

# Processing Gender: The Case of Pronouns and Adjectives in L2 French

Claire Renaud  
Arizona State University

## 1. Availability of features in L2 acquisition

In recent second-language (L2) acquisition research, the debate has shifted to the question of the activation and availability of features in the interlanguage grammar. Such a shift follows directly from the Minimalist Program (e.g., Chomsky, 2001), in which features appear to be the core elements of languages that relate sound and meaning. It is argued that the set of features is universal, but, crucially, not all languages select all features or make identical use of the selected features. According to Chomsky (1995), two types of features are required in the grammar: (a) interpretable features and (b) counterpart uninterpretable features, such as Gender and *u*Gender, respectively. On the one hand, interpretable features are associated with lexical categories and semantic information (e.g., the gender of nouns). For instance, in French, the value of the interpretable gender feature differs between the synonyms *vélo* and *bicyclette* “bike”: *vélo* carries the underspecified gender masculine, [Gender: Ø], whereas *bicyclette* is specified for gender, [Gender: Feminine]. On the other hand, uninterpretable features are usually associated with functional categories (e.g., adjectives) and are deleted under match during computation. To illustrate, in French, adjectives carry uninterpretable features (i.e., *u*Gender and *u*Number) for computations, such that in the expression *la bicyclette grise* “the grey bike”, the interpretable gender feature of the noun *bicyclette* “bike” values the uninterpretable gender feature of the adjective *grise* “grey”, [*u*Gender: Feminine], which then deletes. For a successful computation, all features must enter into a checking relation via the Agree operation (e.g., Chomsky, 1995). L2 acquisition is assumed to be constrained by UG, therefore, to satisfy Full Interpretation, a derivation needs to converge at logical form (LF) and phonological form (PF): This is possible when all uninterpretable features are checked at spell-out. Although L2 researchers seem to agree that features are detectable from the input, we now turn to two (sets of) hypotheses that were proposed to account for the morphological variability in agreement marking observed in L2 data.

### 1.1. Hypothesis 1: Unavailability of features

Some researchers (e.g., Franceschina & Hawkins, 2003; Hawkins & Casillas, 2008; Hawkins & Chan, 1997; Hawkins & Liszka, 2003; Tsimpli & Dimitrakopoulou, 2007) argue that features not selected by the L1 grammar are not available in L2 acquisition. The failed functional features hypothesis (Hawkins & Chan) states that features not instantiated in the L1 grammar are unavailable for grammatical operations in L2 acquisition. This proposal was streamlined by Tsimpli and Dimitrakopoulou, restricting the unavailability only to uninterpretable features not instantiated in the L1 grammar. Directly following from the later proposal, Hawkins and Casillas proposed the contextual complexity hypothesis. On this view, all learners’ grammars are initially relying only on (domain-general) context-sensitive strategies based on distributional regularities in the input. As learners become more proficient, if the relevant uninterpretable features are licensed by the learners’ L1 grammars, then learners come to compute the agreement phenomenon on the basis of (domain-specific) UG-constrained operations. For instance, for English learners of French, the number feature would be an example of such a feature that is part of the L1 grammar and thus available for

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computations in L2 French to advanced learners. Indeed, feature associations are presumed to develop over time. In contrast, Hawkins and Casillas claim that, for uninterpretable features that are not instantiated in the L1 grammar, the L2 grammars maintain a system of rules of co-occurrence to accommodate the incoming input, which relies on feature matching. For English-speaking learners of French, this is the case with the uninterpretable gender feature. Therefore, although proponents of these hypotheses argue that the grammatical operations underlying knowledge of a L2 grammar are constrained by UG, the acquisition of vocabulary items seems to proceed in a radically different manner from L1 acquisition.

### *1.2. Hypothesis 2: Feature calculus in human language and the Universal parser*

Another group of researchers (e.g., Choi & Lardiere, 2006a, 2006b; Hazdenar & Schwartz, 1997; Lardiere, 2005, 2008, 2009; McCarthy, 2007, 2008; Prévost & White, 2000) argues that all features are available in the L2 but that other factors, such as communication pressures, contribute to the observed morphological variability. L2 morphological variability is thus taken to reflect the cost of feature calculations and the use of defaults to mitigate such costs (e.g., Hazdenar & Schwartz; Lardiere, 2005, 2008, 2009; McCarthy, 2007, 2008; Prévost & White). Based on the distributed morphology framework (e.g., Halle & Marantz, 1993), for proponents of the missing surface inflection hypothesis (Hazdenar & Schwartz; Prévost & White), L2 grammars are believed to rely on all functional categories and values related by Agree; however, production pressures may lead to the insertion of underspecified forms, even though specifications of functional categories are acquired. To account for comprehension data that exhibit similar asymmetries to production data and are thus suggestive of underspecified lexical representations, McCarthy (2007) proposed the morphological underspecification hypothesis. Crucially, for McCarthy, L2 grammars can allow the insertion of underspecified forms (i.e., default forms that may be inserted instead of a fully specified form under certain conditions because reducing cost is more important than satisfying feature matching) but cases of feature clash (i.e., forms that carry the mismatched values of features and are thus ungrammatical) are avoided. Couched within the Minimalist framework, Lardiere's feature reassembly hypothesis (Lardiere, 2009) states that L2 acquisition first involves the identification or detection of features, but that the most difficult task facing the L2 learners is the (re)assembly of features into matrices of functional categories and lexical items.

Because the exact mechanisms that constrain L2 acquisition are not discussed by Lardiere, I argue, following Dekydtspotter (2001), that a universal parser provides the essential learning mechanism that constrains L2 acquisition. The contents of the parser are presumably provided by UG, increased by a language-specific lexicon (Crocker, 1996; Dekydtspotter; Schwartz, 1999). Thus, in principle, a UG-sanctioned syntactic analysis can be achieved by any learner. Moreover, if processing is a prerequisite for acquisition (Fodor, 1998), then it follows that what cannot be parsed cannot lead to grammatical development. In other words, the interlanguage grammar presumably develops as a result of the need to fully structure the input more efficiently. In this way, the structure of the representations themselves narrowly constrains the range of features relevant to the analysis of the input. Given the role of the parser in learning feature (re)assembly is expected to occur in the parser before it is reflected in the grammar. More specifically, a (gender) agreement relation is detectable due to morphological alternations, such as *vert* versus *verte* "green." Because the parser must fully interpret the input, such a morphophonological alternation between forms needs to be accommodated via a morphosyntactic dependency, under UG-constrained operations (i.e., Agree and Move), if possible. As a result, the parse assigned to the input must be within the limits of UG, which specifies Agree as a valuation or matching relation between a feature *F* and an unvalued uninterpretable feature *uF* in a c-command relation. This parse then determines the nature of the representations to be stored in the lexicon. The (functional) interlanguage lexicon is in turn updated to reflect parses that are necessitated by the input but not yet grammatically licensed.

## **2. The gender feature in the nominal domain**

English and French differ in their selection as well as in their specification of the gender feature. In English, the gender feature is only expressed with personal pronouns (i.e., *he*, *she*, *it*, *him*, and *her*); however, nouns can carry the gender feature in cases of natural gender. Indeed, animate personal

nouns, like *father* and *mother* are co-referent with the pronouns *he* and *she*, for masculine and feminine nouns, respectively. Moreover, a class of nouns exhibits dual semantic gender, such as *artist* and *professor*, and can be co-referent with *he* or *she* as male or female, depending on the context. Finally, common gender nouns can select the pronouns *he*, *she*, or *it* depending on the noun and on the emotional relation. For example, a child will be referred to as *he* or *she* depending on its sex by the mother but as *it* in a scientific report. An emotional relation also explains why some speakers maintain the gender distinctions for animals or certain inanimate nouns, as in “That’s a lovely ship. What is *she/it* called?” (Quirk, Greenbaum, Leech, & Svartvik, 1985, p. 318), even though for most animals and inanimate nouns, the co-referring pronoun is *it*. It is possible that for those speakers, these nouns are personified and, as a way to reflect the emotional attachment with the referent, the [animacy] feature receives a value, and, in turn, a gender specification.

Whereas, in English, there is no agreement on adjectives, as in (1), gender (and number) agreement is marked on French adjectives, as shown in (2). In the French sentences, the adjective *vert* “green” varies according to the masculine and feminine feature of the noun it modifies as shown in (2a) and (2b), respectively.

- (1) a. *The pants are green.*  
 b. *The dresses are green.*
- (2) a. *Les pantalons sont verts.*  
 The pants-MASC-PL are green-MASC-PL.  
 “The pants are green.”  
 b. *Les robes sont vertes.*  
 The dresses-FEM-PL are green-FEM-PL.  
 “The dresses are green.”

It is assumed, in keeping with the principle and parameter framework (e.g., Chomsky, 1981), that features have either marked or default values. Additionally, features are thought to be modeled in hierarchical geometries (e.g., Harley & Ritter, 2002). Under such a model, the value [Feminine] is contingent on the individuating feature [Gender], whereas the feature [Masculine] is not part of underlying representations of feature matrices. The value [Masculine] is conceivably supplied as a value via a default redundancy rule of insertion in morphophonological representations. Such a dependency of masculine and feminine on the notion of gender requires that the feature Gender and its uninterpretable counterpart *u*Gender mediate the [Feminine] and [Masculine] gender agreements in French. This dependency is constrained by UG via the Agree operation. Direct consequences in the computation of agreement stem from such a hierarchy of features. Let us illustrate with gender agreement on adjectives in French. In a feminine context, two candidates are possible: (a) the adjective *verte* “green,” whose uninterpretable feature *u*Gender has the gender value [Feminine]; or (b) adjective *vert* “green,” which is underspecified for gender. If no other form of the past participle that is fully specified exists in the grammar, then the underspecified morphophonological form *vert* may be inserted as it does not create a feature clash (see e.g., McCarthy, 2007).

Note that the gender feature is examined here because it is not part of the L1 grammar of the English-speaking learners. We now turn to the role of gender in the two contexts investigated: co-reference of pronouns with a noun available in the discourse and adjective agreement, targeting the interpretable and the uninterpretable features, respectively.

### 2.1. Interpretation of pronouns

The analysis of pronouns as co-referent with referential expressions (R-expressions) is assumed to be similar in English (e.g., *the boy...he*) and in French (e.g., *le garçon...il*) and to require two steps. First, a referent needs to be identified in the discourse to establish a dependency at the discourse-semantics interface (which also depends on gender matching; see Kamp, 1981). Second, binding theory (Chomsky, 1981) requires the compatibility of the indexation of the pronoun with the referent identified from the discourse and the checking of the  $\phi$  features of the pronouns in the relevant domain. In other words, the pronoun is interpreted in cases of feature identity, by matching the features of the discourse referent, as is the case of *vélo* “bike” and the pronoun *il* “it” in (3a). In the case of the

sentences in (3a) and in (4a), the two components necessary are in place—gender match between the referent and the pronoun, and the pronoun is free within its governing category; the automatic co-indexation process is therefore fulfilled.

- (3) a. *Les enfants ont oublié le vélo gris. Il est encore dans le garage.*  
 The children have forgotten the bike-MASC grey. it-MASC is still in the garage.  
 b. *Les enfants ont oublié le vélo gris. Elle est encore dans le garage.*  
 The children have forgotten the bike-MASC grey. it-FEM is still in the garage.  
 “The children forgot the grey bike. It is still in the garage.”
- (4) a. *Les enfants ont oublié la bicyclette grise. Elle est encore dans le garage.*  
 The children have forgotten the bike-FEM grey. it-FEM is still in the garage.  
 b. *Les enfants ont oublié la bicyclette grise. Il est encore dans le garage.*  
 The children have forgotten the bike-FEM grey. it-MASC is still in the garage.  
 “The children forgot the grey bike. It is still in the garage.”

This contrasts with sentences (3b) and (4b). In those sentences, because the gender of the pronoun and that of the referent do not match, a referential dependency cannot be established nor can the  $\phi$  features of the pronouns be checked, leading to a crash in the derivation.

## 2.2. Uninterpretable gender and adjective agreement

In French, nouns carry an interpretable gender feature that is either lexically specified as [feminine] or lexically underspecified but that may then receive a [masculine] value via default rules. This interpretable feature must be checked with the uninterpretable features of the determiners and adjectives via the Agree operation by spell out (Chomsky, 1995; Harris, 1991; McCarthy, 2007). I assume here that (a)  $u$ Gender is implicitly part of the grammar of the English learner of French—it is inherent in the universal component—and (b)  $u$ Gender is not explicitly part of knowledge of English—it is not part of the Lexicon. Following from the inclusiveness condition (Chomsky, 1981), the local properties of input (i.e., the features of the noun phrase [NP]) constrain the features relevant for the adjective via the Agree relation. An example NP is provided in (5), and its analysis shown in (6).

- (5) *La robe verte*  
 The-FEM dress-FEM green-FEM
- (6) [DP la [<sub>NumP</sub> robe [<sub>NP</sub> [<sub>AP</sub> verte ] <robe> ]]]

The ingredients for the Agree operation to occur are met: This is a local configuration and there is a dependency between a feature F and its uninterpretable counterpart  $u$ F, which are in a c-command relation. Given the probe-goal relation, the candidate set for F is gender (and number) in the interlanguage grammar of English learners of French. If the features of the probe and the goal are compatible, the Agree operation will delete the uninterpretable features of the goal. However, if the features of the probe and the goal are not compatible, this would result in the crash of the derivation: An incompatible value would indeed block the insertion of a lexical item because its uninterpretable feature could not be checked at spell out.

## 3. Research questions and predictions

Despite the many studies that have focused on the L2 acquisition of the gender feature (e.g., Dekydtspotter & Renaud, 2009; Foucart, 2008; Frenck-Mestre, Osterhout, McLaughlin, & Foucart, 2007; Guillelmon & Grosjean, 2001; McCarthy, 2007, 2008; Montrul, Foote, & Perpiñán, 2008; Renaud, 2010; Sabourin, 2003; Sabourin, Stowe, & de Haan, 2006; White, Valenzuela, Kozłowska-Macgregor, & Leung, 2004), the mechanisms that are activated in the interlanguage grammar still remain to be specified. Indeed, most of these studies have examined gender assignment and gender agreement errors in production and in comprehension; however, only a few studies (Dekydtspotter &

Renaud; Foucart; Renaud; Sabourin) have investigated sensitivity to gender agreement in processing, which allows a window into the nature of feature computations.

Recall that both hypotheses argue that feature detection is possible. Crucially, the two hypotheses propose that interlanguage grammars rely on different mechanisms to reassemble the selected features, thus yielding different processing profiles observed in reading times (RTs). Two main research questions were investigated in the present study: First, is there a difference between the processing of the interpretable and the uninterpretable gender features?

According to hypothesis 1 (e.g., Hawkins & Casillas, 2008), different profiles for beginning and advanced learners in knowledge and processing will result from the development of feature associations. For low-proficiency learners, the two conditions (i.e., pronoun resolution and adjective agreement) will yield similar patterns because they only have access to domain-general rules of co-occurrences. In contrast, advanced learners are expected to rely on UG-constrained operations, or domain-specific computations, in the resolution of pronouns, as it involves an interpretable feature, which is presumably available in L2 as well. However, because the uninterpretable gender feature is absent from their L1 grammar, it should remain unavailable in L2 acquisition. Therefore, advanced learners are also expected to rely on context-sensitive strategies based on the regularities of the input to compute adjective agreement. In processing, matched features are expected to yield lower costs than mismatched features. Additionally, this hypothesis also predicts that effects should be observed in processing and in knowledge of co-occurrences at (approximately) the same time.

In contrast, proponents of hypothesis 2 (e.g., Dekydtspotter & Renaud, 2009; Lardiere, 2009; Renaud, 2010) would predict that learners will rely on UG-constrained operations to compute the gender feature. Following from the feature-geometric model (e.g., Harley & Ritter, 2002), asymmetries resulting from the feature specification are expected to arise. More specifically, longer RTs, reflecting a higher processing cost, will occur in cases of feature clash (i.e., a feminine form in a masculine context), whereas shorter RTs may occur in cases of underspecification (i.e., a masculine form in a feminine context), which presumably incur fewer costs in the computation. Additionally, if acquisition is guided by the universal parser, as this proposal assumes, effects should be found processing before it appears in grammatical knowledge.

The second research question sought to find out what L2 learners (and native speakers) do in case of synonyms of different gender. Interestingly, L2 pronoun resolution with a feature not instantiated in the L1 grammar raises the question of the encoding of the relevant information among three potential levels—namely, the entities, the discourse referents or the lexical entries, and the features deployed. Note that the referents *vélo* and *bicyclette* “bike” are synonyms that differ only in their gender assignment. In other words, both denote the same entity, a bike. It could be argued that there is a way of associating discourse referents with entities in the model regardless of the gender specification of the pronoun. Once again, assuming a feature-geometric model (Harley & Ritter, 2002), it is possible that the less specified masculine form of the pronoun allows for co-indexation to occur with a feminine referent, because the features do not clash—although matching is preferred. Therefore, upon hearing a sentence as in (7) in a context in which the only possible referent for the pronoun is the bike, a listener may accommodate the underspecified gender of the pronoun. Note that such an accommodation would presumably result in an additional processing cost. In contrast, in a sentence as in (8), the feminine pronoun may not lead to co-indexation because the (positively) valued gender feature of the pronoun clashes with the one of the masculine referent. Such a clash should be rejected, as the derivation of the sentence cannot succeed. Such a finding would be consonant with the results of McCarthy (2008).

- (7) *Les enfants ont oublié la bicyclette grise. Il est encore dans le garage.*  
 The children have forgotten the bike-FEM grey. it-MASC is still in the garage.  
 “The children forgot the grey bike. It is still in the garage.”
- (8) *Les enfants ont oublié le vélo gris. Elle est encore dans le garage.*  
 The children have forgotten the bike-MASC grey. it-FEM is still in the garage.  
 “The children forgot the grey bike. It is still in the garage.”

## 4. The Study

### 4.1. Participants

Three groups of English learners of French participated in this study. They represented three different proficiency levels: 24 second-semester learners (mean age = 20, range = 17-39), 26 fourth-semester learners (mean age = 20, range = 17-23), and 15 advanced learners (mean age = 27, range = 22-32). The second- and fourth-semester learners were undergraduate students at a large Midwestern university, and the advanced learners were graduate students in French literature or linguistics at the same university. A control group of 15 French native speakers (mean age = 23, range = 20-42) also completed the task. These native-speaker controls were all English majors in their second year at a French university at the time of data collection.

### 4.2. Tasks

Participants were first asked to complete a short background questionnaire as well as a c-test, which served as an independent measure of proficiency. The results of the c-test confirmed the initial division of the participants in three distinct proficiency levels. The main task consisted of a judgment task on a computer in a non-cumulative self-paced moving-window format. Two conditions are discussed here: 20 items that targeted the matching of gender on co-reference of nouns and pronouns and 28 items that targeted overt gender agreement marking on adjectives. These 48 experimental items were interspersed among 86 distractor items, investigating five other conditions manipulating gender or number agreement. Each condition served as the filler items for the other conditions, so that all participants saw all items, presented in a randomized order. Each experimental item consisted in a short context, which first appeared on the screen, followed by a sentence in which the gender had been manipulated. The context sentence was presented all at once, whereas the follow-up sentence appeared in segments, as shown with the slashes in the examples. To read the next segment, participants pressed the space bar. The preceding segment disappeared once the participant pressed the space bar. At the end of each item, participants were asked to indicate whether, in their opinion, the segmented sentence was a good follow-up to the first sentence (i.e., there was no explicit focus on grammar), by pressing *J* for YES or *F* for NO on the keyboard.

#### 4.2.1. Interpretable grammatical gender condition

This condition consisted in five pairs of synonyms combined with a sentence in which the gender of the subject pronoun was manipulated. The synonym pairs *vélo-bicyclette* “bike,” *ballon-balle* “ball,” *soulier-chaussure* “shoe,” *gazon-pelouse* “grass,” and *magasin-boutique* “shop” were selected because they were as close to true synonyms as possible and because these words were likely to be known by low-proficiency learners. The frequency of the pairs of synonyms was also checked against the Lexique database (New, Pallier, Brysbaert, & Ferrand, 2004; New, Pallier, Ferrand, & Matos, 2001). Note that only two pairs exhibited rather similar frequencies for the two members of the pair, *boutique-magasin* “shop” and *vélo-bicyclette* “bike,” for the other three pairs, *balle-ballon* “ball,” *pelouse-gazon* “grass,” and *chaussure-soulier* “shoe,” the feminine form appears to be the most frequent. In any case, to ensure that learners would be familiar with these words, a list of vocabulary words (including these synonyms and additional words) was provided to each teacher, who then strongly encouraged their students to familiarize themselves with these items. (The presentation of the vocabulary items was left to the teacher.) There were 20 experimental items in total: 10 with a masculine context and 10 with a feminine context. In each item, the context sentence contained a noun-and-adjective sequence, which specified the gender of the noun. An example of experimental item is given in (9).

- (9) a. Masculine referent and masculine pronoun  
*Les enfants ont oublié le vélo gris.*  
 The children have forgotten the grey bike-MASC  
*Il / est / encore / dans / le garage.*  
 it-MASC is still in the garage.

b. Masculine referent and feminine pronoun

*Les enfants ont oublié le vélo gris.*

The children have forgotten the grey bike-MASC

*Elle / est / encore / dans / le garage.*

it-FEM is still in the garage.

c. Feminine referent and masculine pronoun

*Les enfants ont oublié la bicyclette grise.*

The children have forgotten the grey bike-FEM

*Il / est / encore / dans / le garage.*

it-MASC is still in the garage.

d. Feminine referent and feminine pronoun

*Les enfants ont oublié la bicyclette grise.*

The children have forgotten the grey bike-FEM

*Elle / est / encore / dans / le garage.*

it-FEM is still in the garage.

“The children have forgotten the grey bike. It is still in the garage.”

#### 4.2.2. Adjective agreement in a superlative construction

This condition examined overt gender agreement on the adjective when it followed a noun and an intervening subject pronoun, which was also specified for the gender of the noun. There were 7 experimental quadruples, an example of which is provided in (10). In each item, the context sentence provided a noun marked for gender and the follow-up sentence contained a pronoun correctly agreeing with the noun in gender and the adjective, which was manipulated for gender and was in a predicate position.

- (10) a. Masculine context and masculine form  
*Les parents ont remarqué le pantalon immédiatement,*  
 the parents have remarked the pants-MASC immediately,  
*Il / était / étrangement / vert / après / la fête.*  
 it-MASC was strangely green-MASC after the party
- b. Masculine context and feminine form  
*Les parents ont remarqué le pantalon immédiatement,*  
 the parents have remarked the pants-MASC immediately,  
*Il / était / étrangement / verte / après / la fête.*  
 it-MASC was strangely green-FEM after the party
- c. Feminine context and masculine form  
*Les parents ont remarqué la robe immédiatement,*  
 the parents have remarked the dress-FEM immediately,  
*Elle / était / étrangement / vert / après / la fête.*  
 it-FEM was strangely green-MASC after the party
- d. Feminine context and feminine form  
*Les parents ont remarqué la robe immédiatement,*  
 the parents have remarked the dress-FEM immediately,  
*Elle / était / étrangement / verte / après / la fête.*  
 it-FEM was strangely green-FEM after the party

“The parents have remarked the dress immediately, it was strangely green after the party.”

It is also noteworthy that, although not all adjectives realize gender agreement overtly in French, a number of adjectives that does realize overt gender agreement is taught very early on and consists of high frequency items (e.g., *petit* “little”). However, a brief overview of the vocabulary presented in the textbooks used in the first four semesters of French studies (i.e., Valdman, Pons, Scullen, & Jourdain, 2002, in the second semester; Jaraus & Tufts, 2006, in the fourth semester) revealed that, overall, learners are presented with more invariable adjectives or adjectives with no overt phonological realization of the alternation than with adjectives that realize overt gender agreement. In the present study, all adjectives exhibited overt gender agreement. Based on the Lexique database (New, Pallier,

Brysbaert, & Ferrand, 2004; New, Pallier, Ferrand, & Matos, 2001), all the selected adjectives are rather frequent, with the masculine forms more so than the feminine forms. Two exceptions are noteworthy: First, the feminine form of *blanche* “white” appears to be almost as frequent as its masculine counterpart *blanc*. Second, the adjectives *violet* “purple” and *pousséieux* “dusty” were less frequent overall; however, the flower *violet* in English was deemed a cognate. To accommodate for the low frequency of *pousséieux* “dusty,” it was included in the vocabulary list provided to the participants ahead of time.

#### 4.2.3. Analysis

Final acceptability judgments and RTs (reported in ms) on the target segment (i.e., the pronoun or the adjective) were recorded and analyzed. Additionally, to check for any delayed, or spill-over, effects, the segment that immediately follows the critical segment was systematically included in the analysis. The data was coded with SPSS, and extreme RTs (e.g., at two standard deviations from the mean) were eliminated and replaced with the mean for all participants.

For each condition, repeated measures 2x2x4 ANOVAs were run on the acceptance rates and the RT data with context or referent (masculine or feminine) and agreement (masculine or feminine) as within-subjects factor and group (second-semester, fourth-semester, advanced learners, and natives) as between-subjects factor. Note that the masculine and the feminine forms systematically differed in length: for pronouns, two and four letters for the masculine and feminine forms, respectively, and for adjectives, an additional letter on feminine forms compared to the masculine forms. To counter the argument that differences in RTs stem from the differing length of the target segments, residuals were calculated that adjusted for any effects attributed to a letter difference. ANOVAs for these segments (i.e., the pronoun and the adjective) were thus run on the adjusted means. The significance level was set at .05 for planned *t*-tests.

## 5. Results

### 5.1. Interpretable grammatical gender: Pronoun resolution

#### 5.1.1. Acceptance rates

As noted, the experimental items consisted of a context sentence that introduced a referent and the follow-up sentence contained a pronoun that either matched or mismatched the gender of the referent, as in *le vélo gris...il* or *le vélo gris...elle* “the grey bike...it.” Table 1 shows the results of the acceptance rates in percentages for each condition by group. An ANOVA revealed significant interactions: Referent x Agreement,  $F(76, 1) = 299.011, p < .001$ , and Referent x Agreement x Group,  $F(76, 3) = 86.960, p < .001$ . Overall, the data yielded two main profiles. On the one hand, the second- and fourth-semester learners accepted all forms of the pronouns at a fairly high rate independently of the gender of the noun. On the other hand, the advanced learners and the native speakers accepted the matched pronouns and rejected the mismatched pronouns ( $p < .0001$ ).

Table 1. Acceptance Rates for the pronoun condition (in %)

Group	Masculine context		Feminine context	
	Masculine	Feminine	Masculine	Feminine
2 <sup>nd</sup> semester	66.96 (16.97)	58.48 (17.74)	59.13 (22.94)	50.36 (23.16)
4 <sup>th</sup> semester	62.59 (18.68)	53.15 (26.35)	56.11 (28.63)	58.89 (30.83)
Advanced	97.33 (7.04)	7.33 (14.38)	6.67 (14.47)	94.67 (11.87)
Natives	90.67 (14.86)	5.33 (9.15)	10.67 (18.31)	93.33 (9.76)

Note: Standard deviations are provided in parentheses.

#### 5.1.2. RTs

An ANOVA on the corrected RT means for the pronoun segment (i.e., accounting for the length difference) did not reveal any significant differences. To detect any spill-over effects, as delayed effects can be expected in learner data, the verb and the adverb segments were scrutinized (see Table

2). Because the verb is also a very short segment (i.e., three letters), the adverb segment was included in the analysis as it is plausible that effects would appear once more segments have been considered. An ANOVA on the verb segment yielded a main effect of context,  $F(76, 1) = 8.937, p < .005$ . There were three significant interactions: Agreement x Group,  $F(76, 3) = 4.757, p < .005$ , Referent x Agreement,  $F(76, 1) = 32.133, p < .0001$ , and Referent x Agreement x Group,  $F(76, 3) = 3.331, p < .05$ . On the adverb segment, an ANOVA revealed a significant main effect of agreement,  $F(76, 1) = 4.785, p < .05$ , as well as a significant interaction of referent and agreement,  $F(76, 1) = 5.404, p < .05$ .

Table 2. Mean RTs (in ms) on the Verb and the Adverb Segments

Group	Masculine context		Feminine context	
	Masculine	Feminine	Masculine	Feminine
	Verb			
2 <sup>nd</sup> semester	377.12 (134.64)	418.36 (198.33)	418.24 (186.08)	346.23 (104.68)
4 <sup>th</sup> semester	414.53 (169.35)	404.89 (154.21)	404.80 (141.27)	380.14 (126.48)
Advanced	342.17 (69.74)	389.55 (131.12)	419.92 (171.09)	358.17 (93.71)
Natives	333.20 (75.30)	345.05 (99.19)	404.56 (145.62)	333.75 (80.82)
	Adverb			
2nd semester	462.96 (211.21)	502.90 (267.41)	530.32 (309.97)	456.16 (200.64)
4th semester	481.74 (192.43)	462.98 (221.50)	525.88 (294.46)	463.79 (208.94)
Advanced	374.55 (91.67)	370.56 (131.09)	368.91 (120.03)	375.15 (89.18)
Natives	360.59 (96.16)	359.12 (99.42)	413.92 (164.58)	401.23 (175.16)

Note: Standard deviations are provided in parentheses.

Planned *t*-tests were conducted to provide further insight on the asymmetries observed. The second-semester learners exhibited longer RTs in mismatched conditions on the verb (masculine context,  $t(22) = 2.280, p < .05$ , and feminine context,  $t(22) = 3.849, p < .001$ ), and the adverb segments (masculine context,  $t(22) = 2.244, p < .05$ , and feminine context,  $t(22) = 2.426, p < .05$ ). This suggests that the agreeing features are being computed by these learners. The RTs of the fourth-semester learners revealed that they exhibited slower RTs on the adverb following a feminine pronoun paired with a masculine noun compared to following a masculine pronoun paired with a feminine noun,  $t(26) = 2.301, p < .05$ . In other words, there is a distinction between feature clash and underspecification: The fourth-semester learners slowed down in cases of feature clash, whereas the underspecified form triggered similar RTs as the matched form. The advanced learners slowed down on the verb following a feminine pronoun than following a masculine pronoun with a masculine noun,  $t(14) = 3.102, p < .005$ . These longer latencies also appear to indicate a reaction to the clashing feminine feature on the pronoun. Finally, the data from the French native speakers yielded spill-over effects consistent with morphological expectations (masculine,  $t(14) = 2.855, p < .05$ , and feminine,  $t(14) = 2.737, p < .05$ ). On the verb segment, they slowed down when a feminine pronoun followed a masculine noun,  $t(14) = 4.292, p < .001$ . The French natives also read both the verb,  $t(14) = 4.513, p < .0001$ , and the adverb segments,  $t(14) = 2.633, p < .05$ , more slowly after a feminine pronoun with a masculine noun compared to after a masculine pronoun with a feminine noun on.

## 5.2. Interpretable gender: Adjective agreement

### 5.2.1. Acceptance rates

Recall that in this condition, overt gender agreement of the adjective following a noun and a pronoun marked for gender, as in *le pantalon...il...vert* “the pants...it...green,” was scrutinized. Table 3 provides the mean acceptance rates for each condition by group. An ANOVA yielded three significant interactions: Context x Group,  $F(75, 3) = 3.066, p < .05$ , Context x Agreement,  $F(75, 1) = 468.101, p < .0001$ , and Context x Agreement x Group,  $F(75, 3) = 79.137, p < .0001$ . Paired-samples *t*-tests showed that, overall, all participant groups exhibited patterns reflecting morphological expectations: More masculine forms with a masculine context and more feminine forms with a feminine context. Nonetheless, the acceptance rates of the low-proficiency learners do not seem to

show robust grammatical knowledge. Indeed, the agreeing forms are accepted at chance and the mismatched forms are accepted at non-negligible rates (above 30%).

Table 3. *Acceptance Rates (in %)*

Group	Masculine context		Feminine context	
	Masculine	Feminine	Masculine	Feminine
2 <sup>nd</sup> semester	51.88 (29.79)	37.68 (19.60)	34.93 (19.28)	50.14 (24.89)
4 <sup>th</sup> semester	55.19 (26.92)	39.74 (23.61)	30.06 (17.77)	47.18 (29.93)
Advanced	95.33 (8.05)	2.22 (5.86)	4.44 (7.63)	96.44 (7.40)
Natives	90.00 (10.54)	2.22 (8.61)	0.00 (0.00)	95.56 (7.63)

*Note:* Standard deviations are provided in parentheses.

### 5.2.2. RTs

An ANOVA was run on the adjusted means for the RTs on the adjective segment and revealed an interaction of context and group,  $F(75, 3) = 2.910$ ,  $p < .05$ . To measure any potential spill-over effects, the RTs on the segment following the adjective were analyzed (see Table 4). An ANOVA yielded a significant interaction of context and agreement,  $F(75, 1) = 4.305$ ,  $p < .05$ . Paired-samples  $t$ -tests showed two asymmetries in the feminine context: The fourth-semester learners read the segment following a matching feminine adjective more slowly compared to when it followed a masculine adjective,  $t(25) = 2.831$ ,  $p < .01$ , and likewise the native speakers read the adjective that matched the feminine context more slowly,  $t(14) = 4.489$ ,  $p < .001$ .

Table 4. *Mean RTs (in ms) on the Following Segment*

Group	Masculine context		Feminine context	
	Masculine	Feminine	Masculine	Feminine
2 <sup>nd</sup> semester	479.98 (121.33)	520.98 (124.58)	501.79 (109.90)	546.34 (131.96)
4 <sup>th</sup> semester	530.33 (137.10)	499.88 (112.16)	472.49 (97.51)	529.98 (140.18)
Advanced	379.44 (62.05)	368.78 (63.16)	381.91 (69.72)	385.94 (56.93)
Natives	400.93 (46.64)	378.64 (28.22)	391.79 (35.43)	401.47 (42.57)

*Note:* Standard deviations are provided in parentheses.

Despite the fact that the low-proficiency learners exhibited asymmetries in the expected direction in their acceptance rates, they accepted the agreeing form at chance and the clashing form at fairly high rates (above 35%). Their pattern of response contrasts with the advanced learners, whose judgments instead reflected morphological expectation and mirrored the native speakers' data. In processing, only one asymmetry was found for this agreement condition: Fourth-semester learners, like the native speakers, were found to compute the agreeing feminine form more slowly; the underspecified form was read more quickly, reflecting a lesser cost.

## 6. Discussion

### 6.1. Gender matching in discourse

When presented with sentences in which the referent introduced in the context has a synonym of a different gender, as in *le vélo gris, il* "the grey bike, it," the acceptance rates of the participants yielded two main profiles. The low-proficiency learners accepted all forms of the pronouns at fairly high rates (between 50 and 67%) regardless of the context in which it occurred. In contrast, the advanced learners behaved like the native speakers, rejecting the mismatched pronouns and accepting the matched pronouns. The finding from the low-proficiency learners seems at odds with hypothesis 2 (e.g., Lardiere, 2009), because based on a feature-geometric model, feature clash should be avoided (see, e.g., McCarthy, 2007). This finding is not easily explained by hypothesis 1 either (e.g., Hawkins & Casillas, 2008), because mismatched forms should be rejected (those forms cannot be associated). However, the RT data revealed that all learners were sensitive to the gender feature. Asymmetries

between matched and mismatched forms were obtained: The second-semester learners and the native speakers were found to slow down on the mismatched forms compared to the matched forms, suggesting the computation of the agreeing relation. Additionally, the fourth-semester and the advanced learners, like the native speakers, exhibited longer RTs on the clashing forms, suggestive of the crash in the derivation, compared to the underspecified forms, which triggered RTs similar to cases of agreeing forms. Such an asymmetry between cases of underspecification and cases of feature clash cannot be easily explained by hypothesis 1, but it is consistent with the predictions of hypothesis 2. Overall, effects of grammatical gender as a condition of the relation between pronouns and their antecedents were obtained in processing before they were observed in grammatical knowledge. Indeed, even though the second- and fourth-semester learners accepted all forms in all contexts, they exhibited RT asymmetries consistent with the computation of grammatical gender. Such a finding provides further support for hypothesis 2, but a dissociation is not predicted by hypothesis 1.

Because it could be argued that learners relied merely on frequency of the forms themselves, the frequency of the masculine and the feminine pronouns, *il* and *elle*, was checked against the Lexique database (New, Pallier, Brysbaert, & Ferrand, 2004; New, Pallier, Ferrand, & Matos, 2001). It revealed that the masculine form is twice as frequent as the feminine form. In other words, if learners were merely relying on frequency information, they would presumably compute the masculine form faster in all contexts. However, although the low-proficiency learners exhibited a preference for the masculine forms in their acceptance rates, a frequency account does not fully account for the RTs obtained here because the feminine form in a feminine context yielded similar latencies as a masculine form in a masculine context, for instance. Additionally, such a proposal would not predict the dissociation observed between processing and grammar. In short, hypothesis 2, or the feature reassembly hypothesis augmented with a universal parser, seems to best account for the results. Moreover, in response to the second research question, learners (and native speakers) were found to rely on grammatical information (as exemplified with the computation of the gender feature) during the resolution of pronouns. Thus, not only are the discourse context and the features deployed relevant, but the level of entities is also entertained, as was demonstrated by the synonyms denoting a single entity.

## 6.2. Feature calculations

Across the two conditions (i.e., pronouns resolution and adjective agreement) overall, two profiles emerge in the acceptance rates: The second- and fourth-semester learners accepted all forms in all conditions, whereas the advanced learners' data reflected morphological expectations, like the native speakers. This suggests that the low-proficiency learners do not yet have robust grammatical knowledge. Once again, the high acceptance rates of the clashing forms by the low-proficiency learners cannot be explained unless it is assumed that the universal parser triggers grammatical changes. Indeed, effects would then be expected to occur in processing before they appear in lexical knowledge, which seems to be the case for the second- and fourth-semester learners in this study (see also Dekydtspotter & Renaud, 2009; Renaud, 2010, 2011; Tokowicz & MacWhinney, 2005).

In contrast, the RT data revealed a single processing profile: All groups exhibited discourse- and form-dependent RT asymmetries. The data from the condition examining the interpretable gender feature (i.e., pronoun resolution with synonyms of differing gender), asymmetries between the matching and the mismatching forms were obtained. In the case of the uninterpretable gender feature (i.e., overt adjective agreement), although the results only yielded a single asymmetry, further evidence for the computation of the gender feature by all learner groups was found from adjective agreement in two additional contexts (see Renaud, 2010). In any case, hypothesis 1 (e.g., Hawkins & Casillas, 2008): cannot easily explain the similar sensitivity to interpretable and uninterpretable gender in processing by the learners or the asymmetries in the RTs resulting from domain-specific feature computations. Finally, this hypothesis cannot account for the dissociation between processing and grammatical knowledge found in both conditions. Hypothesis 2 (e.g., Lardiere, 2009; McCarthy, 2007), on the other hand, seems supported by the results: Learners exhibited processing asymmetries suggestive of checking relations, even before evidence of robust grammatical knowledge. Additionally, the RT asymmetry between feature clash and feature underspecification provides evidence for the possible co-reference of a masculine pronoun with a feminine noun denoting the same entity and for the use of default. Thus, in response to the first research question, the data from this

study suggest that learners, like native speakers, treat the interpretable and uninterpretable gender features similarly during computation.

In short, the similar findings across conditions suggest that the encoding of pronouns occurs at the grammatical level. The fact that learners (and native speakers) were able to accommodate the underspecified gender of the pronoun, albeit with a certain processing cost provides support for the claim that L2 grammars are organized following a feature-geometric model (Harley & Ritter, 2002). Indeed, native speakers and learners exhibited RTs suggestive of the fact that the feature [feminine] is dependent on [gender] (i.e., class) and that [masculine] is not part of underlying representations. Therefore, the hierarchy between the marked and the default values of the gender feature easily accounts for the findings.

## 7. Conclusion

The present study provided evidence for the feature reassembly hypothesis combined with a universal parser (see, e.g., Dekydtspotter & Renaud, 2009; Lardiere, 2009; Renaud, 2010, 2011). Indeed, although at first the acceptance rates can be taken to contradict this hypothesis, if the parser drives the acquisition of representations, then the asymmetries found in the RT data are quite revealing of the computation of the gender feature at all levels of proficiency in the L2. Furthermore, the asymmetries between matched and mismatched forms as well as between underspecified forms and clashing forms in the learner data follow naturally from a hierarchy of feature specifications as well as from the computation of agreement via the Agree operation by spell out. Crucially, when confronted with the co-reference of pronouns with a noun in the discourse, learners were found to rely on grammatical information (i.e., the gender feature). Once again, a feature-geometric account was found to best account for the possible accommodation of an underspecified pronoun with a feminine noun but the lack of such an accommodation in the case of feature clash. Finally, it is important to point out that the results of the present study indicate that, although core grammatical mechanisms are involved during processing, they may not be observed in performance in all contexts, as seen by the results of the acceptance rates. In other words, researchers should turn their attention to processing evidence in order to fully explain the mechanisms at play in L2 acquisition.

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