# Resolving Pronouns in L2 French: Processing Evidence for the Computation of the Gender Feature

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## 1. Interpretation and licensing of pronouns

Two levels are necessary for the resolution of pronouns as co-referent with referential expressions (R-expressions) in English and in French: (a) the identification of referents in discourse representation (Kamp, 1981) and (b) the syntactic licensing by binding theory (Chomsky, 1981). Indeed, to be interpreted, pronouns require the introduction of discourse referents in a context, be it linguistic or not. Kamp's (1981) discourse representation theory assumed an intermediate level of representations mediating between the syntax and the discourse—namely, the discourse representation structure. For a discourse representation to be true with respect to a set of information structure (i.e., a complete model), all the (semantic) conditions of this model need to be satisfied. In other words, for a pronoun to be semantically interpreted, 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). The second level follows from binding theory (Chomsky, 1981) requiring the compatibility of the indexation of the pronoun with the referent identified from the discourse and the checking of the φ features of the pronoun in the relevant domain. In other words, the pronoun is interpreted in cases of feature identity, by matching the features of the discourse referent. This is exemplified in (1a) where *vélo* "bike" and the pronoun *il* "it" carry identical φ features—namely, masculine and singular.

(1) 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."

(2) 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."

Whereas in sentences (1a) and (2a), the two components necessary are in place—gender match between the referent and the pronoun, and the pronoun is free within its governing category—sentences (1b) and (2b) illustrate cases in which the gender of the pronoun and that of the referent do not match, preventing the establishment of a referential dependency as well as the checking of the φ features of the pronouns.

In short, the behavior of pronominals "can be fully understood on the basis of the φ-features they possess, and the way these interact with properties of the grammatical system" (Reuland, 2001, p. 444). There are thus two possible options for the resolution of pronoun: "At the C-I interface pronouns can be translated either as expressions receiving a value directly from a discourse storage or as

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variables to be bound by an antecedent" (Reuland, p. 447). Although both entail processing costs, the syntactic binding option is presumably less costly, providing support for the economy principle (Chomsky, 1995). In their (2001) article, Guillelmon and Grosjean noted that, "at the level of discourse processing, gender marking can help keep track of referents and so help disambiguate anaphoric or deictic referential constructions" (p. 504). To examine this notion of cost entailed by the indexation of pronoun, Rigalleau and Caplan (2000) conducted a processing experiment in which they manipulated the gender of the pronoun. When the pronoun mismatched in gender with one of two potential referents, native English speakers took longer to name the object depicted on the screen. This finding led Rigalleau and Caplan to propose an "automatic gender co-indexation process" (p. 45), linking a pronoun to potential antecedents on the basis of morphophonological agreement, followed by the "delinking" (p. 44) of the pronoun when the referent is not matching. Note that this co-indexation process occurs independently from syntactic computations, which corresponds to another level. This study points to the role of the gender feature in the resolution of pronouns.

## 2. The gender feature

Even though there is a set of universal features, according to the Minimalist Program (e.g., Chomsky, 2001), languages need not select all features nor do they use selected features identically. This is the case of the gender feature in English and French. Indeed, in English, the gender feature is only expressed with personal pronouns (i.e., *he*, *she*, *it*, *him*, and *her*). Some nouns also carry the gender feature in cases of natural gender, as can be observed with the co-reference of animates such as *mother* and *father* with the pronouns *she* and *he*, respectively. Additionally, dual semantic gender can be found with certain nouns, like *artist* and *professor*, which can be co-referent with either *he* or *she* depending on the context. Due to a strong emotional relation, some speakers maintain the gender distinctions for animals or certain inanimate nouns, such as *ship*, even though, prescriptively, the co-referring pronoun is *it*. This scenario contrasts with French, in which all nouns are necessarily assigned a gender (i.e., masculine or feminine). That is to say, the gender feature is systematically applied to all nouns, requiring that the φ features of the referent and those of the pronoun match for the pronoun to be licensed and interpreted.

Important properties of features are that they have either marked or default values (e.g., Chomsky, 1981). I follow Harley and Ritter (2002), among others, in assuming that features are modeled in hierarchical geometries. These assumptions provide a specific hierarchy for the gender values within the gender feature itself. Indeed, the masculine value is presumably the default value and thus not part of the underlying representation of feature matrices. In contrast, the feminine value is dependent on the individuating feature—that is, gender—and thus marked. It is assumed that the masculine value is supplied via a default redundancy rule of insertion in morphophonological representations. Such a hierarchy has direct consequences in the computation of the gender feature.

In his study of Greek, a language with three gender (i.e., feminine, masculine, and neuter), Spathas (2007) observed that pronoun resolution based on gender information may result from: (a) agreement between the grammatical gender feature on the antecedent and the gender feature on the pronoun or (b) agreement between the natural, semantically interpreted gender on the referent and the gender feature on the pronoun. In Greek, the word *to koritsi* "the-NEU girl-NEU" exhibits different values for grammatical and natural gender—namely, neuter and feminine. Example (3), adapted from Spathas's example (40), illustrates that, in such cases, the gender feature on the pronoun can have two values, either neuter or feminine.

(3) a. *To koritsi pije sto jrafio tu.*
the.neu girl went to-the office it
"The girl went to her office."

b. *To koritsi pije sto jrafio tis.*
the.neu girl went to-the office her
"The girl went to her office." (p. 18)

An extension of Spathas's observation will be tested here with synonyms of different gender. Indeed, in French, there are synonyms that differ in the value of their gender feature. This is the case of the inanimate nouns *vélo* and *bicyclette* "bike" for instance: The noun *vélo* carries the underspecified gender masculine, whereas *bicyclette* is specified for gender, with the feminine value. Crucially, both *vélo* and *bicyclette* denote the same entity, a bike. Therefore, it seems possible that discourse referents be associated with entities in the model regardless of the gender specification of the pronoun. There are direct processing consequences that stem from such a possibility and the assumption of a feature-geometric model (Harley & Ritter, 2002). Although feature identity is preferred, the co-indexation of a masculine pronoun with a feminine referent could be allowed, because the gender of the pronoun is less specified. For instance, in sentence (4), the context sentence contains a referent that is specified for the feminine gender value. When encountering the pronoun *il* "it" with the masculine default value, one may accommodate the underspecified gender of the pronoun as the only possible referent is the bike in the previous sentence. However, this would presumably entail additional processing costs. This possibility of accommodating the gender value of the referent will be blocked in sentence (5) because the marked feminine value of the pronoun clashes with the one of the masculine referent, yielding a crash in the derivation and highest processing costs.

(4) *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."

(5) *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."

## 3. Gender and pronoun resolution in L2 acquisition

Although a great deal of research has focused on the gender feature in L2 acquisition (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, 2011, 2012; Sabourin, 2003; Sabourin, Stowe, & de Haan, 2006; White, Valenzuela, Kozlowska-Macgregor, & Leung, 2004), very few studies have examined the role of gender in the resolution of pronouns. Moreover, only recently have studies begun to investigate sensitivity to gender agreement in processing, which allows a window into the nature of feature computations (Dekydtspotter & Renaud, 2009; Foucart, 2008; Keating, 2009; Renaud, 2010, 2011, 2012; Sabourin, 2003).

Only one study thus far has focused on the role of gender in pronoun resolution in L2 acquisition in the case of synonyms differing in gender values (Renaud, 2012). In this study, there were 65 English learners of French—namely, 24 second-semester, 26 fourth-semester, and 15 advanced learners. There was also a native control group ($n$ = 15). Participants were asked to complete a judgment task in a noncumulative self-paced moving-window format (Rohde, 2001). Each experimental item consisted in a short context sentence, which appeared on the screen all at once. It was followed by a sentence in which the gender of the pronoun had been manipulated and which appeared in segments, as shown with the slashes in example (6). To continue reading, participants were to press the space bar, at which point the preceding segment disappeared from the screen. 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). To do so, they were to press the key *J* for YES or *F* for NO.

(6) a. Masculine referent and masculine pronoun
*Les enfants ont oublié* ***le vélo gris***.
The children have forgotten the bike-MASC grey
***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 bike-MASC grey
***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 bike-FEM grey
***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 bike-FEM grey
***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."

The acceptance rates results provided two main profiles. First, the second- and fourth-semester learners accepted all forms of the pronouns at fairly high rates (between 50 and 67%) regardless of the gender of the referent with which it occurred. Second, the advanced learners patterned like the native speakers, rejecting mismatching pronouns and accepting matching pronouns. The RT data revealed that all learners exhibited sensitivity to the gender feature. The second-semester learners and the native speakers were found to slow down on the mismatching forms compared to the matching forms. Additionally, the fourth-semester, the advanced learners, and the native speakers exhibited asymmetries between the two types of mismatching pronouns: Longer RTs on the feminine forms paired with masculine referents compared to the masculine forms paired with feminine referents, which triggered RTs similar to cases of agreeing forms. In short, the findings suggest that learners (and native speakers) rely on grammatical information—the discourse context and the features deployed—during the online resolution of pronouns. The level of entities also seems to be entertained, because participants could associate a masculine pronoun with a feminine noun denoting the same entity, albeit with a processing cost. In sum, the findings from this study provided evidence in support of the organization of L2 grammars following a feature-geometric model (Harley & Ritter, 2002).

The goal of the present study is twofold: First, to replicate the findings from Renaud's (2012) study, which examined the resolution of pronouns with synonyms of different gender in L2 French with offline and online data. Second, the current study aims at comparing the moving-window methodology with the eye-tracking methodology. The research questions are as follows: What do L2 learners (and native speakers) do in case of synonyms of different gender? Moreover, because L2 pronoun resolution occurs with the gender feature—a feature absent from the L1 grammar (English)—how is the relevant information encoded among three potential levels—namely, the entities, the discourse referents or the lexical entries, and the features deployed?

## 4. The Present Study

### *4.1. Participants*

A total of 20 English learners of French participated in this study. They were all undergraduate or graduate students in French literature or linguistics at a large Southwestern university. Based on the results from a c-test, they were divided into two proficiency levels: 7 high-intermediate learners (mean age = 22, range = 19-29) and 13 advanced learners (mean age = 33, range = 20-57). The c-test consisted in two short texts (of 74 and 97 words), in which the half of every other words had been removed beginning with the second word of the second sentence. Participants were to fill in the end of these words and took between 5 and 10 minutes to do so. Intermediate learners scored 39.21 out of 50 points on average (range = 36-42), the advanced learners scored 46.31 on average (range = 43.5-50). These results confirmed the division of the participants in two distinct proficiency levels. Additionally, 9 French native speakers (mean age = 36, range = 22-55) constituted the control group. These native-

speaker controls were all living in the Southwestern United States at the time of data collection and scored 49 points on average (range = 47-50) on the c-test.

### *4.2. Tasks*

Participants were asked to complete several tasks: (a) a short background questionnaire, (b) a c-test, which served as an independent measure of proficiency, (c) a judgment task on a computer in a non-cumulative self-paced moving-window format, and (d) the same judgment task presented in a PowerPoint presentation on a computer while the eye-movements of participants were being tracked. The short background questionnaire enabled the researcher to eliminate participants who did not meet the basic requirements of the study (e.g., those participants whose native language was not English nor French). The judgment task was presented using two methodologies to enable comparing the results from the two methodologies—namely, moving-window and eye-tracking. Note that the order of the tasks was randomly assigned, so that half the participants did the eye-tracking part first and the moving-window part second, and the other half completed the tasks in the opposite order. The tasks were completed at least a day apart to avoid fatigue and to mitigate rehearsal effects.

In the judgment task, the matching of gender on co-reference of nouns and pronouns was targeted by 20 experimental items. The selected nouns created five pairs of synonyms: *vélo-bicyclette* "bike," *ballon-balle* "ball," *soulier-chaussure* "shoe," *gazon-pelouse* "grass," and *magasin-boutique* "shop." These synonym pairs were chosen because these words are likely to be known by low-proficiency learners and because they are as close to true synonyms as possible. The frequency of the synonyms checked against the Lexique database (New, Pallier, Brysbaert, & Ferrand, 2004; New, Pallier, Ferrand, & Matos, 2001) revealed that only two pairs had rather similar frequencies for the two members of the pair, *boutique-magasin* "shop" and *vélo-bicyclette* "bike." In case of the other three pairs, *balle-ballon* "ball," *pelouse-gazon* "grass," and *chaussure-soulier* "shoe," the feminine form appears to be the most frequent. Each item included a context sentence and a follow-up sentence to create cases of cross-sentential anaphora. The context sentence contained the referent (i.e., one of the synonyms) with an adjective that specified the gender of the noun. The gender of the subject pronoun from the second sentence was manipulated so that half of the items involved a masculine pronoun and the other half involved a feminine pronoun—that is, so that half of the pronouns matched and the other half mismatched the gender of the referent. This created five quadruple items in 2 (nouns) by 2 (gender) design, an example of which is shown in (7). These items were the same as the ones used in Renaud (2012).

(7) a. Masculine referent and masculine pronoun
*Les enfants ont oublié* ***le vélo gris****.*
The children have forgotten the bike-MASC grey
***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 bike-MASC grey
***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 bike-FEM grey
***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 bike-FEM grey
***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."

There were 114 distractor items, investigating other conditions manipulating gender or number agreement. All participants saw all items in a randomized order (or pseudo-randomized order for the eye-tracking methodology), and each condition served as the filler items for the other conditions.

In the moving-window version of the experiment, items were presented in a noncumulative self-paced format using Linger (Rohde, 2001). Once participants read the context sentence, which was presented all at once, they were to press the space bar to read the follow-up sentence, which appeared in segments, as shown with the slashes in example (7). Every time participants pressed the space bar, the preceding segment disappeared. This methodology and the experimental items were identical to the ones used in Renaud (2012). In the eye-tracking version of the experiment, the eye-tracking technology was combined with screen-capture, so as to record the eye-gazes as they occurred during the experiment. All items were presented in a Power Point presentation. In this format, just as in the moving-window format, the context sentence appeared all at once. Here, participants were asked to press the down arrow on the keyboard to see the follow-up sentence, which also appeared all at once in the next slide. Participants were asked not to go back, and since the computer was recording the experiment, it was checked that they never did so. This allowed the two methodologies to only differ in the presentation of the follow-up sentence (i.e., in segments vs. all at once). In both methodologies, participants were asked to judge the second sentence at the end of each experimental item (i.e., a context and a follow-up sentence). If they found that the second sentence was a good follow-up to the first sentence (i.e., both in terms of grammar and logic), they were to accept the sentence. Should they found the sentence unacceptable, they were to reject it. There was also an option to opt-out, should participants be unable to decide. In the moving-window version, participants responded by pressing *J* for YES or *F* for NO on the keyboard, whereas in the eye-tracking version, participants were asked to fixate on a green circle for YES and on a red circle for NO, which appeared on two opposite sides of the screen and directly below the words *yes* and *no*.

### *4.3. Analysis*

With both methodologies, final acceptability judgments were analyzed. Note that, due to the small number of participants in each group, only descriptive statistics are provided here. In the moving-window version of the experiment, reading times (RTs) on the target segment (i.e., the pronoun) were recorded and analyzed. To check for any delayed effects, RTs on the segments that immediately followed (i.e., the verb and the adverb) were also examined. The data were 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. In the eye-tracking version of the experiment, durations and fixations were analyzed. A duration corresponded to the average time (in milliseconds) participants spent on a given segment, whereas a fixation was operationalized as the number of times a participant looked at a given segment for a duration greater than 200 milliseconds in duration. Note that data from three native speakers were lost due to the fact that the computer lost track of the pupils of these participants. A portable, remote eye-tracker from EyeTech Digital Systems (model TM3) was used along with the Gaze Tracker 9.0 Data Analysis Software. The software systematically creates a video file similar to a screen-capture record but with the participant's eye movements superimposed on the screen. For ease of analysis, each sentence was divided into four regions of interest: the pronoun, pronoun-verb, verb, and adverb. The reason for including the pronoun-verb region in addition to the pronoun region was because these fixations correspond to a participant's gaze fixating in between the pronoun and the verb.

## 5. Results

### *5.1. Moving-window methodology*

#### *5.1.1. Acceptance rates*

Table 1 shows the results of the acceptance rates in percentages (%) for each condition by group. All groups accepted matching pronouns at extremely high rates. Rejection rates for the mismatching pronouns were almost categorical for the native speakers, hovered around 10% for the advanced learners, and were between 20 and 30% for the intermediate learners. Even though 20 and 30% are fairly high rates of acceptance, it is noteworthy that masculine mismatching pronouns tended to be accepted more than the feminine clashing pronouns by the intermediate learners. We will return to these differences in the discussion section.

Table 1. *Acceptance Rates (in %)*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Group | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Intermediate | 90.91 | 21.21 | 30.30 | 90.91 |
| Advanced | 87.69 | 13.85 | 7.94 | 96.82 |
| Natives | 95.35 | 0.00 | 2.33 | 97.67 |

#### *5.1.2. RTs*

For each group, the raw RTs are provided in Tables 2-4 by segment (i.e., pronoun, verb, and adverb) and by condition. It is interesting to point out that the intermediate learners took longer to read the masculine pronoun following a masculine referent overall, whereas they read the feminine pronoun following a masculine referent the fastest. The asymmetry continued on the verb segment, albeit in the opposite direction. The RTs on the adverb segment seem to be flat for this group. The asymmetries between the two mismatching cases (the two middle columns in Table 2) on the pronoun and the verb segments are noteworthy: First, the intermediate learners appeared to read the feminine mismatching pronoun faster than the masculine mismatching pronoun but the effect is reversed on the next segment, with the feminine mismatching pronoun triggering the longest RTs. For the advanced learner group, the same pattern of asymmetries seems to emerge but the RT differences are less strong in general. As for the native speakers, their RTs appear to be flat, with the possible exception of longer RTs on the masculine compared to the feminine pronouns when following a masculine referent.

Table 2. *Raw RTs (in ms) by Region and Condition for the Intermediate Learners*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Segment | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 3062.97 | 2804.58 | 2909.55 | 2927.23 |
| Verb | 602.26 | 833.29 | 613.21 | 670.06 |
| Adverb | 517.27 | 443.16 | 476.47 | 475.32 |

Table 3. *Raw RTs (in ms) by Region and Condition for the Advanced Learners*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Segment | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 2838.64 | 2715.84 | 2755.97 | 2577.69 |
| Verb | 619.20 | 673.21 | 611.15 | 589.59 |
| Adverb | 469.55 | 455.75 | 497.32 | 422.95 |

Table 4. *Raw RTs (in ms) by Region and Condition for the Native Speakers*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Segment | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 1490.23 | 1378.02 | 1459.98 | 1448.69 |
| Verb | 517.85 | 500.09 | 487.60 | 500.41 |
| Adverb | 367.02 | 397.79 | 400.31 | 336.45 |

## *5.2. Eye-tracking methodology*

### *5.2.1. Acceptance rates*

The results of the acceptance rates are presented in Table 5. As in the moving-window format, all participant groups accepted the matching pronouns and rejected the mismatching pronouns at very high rates. The exception seems to be the fairly high acceptance (18.18%) of the feminine pronoun after a masculine noun by the intermediate learners. In short, all participants showed grammatical knowledge overall.

Table 5. *Acceptance Rates (in %)*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Group | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Intermediate | 87.50 | 18.18 | 9.38 | 83.33 |
| Advanced | 98.31 | 7.02 | 12.07 | 96.61 |
| Natives | 96.67 | 3.85 | 3.45 | 93.10 |

### *5.2.2. Durations*

Gaze durations were recorded (in ms) for the four critical regions—the pronoun, the pronoun-verb, the verb, and the adverb. Results are presented in Tables 6-8 for each group, respectively. Table 6 shows a delayed pattern for the intermediate learners: Indeed, they did not exhibit any gaze duration on the pronoun segment. The longest durations occurred in cases of a clashing feminine pronoun as well as in cases of underspecified masculine pronouns as delayed effects. In short, mismatching cases yielded longer durations than matching cases, which seems to point to the additional processing costs from the lack of feature matching. The advanced learners also exhibited longer durations in cases of a mismatching feminine form on the verb and the adverb regions. In general, the masculine forms of pronoun seemed to trigger longer durations on the adverb region. The native speakers also seemed to slow down with masculine forms on the pronoun-verb region, regardless of whether the pronoun matched or mismatched its referent.

Table 6. *Durations (in ms) by Region and Condition for the Intermediate Learners*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Region | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 0.00 | 0.00 | 0.00 | 0.00 |
| Pronoun-verb | 394.06 | 499.14 | 311.94 | 357.80 |
| Verb | 397.03 | 330.86 | 437.17 | 380.11 |
| Adv | 394.26 | 585.03 | 344.94 | 289.97 |

Table 7. *Durations (in ms) by Region and Condition for the Advanced Learners*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Region | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 304.93 | 397.02 | 416.88 | 433.20 |
| Pronoun-verb | 428.18 | 318.88 | 430.07 | 374.02 |
| Verb | 416.18 | 454.12 | 382.02 | 388.13 |
| Adv | 441.95 | 418.13 | 449.05 | 339.93 |

Table 8. *Durations (in ms) by Region and Condition for the Native Speakers*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Region | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 259.00 | 262.03 | 259.10 | 303.97 |
| Pronoun-verb | 399.87 | 275.97 | 319.07 | 297.97 |
| Verb | 358.03 | 349.97 | 452.97 | 302.00 |
| Adv | 357.07 | 344.00 | 305.17 | 283.00 |

### *5.2.3. Fixations*

Recall that a fixation occurred when a participant's gaze fixated a region for at least 200 milliseconds. This means that the fixation patterns should pattern similarly to the duration information, as more fixations mean more duration. Note also that not all regions were fixated in each item, so the numbers are averaged over the five items in each condition. Tables 9-11 present the results by segment and condition for each group, respectively.

Table 9. *Fixations by Region and Condition for the Intermediate Learners*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Region | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 0.00 | 0.00 | 0.00 | 0.00 |
| Pronoun-verb | 1.29 | 1.54 | 1.10 | 1.27 |
| Verb | 1.12 | 1.15 | 1.15 | 1.21 |
| Adv | 1.19 | 1.71 | 1.17 | 1.00 |

Table 10. *Fixations by Region and Condition for the Advanced Learners*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Region | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 1.00 | 1.18 | 1.23 | 1.27 |
| Pronoun-verb | 1.25 | 1.09 | 1.33 | 1.00 |
| Verb | 1.27 | 1.43 | 1.10 | 1.12 |
| Adv | 1.56 | 1.39 | 1.42 | 1.12 |

Table 11. *Fixations by Region and Condition for the Native Speakers*

| | Masculine referent | | Feminine referent | |
|---|---|---|---|---|
| Region | Masculine pronoun | Feminine pronoun | Masculine pronoun | Feminine pronoun |
| Pronoun | 1.00 | 1.00 | 1.00 | 1.18 |
| Pronoun-verb | 1.11 | 1.00 | 1.00 | 1.00 |
| Verb | 1.20 | 1.00 | 1.67 | 1.00 |
| Adv | 1.11 | 1.67 | 1.00 | 1.00 |

It is clear that the intermediate group exhibited a delayed pattern, compared to the advanced learners and the native speakers, as they had no fixation on the pronoun region. The mismatching conditions triggered the fewest (i.e., the underspecified masculine pronoun) and the most (i.e., the clashing feminine pronoun) fixations for this group. The results from the advanced learner group show that the two types of mismatching forms triggered the most fixations. Similarly, the adverb segment in the matching masculine case yielded more fixations than the other conditions. For the native speakers, the fixation pattern was fairly similar in every condition with the possible exception of the adverb region with the mismatched feminine pronoun and the verb region with the mismatched masculine pronoun.

## 6. Discussion

Because the same participants judged the same sentences, the results from the acceptance rates were expected to be similar across the two methodologies. This was borne out in the data. Indeed, the two learner groups were found to pattern like the native speakers, following morphosyntactic expectations: They rejected mismatching pronouns and accepted matching pronouns. What is more, these results mirror those from Renaud (2012). The fact that the intermediate learners in the present study exhibited more determinate judgments than those in Renaud (2012) is not surprising, as the current participants had a higher proficiency level. Nonetheless, the intermediate learners from the present study also exhibited non-negligible acceptance rates (around 20% and up to 30%) of mismatched cases (see also Renaud, 2012). Such a finding is difficult to explain if one relies on frequency explanations, because mismatching cases are not present in the input. This finding also cannot be explained by accounts that rely purely on associative mechanisms (e.g., Hawkins & Casillas, 2008; Tsimpli & Dimitrakopoulou, 2007) because mismatching forms cannot be associated and should thus be rejected. That the intermediate learners seemed to accept more feminine pronouns as co-referent to a masculine noun than masculine pronouns as co-referent to a feminine noun is also surprising. Indeed, based on a feature-geometric model (see Harley & Ritter, 2002), it should be more difficult, if not impossible, to match a feminine pronoun with a masculine noun, whereas inserting a less specified form, like the masculine pronoun, could occur to relieve processing costs. However, these offline findings should not be separated from the online results.

Several asymmetries emerged in the intermediate learners' online data. In the moving-window version of the task, they were found to read the feminine, mismatching pronoun faster than the masculine, matching pronoun when it followed a masculine referent. The two other conditions yielded RTs in the middle. Interestingly, on the verb segment, the longest RTs were obtained following the feminine pronoun paired with a masculine noun, with the other conditions yielding similar RTs overall. Even though it is not clear why there is this reversed pattern, the fact that the mismatching feminine pronoun triggered different RTs than the other conditions suggest that intermediate learners were sensitive to the gender feature (e.g., Lardiere, 2009). In the eye-tracking version of the task, only delayed effects were obtained for this group. The longest durations occurred on the pronoun-verb and the adverb regions following the feminine noun paired with a masculine referent. This effect was also observed in the fixations. Once again, this suggests that these intermediate proficiency learners were sensitive to the higher costs of a feminine pronoun that mismatches the gender of the only possible referent in the context. The asymmetry on the verb segment between the two mismatching conditions found in the moving-window data was also observed in the eye-tracking data on both the pronoun-verb and the adverb regions. This finding, which is similar to that in Renaud (2012), seems to provide support to the claim that L2 grammars rely on feature hierarchy, with the feminine gender value triggering different computational costs from the unspecified masculine value (e.g., Harley & Ritter, 2002). As noted, offline findings need to be discussed together with online results. This is crucial because effects of grammatical gender as a condition of the relation between pronouns and their antecedents were detected here in processing before they were observed in grammatical knowledge (or offline acceptance rates). In other words, even though the intermediate learners accepted mismatching forms at fairly high rates, they demonstrated RT asymmetries consistent with the computation of grammatical gender. This finding cannot be explained unless it is assumed that the universal parser triggers grammatical changes (see also Dekydtspotter & Renaud, 2009; Renaud, 2010, 2011; Tokowicz & MacWhinney, 2005).

The online results of the advanced learners show that they read the pronoun segment more slowly when it matched the masculine referent. This same finding was obtained in the native speakers, although the asymmetry is less prominent. An account that relies solely on frequency to explain the data will fall short of explaining this finding because the masculine pronoun is the most frequent form. Indeed, the Lexique database (New, Pallier, Brysbaert, & Ferrand, 2004; New, Pallier, Ferrand, & Matos, 2001) indicated that the masculine pronoun is twice as frequent as the feminine pronoun. Should learners (and native speakers) only rely on frequency information, then the masculine form should yield the fastest RTs. Note that, in all three participant groups, the masculine matching pronouns never triggered the slowest RTs in the present study. The results of the eye-tracking part of the study are slightly different for the advanced learners: In this case, the masculine pronoun paired with a feminine referent triggered the longest durations. Once again, this finding goes counter to a frequency explanation. That the mismatching masculine pronoun triggered longer durations than the matching masculine pronoun can be argued to reflect the higher processing costs needed to allow for the co-reference of these mismatching forms. Another interesting finding from the eye-tracking data for the advanced learner group is the longer durations on the verb and adverb regions following from the feminine pronoun paired with a masculine referent. The same result was obtained on the verb segment in the moving-window data. This finding can be explained by from the high processing costs stemming from the mismatching features of the pronoun and its referent.

The native speaker data in the moving-window version of the task did not reveal many asymmetries, although there seems to be a tendency to read the masculine pronouns matched with a masculine referent more slowly overall. This finding was also observed in the eye-tracking data with longer durations on the pronoun-verb region in this condition. It is unclear why this condition would have triggered the longest RTs and durations. Indeed, in terms of feature association (e.g., Hawkins & Casillas, 2008; Tsimpli & Dimitrakopoulou, 2007), which also relies on frequency information, the matching masculine form should yield faster RTs than the feminine matching pronoun. If one assumes the feature hierarchy, however, it is possible that the higher processing costs observed stem from the application of the default redundancy rule providing the masculine value (e.g., Harley & Ritter, 2002). The only other interesting asymmetry in the native speakers' eye-tracking data was the longer duration on the verb region in cases of a masculine pronoun paired with a feminine referent. This result seems to suggest the higher costs associated with the accommodation of the co-indexation of the masculine, underspecified pronoun, with a specified feminine noun. In short, the native speakers and the advanced learner patterned similarly.

In terms of the comparison of the two methodologies, it is clear that the findings are similar overall. However, there are several differences that may stem from the various moments captured by each methodology. For instance, the acceptance of mismatching cases seems exacerbated in the moving-window data, probably due to the fact that learners have to remember the various segments and cannot go back as they can in the eye-tracking methodology. Another example is the delayed effects obtained in the intermediate learners with the eye-tracking methodology, which was not the case with the moving-window methodology, as RT asymmetries were found on the pronoun segment.

As noted, the acceptance rates pattern like those of Renaud (2012). Similarly, the moving-window results seem to mirror those from Renaud (2012): Participants exhibited sensitivity to the gender feature. In both studies, asymmetries between the matching and the mismatching forms as well as asymmetries between the two types of mismatches were obtained. These findings suggest that the encoding of pronouns occurs at the grammatical level as well as provide support for the claim that L2 grammars are organized following a feature-geometric model (Harley & Ritter, 2002). Indeed, learners (and native speakers) were able to accommodate the lesser-specified masculine value of the pronoun, albeit with a certain processing cost, to allow for the co-indexation of the pronoun with the only possible referent, denoting the same entity.

## 7. Conclusion

This study had two goals: (a) to replicate the findings from Renaud (2012) and (b) to compare the methodologies. In regards to the first goal, the current study provided further support for Renaud's (2012) findings and claims that learners (and native speakers) rely on all three levels—namely, the

discourse context, the features deployed, and the level of entities—to resolve pronouns. In other words, the encoding of pronouns occurs at the grammatical level, in support of a feature-geometric model (Harley & Ritter, 2002). Moreover, the L2 learners at all proficiency levels were found to rely on a feature that is not instantiated in their L1 grammar (e.g., Lardiere, 2009). In regards to the second goal, the two methodologies yielded similar results overall. This study is not without limitations, however. First, conclusions should be taken with a grain of salt, as the number of participants in each group is rather small, and statistical analyses were not possible. Nonetheless, the results pattern like those from Renaud (2012), in which the groups were much larger. Second, the eye-tracking results presented here are a bit unconventional as the study was designed to allow a direct comparison between the moving-window data and the eye-tracking data. Further investigation using the usual eye-tracking method will be necessary to confirm the results obtained here. It is encouraging, however, that the results of the eye-tracking version of the task are similar to those of the moving-window version. In short, the present study provided additional evidence for the computation of the gender feature during the resolution of pronouns in L2 acquisition.

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