelle	Manter	Pirom	Tourard
Cateaux	Hassport	Masst	Pitune	Tournu
Chadeu	Heuilles	Mecre	Plave	Trabune
Chaup	Hiage	Messant	Pmeu	Trihent
Choip	Hontre	Mogue	Pouvet	Trite
Chomeau	Houte	Momter	Pruit	Tront
Chottiar	Huesseur	Morc	Purc	Troudle
Choual	Huotre	Mouder	Purte	Tumps
Cisile	Iparse	Mouras	Qoller	Tun
Clis	Jappon	Mude	Qorge	Unge
Covo	Jeuge	Muindre	Qulp	Urbre
Crocse	Jiger	Murdre	Raot	Valile
Culle	Jisse	Mylle	Recein	Vare
Dagne	Joi	Nege	Recien	Vez
Debul	Jonche	Nembon	Rei	Vonne
Deurre	Jorre	Niopecte	Remos	Vourd
Dommence	Jos	Niper	Rinde	Vulet
Dramier	Jouelles	Noca	Roate	Vurt
Druige	Jout	Noine	Romanze	Wat
Ecote	Juute	Nonche	Rouje	Were
Efuise	Karche	Nôque	Saple	Werre
Fler	Klee	Nouveil	Sebre	
Fluyr	Kris	Ofousse	Seiu	

APPENDIX C: LANGUAGE BACKGROUND QUESTIONNAIRE

This appendix includes the English and French versions of the Language Background Questionnaire used in all studies. All the experiments in the current dissertation, apart from Experiment 1 in Chapter 2, were conducted online. The questionnaires were slightly modified from what is seem here to fit the online format.

Language Background Questionnaire - Short Version (English)

Participant information – *To be filled out by the researcher*

Project code: _____ Today's date: _____ Participant code: _____

1. Biographical information

Month and year of birth: _____ Current Age: _____ Gender: _____

Your native language(s)? _____
Mother's native language(s)? _____
Father's native language(s)? _____
Other caregivers' native language(s)? _____

Are you left- or right-handed? _____
Do you have any known visual impairments (including colour-blindness)? _____
Do you have any known hearing impairments? _____
Have you ever had a serious head injury? _____

What is your current profession? _____

Place of birth (city, country): _____

Please list all the places where you have lived, when you lived there, and for how long. Please list these in chronological order.

_____
_____

2. Basic language information

For an example, see page 3. Please ask if you have any questions.

In the first row, please list all the spoken or signed languages of which you have ANY current or previous knowledge in order of DOMINANCE, i.e. how comfortable you are using them.

In the second row, please write the age at which you were first exposed to this language, i.e. when it first became present in your environment.

In the third row, please indicate whether you were ever IMMMERSED in this language, i.e. if you received significant exposure to this language in either a community/home setting or a school (greater than 20%). If so, please also indicate the age or grade at which this began.

Dominance	Most ⟷ Least				
Language:	1.	2.	3.	4.	5.

Age/grade of 1st exposure:					
Immersed: Age/grade:	YES / NO ________	YES / NO ________	YES / NO ________	YES / NO ________	YES / NO ________

For each of the above-listed languages, please provide your current and highest ever attained level of proficiency. This consists of your general proficiency. If you feel that you are between categories, simply indicate where along the scale you feel your proficiency is best represented.

Language: ______________	Current level of general proficiency very low — low — intermediate — advanced — near-native — native
	Highest level of proficiency ever attained very low — low — intermediate — advanced — near-native — native

Language: ______________	Current level of general proficiency very low — low — intermediate — advanced — near-native — native
	Highest level of proficiency ever attained very low — low — intermediate — advanced — near-native — native

Language: ______________	Current level of general proficiency very low — low — intermediate — advanced — near-native — native
	Highest level of proficiency ever attained very low — low — intermediate — advanced — near-native — native

Language: ______________	Current level of general proficiency very low — low — intermediate — advanced — near-native — native
	Highest level of proficiency ever attained very low — low — intermediate — advanced — near-native — native

Language: ______________	Current level of general proficiency very low — low — intermediate — advanced — near-native — native
	Highest level of proficiency ever attained very low — low — intermediate — advanced — near-native — native

EXAMPLE 1: Julia's mother is a native speaker of Spanish, and her father is a native speaker of English. However, Julia's mother passed away when she was four years old, and Julia therefore did not get much exposure to Spanish after that age. Julia spoke Spanish natively until the age of four (highest level of proficiency ever attained) and considers her current level of proficiency to be advanced. Her current and highest ever level of proficiency in English is native. Furthermore, Julia was in French immersion all throughout high school. When she graduated, her level of proficiency was advanced, but she now feels

that it is closer to intermediate. She also took a beginner-level course in Japanese when she was in her first year of university.

Dominance:	Most ⟵			Least
Language:	1. English	2. Spanish	3. French	4. Japanese	5.
Age/grade of 1st exposure:	Birth (age=0)	Birth (age=0)	First grade (age=6)	First year univ. (age=18)	
Immersion: Age/grade:	YES / NO Age: Birth	YES / NO Age: Birth	YES / NO Age: 12	YES / NO Age: _____	YES / NO Age: _____

Language: English	Current level of general proficiency very low · low · intermediate · advanced · near-native · native (X at native) Highest level of proficiency ever attained very low · low · intermediate · advanced · near-native · native (X at native)
Language: Spanish	Current level of general proficiency very low · low · intermediate · advanced · near-native · native (X at advanced) Highest level of proficiency ever attained very low · low · intermediate · advanced · near-native · native (X at native)
Language: French	Current level of general proficiency very low · low · intermediate · advanced · near-native · native (X between intermediate and advanced) Highest level of proficiency ever attained very low · low · intermediate · advanced · near-native · native (X at advanced)
Language: Japanese	Current level of general proficiency very low · low · intermediate · advanced · near-native · native (X at very low) Highest level of proficiency ever attained very low · low · intermediate · advanced · near-native · native (X at very low)

Participant information – *To be filled out by the researcher*
Project code: _____ Today's date: _____ Participant code:

1.1 Parent/Caregivers' information

List your parents/caregivers in order of amount of time you spent with them from birth to 24 months, and indicate approximately how much time you spent with each of them during a typical week. Include time spent in daycare and with grand-parents, and note whether there was any variation over the time period.

Caregiver	Approx, time spent per week	Language(s) spoken with you
1)		
2)		
3)		
4)		
5)		

1) Parent/Primary caregiver (from birth to 24 months): _____
Native language(s): _____ Other language(s): _____
During your infancy, their language(s) of communication:
in the home: _____
with other family members: _____
with people outside the home: _____
Place of birth: _____ Current residence: _____
Please list all places where this caregiver has lived, when they lived there, and for how long, in chronological order:
_____
_____

2) Parent/Other primary caregiver (from birth to 24 months): _____
Native language(s): _____ Other language(s): _____
During your infancy, their language(s) of communication:
in the home: _____
with other family members: _____
with people outside the home: _____
Place of birth: _____ Current residence: _____
Please list all places where this caregiver has lived, when they lived there, and for how long, in chronological order:
_____
_____

3) Other caregiver(s) (from birth to 24 months): _____
Native language(s): _____ Other language(s): _____
During your infancy, their language(s) of communication:
in the home: _____
with other family members: _____
with people outside the home: _____
Place of birth: _____ Current residence: _____

Please list all places where this caregiver has lived, when they lived there, and for how long, in chronological order:

_____

_____

1.2 Languages in your environment during infancy (0 to 24 months of age inclusively)

Please list all the languages that you were exposed to during your infancy and, for each language, the approximate percentage of the time that you heard it on a weekly basis. Note: This should add up to 100%.

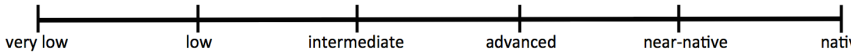
Language(s)	Percentage of the time that you heard this language on a weekly basis DURING INFANCY:

2. Current Language Proficiency

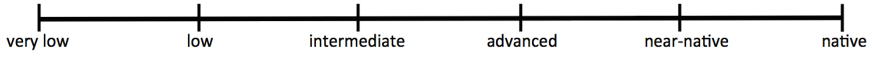
Please evaluate your current level of proficiency for all languages that you have ever been exposed to:

Language: _____

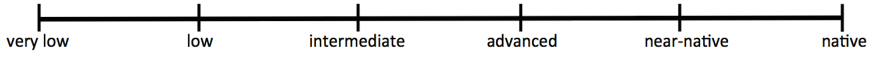
Oral comprehension:



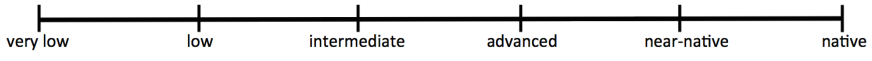
Oral production:



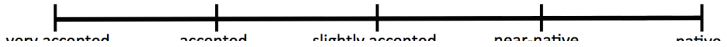
Writing proficiency:



Reading proficiency:



Pronunciation:



Language: ______________________________

Oral comprehension:

very low | low | intermediate | advanced | near-native | native

Oral production: very low | low | intermediate | advanced | near-native | native

Writing proficiency: very low | low | intermediate | advanced | near-native | native

Reading proficiency: very low | low | intermediate | advanced | near-native | native

Language: ______________________________

Oral comprehension:

very low | low | intermediate | advanced | near-native | native

Oral production: very low | low | intermediate | advanced | near-native | native

Writing proficiency: very low | low | intermediate | advanced | near-native | native

Reading proficiency: very low | low | intermediate | advanced | near-native | native

Language: ______________________________

Oral comprehension:

very low | low | intermediate | advanced | near-native | native

Oral production: very low | low | intermediate | advanced | near-native | native

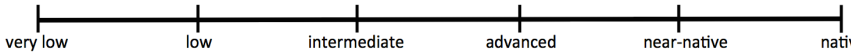
Writing proficiency: very low | low | intermediate | advanced | near-native | native

Reading proficiency: very low | low | intermediate | advanced | near-native | native

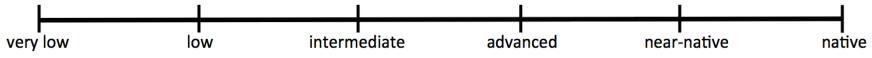
Pronunciation:

Language: _____

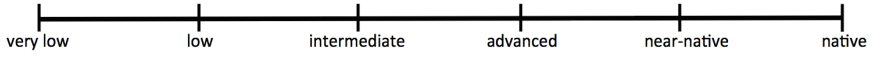
Oral comprehension:



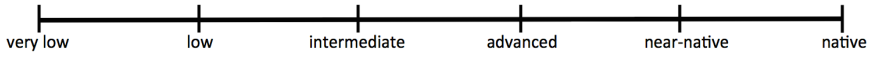
Oral production:



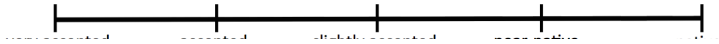
Writing proficiency:



Reading proficiency:



Pronunciation:



If you have been exposed to more than the above 5 languages, please list the others here and comment on your general proficiency for each:

_____

_____

3. School System

What type of school(s) did you attend? Tick all that apply.

☐ English-language school	☐ French-language school
☐ French immersion program *Grade started:* _____ *Grade finished:* _____ ☐ Core French program *Grade started:* _____ *Grade finished:* _____ ☐ No French	*Grade started:* _____ *Grade finished:* _____ Other than English literature/grammar classes, were any of your courses/ taught in English? ☐ Yes ☐ No *If yes, comment on course and grade info at the bottom of p. 5.*

4. Evolution of Language Use

In the first row, fill in the ages, grades, or calendar years corresponding to the education level specified on top of each column. Please ask the researcher if you need help.
In each cell, use percentages to indicate your usage of/exposure to English, French, and other languages (combined) for the corresponding context and age.

Note: If your language use changed within these age groups, or if the age group is inaccurate with respect to education level, please specify by writing it inside the box or explain in the comments sections below.

	Age 2 to kindergarten	Kindergarten	Elementary school 1	Elementary school 2
Ages/grades/calendar years				
School: i.e. language of instruction.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
At home: interactions with immediate and extended family, significant other (if you lived with them) and roommates	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Friends: interactions with friends and significant other (if you did not live with them)	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Media use: social media, leisurely reading, television, cinema, radio, internet, music, etc.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Extracurricular activities: sports, hobbies, work (if part-time), etc.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Daily activities in the community: grocery store, shopping mall, restaurants, gas station, etc.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Other: _____	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:

	High school	College/Cégep	University	Other: _____
Ages/grades/calendar years				
School: i.e. language of instruction.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
At home: interactions with immediate and extended family, significant other (if you lived with them) and roommates	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Friends: interactions with friends and significant other (if you did not live with them)	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:

Media use: social media, leisurely reading, television, cinema, radio, internet, music, etc.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Extracurricular activities: sports, hobbies, work (if less than 20h/week), etc.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Daily activities in the community: grocery store, shopping mall, restaurants, gas station, etc.	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Work: (if over 20h/week)	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:
Other: _____	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:	Eng: Fr: other:

Comments:

_____

_____

Thank you!

Questionnaire des antécédents langagiers – version courte

Renseignements sur le participant – *Réservé au chercheur*		
Code du projet : _____	Date : _____	Code du participant :

1. Renseignements biographiques

Mois et année de naissance : _____ Âge actuel : _____ Sexe : _____

Votre/vos langue(s) maternelle(s)? _____
Celle(s) de votre mère? _____
Celle(s) de votre père? _____
Celle(s) d'un fournisseur de soins autre que vos parents? _____

Êtes-vous droitier ou gaucher? _____
Souffrez-vous d'une déficience visuelle connue (y compris le daltonisme)? _____
Souffrez-vous d'une déficience auditive connue? _____
Avez-vous déjà subi de graves blessures à la tête? _____

Quelle est votre profession actuelle? _____

Lieu de naissance (ville, pays) : _____

Veuillez énumérer, en ordre chronologique, tous les endroits où vous avez habité et veuillez préciser quand et combien de temps vous avez habité à chaque endroit.

_____
_____

2. Renseignements de base relatifs à la langue

Pour un exemple, consulter la page 3. N'hésitez pas à poser des questions au chercheur.

Sur la première ligne, veuillez énumérer en ordre de DOMINANCE (c-à-d selon le degré de confort avec lequel vous les utilisez) toute langue (parlée ou signée) dont vous avez présentement ou dont vous avez déjà eu des connaissances, même si ces connaissances étaient négligeables.

Sur la deuxième ligne, veuillez indiquer l'âge auquel vous avez été exposé à la langue en question pour la première fois (c-à-d lorsque la langue est devenue présente dans votre environnement).

Sur la troisième ligne, veuillez indiquer si vous avez déjà été IMMERSÉ dans la langue en question (c-à-d exposé à la langue plus de 20% du temps), soit dans un milieu communautaire, familial ou scolaire. Si oui, veuillez indiquer l'âge ou l'année à laquelle cette immersion a commencé.

Dominance	+ ⟷ -				
Langue :	1.	2.	3.	4.	5.

Âge/année de la 1ère exposition :					
Immersé : Âge/année :	OUI / NON ________	OUI / NON ________	OUI / NON ________	OUI / NON ________	OUI / NON ________

Pour chacune des langues mentionnées ci-dessus, veuillez indiquer votre niveau de compétence actuel ainsi que le niveau de compétence le plus élevé que vous ayez déjà atteint. Ceci concerne votre niveau de compétence global. Si vous sentez que votre niveau de compétence se situe entre deux catégories, vous n'avez qu'à mettre une marque à l'endroit sur l'échelle qui représente le mieux votre niveau de compétence.

Langue : ______________	Niveau de compétence actuel très bas — bas — intermédiaire — avancé — quasi-natif — natif
	Niveau de compétence le plus élevé déjà atteint très bas — bas — intermédiaire — avancé — quasi-natif — natif

Langue : ______________	Niveau de compétence actuel très bas — bas — intermédiaire — avancé — quasi-natif — natif
	Niveau de compétence le plus élevé déjà atteint très bas — bas — intermédiaire — avancé — quasi-natif — natif

Langue : ______________	Niveau de compétence actuel très bas — bas — intermédiaire — avancé — quasi-natif — natif
	Niveau de compétence le plus élevé déjà atteint très bas — bas — intermédiaire — avancé — quasi-natif — natif

Langue : ______________	Niveau de compétence actuel très bas — bas — intermédiaire — avancé — quasi-natif — natif
	Niveau de compétence le plus élevé déjà atteint très bas — bas — intermédiaire — avancé — quasi-natif — natif

Langue : ______________	Niveau de compétence actuel très bas — bas — intermédiaire — avancé — quasi-natif — natif
	Niveau de compétence le plus élevé déjà atteint très bas — bas — intermédiaire — avancé — quasi-natif — natif

EXEMPLE 1 : La mère de Julia est une locutrice native de l'espagnol, et son père est un locuteur natif du français. Or, la mère de Julia est décédée lorsqu'elle avait quatre ans, donc Julia n'a pas eu beaucoup de contact l'espagnol après cet âge. Julia parlait l'espagnol de façon native jusqu'à l'âge de quatre ans

(niveau de compétence le plus élevé déjà atteint) et elle évalue son niveau de compétence actuel comme étant avancé. Son niveau de compétence actuel en français est natif, et c'est aussi le niveau de compétence le plus élevé qu'elle ait atteint. De plus, Julia a fait un voyage échange de six mois à New-York lors de sa dernière année de secondaire, et elle peut donc dire qu'elle a déjà été immersée dans un milieu anglophone. Lorsqu'elle a terminé le secondaire, son niveau d'anglais était avancé, mais maintenant, elle a plutôt l'impression qu'il est devenu plus ou moins intermédiaire. Finalement, Julia a aussi pris un cours d'introduction au japonais pendant sa première année à l'université.

Dominance	+ ⟷ -				
Langue :	1. français	2. espagnol	3. anglais	4. japonais	5.
Âge/année de la 1ère exposition :	À la naissance (âge=0)	À la naissance (âge=0)	1ère année (âge=6)	1ère année uni. (âge=18)	
Immersé : Âge/année :	<u>OUI</u> / NON À la naissance	<u>OUI</u> / NON À la naissance	<u>OUI</u> / NON 12 ans	OUI / <u>NON</u> _____	OUI / NON _____

Langue: <u>français</u>	Niveau de compétence actuel très bas · bas · intermédiaire · avancé · quasi-natif · natif (*) Niveau de compétence le plus élevé déjà atteint très bas · bas · intermédiaire · avancé · quasi-natif · natif (*)
Langue: <u>espagnol</u>	Niveau de compétence actuel très bas · bas · intermédiaire · avancé (*) · quasi-natif · natif Niveau de compétence le plus élevé déjà atteint très bas · bas · intermédiaire · avancé · quasi-natif · natif (*)
Langue: <u>anglais</u>	Niveau de compétence actuel très bas · bas · intermédiaire (*) · avancé · quasi-natif · natif Niveau de compétence le plus élevé déjà atteint très bas · bas · intermédiaire · avancé (*) · quasi-natif · natif
Langue: <u>japonais</u>	Niveau de compétence actuel très bas (*) · bas · intermédiaire · avancé · quasi-natif · natif Niveau de compétence le plus élevé déjà atteint très bas (*) · bas · intermédiaire · avancé · quasi-natif · natif

Questionnaire des antécédents langagiers – version longue

Renseignements sur le participant – *Réservé au chercheur*
Code du projet : _____ Date : _____ Code du participant :

1.1 Renseignements sur les parents ou fournisseurs de soins

Veuillez placer vos parents/fournisseurs de soins en ordre selon le montant de temps que chacun d'eux passait avec vous lorsque vous étiez âgé de 0 à 24 mois., et précisez combien de temps vous passiez avez chacun d'eux au cours d'une semaine typique. Incluez vos grand-parents et votre garderie, ainsi que toute variation au cours de la période en question.

Fournisseur de soins	Temps approx. par semaine	Langue utilisée pour communiquer avec toi
1)		
2)		
3)		
4)		
5)		

1) Fournisseur de soins principal (de la naissance à 24 mois) : _____
Langue(s) maternelle(s) : _____ Autre(s) langue(s) : _____
Lorsque vous étiez âgé de 0 à 24 mois, les langues que cette personne utilisait pour communiquer… :
à la maison : _____
avec d'autres membres de la famille : _____
avec des personnes à l'extérieur de la maison : _____
Lieu de naissance : _____ Lieu de résidence actuel : _____
Veuillez énumérer, en ordre chronologique, tous les endroits où cette personne a habité et veuillez préciser quand et combien de temps il ou elle a habité à chaque endroit.
_____
_____

2) Fournisseur de soins secondaire (de la naissance à 24 mois) : _____
Langue(s) maternelle(s) : _____ Autre(s) langue(s) : _____
Lorsque vous étiez âgé de 0 à 24 mois, les langues que cette personne utilisait pour communiquer… :
à la maison : _____
avec d'autres membres de la famille : _____
avec des personnes à l'extérieur de la maison : _____
Lieu de naissance : _____ Lieu de résidence actuel : _____
Veuillez énumérer, en ordre chronologique, tous les endroits où cette personne a habité et veuillez préciser quand et combien de temps il ou elle a habité à chaque endroit.
_____
_____

3) Autre fournisseur de soins (de la naissance à 24 mois) : _____
Langue(s) maternelle(s) : _____ Autre(s) langue(s) : _____
Lorsque vous étiez âgé de 0 à 24 mois, les langues que cette personne utilisait pour communiquer… :
à la maison : _____

avec d'autres membres de la famille : _____
avec des personnes à l'extérieur de la maison : _____
Lieu de naissance : _____ Lieu de résidence actuel : _____
Veuillez énumérer, en ordre chronologique, tous les endroits où cette personne a habité et veuillez préciser quand et combien de temps il ou elle a habité à chaque endroit.
_____
_____

1.2 Langues dans votre environnement durant la petite enfance (de 0 à 24 mois inclusivement)

Veuillez énumérer toutes les langues auxquelles vous avec été exposé(e) lors de la petite enfance (c-à-d de 0 à 24 mois inclusivement) et pour chacune d'elles, veuillez indiquer à l'aide d'un pourcentage combien de temps vous entendiez cette langue à chaque semaine. Notez bien : Le somme des pourcentages doit être 100%.

Langue(s)	En pourcentage, le montant de temps que vous entendiez cette langue à chaque semaine LORS DE LA PETITE ENFANCE :

2. Niveau de compétence actuel

Veuillez évaluer votre niveau de compétence actuel pour chacune des langues (sans aucune exception) auxquelles vous avez déjà été exposé(e) :

Langue: _____

Compréhension orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Expression orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Expression écrite :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Compréhension écrite :

Langue: ______________________________

Compréhension orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Expression orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Expression écrite :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Compréhension écrite :

Langue: ______________________________

Compréhension orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Expression orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Expression écrite :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Compréhension écrite :

Langue: ______________________________

Compréhension orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

Expression orale :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

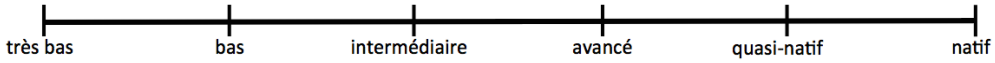
Expression écrite :

très bas | bas | intermédiaire | avancé | quasi-natif | natif

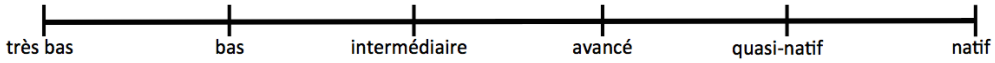
Compréhension écrite :

Langue: _____

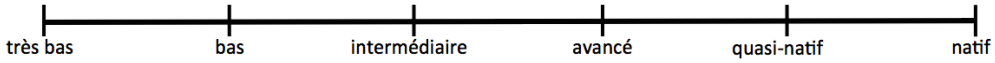
Compréhension orale :



Expression orale :



Expression écrite :



Compréhension écrite :

3. Système scolaire

Quel type d'école(s) avez-vous fréquentée(s)? Veuillez cocher toutes les boîtes pertinentes.

☐ École anglophone	☐ École francophone
☐ Programme d'immersion française *Année débuté: _____ Année terminé: _____* ☐ Programme de français de base (*core French*) *Année débuté: _____ Année terminé: _____* ☐ Pas de français à l'école	*Année débuté: _____ Année terminé: _____* À part les cours de littérature/grammaire anglaise, avez-vous suivis des cours en anglais? ☐ Oui ☐ Non *Si oui, fournissez les détails concernant la matière/l'année au bas de la pp. 5.*

4. Évolution de l'utilisation du langage

Dans la première ligne, fournissez les âges ou les années (soit scolaires ou civiles) qui correspondent au niveau d'éducation indiqué au haut de chaque colonne.
Dans chacune des cases, indiquez à l'aide de pourcentages votre usage ou votre exposition au français, à l'anglais et à d'autres langues (la somme des pourcentage doit être 100%) pour le contexte et l'âge en question.

Notez bien : Si vos habitudes langagières ont évolué au cours d'une des périodes indiquées, ou bien si les groupes d'âges sont mal organisés pour refléter vos habitudes langagières au cours de la période en question, veuillez l'indiquer en l'écrivant à l'intérieur de la case et veuillez fournir une explication dans la section réservée aux commentaires. N'hésitez pas à poser des questions au chercheur.

	De 2 ans à la maternelle	Maternelle	École primaire 1	École primaire 2
âges/années (civiles ou scolaires)				
École : c-à-d la langue d'enseignement.	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
À la maison : interactions avec la famille immédiate et élargie, avec votre partenaire (si vous avez habité ensemble) ou colocataires	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Amis : interactions avec vos amis et votre partenaire (si vous n'avez jamais habité ensemble)	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Utilisation des médias : médias sociaux, lecture de détente, télé, cinéma, radio, internet, musique, etc.)	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Activités parascolaires : sports, passe-temps, travail (moins de 20 h/semaine), etc.	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Activités quotidiennes dans la communauté : épicerie, centre d'achats, restaurant, station de service, etc.	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Travail : (20 h/semaine ou plus)	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Autre : _____	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :

	École secondaire	Cégep	Université	Autre : _____
âges/années (civiles ou scolaires)				
École : c-à-d la langue d'enseignement.	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
À la maison : interactions avec la famille immédiate et élargie, avec votre partenaire (si vous avez habité ensemble) ou colocataires	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Amis : interactions avec vos amis et votre partenaire (si vous n'avez jamais habité ensemble)	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :

Utilisation des médias : médias sociaux, lecture de détente, télé, cinéma, radio, internet, musique,	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Activités parascolaires : sports, passe-temps, travail (moins de 20 h/semaine), etc.	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Activités quotidiennes dans la communauté : épicerie, centre d'achats, restaurant, station de service, etc.	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Travail : (20 h/semaine ou plus)	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :
Autre : _____	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :	fra : ang : autre :

Commentaires :

_____

_____

Merci!

APPENDIX D: CHAPTER 2 INDIVIDUAL CONDITION GRAPHS

This appendix includes the graphs for each the individual gender conditions for Experiments 1 and 2 in Chapter 2.

Experiment 1

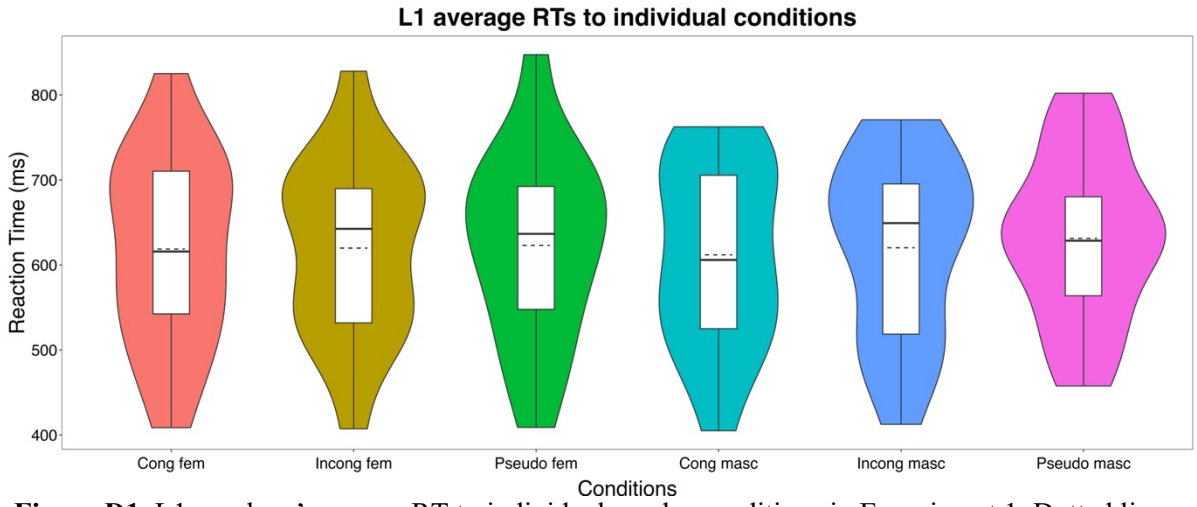


Figure D1. L1 speakers' average RT to individual gender conditions in Experiment 1. Dotted line = mean, solid line = median.

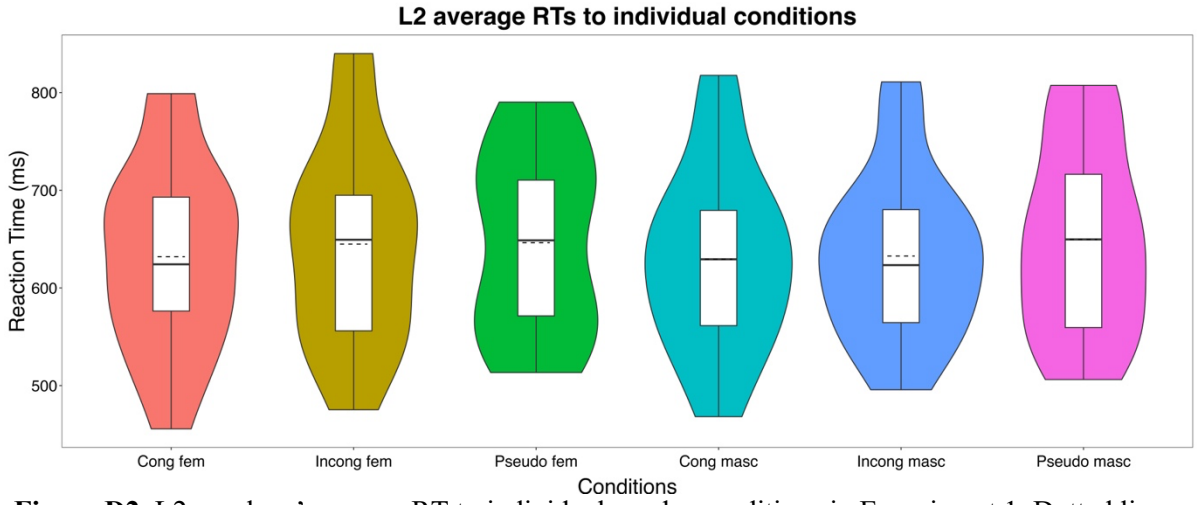


Figure D2. L2 speakers' average RT to individual gender conditions in Experiment 1. Dotted line = mean, solid line = median.

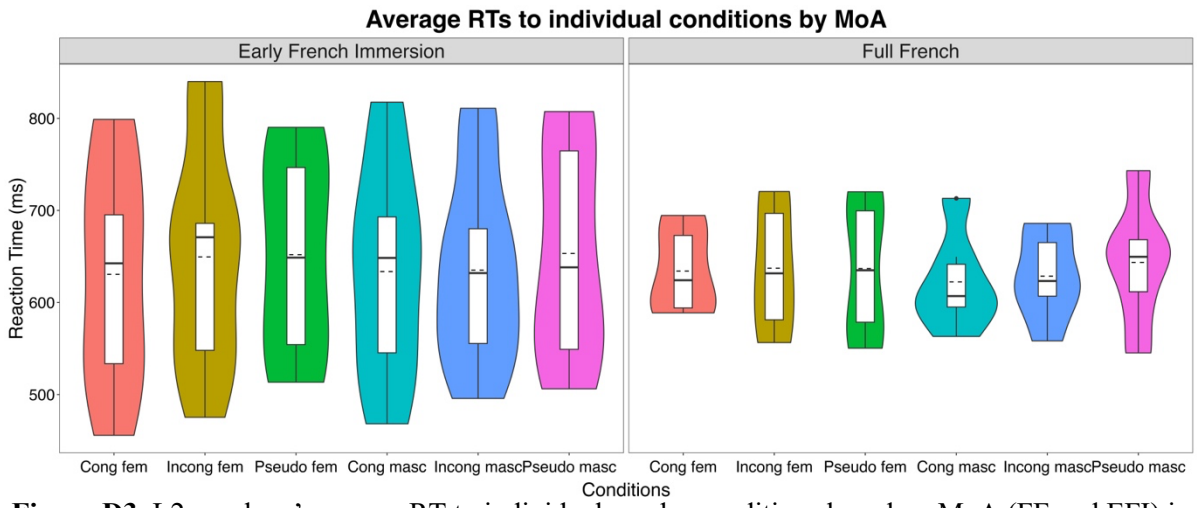


Figure D3. L2 speakers' average RT to individual gender conditions based on MoA (FF and EFI) in Experiment 1. Dotted line = mean, solid line = median.

Experiment 2

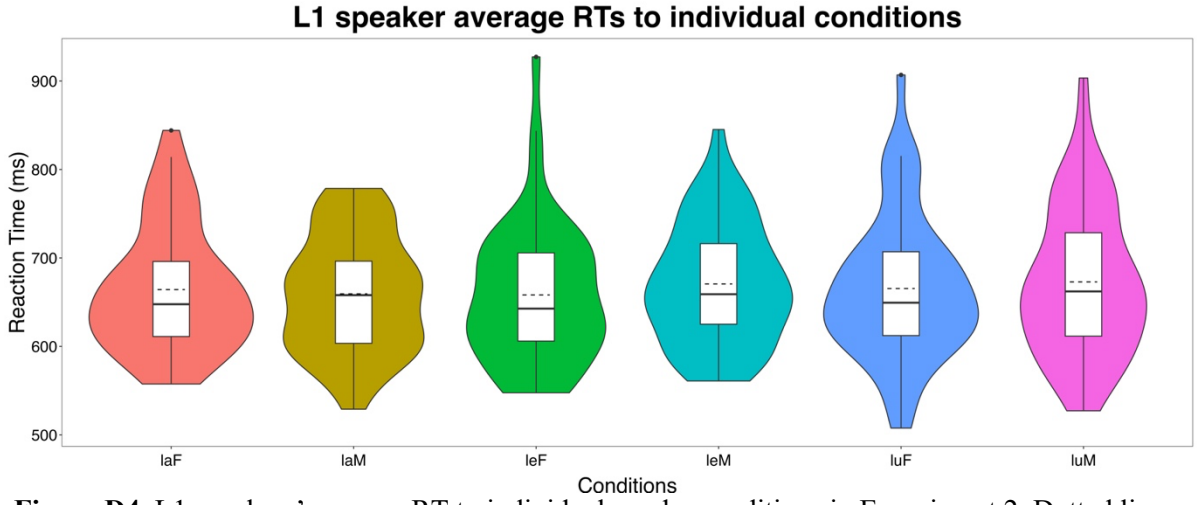


Figure D4. L1 speakers' average RT to individual gender conditions in Experiment 2. Dotted line = mean, solid line = median.

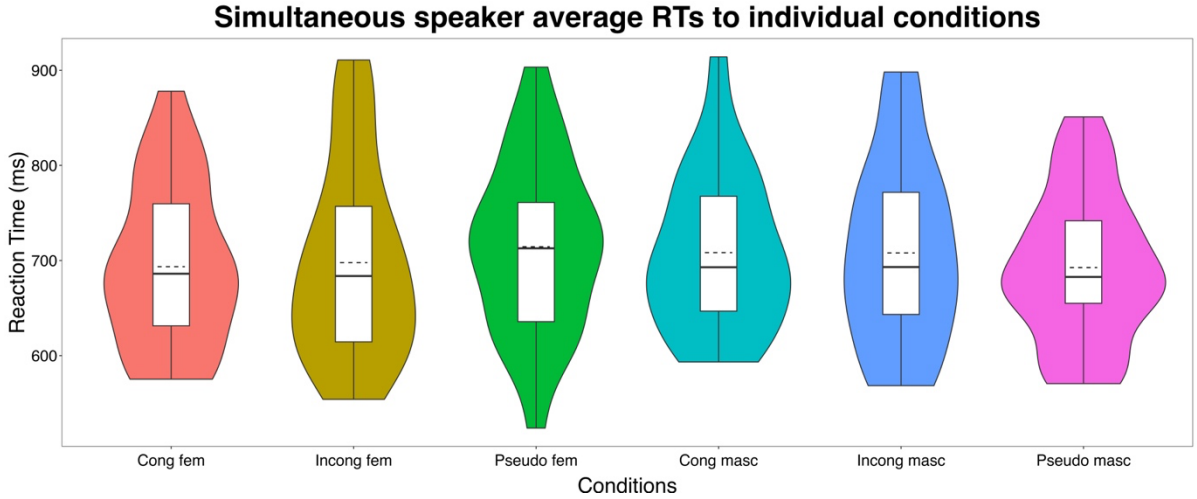


Figure D5. Simultaneous speakers' average RT to individual gender conditions in Experiment 2. Dotted line = mean, solid line = median.

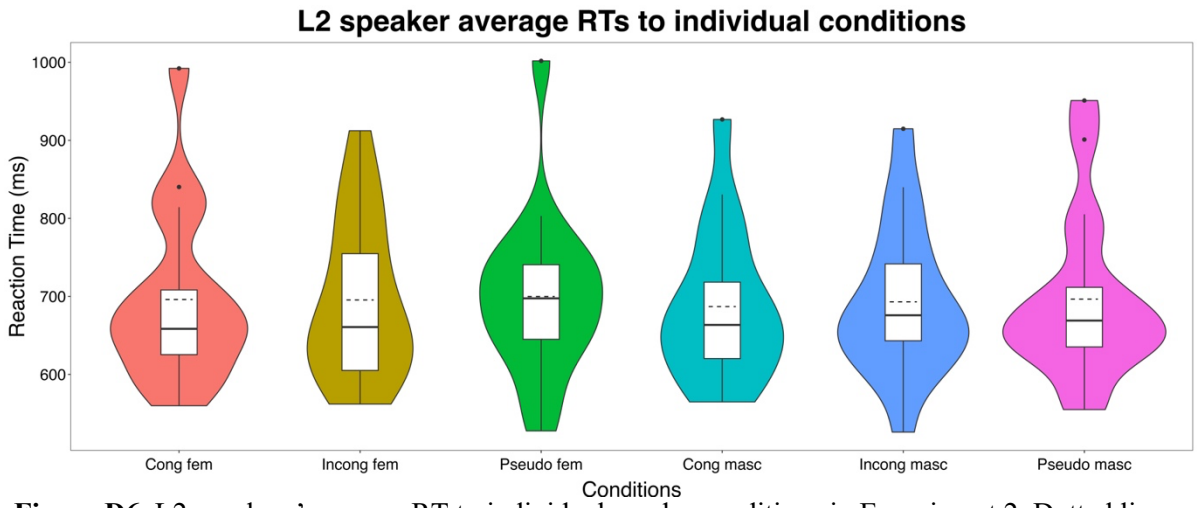


Figure D6. L2 speakers' average RT to individual gender conditions in Experiment 2. Dotted line = mean, solid line = median.

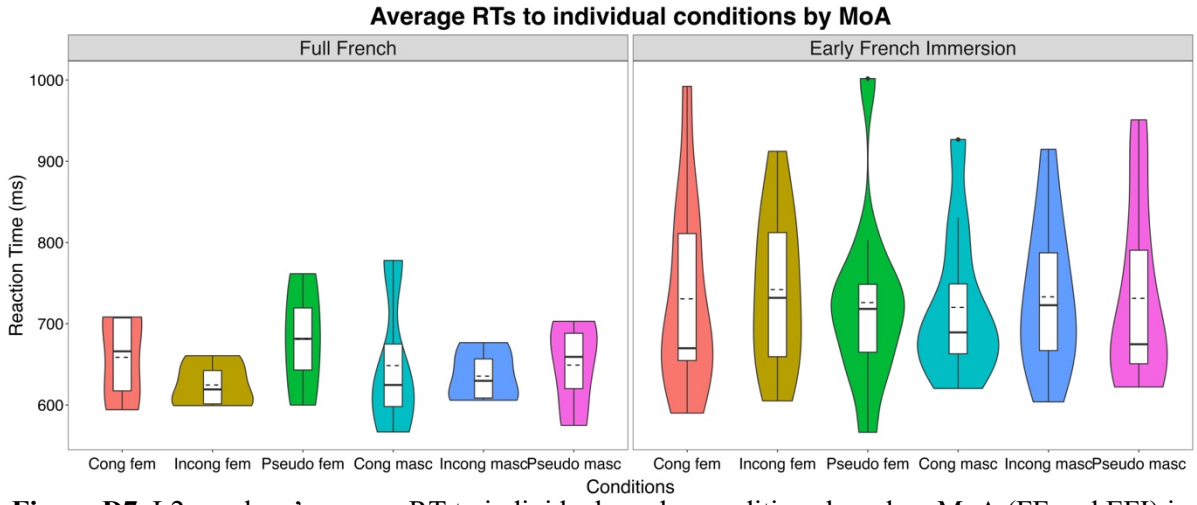


Figure D7. L2 speakers' average RT to individual gender conditions based on MoA (FF and EFI) in Experiment 2. Dotted line = mean, solid line = median.

APPENDIX E: ERP STATISTICAL MODELS AND MASCULINE WAVES

This appendix includes the complete statistical model outputs that are reported in Chapter 3 and the masculine noun waveforms. The 100-300 ms time-window is presented in Table E1 and the 300-500 ms time-window is presented in Table E2. Significant effects are bolded. The ERP waveforms for masculine noun conditions (Figure E1) are presented by regions of interest.

Table E1. Liner mixed model output for the 100-300 ms time-window.

Predictors	Estimates	95% CI	*t*-value	*p*-value
Intercept	4.05	2.81 – 5.29	6.408	**<0.001**
Noun gender	-0.06	-0.13 – 0.02	-1.47	0.14
Congruency	**-0.19**	**-0.26 – -0.11**	**-4.818**	**<0.001**
Laterality [1]	**-0.65**	**-1.12 – -0.17**	**-2.677**	**0.01**
Laterality [2]	**0.45**	**0.03 – 0.88**	**2.092**	**0.04**
Anteriority [1]	**1.47**	**1.01 – 1.92**	**6.26**	**<0.001**
Anteriority [2]	0.09	-0.37 – 0.55	0.37	0.71
Noun gender*Congruency	0.06	-0.01 – 0.14	1.583	0.11
Noun gender*Laterality [1]	**0.14**	**0.03 – 0.25**	**2.451**	**0.01**
Noun gender*Laterality [2]	-0.04	-0.14 – 0.06	-0.77	0.44
Congruency*Laterality [1]	0.02	-0.09 – 0.13	0.383	0.70
Congruency*Laterality [2]	-0.02	-0.12 – 0.08	-0.309	0.76
Noun gender*Anteriority [1]	-0.07	-0.18 – 0.03	-1.331	0.18
Noun gender*Anteriority [2]	-0.02	-0.13 – 0.09	-0.34	0.73
Congruency*Anteriority [1]	-0.01	-0.12 – 0.10	-0.141	0.89
Congruency*Anteriority [2]	-0.04	-0.15 – 0.07	-0.742	0.46
Laterality [1]*Anteriority [1]	0.37	-0.30 – 1.04	1.077	0.29
Laterality [2]*Anteriority [1]	-0.58	-1.18 – 0.03	-1.877	0.07
Laterality [1]*Anteriority [2]	0.02	-0.65 – 0.69	0.067	0.95
Laterality [2]*Anteriority [2]	0.03	-0.57 – 0.64	0.111	0.91
Noun gender * Congruency * Laterality [1]	**0.12**	**0.01 – 0.23**	**2.143**	**0.03**
Noun gender * Congruency * Laterality [2]	0.01	-0.09 – 0.11	0.207	0.84
Noun gender * Congruency * Anteriority [1]	0.04	-0.07 – 0.15	0.76	0.45
Noun gender * Congruency * Anteriority [2]	-0.01	-0.12 – 0.09	-0.261	0.79
Noun gender*Laterality [1]*Anteriority [1]	0	-0.16 – 0.16	0.023	0.98

Noun gender*Laterality [2]*Anteriority [1]	0.03	-0.12 – 0.17	0.366	0.71
Noun gender*Laterality [1]*Anteriority [2]	0.04	-0.12 – 0.20	0.487	0.63
Noun gender*Laterality [2]*Anteriority [2]	-0.01	-0.15 – 0.13	-0.148	0.88
Congruency*Laterality [1]*Anteriority [1]	-0.08	-0.24 – 0.08	-0.961	0.34
Congruency*Laterality [2]*Anteriority [1]	0.01	-0.13 – 0.16	0.172	0.86
Congruency*Laterality [1]*Anteriority [2]	0	-0.15 – 0.16	0.058	0.95
Congruency*Laterality [2]*Anteriority [2]	0	-0.14 – 0.14	-0.014	0.99
Noun gender*Congruency*Laterality [1]*Anteriority [1]	0.03	-0.13 – 0.19	0.381	0.70
Noun gender*Congruency*Laterality [2]*Anteriority [1]	-0.02	-0.16 – 0.12	-0.28	0.78
Noun gender*Congruency*Laterality [1]*Anteriority [2]	0.03	-0.13 – 0.19	0.376	0.71
Noun gender*Congruency*Laterality [2]*Anteriority [2]	0.01	-0.13 – 0.16	0.172	0.86

Marginal R^2 = 0.099, **Conditional R^2** = 0.663

Table E2. Liner mixed model output for the 300-500 ms time-window.

Predictors	Estimates	95% CI	*t*-value	*p*-value
Intercept	4.05	2.50 – 5.60	5.123	**<0.001**
Noun gender	0.02	-0.07 – 0.12	0.506	0.61
Congruency	**0.14**	**0.05 – 0.23**	**3.03**	**0.002**
Laterality [1]	**-0.67**	**-1.18 – -0.16**	**-2.591**	**0.01**
Laterality [2]	0.43	-0.03 – 0.88	1.853	0.07
Anteriority [1]	**-1.17**	**-1.66 – -0.68**	**-4.657**	**<0.001**
Anteriority [2]	0.31	-0.18 – 0.80	1.226	0.23
Noun gender*Congruency	0.02	-0.07 – 0.11	0.465	0.64
Noun gender*Laterality [1]	0.13	-0.01 – 0.26	1.867	0.06
Noun gender*Laterality [2]	-0.05	-0.17 – 0.07	-0.782	0.43
Congruency*Laterality [1]	-0.01	-0.14 – 0.13	-0.081	0.94
Congruency*Laterality [2]	0.01	-0.11 – 0.13	0.097	0.92
Noun gender*Anteriority [1]	-0.02	-0.15 – 0.11	-0.339	0.73
Noun gender*Anteriority [2]	-0.05	-0.18 – 0.08	-0.815	0.42
Congruency*Anteriority [1]	0.06	-0.07 – 0.19	0.902	0.37
Congruency*Anteriority [2]	0	-0.13 – 0.13	-0.06	0.95
Laterality [1]*Anteriority [1]	0.37	-0.34 – 1.09	1.018	0.32
Laterality [2]*Anteriority [1]	**-0.76**	**-1.41 – -0.11**	**-2.305**	**0.03**
Laterality [1]*Anteriority [2]	-0.02	-0.73 – 0.70	-0.043	0.97
Laterality [2]*Anteriority [2]	0.16	-0.49 – 0.81	0.491	0.63
Noun gender * Congruency * Laterality [1]	0.12	-0.01 – 0.26	1.822	0.07
Noun gender * Congruency * Laterality [2]	-0.03	-0.15 – 0.09	-0.421	0.67
Noun gender * Congruency * Anteriority [1]	-0.03	-0.16 – 0.10	-0.454	0.65
Noun gender * Congruency * Anteriority [2]	-0.06	-0.19 – 0.07	-0.86	0.39
Noun gender*Laterality [1]*Anteriority [1]	-0.07	-0.26 – 0.12	-0.711	0.48
Noun gender*Laterality [2]*Anteriority [1]	0.08	-0.10 – 0.25	0.866	0.39
Noun gender*Laterality [1]*Anteriority [2]	0	-0.19 – 0.19	0.014	0.99
Noun gender*Laterality [2]*Anteriority [2]	-0.02	-0.19 – 0.16	-0.177	0.86
Congruency*Laterality [1]*Anteriority [1]	-0.09	-0.28 – 0.10	-0.965	0.33
Congruency*Laterality [2]*Anteriority [1]	0.01	-0.16 – 0.18	0.151	0.88
Congruency*Laterality [1]*Anteriority [2]	-0.03	-0.22 – 0.16	-0.277	0.78

Congruency*Laterality [2]*Anteriority [2]	0.02	-0.16 – 0.19	0.175	0.86
Noun gender*Congruency*Laterality [1]*Anteriority [1]	-0.03	-0.22 – 0.16	-0.354	0.72
Noun gender*Congruency*Laterality [2]*Anteriority [1]	-0.01	-0.18 – 0.17	-0.067	0.95
Noun gender*Congruency*Laterality [1]*Anteriority [2]	0.05	-0.14 – 0.24	0.488	0.63
Noun gender*Congruency*Laterality [2]*Anteriority [2]	0	-0.17 – 0.17	-0.017	0.99

Marginal R^2 = 0.054, **Conditional R^2** = 0.662

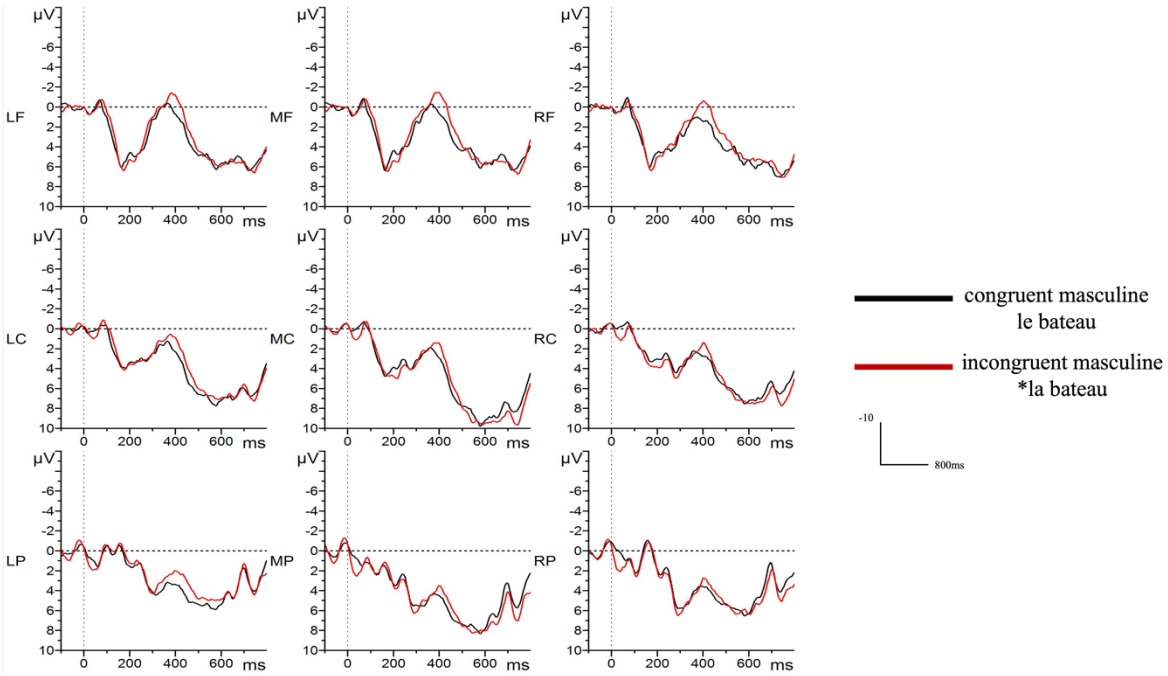


Figure E1. ERP waveforms to masculine noun conditions.

APPENDIX F: SELF-PACED READING STIMULI

This appendix includes the experimental (Table F1) and filler (Table F2) stimuli items used in the self-paced reading task in Chapter 4. The determiner and noun are bolded in the experimental sentences. The ungrammatical portion of the sentence is bolded in the filler sentences.

Table F1. Experimental sentence stimuli.

Condition	Item	Sentence	Translation	N frequency	Comprehension question	Question translation	Answer
congruent masculine	1	Eric a acheté trois livres pendant **le mois** de mai.	Eric bought three books during the month of May.	312.31	Eric a-t-il acheté un livre en juin?	Did Eric buy a book in june?	N
incongruent masculine	1	Eric a acheté trois livres pendant **la mois** de mai.		312.31	Eric a-t-il acheté un livre en juin?	Did Eric buy a book in june?	N
congruent masculine	2	Lucas a nettoyé le tapis après que **le lait** soit tombé par terre.	Lucas cleaned the carpet after the milk spilled on the floor.	44.9	Lucas a-t-il nettoyé le lait?	Did Lucas clean up the milk?	Y
incongruent masculine	2	Lucas a nettoyé le tapis après que **la lait** soit tombé par terre.		44.9	Lucas a-t-il nettoyé le lait?	Did Lucas clean up the milk?	Y
congruent masculine	3	Daniel a monté la pente et s'est assis sur **le gazon** pour manger son dîner.	Daniel climbed the hill and sat in the grass to eat his lunch.	3.81	Daniel est-il allé à la pêche?	Did Daniel go fishing?	N
incongruent masculine	3	Daniel a monté la pente et s'est assis sur **la gazon** pour manger son dîner.		3.81	Daniel est-il allé à la pêche?	Did Daniel go fishing?	N
congruent masculine	4	David est monté sur la table pour peinturer **le plafond** de sa cuisine.	David climbed on the table to paint the ceiling of his kitchen.	29.58	David avait-il un pinceau?	Did David have a paint brush?	Y
incongruent masculine	4	David est monté sur la table pour peinturer **la plafond** de sa cuisine.		29.58	David avait-il un pinceau?	Did David have a paint brush?	Y
congruent masculine	5	Jason a trouvé deux bijoux dans **le soulier** qu'il portait.	Jacob found two jewels in the show that he was wearing.	9.76	Jason a-t-il trouvé deux bijoux dans sa chaussure?	Did Jason find two jewels in his shoe?	Y
incongruent masculine	5	Jason a trouvé deux bijoux dans **la soulier** qu'il portait.		9.76	Jason a-t-il trouvé deux bijoux dans sa chaussure?	Did Jason find two jewels in his shoe?	Y
congruent masculine	6	Noah porte toujours son chapeau quand **le soleil** brille.	Noah always wears his hat when the sun is shining.	123.34	Noah a-t-il un chapeau?	Does Noah have a hat?	Y
incongruent masculine	6	Noah porte toujours son chapeau quand **la soleil** brille.		123.34	Noah a-t-il un chapeau?	Does Noah have a hat?	Y
congruent masculine	7	James a lavé le cochon avec **le savon** que je lui donné.	James washed the pig with the soap that I gave him.	16.68	Jean a-t-il lavé le chien?	Did John wash the dog?	N
incongruent masculine	7	James a lavé le cochon avec **la savon** que je lui donné.		16.68	Jean a-t-il lavé le chien?	Did John wash the dog?	N
congruent masculine	8	Emma a tracé deux coeurs dans **le sable** avec son doigt.	Emma traced two hearts in the sand with her finger.	25.23	Emma a-t-elle tracé des cœurs?	Did Emma trace hearts?	Y
incongruent masculine	8	Emma a tracé deux coeurs dans **la sable** avec son doigt.		25.23	Emma a-t-elle tracé des cœurs?	Did Emma trace hearts?	Y

congruent masculine	9	Mila a suivi le renard à travers **le pont** et dans le forêt.	Mila followed the fox across the bridge and into the forest.	56.43	Un écureuil a-t-il traversé le pont?	Did a squirrel go across the bridge?	N
incongruent masculine	9	Mila a suivi le renard à travers **la pont** et dans le forêt.		56.43	Un écureuil a-t-il traversé le pont?	Did a squirrel go across the bridge?	N
congruent masculine	10	Clara a écrasé la fourmi avec **le livre** qu'elle lisait.	Clara crushed the ant with the books she was reading.	144.29	Clara a-t-elle vu une abeille?	Did Clara see a bee?	N
incongruent masculine	10	Clara a écrasé la fourmi avec **la livre** qu'elle lisait.		144.29	Clara a-t-elle vu une abeille?	Did Clara see a bee?	N
congruent masculine	11	Julia a vu que la mouche était prise dans **le miel** sur son pain.	Julia saw that the fly was stuck in the honey on her toast.	17.36	La mouche était-elle prise dans le miel?	Was the fly stuck in the honey?	Y
incongruent masculine	11	Julia a vu que la mouche était prise dans **la miel** sur son pain.		17.36	La mouche était-elle prise dans le miel?	Was the fly stuck in the honey?	Y
congruent masculine	12	Sarah a attrapé le ballon avant qu'il ait frappé **le cadre** sur la table.	Sarah caught the ball before it hit the frame on the table.	13.53	Sarah a-t-elle attrapé le ballon?	Did Sarah catch the ball?	Y
incongruent masculine	12	Sarah a attrapé le ballon avant qu'il ait frappé **la cadre** sur la table.		13.53	Sarah a-t-elle attrapé le ballon?	Did Sarah catch the ball?	Y
congruent masculine	13	Caroline a mis du sel pour améliorer **le goût** de sa soupe.	Caroline added some salt to improve the taste of her soup.	57.94	Du poivre a-t-il été ajouté à la soupe?	Was pepper added to the soup?	N
incongruent masculine	13	Caroline a mis du sel pour améliorer **la goût** de sa soupe.		57.94	Du poivre a-t-il été ajouté à la soupe?	Was pepper added to the soup?	N
congruent masculine	14	Liam s'est assis sur le quai pour voir **le navire** qui s'approchait.	Liam sat down on the dock to watch the ship that was approaching.	21.98	Le navire s'envolait-il?	Was the ship floating away?	N
incongruent masculine	14	Liam s'est assis sur le quai pour voir **la navire** qui s'approchait.		21.98	Le navire s'envolait-il?	Was the ship floating away?	N
congruent masculine	15	Annie a ouvert son sac et a mis **le patin** par terre.	Annie opened her bag and put the skate on the ground.	3.77	Le patin a-t-il été posé sur la table?	Was the skate placed on the table?	N
incongruent masculine	15	Annie a ouvert son sac et a mis **la patin** par terre.		3.77	Le patin a-t-il été posé sur la table?	Was the skate placed on the table?	N
congruent masculine	16	Thomas est allé au marché pour acheté **le fromage** que sa mère préfère.	Thomas went to the market to but the cheese that his mom likes best.	12.52	Thomas est-il allé au marché?	Did Thomas go to the market?	Y
incongruent masculine	16	Thomas est allé au marché pour acheté **la fromage** que sa mère préfère.		12.52	Thomas est-il allé au marché?	Did Thomas go to the market?	Y
congruent masculine	17	Marc a conduit à l'aéroport dans **le camion** qu'il a loué.	Marc drove to the airport in the truck that he rented.	18.19			
incongruent masculine	17	Marc a conduit à l'aéroport dans **la camion** qu'il a loué.		18.19			
congruent masculine	18	L'étudiant a mis ses devoirs sur **le pupitre** et s'est assis.	The student put his homework on	99.77			

incongruent masculine	18	L'étudiant a mis ses devoirs sur **la pupitre** et s'est assis.	the desk and sat down.	99.77			
congruent masculine	19	Claire est allé au magasin pour acheter **le poivre** qui était en vente.	Claire went to the store to buy the pepper that was on sale.	3.8			
incongruent masculine	19	Claire est allé au magasin pour acheter **la poivre** qui était en vente.		3.8			
congruent masculine	20	Louise cherchait ses tiroirs pour **le gant** qu'elle a perdu.	Louise looked though her drawers for the glove she lost.	25.02			
incongruent masculine	20	Louise cherchait ses tiroirs pour **la gant** qu'elle a perdu.		25.02			
congruent masculine	21	Joan veut en savoir plus sur **le cerveau** ce semestre.	Joan wants to learn more about the brain this semester.	28.23			
incongruent masculine	21	Joan veut en savoir plus sur **la cerveau** ce semestre.		28.23			
congruent masculine	22	Kevin a marché jusqu'à l'eau et a vu **le bateau** s'éloigner.	Kevin walked to the water and saw the boat float away.	41.94			
incongruent masculine	22	Kevin a marché jusqu'à l'eau et a vu **la bateau** s'éloigner.		41.94			
congruent masculine	23	Le serveur posât l'eau et **le beurre** sur la table.	The waiter placed the water and the butter on the table.	24.48			
incongruent masculine	23	Le serveur posât l'eau et **la beurre** sur la table.		24.48			
congruent masculine	24	Leah a choisi entre le chocolat et **le bonbon** au magasin.	Leah decided between the chocolate and the candy at the store.	23.45			
incongruent masculine	24	Leah a choisi entre le chocolat et **la bonbon** au magasin.		23.45			
congruent masculine	25	L'enfant tenait **le bras** de sa mère dans le marché occupé.	The child held the arm of their mother in the busy market.	290.89			
incongruent masculine	25	L'enfant tenait **la bras** de sa mère dans le marché occupé.		290.89			
congruent masculine	26	Allison est sortie parce qu'elle a entendu **le bruit** d'un feu d'artifice.	Allison went outside because she heard the noise of fireworks.	139.52			
incongruent masculine	26	Allison est sortie parce qu'elle a entendu **la bruit** d'un feu d'artifice.		139.52			
congruent masculine	27	James courut vers la table avec **le cadeau** de son ami.	James ran towards the table with the present from his friend.	18.65			
incongruent masculine	27	James courut vers la table avec **la cadeau** de son ami.		18.65			
congruent masculine	28	Elliot a appelé à l'aide lorsque **le camion** a quitté la route.	Elliot called for help when the truck	18.19			

incongruent masculine	28	Elliot a appelé à l'aide lorsque **la camion** a quitté la route.	went off the road.	18.19			
congruent masculine	29	Julie s'est assurée de mettre **le chapeau** sur le crochet à la maison.	Julie made sure to put the hat on the hook at home.	42.48			
incongruent masculine	29	Julie s'est assurée de mettre **le chapeau** sur le crochet à la maison.		42.48			
congruent masculine	30	Turner regarda vers le ciel et vit **le drapeau** flotter au vent.	Turner looked to the sky and saw the flag flapping in the wind.	15.16			
incongruent masculine	30	Turner regarda vers le ciel et vit **la drapeau** flotter au vent.		15.16			
congruent masculine	31	Michael n'a pas regardé le film à cause **de le fantôme** qu'il contenait.	Michael didn't watch the movie because of the ghost in it.	16.84			
incongruent masculine	31	Michael n'a pas regardé le film à cause de **la fantôme** qu'il contenait.		16.84			
congruent masculine	32	Alyssa a appelé quelqu'un pour aider avec **le feu** à l'extérieur.	Alyssa made a call for someone to help with the fire outside.	156.29			
incongruent masculine	32	Alyssa a appelé quelqu'un pour aider avec **la feu** à l'extérieur.		156.29			
congruent masculine	33	La créatrice a remporté un concours avec **le foulard** qu'elle a réalisé.	The designer won a competition with the scarf she made.	8.23			
incongruent masculine	33	La créatrice a remporté un concours avec **la foulard** qu'elle a réalisé.		8.23			
congruent masculine	34	Jan s'est arrêté pour regarder **le gâteau** exposé à la boulangerie.	Jan stopped to look at the cake on display at the bakery.	55.19			
incongruent masculine	34	Jan s'est arrêté pour regarder **le gâteau** exposé à la boulangerie.		55.19			
congruent masculine	35	John admirait son travail sur **le jardin** dans la cour arrière.	John admired his work on the garden in the backyard.	88.42			
incongruent masculine	35	John admirait son travail sur **la jardin** dans la cour arrière.		88.42			
congruent masculine	36	Amanda a créé le présentoir dans **le magasin** de sacs.	Amanda created the display in the store of bags.	27.53			
incongruent masculine	36	Amanda a créé le présentoir dans **la magasin** de sacs.		27.53			
congruent masculine	37	Brittany a oublié de mettre **le manteau** dans le placard.	Brittany forgot to put the coat in the closet.	36.29			
incongruent masculine	37	Brittany a oublié de mettre **la manteau** dans le placard.		36.29			

congruent masculine	38	Jeff a essayé de trouver **le poisson** jaune dans le réservoir.	Jeff tried to find the yellow fish in the tank.	30.03			
incongruent masculine	38	Jeff a essayé de trouver **la poisson** jaune dans le réservoir.		30.03			
congruent masculine	39	L'enfant était content car **le papillon** s'est posé sur sa main.	The child was happy because the butterfly landed on their hand.	13.03			
incongruent masculine	39	L'enfant était content car **la papillon** s'est posé sur sa main.		13.03			
congruent masculine	40	Austin a oublié de mettre **le sucre** dans son café.	Austin forgot to put the sugar in his coffee.	26.71			
incongruent masculine	40	Austin a oublié de mettre **la sucre** dans son café.		26.71			
congruent masculine	41	James s'est rendu en Angleterre pour voir **le roi** pour la première fois.	James travelled to England to see the king for the first time.	106.61			
incongruent masculine	41	James s'est rendu en Angleterre pour voir **la roi** pour la première fois.		106.61			
congruent masculine	42	Le magasin a affiché **le sac** à main dans la fenêtre.	The store displayed the bag in the window.	124.6			
incongruent masculine	42	Le magasin a affiché **la sac** à main dans la fenêtre.		124.6			
congruent masculine	43	Henry voulait acheter **le singe** en peluche pour son fils.	Henry wanted to buy the monkey stuffed animal for his son.	10.39			
incongruent masculine	43	Henry voulait acheter **la singe** en peluche pour son fils.		10.39			
congruent masculine	44	Quelqu'un a accidentellement heurté la table et **le stylo** est tombé.	Someone accidentally hit the table and the pen fell off.	5.68			
incongruent masculine	44	Quelqu'un a accidentellement heurté la table et **la stylo** est tombé.		5.68			
congruent masculine	45	Il y avait une araignée sur **le tapis** du salon.	There was a spider on the carpet in the living room.	39.94			
incongruent masculine	45	Il y avait une araignée sur **la tapis** du salon.		39.94			
congruent masculine	46	Mélanie a laissé tomber **le verre** et il s'est brisé sur le sol.	Melanie dropped the glass, and it shattered on the floor.	155.29			
incongruent masculine	46	Mélanie a laissé tomber **la verre** et il s'est brisé sur le sol.		155.29			
congruent masculine	47	Jesse n'a pas vu **le ver** dans le sol pendant qu'elle jardinait.	Jesse didn't see the worm in the soil	727.26			

incongruent masculine	47	Jesse n'a pas vu **la ver** dans le sol pendant qu'elle jardinait.	while she was gardening.	727.26			
congruent masculine	48	L'hôte a sorti **le vin** de l'étagère pour le servir.	The host took the wine from the shelf to serve.	64.97			
incongruent masculine	48	L'hôte a sorti **la vin** de l'étagère pour le servir.		64.97			
congruent masculine	49	Shana essayait de comprendre d'où elle connaissait **le visage** sur l'affiche.	Shana tried to figure out where she knew the face on the poster from.	270.74			
incongruent masculine	49	Shana essayait de comprendre d'où elle connaissait **la visage** sur l'affiche.		270.74			
congruent masculine	50	L'enfant voulait caresser **le cochon** à la ferme.	The child wanted to put the pig on the farm.	9.06			
incongruent masculine	50	L'enfant voulait caresser **la cochon** à la ferme.		9.06			
congruent feminine	51	Robert a vu un écureuil dans **la maison** d'à côté.	Robert saw a squirrel in the house next door.	299.65	Robert a-t-il vu un écureuil?	Did Robert see a squirrel?	Y
incongruent feminine	51	Robert a vu un écureuil dans **le maison** d'à côté.		299.65	Robert a-t-il vu un écureuil?	Did Robert see a squirrel?	Y
congruent feminine	52	Anne a planté des fleurs sur **la colline** derrière son appartement.	Anne planted some flowers on the hill behind her apartment.	26.39	Anne vit-elle dans une maison?	Does Anne live in a house?	N
incongruent feminine	52	Anne a planté des fleurs sur **le colline** derrière son appartement.		26.39	Anne vit-elle dans une maison?	Does Anne live in a house?	N
congruent feminine	53	Le prof a entendu le tonnerre et a échappé **la craie** par terre.	The prof heard the thunder and dropped the chalk on the floor.	5.8	Le prof tenait-il un stylo?	Was the prof holding a pen?	N
incongruent feminine	53	Le prof a entendu le tonnerre et a échappé **le craie** par terre.		5.8	Le prof tenait-il un stylo?	Was the prof holding a pen?	N
congruent feminine	54	Alex a perdu une mitaine pendant **la tempête** la semaine dernière.	Alex lost a mitten during the storm last week.	19.73	Y a-t-il eu une tempête la semaine dernière?	Was there a storm last week?	Y
incongruent feminine	54	Alex a perdu une mitaine pendant **le tempête** la semaine dernière.		19.73	Y a-t-il eu une tempête la semaine dernière?	Was there a storm last week?	Y
congruent feminine	55	Nicholas a vu trois gouttes de sang sur **la manche** de sa chemise.	Nicholas saw three drops of blood on the sleeve of his shirt.	14.25	Le sang était-il sur son pantalon?	Was the blood on his pants?	N
incongruent feminine	55	Nicholas a vu trois gouttes de sang sur **le manche** de sa chemise.		14.25	Le sang était-il sur son pantalon?	Was the blood on his pants?	N
congruent feminine	56	Dominic a vu le village par **la fenêtre** de l'autobus.	Dominic saw the village from the window of the bus.	70.2	Dominic était-il dans un bus?	Was Dominic on a bus?	Y
incongruent feminine	56	Dominic a vu le village par **le fenêtre** de l'autobus.		70.2	Dominic était-il dans un bus?	Was Dominic on a bus?	Y
congruent feminine	57	Charlie a lancé une roche vers **la ciel** et a frappé l'oiseau.	Charlie threw a rock up in	142.32	Charlie a-t-il jeté une pierre?	Did Charlie throw a rock?	Y

incongruent feminine	57	Charlie a lancé une roche vers **le ciel** et a frappé l'oiseau.	the sky and hit the bird.	142.32	Charlie a-t-il jeté une pierre?	Did Charlie throw a rock?	Y
congruent feminine	58	Tristan a utilisé une brosse pour laver **la tasse** qui était dans le lavabo.	Tristian used a brush to wash the cup that was in the sink.	14.61	Tristan a-t-il utilisé une serviette?	Did Tristan use a towel?	N
incongruent feminine	58	Tristan a utilisé une brosse pour laver **le tasse** qui était dans le lavabo.		14.61	Tristan a-t-il utilisé une serviette?	Did Tristan use a towel?	N
congruent feminine	59	Caleb a écrit un poème pour raconter **la rêve** qu'il a fait hier soir.	Caleb wrote a poem to describe the dream he had last night.	158.75	Caleb a-t-il écrit un livre?	Did Caleb write a book?	N
incongruent feminine	59	Caleb a écrit un poème pour raconter **le rêve** qu'il a fait hier soir.		158.75	Caleb a-t-il écrit un livre?	Did Caleb write a book?	N
congruent feminine	60	Olivia a choisi un foulard pour mettre avec **la jupe** qu'elle a acheté.	Olivia picked out a scarf to wear with the skirt that she bought.	18.13	Olivia a-t-elle acheté un chapeau?	Did Olivia buy a hat?	N
incongruent feminine	60	Olivia a choisi un foulard pour mettre avec **le jupe** qu'elle a acheté.		18.13	Olivia a-t-elle acheté un chapeau?	Did Olivia buy a hat?	N
congruent feminine	61	Isabelle a ouvert la porte pour voir **la neige** tomber.	Isabelle opened the door to watch the snow fall.	48.23	Est-ce qu'il pleuvait dehors?	Was it raining outside?	N
incongruent feminine	61	Isabelle a ouvert la porte pour voir **le neige** tomber.		48.23	Est-ce qu'il pleuvait dehors?	Was it raining outside?	N
congruent feminine	62	Simon a disparu deux jours après que **la guerre** a commencé.	Simon disappeared two days after the war had started.	320.86	Simon était-il parti avant la guerre?	Was Simon gone before the war?	N
incongruent feminine	62	Simon a disparu deux jours après que **le guerre** a commencé.		320.86	Simon était-il parti avant la guerre?	Was Simon gone before the war?	N
congruent feminine	63	Sophie a mangé la cerise et a mis **la tige** dans la poubelle.	Sophie ate the cherry and put the stem in the garbage.	3.73	Sophie a-t-elle mangé une cerise?	Did Sophie eat a cherry?	Y
incongruent feminine	63	Sophie a mangé la cerise et a mis **le tige** dans la poubelle.		3.73	Sophie a-t-elle mangé une cerise?	Did Sophie eat a cherry?	Y
congruent feminine	64	L'enfant jouait dans la cour quand **la pluie** a commencé à tomber.	The kid played in the yard when the rain started to fall.	46.1	Est-ce qu'il pleuvait?	Was it raining?	Y
incongruent feminine	64	L'enfant jouait dans la cour quand **le pluie** a commencé à tomber.		46.1	Est-ce qu'il pleuvait?	Was it raining?	Y
congruent feminine	65	Michelle a scellé l'enveloppe avec **la cire** de la chandelle.	Michelle sealed the envelope with the wax from the candle.	5.59	Michelle a-t-elle utilisé une enveloppe?	Did Michelle use an envelope?	Y
incongruent feminine	65	Michelle a scellé l'enveloppe avec **le cire** de la chandelle.		5.59	Michelle a-t-elle utilisé une enveloppe?	Did Michelle use an envelope?	Y
congruent feminine	66	Myriam a préparé un repas pour célébrer **la récolte** de la saison.	Myriam prepared a meal to celebrate the harvest of the season.	9.83	Un repas a-t-il été préparé?	Was a meal made?	Y
incongruent feminine	66	Myriam a préparé un repas pour célébrer **le récolte** de la saison.		9.83	Un repas a-t-il été préparé?	Was a meal made?	Y

congruent feminine	67	Nathan ouvre les rideaux pour voir **la ville** qu'il va visiter aujourd'hui.	Nathan opened the curtains to see the city that he was visiting today.	295.14			
incongruent feminine	67	Nathan ouvre les rideaux pour voir **le ville** qu'il va visiter aujourd'hui.		295.14			
congruent feminine	68	La mère a enlevé le bouton qui était dans **la bouche** de son bébé.	The mother removed the button that was in the mouth of her baby.	150.68			
incongruent feminine	68	La mère a enlevé le bouton qui était dans **le bouche** de son bébé.		150.68			
congruent feminine	69	Danielle a vu la falaise et a remarqué **la peur** sur le visage de son ami.	Danielle saw the cliff and noticed the fear on his friend's face.	557.21			
incongruent feminine	69	Danielle a vu la falaise et a remarqué **le peur** sur le visage de son ami.		557.21			
congruent feminine	70	Justin lui donné une claque sur **la cuisse** quand il s'est assis.	Justin gave him a slap on the thigh when he sat down.	12.73			
incongruent feminine	70	Justin lui donné une claque sur **le cuisse** quand il s'est assis.		12.73			
congruent feminine	71	Max a tiré une flèche et a manqué **la cible** encore une fois.	Max shot an arrow and missed the target once again.	33.55			
incongruent feminine	71	Max a tiré une flèche et a manqué **le cible** encore une fois.		33.55			
congruent feminine	72	Paul regardait par la fenêtre pour voir **la plage** où son fils jouait.	Paul looked out the window to see the beach where his son was playing.	42.23			
incongruent feminine	72	Paul regardait par la fenêtre pour voir **le plage** où son fils jouait.		42.23			
congruent feminine	73	Il y avait un événement d'auteur à **la bibliothèque** hier soir.	There was an author event at the library last night.	42.23			
incongruent feminine	73	Il y avait un événement d'auteur à **le bibliothèque** hier soir.		42.23			
congruent feminine	74	Les peintres ont utilisé la mauvaise couleur pour **la chambre** à l'étage.	The painters used the wrong colour for the bedroom upstairs.	231.23			
incongruent feminine	74	Les peintres ont utilisé la mauvaise couleur pour **le chambre** à l'étage.		231.23			
congruent feminine	75	Hannah a entendu **la chanson** qu'elle chante à la radio.	Hannah heard the song that she sings on the radio.	23.52			
incongruent feminine	75	Hannah a entendu **le chanson** qu'elle chante à la radio.		23.52			

congruent feminine	76	Le couple a reçu **la clé** de leur nouvelle maison.	The couple received the key to their new house.	22.61			
incongruent feminine	76	Le couple a reçu **le clé** de leur nouvelle maison.		22.61			
congruent feminine	77	Il y avait une fuite dans **la douche** en haut.	There was a leak in the shower upstairs.	10.39			
incongruent feminine	77	Il y avait une fuite dans **le douche** en haut.		10.39			
congruent feminine	78	Bruno était excité de recevoir une invitation à **la fête** cette fin de semaine.	Bruno was excited to get an invitation to the party this weekend.	50.45			
incongruent feminine	78	Bruno était excité de recevoir une invitation à **le fête** cette fin de semaine.		50.45			
congruent feminine	79	Chase a couru pour attraper **la plume** qui flottait dans le vent.	Chase ran to catch the feather floating in the wind.	6.49			
incongruent feminine	79	Chase a couru pour attraper **le plume** qui flottait dans le vent.		6.49			
congruent feminine	80	Mel a accidentellement touché **la jambe** de la personne à côté d'elle.	Mel accidently touched the leg of the person beside her.	36.68			
incongruent feminine	80	Mel a accidentellement touché **le jambe** de la personne à côté d'elle.		36.68			
congruent feminine	81	Les gens se sont rassemblés au parc pour voir **la lune** hier soir.	People gathered at the park to see the moon last night.	52.45			
incongruent feminine	81	Les gens se sont rassemblés au parc pour voir **le lune** hier soir.		52.45			
congruent feminine	82	Travis a fait sa valise **la nuit** avant de son voyage.	Travis packed his suitcase the night before his trip.	404.42			
incongruent feminine	82	Travis a fait sa valise **le nuit** avant de son voyage.		404.42			
congruent feminine	83	L'enfant a pris **la pomme** de chez lui pour le déjeuner.	The child took the apple from home for lunch.	26.45			
incongruent feminine	83	L'enfant a pris **le pomme** de chez lui pour le déjeuner.		26.45			
congruent feminine	84	Tout le monde franchit **la porte** en une seule ligne.	Everyone walked through the door in a single line.	426.48			
incongruent feminine	84	Tout le monde franchit **le porte** en une seule ligne.		426.48			
congruent feminine	85	Les travailleurs ont installé **la cloche** dans la nouvelle tour.	The workers installed the bell in the new tower.	15.06			
incongruent feminine	85	Les travailleurs ont installé **le cloche** dans la nouvelle tour.		15.06			

congruent feminine	86	Le temps était si mauvais que **la rue** n'était pas visible.	The weather was so bad that the road was not visible.	260.97			
incongruent feminine	86	Le temps était si mauvais que **le rue** n'était pas visible.		260.97			
congruent feminine	87	L'enfant voulait voir **la vache** à la ferme.	The child wanted to see the cow at the farm.	18.45			
incongruent feminine	87	L'enfant voulait voir **le vache** à la ferme.		18.45			
congruent feminine	88	Jessica a perdu **la bague** qui appartenait à sa mère.	Jessica lost the ring that belonged to her mother.	9.1			
incongruent feminine	88	Jessica a perdu **le bague** qui appartenait à sa mère.		9.1			
congruent feminine	89	Emily a trébuché sur **la roche** qui était sur le trottoir.	Emily tripped on the rock that was on the sidewalk.	13.77			
incongruent feminine	89	Emily a trébuché sur **le roche** qui était sur le trottoir.		13.77			
congruent feminine	90	Le garçon a mangé toute **la glace** qui était dans sa boisson.	The boy ate all of the ice that was in his drink.	49.58			
incongruent feminine	90	Le garçon a mangé toute **le glace** qui était dans sa boisson.		49.58			
congruent feminine	91	Jennifer a vu son chien mâcher **la chaussette** par terre.	Jennifer saw her dog eat the sock on the floor.	2.26			
incongruent feminine	91	Jennifer a vu son chien mâcher **le chaussette** par terre.		2.26			
congruent feminine	92	Le vendeur a mis **la chemise** sur le mannequin du magasin.	The salesperson put the shirt on the store mannequin.	38.71			
incongruent feminine	92	Le vendeur a mis **le chemise** sur le mannequin du magasin.		38.71			
congruent feminine	93	Le couloir sentait mauvais parce que **la poubelle** avaient débordé.	The hallway smelled bad because the garbage had overflowed.	5.68			
incongruent feminine	93	Le couloir sentait mauvais parce que **le poubelle** avaient débordé.		5.68			
congruent feminine	94	L'enfant étreint **la poupée** qui appartenait à sa sœur.	The child hugged the doll that belonged to his sister.	27.59			
incongruent feminine	94	L'enfant étreint **le poupée** qui appartenait à sa sœur.		27.59			
congruent feminine	95	Hailey rêvait d'être **la reine** de son propre pays.	Hailey dreamed about being the queen of her own country.	37.9			
incongruent feminine	95	Hailey rêvait d'être **le reine** de son propre pays.		37.9			

congruent feminine	96	Cloe voulait acheter **la valise** avec le beau design.	Cloe wanted to buy the suitcase with the beautiful design.	23.77			
incongruent feminine	96	Cloe voulait acheter **le valise** avec le beau design.		23.77			
congruent feminine	97	Le couple a mis **la serrure** avec leurs initiales sur le pont.	The couple put the lock with their initials on the bridge.	9.58			
incongruent feminine	97	Le couple a mis **le serrure** avec leurs initiales sur le pont.		9.58			
congruent feminine	98	Henry passa sa ceinture dans **la boucle** de son pantalon.	Henry put his belt through the loop of his pants.	9.1			
incongruent feminine	98	Henry passa sa ceinture dans **le boucle** de son pantalon.		9.1			
congruent feminine	99	Travis a accidentellement renversé du café sur **la chaussure** sur l'étagère.	Travis accidentally spilled coffee on the shoe on the shelf.	5			
incongruent feminine	99	Travis a accidentellement renversé du café sur **le chaussure** sur l'étagère.		5			
congruent feminine	100	Le mécanicien a laissé tomber **la vis** sous la voiture.	The mechanic dropped the screw under the car.	95.48			
incongruent feminine	100	Le mécanicien a laissé tomber **le vis** sous la voiture.		95.48			

Table F2. Filler sentence stimuli

Item	Sentence	Translation	Comprehension question	Comprehension question translation	Answer
1	Julien a mangé son souper dans son bateau la nuit dernière.	Julien ate his dinner on his boat last night.	Julien a-t-il pris son petit-déjeuner sur le bateau?	Did Julien eat breakfast on the boat?	N
1	Julien **est** mangé son souper dans son bateau la nuit dernière.		Julien a-t-il pris son petit-déjeuner sur le bateau?	Did Julien eat breakfast on the boat?	N
2	Justine a acheté une poubelle pour la classe de son professeur.	Justine bought a garbage can for her teacher's classroom.	Justine a-t-elle acheté une poubelle?	Did Justine buy a garbage can?	Y
2	Justine a acheté une poubelle**s** pour la classe de son professeur.		Justine a-t-elle acheté une poubelle?	Did Justine buy a garbage can?	Y
3	Luca est descend les escaliers trop rapidement et est tombé.	Luca came down the stairs too quickly and fell.	Luca faisait-il attention?	Was Luca being careful?	N
3	Luca est descend**u** les escaliers trop rapidement et est tombé.		Luca faisait-il attention?	Was Luca being careful?	N
4	Jack a dessiné une belle image pour l'anniversaire de son ami.	Jack drew a nice picture for his friend's birthday.	Jack a-t-il fait un dessin?	Did Jack draw a picture?	Y
4	Jack a dessiné une belle image **sur** l'anniversaire de son ami.		Jack a-t-il fait un dessin?	Did Jack draw a picture?	Y
5	Gabriel voulait avoir deux cuillères pour manger sa crème glacée.	Gabriel wanted two spoons to eat his ice cream.	Gabriel mangeait-il un biscuit?	Was Gabriel eating a cookie?	N
5	Gabriel voulait avoir deux **cuillère** pour manger sa crème glacée.		Gabriel mangeait-il un biscuit?	Was Gabriel eating a cookie?	N
6	Antoine a pris son temps marcher à l'école parce qu'il faisait chaud.	Antoine took his time walking to school because it was warm out.	Il faisait froid dehors?	Was it cold outside?	N
6	Antoine a **prend** son temps marcher à l'école parce qu'il faisait chaud.		Il faisait froid dehors?	Was it cold outside?	N
7	Oliver est allé voir un film avec des deux amis hier soir.	Oliver went to see a movie with his two friends last night.	Trois personnes sont-elles allées voir le film?	Did three people go to see the movie?	Y
7	Oliver est allé voir un film avec des deux **ami** hier soir.		Trois personnes sont-elles allées voir le film?	Did three people go to see the movie?	Y

8	Xavier a lavé ses mains avant de manger son souper.	Xavier washed his hands before eating his dinner.	Xavier s'est-il lavé les mains après avoir mangé?	Did Xavier wash his hands after eating?	N
8	Xavier a lavé ses **main** avant de manger son souper.		Xavier s'est-il lavé les mains après avoir mangé?	Did Xavier wash his hands after eating?	N
9	Mathieu est allé se promener au lac avec son chien.	Matthew went for a walk to the lake with his dog.	Mathieu est-il allé au lac?	Did Mathieu go to the lake?	Y
9	Mathieu est allé se promener au **lacs** avec son chien.		Mathieu est-il allé au lac?	Did Mathieu go to the lake?	Y
10	Rose adore patiner sur l'étang gelé près de son école.	Rose loves to skate on the frozen pond near her school.	L'étang était-il près d'une école?	Was the pond near a school?	Y
10	Rose ador**ée** patiner sur l'étang gelé près de son école.		L'étang était-il près d'une école?	Was the pond near a school?	Y
11	Peter a trouvé son chat endormi dans sa chaise préférée.	Pater found his cat sleeping on his favourite chair.			
11	Peter a trouvé son chat endormi dans **son** chaise préférée.				
12	Derek regarda dans le réfrigérateur pour voir s'il y avait quelque chose à manger.	Derek looked in the fridge to see is there was something to eat.			
12	Derek regarda dans le réfrigérateur pour voir s'il y **avez** quelque chose à manger.				
13	Samuel savait que son frère rentrerait à la maison pour Noël.	Samuel knows that his brother would be coming home for Christmas.			
13	Samuel savait que **sa** frère rentrerait à la maison pour Noël.				
14	Jackie rendait visite à sa soeur qui habite à Montréal.	Jackie was visiting her sister who lived in Montreal.			
14	Jackie rendait visite à sa soeur qui habite**nt** à Montréal.				
15	Amelia a détesté quand sa petite soeur lui emprunte ses vêtements.	Amelia hated it when her little sister borrowed her clothes.			

15	Amelia a détest**ait** quand sa petite soeur lui emprunte ses vêtements.				
16	Laura a commencé le concert avec une chanson à propos de son frère.	Laura started the concert with a song about her brother.			
16	Laura a commenc**er** le concert avec une chanson à propos de son frère.				
17	Charlotte a éteint le feu avec un seau rempli d'eau.	Charlotte put out the fire with a bucket full of water.			
17	Charlotte a éteint le feu avec un seau**s** rempli d'eau.				
18	Julie a vu un fantôme dans une église proche de chez elle.	Julie saw a ghost in a church close to her house.			
18	Julie a vu**e** un fantôme dans une église proche de chez elle.				
19	Adam pensait que les nuages ressemblaient à un cheval avec six jambes.	Adam thought that the clouds looked like a horse with six legs.			
19	Adam pensait que les **nuage** ressemblaient à un cheval avec six jambes.				
20	Sam a frappé l'arbre avec une pelle parce qu'il était fâché.	Sam hit the tree with a shovel because he was angry.			
20	Sam a frappé**s** l'arbre avec une pelle parce qu'il était fâché.				
21	Fred marchait à l'école avec un sourire sur le visage.	Fred walked to school with a smile on his face.			
21	Fred march**é** à l'école avec un sourire sur le visage.				
22	John a mangé une pomme pour déjeuner parce qu'il aime les fruits.	John ate an apple for lunch because he likes fruit.			
22	John a mangé une pomme**s** pour				

	déjeuner parce qu'il aime les fruits.				
23	Harry est allé à Toronto la semaine passée.	Harry went to Toronto last week.			
23	Harry est all**er** à Toronto la semaine passée.				
24	Christie adore aller au zoo pour voir les éléphants.	Christie loves going to the zoo to see the elephants.			
24	Christie adore aller au zoo pour **vu** les éléphants.				
25	Claude veut avoir un gâteau au chocolat pour son anniversaire lundi.	Claude would like a chocolate cake for his birthday on Monday.			
25	Claude **vouloir** avoir un gâteau au chocolat pour son anniversaire lundi.				
26	Antoine a vu son ami quand il est allé au centre commercial.	Antoine saw his friend when he went to the mall.			
26	Antoine a vu**e** son ami quand il est allé au centre commercial.				
27	Olivier savait que sa mère était fière de lui.	Oliver knew that his mother was proud of him.			
27	Olivier savait que sa mère **été** fière de lui.				
28	Dan ne voulait pas déranger l'homme fâché qui était assis à côté de lui.	Dan didn't want to disturb the man who was sitting beside him.			
28	Dan ne voulait pas dérang**é** l'homme fâché qui était assis à côté de lui.				
29	Natasha voulait aider son chien fatigué à monter les escaliers.	Natasha wanted to help her tired dog up the stairs.			
29	Natasha voulait aid**é** son chien fatigué à monter les escaliers.				
30	Sophia a mis un chapeau jaune pour se protéger du soleil.	Sophia put a yellow hat on to protect herself from the sun.			
30	Sophia a **mettez** un chapeau jaune pour se protéger du soleil.				

31	Ellen a vu un lapin noir dans le jardin derrière sa maison.	Ellen saw a black rabbit in the garden behind her house.			
31	Ellen à **voir** un lapin noir dans le jardin derrière sa maison.				
32	Carole ne pouvait pas dormir après avoir entendu l'explosion.	Carloe couldn't sleep after she heard the explosion.			
32	Carole ne pouv**oir** pas dormir après avoir entendu l'explosion.				
33	Jack a mangé le biscuit parce qu'il pensait que c'était pour lui.	Jack ate the cookie because he thought it was for him.			
33	Jack a mangé le biscuit parce qu'il pens**é** que c'était pour lui.				
34	Stacey a dit au chauffeur qu'elle voulait aller à la station centrale.	Stacey told the chauffer that she wanted to go to the central station.			
34	Stacey a **dire** au chauffeur qu'elle voulait aller à la station centrale.				
35	Henry ne pouvait pas voir très bien parce qu'il avait cassé ses lunettes.	Henry couldn't see very well because he had broken his glasses.			
35	Henry ne pouvait pas voir très bien parce qu'il **avoir** cassé ses lunettes.				
36	Anna a donné une carte à Peter parce qu'elle avait entendu que c'était sa fête.	Anna gave a card to Peter because she heard that it was his birthday.			
36	Anna a donné une carte à Peter parce qu'elle avait entend**é** que c'était sa fête.				
37	Alfred voulait savoir si la serveuse avait dit que la soupe était trop chaude.	Alfred wanted to know if the waitress said that the soup was hot.			
37	Alfred voulait savoir si la serveuse avait **dis** que la soupe était trop chaude.				
38	Le critique de cinéma avait vu le	The movie critic saw the movie			

	film quand il avait dix-huit ans.	when he was eighteen years old.			
38	Le critique de cinéma avait vu le film**s** quand il avait dix-huit ans.				
39	Louis joue au baseball toutes les fins de semaine cet été.	Louis played baseball every weekend this summer.			
39	Louis joue au baseball toutes les **fin** de semaine cet été.				
40	Elliot est sorti après qu'il a mangé son déjeuner.	Elliot went outside after finishing his lunch.			
40	Elliot est sorti**r** après qu'il a mangé son déjeuner.				

APPENDIX G: CHAPTER 4 STATISTICAL MODELS

This appendix includes the complete statistical model outputs reported in Chapter 4. Table G1 consists of the SPR model output and Table G2 is the AX task model output. Significant effects are bolded.

Table G1. Liner mixed model output for SPR task.

Predictors	Estimates	95% CI	*t*-value	*p*-value
(Intercept)	351.60	329.24 – 374.00	30.80	**<0.001**
Congruency	-11.06	-12.25 – -9.87	-18.21	**<0.001**
Noun gender	1.04	-6.10 – 8.18	0.29	0.78
Group [1]	-3.99	-31.91 – 23.92	-0.28	0.78
Group [2]	2.65	-30.31 – 35.61	0.16	0.88
Word [1]	0.95	-0.74 – 2.64	1.11	0.27
Word [2]	10.36	8.68 – 12.04	12.08	**<0.001**
Congruency*Noun gender	-4.54	-5.73 – -3.35	-7.47	**<0.001**
Congruency*Group [1]	-2.07	-3.65 – -0.50	-2.59	**0.01**
Congruency*Group [2]	-3.10	-4.95 – -1.25	-3.29	**0.001**
Noun gender*Group [1]	0.30	-1.27 – 1.87	0.38	0.71
Noun gender*Group [2]	-0.41	-2.25 – 1.43	-0.43	0.66
Congruency*Word [1]	0.88	-0.81 – 2.56	1.02	0.30835
Congruency*Word [2]	-5.93	-7.61 – -4.25	-6.91	**<0.001**
Noun gender*Word [1]	0.27	-1.42 – 1.95	0.31	0.7545
Noun gender*Word [2]	0.38	-1.30 – 2.06	0.44	0.66
Group [1]*Word [1]	0.65	-1.57 – 2.87	0.57	0.57
Group [2]*Word [1]	-1.71	-4.32 – 0.90	-1.29	0.20
Group [1]*Word [2]	2.75	0.54 – 4.97	2.44	**0.01**
Group [2]*Word [2]	2.49	-0.11 – 5.09	1.88	0.06
Congruency*Noun gender*Group [1]	0.04	-1.53 – 1.61	0.05	0.96
Congruency*Noun gender*Group [2]	-1.18	-3.02 – 0.67	-1.25	0.21
Congruency*Noun gender*Word [1]	-0.88	-2.57 – 0.80	-1.03	0.30
Congruency*Noun gender*Word [2]	1.56	-0.12 – 3.24	1.82	0.07
Congruency*Group [1]*Word [1]	0.48	-1.74 – 2.70	0.42	0.67
Congruency*Group [2]*Word [1]	0.61	-2.00 – 3.22	0.46	0.65

Congruency*Group [1]*Word [2]	-2.54	-4.75 – -0.32	-2.25	**0.02**
Congruency*Group [2]*Word [2]	-2.85	-5.45 – -0.24	-2.14	**0.03**
Noun gender*Group [1]*Word [1]	1.91	-0.31 – 4.12	1.68	0.09
Noun gender*Group [2]*Word [1]	-1.25	-3.86 – 1.36	-0.94	0.35
Noun gender*Group [1]*Word [2]	-1.70	-3.92 – 0.51	-1.51	0.13
Noun gender*Group [2]*Word [2]	3.28	0.68 – 5.89	2.47	**0.01**
Congruency*Noun gender*Group [1]*Word [1]	-2.42	-4.64 – -0.20	-2.14	**0.03**
Congruency*Noun gender*Group [2]*Word [1]	0.22	-2.38 – 2.83	0.17	0.87
Congruency*Noun gender*Group [1]*Word [2]	1.36	-0.86 – 3.57	1.20	0.23
Congruency*Noun gender*Group [2]*Word [2]	-0.30	-2.90 – 2.31	-0.22	0.82

Marginal R^2 = 0.017, **Conditional R^2** = 0.583

Table G2. Liner mixed model output for AX task.

Predictors	Estimates	95% CI	*t*-value	*p*-value
(Intercept)	561.80	538.31 – 585.28	46.891	**< 0.001**
Condition [1]	-31.23	-37.49 – -24.97	-9.784	**< 0.001**
Condition [2]	114.33	103.95 – 124.72	21.581	**< 0.001**
Condition [3]	-51.91	-62.20 – -41.62	-9.89	**< 0.001**
Language [1]	-9.27	-40.13 – 21.60	-0.589	0.56
Language [2]	-16.46	-52.89 – 19.97	-0.886	0.38
Condition [1]*Language [1]	13.93	5.68 – 22.17	3.311	**0.001**
Condition [2]*Language [1]	14.45	0.74 – 28.16	2.066	**0.04**
Condition [3]*Language [1]	-16.59	-30.15 – -3.04	-2.4	**0.02**
Condition [1]*Language [2]	-9.44	-19.10 – 0.22	-1.916	0.06
Condition [2]*Language [2]	-2.22	-18.27 – 13.83	-0.271	0.79
Condition [3]*Language [2]	13.65	-2.18 – 29.47	1.691	0.09

Marginal R^2 = 0.064, **Conditional R^2** = 0.329