The relation between language and cognition in children aged 3 to 9 : The acquisition of grammatical gender in French

Alix Seigneuric, Daniel Zagar, Frédéric Meunier, E. Spinelli

▶ To cite this version:

HAL Id: hal-00568195

https://hal-univ-bourgogne.archives-ouvertes.fr/hal-00568195

Submitted on 26 May 2011

The relation between language and cognition in 3- to 9-year-olds: The acquisition of grammatical gender in French

Alix Seigneuric, Daniel Zagar , Fanny Meunier , Elsa Spinelli

Abstract

The French language has a grammatical gender system in which all nouns are assigned either a masculine or a feminine gender. Nouns provide two types of gender cues that can potentially guide gender attribution: morphophonological cues carried by endings and semantic cues (natural gender). The first goal of this study was to describe the acquisition of the probabilistic system based on phonological oppositions on word endings by French-speaking children. The second goal was to explore the extent to which this system affects categorization. In the study, 3- to 9-year-olds assigned gender categorization to invented nouns whose endings were typically masculine, typically feminine, or neutral. Two response conditions were used. In the *determiner* condition, children indicated the gender class by orally providing the determiner *un* or *une* marked for gender. In the *picture* condition, responses were given by pointing to the picture of a Martian-like female or male person that would be best called by each spoken pseudoword. Results indicated that as young as 3 years, children associated the determiner corresponding to the ending bias at greater than chance levels. Ending-consistent performance increased from 3 to 9 years of age. Moreover, from 4 years of age onward, sensitivity to endings aVected categorization. Starting at that age, pictures were selected according to endings at greater than chance levels. This eVect also increased with age. The discussion deals with the mechanisms of language acquisition and the relation between language and cognition.

Keywords: Language acquisition; Grammatical gender; French gender; Gender-ending regularities; Gender cues

Introduction

Acquiring language requires discovering the complex morphosyntactic system that defines the underlying organization of the language. A feature that plays an important role in the linguistic structure of many natural languages is grammatical gender. The French language, like many languages of the world, organizes all nouns into grammatical gender categories. In French, all nouns are categorized into two classes: masculine and feminine. The attribution of the nouns to the gender classes is largely arbitrary, although some principles play a role. There are semantic cues carried by the nouns that refer to male or female entities, morphophonological cues carried by the endings of some nouns, and morphosyntactic cues carried by words syntactically related to the noun (e.g., determiners, adjectives). Given the complexity of this multiple-cue linguistic system, it is striking to observe how French children acquire knowledge of grammatical

categories without the need for direct instruction. Despite the relevance of this phenomenon for understanding language acquisition, only a few studies have been carried out to explore how grammatical gender is acquired. One reason might be that the English language is not characterized by this grammatical feature. The purpose of our study was to provide substantial data about the acquisition of grammatical gender in French and to address theoretical points regarding this issue. More precisely, this experiment was designed to describe the development of sensitivity to the gender cues carried by noun endings from both a quantitative and a qualitative point of view. The presentation of the rationale for our study follows an overview of the gender system in French and a more detailed account of prior studies concerning this question.

Overview of the French gender system

Le verre est sur la table is a French sentence that means "The glass is on the table." This is a very simple sentence that we could easily imagine being spoken to a child. Its translation in English points to a characteristic of French language. All nouns belong to one of two gender classes: masculine or feminine. Gender class determines the form taken by the words syntactically related to the noun such as the article and the adjective that agree in gender with the gender of the noun. In the above example, *verre*, the French word for "glass," is a masculine word and therefore is preceded by the masculine determiner *le. Table*, the French word for "table," is a feminine word and is preceded by the corresponding feminine article *la.* Consider another sentence involving human entities such as *Est-ce que tu as un frère ou une soeur?* ("Do you have a brother or a sister?"). In this latter example, the form taken by the determiners indicates that *frère* is a masculine word (preceded by the masculine indefinite *un*) and *soeur* is a feminine word (preceded by the feminine indefinite *une*). In this case, gender assignment to each of the two classes seems obvious even to the novice. For entities with biological sex, gender attribution is guided by the meaning of the nouns in such a way that nouns denoting male entities are masculine and nouns denoting female entities are feminine. These nouns, however, represent only a small portion of the entire set of nouns. For the great majority of nouns, meaning suggests nothing about grammatical gender.

What about the form of the nouns? Does any portion of French nouns carry gender information? At first sight, there are no clear morphological or phonological marks that seem to evoke a particular gender class. Such marks do exist in some Latin languages. For example, in Spanish, final *-o* almost always suggests masculine gender and final *-a* almost always suggests feminine gender. In French, noun endings are so numerous that gender assignment seems to be arbitrary. To give a rough idea, Séguin (1969) identiWed 570 different word endings for the masculine words only. However, the arbitrariness of the relation between form and gender is only apparent. Tucker, Lambert, and Rigault (1977) analyzed the entire noun corpus of a French dictionary and found that noun endings "co-occur in asystematic and predictable manner with gender" (p. 57). In their study, detailed computations that give the frequency of noun endings for each gender class are provided. These results show that many word endings that recur across sets of nouns are strongly associated with a particular gender. For example, 96% of

nouns ending in -*ette* are feminine (e.g., *cigarette* ["cigarette"], *fourchette* ["fork"]) and 99% of nouns ending in -*ain* are masculine (e.g., *train* ["train"], *pain* ["bread"]). Word endings can be characterized as highly or weakly predictive of a specific gender. Highly predictive endings are numerous. According to Tucker and colleagues, more than 60% of the nouns carry such predictive endings. These nouns usually are referred to as regular nouns. However, there is a range of predictiveness. Some endings are not predictive of a speciWc gender, and in nearly every case exceptions exist (e.g., *squelette* ["skeleton"] is masculine whereas ending with the typical feminine ending -*ette*). The nouns belonging to the gender class opposite to that evoked by high predictive endings usually are referred to as irregular nouns.

Sensitivity to phonological and semantic cues by French adult speakers

Several studies have been carried out to investigate whether native speakers of French are able to take into account the gender information carried by nouns to retrieve grammatical gender. Using a gender categorization task in which participants were asked to assign gender to real nouns, Desrochers and Brabant (1995) found that gender decisions were faster when nouns refer to human entities rather than inanimate objects. Thus, semantic gender cues are accessed during explicit gender retrieval. Using a gender categorization task with invented words, Tucker, Lambert, Rigault, and Segalowitz (1968) found that the gender attributed to a pseudoword was correlated with the frequency with which its ending was actually associated with that gender in French. For example, a pseudoword with the typical feminine ending -*ette* (e.g., *coumette**)1 was classiWed as feminine, a pseudoword with the typical masculine ending -*on* (e.g., *tovon**) was classiWed as masculine, and a pseudoword with a neutral ending (e.g., *tugique**) was inconsistently classiWed as masculine or feminine. Using real words, Desrochers, Paivio, and Desrochers (1989) found faster and more accurate gender classiWcation for words with gender-typical endings than for words whose endings were unbiased. Along the same lines, Taft and Meunier (1998) showed that gender assignment was more rapid and accurate if the gender class of the word was consistent with that evoked by the ending (regular word as in *fourchette*) rather than inconsistent (irregular word as in *squelette*). Taken together, these Wndings clearly show that native speakers of French are sensitive to the semantic and phonological gender information carried by the nouns. Regarding phonological cues, results show that French speakers have extracted a set of linguistic regularities that associate noun endings with grammatical gender.

---

1 Pseudowords are marked by an asterisk (¤).

Sensitivity to phonological and semantic gender cues in French language acquisition: KarmiloV-Smith's experiments

Native speakers of French exhibit high ability on gender attribution by 3–4 years of age without the need for explicit rules (Clark, 1985; KarmiloV-Smith, 1979). The question therefore arises as to how grammatical gender is acquired by native French children. More precisely, what kind of gender information is used, and how are the several gender cues integrated during the course of language acquisition? The seminal study conducted by KarmiloV-Smith (1979) provides some information concerning these issues (for similar experiments with Spanish-speaking children, see also Pérez-Pereira, 1991). However, as we describe subsequently, this study does not allow one to draw conclusions about several important questions. The goal of KarmiloV-Smith's study was to developmentally assess the gender-predictive weight attributed to diVerent types of gender cues to determine the gender of invented nouns. From a theoretical point of view, the question regarding gender acquisition consisted in testing two opposite positions. According to a "semantic" hypothesis, gender acquisition would stem from the natural gender classiWcation from which grammatical gender would arise as an extension. According to a "linguistic" hypothesis, gender classes would emerge from the associations between particular noun endings and other parts of speech such as determiners and pronouns. Children would progressively acquire the phonological system based on noun-ending cues. To test these hypotheses, KarmiloV-Smith (1979) conducted several experiments on grammatical gender acquisition by French-speaking children between 3 and 12 years of age. Two of these experiments are considered in more detail here because they are directly relevant to our own study. One of these experiments (Experiment 8) measured the ability of French-speaking children to provide a deWnite article on the basis of the phonological cues carried by pseudoword endings. In this experiment, children were presented with pictures of imaginary animate and inanimate objects to which invented nouns were given. Invented nouns were French-sounding names whose endings were typically masculine (e.g., *-on* as in *bicron**), typically feminine (e.g., *-ine* as in *fasine**), or neutral (e.g., *-ire* as in *fodire**). The invented nouns were aurally presented without any article but with the nominal *deux*, which gives no clue to the gender (e.g., *Voici deux fasines* ["Look, that's two fasines"]). The nouns were assigned to pairs of identical but differently colored pictures. Children were first asked to repeat the name given to the pictures. Then the experimenter performed an action such as hiding one of the two pictures. Children were prompted to describe the action by eliciting statements marked for gender. Children would answer with something like "*Vous avez caché la fasine* blanche" ("You hid the white fasine"). Participants' responses involved providing the critical gender agreement information carried by the article and the adjective. In the example, the definite article *la* and the suffix carried by the adjective *blanche* (vs. *blanc* for the masculine form) consistently indicate that a feminine gender has been selected with the correct agreement. The data reported by KarmiloV-Smith (1979) consisted of the percentages of endingconsistent responses (based on the article) given to four pseudowords with gender typical endings (two pseudowords in each gender). The results showed that from 3 years of age, children selected the gender of the article that corresponds to the gender evoked by the ending (100% was reached for three of the pseudowords). Percentages were somewhat lower for the feminine gender but still were above the 50% level (67% for the pseudoword *fasine**). The results also

indicated that for children older than 9 years, there was a tendency to attribute masculine gender to all unknown words despite the potential feminine phonological cues provided by the endings. In this experiment, the noun endings were the only available gender cues that could guide gender agreement. On the basis of these data, KarmiloV-Smith concluded that the phonological clue was effective at all ages. In another experiment (Experiment 10), KarmiloV-Smith (1979) addressed the question of which cue was predominantly used when two kinds of gender information were inconsistent, namely a phonological cue from the suffix and a semantic gender cue (sex of a person in a picture). In this experiment, pictures depicting male or female animates were associated with invented nouns. As in the previous experiment, the invented nouns could have gender-biased suffixes, but no marked articles were given. The experiment was designed in such a way that a conflict was created between a natural gender cue and a phonological cue. In some cases, the sex of the person depicted in the picture and the noun ending were inconsistent (e.g., females called *deux bicrons**). As before, children needed to provide a determiner and an adjective marked for gender that indexed the children's classification of the gender of the person depicted in the picture. The results showed that although natural gender could be taken into account in cases of no discord (pseudowords with neutral endings), children tended to base their decisions on the phonological cue irrespective of whether the picture was of a boy or a girl. These results were observed from 3 to 10 years of age. As children grow older, they gradually make use of semantic and syntactic cues. Using the procedure of KarmiloV-Smith (1979), Pérez-Pereira (1991) observed similar results with children learning Spanish whose gender system is very close to that of French. According to Pérez-Pereira, such results are incompatible with a semantic gender theory positing that children would primarily attribute the gender of nouns on the basis of semantic features. On the contrary, the results showing that semantic gender cues are never predominantly used when endings carry gender information suggest that gender is a feature of the linguistic system that children learn by processing the linguistic information per se.

Question of independence between linguistic and semantic gender cues

KarmiloV-Smith's (1979) findings, however, leave open the question of the independence between phonological and semantic gender cues. What they clearly show is that children are able to take both cues into account but that the gender information carried by noun endings is the earliest and the strongest to exert an influence. However, KarmiloV- Smith's study did not address the question of whether linguistic and semantic cues are independent, that is, whether linguistic cues can affect a classification relying on semantic criteria. As we described previously, in French language the gender categorization of inanimate nouns has no semantic basis, whereas the gender class given to animate nouns corresponds to the sex of the referents. The results reported by KarmiloV-Smith show that the probabilistic system of phonological gender cues starts to be acquired by children at an early age through natural exposure to inanimate and animate nouns. By this age, children have acquired the knowledge of the distinction between the two sexes and are able to assign the masculine or feminine gender categories to the corresponding male or female referents. The binary structure of the gender system in French makes a neutral assignment impossible. French speakers must assign a gender class to each noun.

However, this does not mean that they assign a sex category to each noun. It is only true for animate nouns. Besides, it seems clear that the obligatory gender assignment in French results in a more radical sex categorization for French speakers compared with speakers of a nonbinary gender system such as English. Consider the case of "Tweety Bird." Whereas English speakers, when asked, have doubts about the sex of this fictional character, the answer is straightforward for French speakers: Tweety Bird is male. This clear-cut categorization by French speakers is obtained thanks to the systematic gender cues that are needed to refer to "him" that mark the masculine gender unambiguously. A similar process could be involved when children are asked to assign a gender to inanimate or invented nouns. This process would lead to the generalization of male and female attributes to objects. This issue was raised more recently in a study conducted by Sera and colleagues (2002), who examined whether grammatical gender was independent of perceptual classification by exploring whether grammatical gender could influence a categorization based on semantic features. In their experiments, English-, Spanish-, French-, and German- speaking children were asked to attribute male or female voices to picture objects. For example, French-speaking children needed to decide whether *une fourchette* ("a fork"), which is a feminine noun, would rather speak with the voice of a man or the voice of a woman if it came to life in a movie. They found that by roughly 7 years of age,

French-speaking children assign a man's voice or a woman's voice to object names in accordance with the grammatical gender of their labels. This was taken as evidence that there was an interaction between language and categorization in which an arbitrary linguistic category was able to activate a semantic feature related to the same gender class. According to these authors, these results were in apparent contradiction with those observed by KarmiloV-Smith (1979), of which they gave the following interpretation: "Because children ignored the perceptual gender of the figures when generating adjectival endings, these findings suggest that language and perceptual processing of gender are independent" (Sera et al., 2002, p. 379). However, this interpretation seems not to be valid if we closely compare the paradigms used in both studies. Indeed, it is obvious that the two tasks are not alike regarding the processing of gender information. Two features must be taken into account: the type of gender information provided to the child and the type of response required. In the paradigm used by Sera and colleagues (2002), children were given real inanimate nouns that belong to one grammatical gender. The response consisted of attributing a semantic feature indicating gender. Thus, in their paradigm, the connection between grammatical and semantic information was directly tested. In KarmiloV-Smith's (1979) study, children were given two conflicting cues: a phonological cue carried by the pseudoword ending and a semantic cue provided by the associated picture. The response consisted of producing a noun phrase with a determiner indicating the gender class. Thus, in KarmiloV-Smith's paradigm, the relation between linguistic and semantic gender cues never was tested because both cues were conflicting. Consequently, it appears that the paradigm used by KarmiloV-Smith was not suitable to test whether phonological gender cues could be associated with semantic features.

Rationale and goals of the current study

We conducted a study to address two main questions regarding gender acquisition. A first goal was to give a comprehensive picture of the acquisition of sensitivity to noun gender-ending

correspondences by French children. It appeared necessary to collect new data because those provided by KarmiloV-Smith (1979) suffer from two kinds of limitations. First, results were presented for four pseudowords only: two pseudowords with masculine suffixes and two pseudowords with feminine suffixes. Generalization is therefore very limited, and results have only a descriptive value. Moreover, the results for the neutral-ending pseudowords were not provided, so no baseline was available to assess the strength of the phonological endings when these were present. The major concern lies in the paradigm used in the KarmiloV-Smith (1979) experiment. As described previously, attribution of pseudowords to one of the two gender classes was assessed by asking children to produce a noun phrase in which an article and an adjective needed to concord in gender. In this paradigm, assignment ability was assessed within a concord task so that this task confounded assessment of assignment and agreement abilities.

This may have induced specific strategies to limit cognitive demand. The result of children older than 9 years showing a tendency to attribute masculine gender to all unknown words, even to the pseudowords with feminine-typical endings, may result from a specific adaptation to the task. The answer was indeed easier to give if the masculine form was selected because the feminine form is marked by adding a suffix to the adjective. The masculine form corresponds to a canonical form. More important, it has been suggested that the processes involved in gender assignment may be different from those involved in gender agreement (Clahsen & Almazan, 1998). The theoretical proposal that assignment and agreement in gender rely on different systems has important implications for the measurement of these abilities. Obviously, it follows that the proper assessment of assignment ability requires a paradigm that specifically measures this ability, for example, by means of a gender categorization task (also called a gender decision task). This task has been found to be particularly appropriate to study the influence of word endings in different kinds of populations (Monnery, Seigneuric, Zagar, & Robichon, 2002). In the current study, we used a gender categorization task of pseudowords. Children from 3 to 10 years of age needed to classify pseudowords whose endings were typically masculine, typically feminine, or neutral. We expected that as children grow older, they would progressively acquire the partially regular system that associates word ending with grammatical gender. According to this hypothesis, percentages of ending-consistent responses to pseudowords with high predictive endings should increase regularly with age. The second aim of our study was to test whether morphophonological cues carried by noun endings could activate the semantic features of the corresponding gender class. In other words, we wanted to replicate Sera and colleagues' (2002) findings showing that grammatical gender information could influence classification. In our study, however, the gender information provided to the children was not the grammatical categories of inanimate objects but rather the gender cues carried by noun endings. To test this second goal, we manipulated the type of proposed responses to indicate gender attributions. In one condition, children indicated their gender classification by orally providing the determiner *un* or *une* marked for gender that would be the most appropriate for each pseudoword. This procedure has proved to be easily understood by young children (Monnery et al., 2002). In another condition, responses were given by pointing to the picture of a Martian-like female or male person that would be best called by each spoken pseudoword. According to Sera and colleagues (2002), an interaction exists between the linguistic and semantic gender information. It follows that in the picture condition, we expected that children would associate the pseudowords with masculine endings more frequently with male pictures

and would associate the pseudowords with feminine endings more frequently with female pictures. The design allowed us to further explore the second aim. First, we wanted to examine when (if ever) grammatical gender could affect a semantic classification. In Sera and colleagues'study, these effects were observed with second-grade children, that is, by 7 years of age. These effects were qualified as being rather late compared with the early age (»3–4 years) at which native speakers learn correct gender attribution. One interpretation given by the authors is that their task was not sensitive enough to detect these effects. Our paradigm, which was very simple, provided a potentially fruitful way to reveal effects at an early age. Sera and colleagues (2002) also proposed another interpretation for these late effects. It may be that a substantial amount of time is necessary before observing that language can affect categorization. One way to test this interpretation was to compare the two response conditions used in our study. If there is a time lag before linguistic gender cues can influence categorization, we might observe that at an early point during language acquisition, more ending-consistent responses would be given in the determiner condition than in the picture condition. For example, when presenting the feminine-biased pseudoword *coumette**, the percentage of feminine responses would be higher in the determiner condition (by saying *une coumette**) than in the picture condition (by pointing to the female picture). This could be explained by the fact that *une coumette** corresponds to the condition of natural language acquisition that relies on exposure of millions of utterances associating this ending with gender marks specially carried by articles. As this statistical learning acquisition would be taking place, it would progressively influence cognition.

Method

Participants

A total of 144 native French-speaking children from three preschools and elementary public schools participated in the study. They came from middle-class social environments of Burgundy. The sample was distributed into six age groups of 24 children each ranging from 3 to 9 years: 3-year-olds (*M*D 3.5 years, *SD* D 3.2 months, 12 girls and 12 boys), 4-year-olds (*M*D4.4 years, *SD*D3.5 months, 9 girls and 15 boys), 5-year-olds (*M*D 5.7 years, *SD*D2.9 months, 12 girls and 12 boys), 6-year-olds (*M*D6.6 years, *SD*D4.1 months, 12 girls and 12 boys), 7-year-olds (*M*D7.5 years, *SD*D3.9 months, 12 girls and 12 boys), and 9-year-olds (*M*D9.4 years, *SD*D4.4 months, 12 girls and 12 boys).

Materials

A total of 32 pseudowords were constructed. Of these, 8 had typically masculine endings, 8 had typically feminine endings, and 16 had unbiased endings. All obeyed the phonotactics of French and began with a consonant. The endings used were *-on*, *-eau*, *-ier*, and *-in* for the masculine endings; *-ine*, *-ette*, *-otte*, and *-elle* for the feminine endings; and *-ige*, *-ale*, *-iste*, *-ique*, *-ire*, *-ole*, and *-ache* for the neutral endings. Most of the pseudowords had been used previously in KarmiloV-Smith's (1979) study. The bias value of each ending was based on the data provided by Tucker and colleagues (1977) and was confirmed by extra

analyses from the Brulex database (Content, Mousty, & Radeau, 1990). The average lengths of words were equated across conditions. They were 8.5 letters for the masculine pseudowords, 9.0 letters for the feminine pseudowords, and 8.4 letters for the neutral pseudowords. The list of pseudowords is given in Appendix A. Two colored drawings of imaginary beings having secondary sexual features were employed.

Procedure

Children were first told a pseudoword without any determiner and then were asked to repeat it. Then the experimenter asked children to indicate the possible gender of the pseudoword. In one condition, the gender decision was made by giving the determiner *un/ une* with the following instruction: *J'ai inventé des nouveaux mots. Voici tanline*. Tu préfèrerais dire un taline* ou une tanline*?* ("I have invented new words. This is tanline. Do you prefer to say a (masculine) tanline or a (feminine) tanline?"). *Un* and *une* were emphasized by the experimenter when addressing the children. The order in which the two possible responses were proposed was counterbalanced across items. In another condition, the gender decision was made by pointing to one of the pictures referring to sexually differentiated imaginary persons. We first made sure that children were able to recognize female/male distinctions in the picture (i.e., the sex of each person depicted in the picture). The instruction was as follows: *Regarde ces deux images. C'est un couple de personnes imaginaires. Montre-moi le garçon et la fille. Ecoute le mot "tanline*." C'est un mot que j'ai inventé. Montre-moi qui pourrait s'appeler "tanline"?* ("Look at these pictures. This is a couple of imaginary beings (Martian-like persons). Show me the girl and show me the boy. Listen to the invented word "tanline." Who would you prefer to call "tanline" between these two imaginary persons?"). Practice items were used to ensure that participants understood the procedure. Each child was presented with the two conditions. The possible eVect of order of presentation was controlled by using the reverse order for half of the participants. Half of the participants were given the determiner condition first, and half were given the picture condition first. The pseudowords were divided into two lists so that each list contained the same number of items of each type of ending (eight pseudowords with neutral endings, four pseudowords with masculine endings, and four pseudowords with feminine endings). Order of response conditions was balanced across the two lists using a Latin square design. The masculine, feminine, and neutral items were randomized in each condition. Each child was tested individually. The duration of the experiment was 30min on average with inclusion of breaks if necessary.

Results

Pseudowords were classified according to their ending bias—masculine, feminine, or neutral. For each participant, the average percentage of responses consistent with the ending bias was computed for feminine and masculine ending bias. For pseudowords with unbiased endings, a gender class (masculine or feminine) was arbitrarily attributed in such a way that half of them were assigned to the masculine gender and the other half were assigned to the feminine gender. Participants' responses were scored according to these arbitrary classes. Consequently, if participants randomly assigned the neutral pseudowords to the two gender classes, the

percentage of ending-consistent responses was 50%, corresponding to the chance level. Performance in this condition was taken as a baseline. Means and standard deviations of ending-consistent responses according to age, response condition (determiner or picture), and type of ending bias (masculine, feminine, or neutral) are given in Table 1. Mean performance for all word endings as a function of response condition can be found in Appendix B. An analysis of variance (ANOVA) was conducted with age level (3, 4, 5, 6, 7, or 9 years) as a between-participant variable and response condition (determiner or picture) and ending bias (masculine, feminine, or neutral) as within-participant variables. Statistical analyses were performed by participants ($F1$) and by items ($F2$). As shown in Table 1, more ending-consistent responses were given to gender-biased pseudowords than to unbiased pseudowords (71.5% for masculine endings, 73.1% for feminine endings, and 52.3% for neutral endings). The effect of ending bias was signiWcant both by participants and by items, $F1(2, 276)D89.01$, $p<.001$, $F2(2, 29)D32.79$, $p<.001$. This effect was modulated by age, as shown by the significant interaction between ending bias and age level, $F1(10, 276)D5.63$, $p<.001$, $F2(10, 145)D4.93$, $p<.001$. The significant interaction between ending bias and age level revealed that the sensitivity to ending bias clearly increased with age. The specific interaction between age level and pseudoword bias (gender-biased collapsed across masculine and feminine vs. unbiased) was significant both by participants and by items, $F1(5, 138)D 8.14$, $p<.001$, $F2(5, 145) D6.85$, $p<.001$. The interaction between ending bias and age level was also explained by the fact that the percentage of ending-consistent responses differed between the masculine and feminine endings. The interaction between age level and gender of pseudoword bias (masculine vs. feminine endings) was significant both by participants and by items, $F1(5,138)D 3.57$, $p < .01$, $F2(5,145)D3.03$, $p < .05$. This effect was due to the fact that younger children (3 and 4 years) made more ending-consistent responses to the feminine pseudowords than to the masculine pseudowords. The difference between the masculine and feminine items was significant at 4 years of age, $F1(1,138)D14.09$, $p<.001$, $F2(1,29)D8.74$, $p<.01$, but not at 3 years of age, $F1(1, 138)D1.67$, $pD.20$, $F2(1, 29)D 2.32$, $p<.14$.

Table 1
Percentages of ending-consistent responses as a function of age, response condition, and pseudoword gender bias

Response condition	Gender-biased endings	Age (years)					
		3	4	5	6	7	9
Determiner	Masculine	57.3 (28.1)	45.8 (27.3)	66.7 (24.1)	75.0 (18.1)	82.3 (17.3)	86.5 (14.7)
	Feminine	62.5 (28.6)	66.7 (22.9)	59.4 (28.4)	74.0 (18.8)	75.0 (20.9)	78.1 (19.9)
	Unbiased endings[a]	47.4 (17.7)	48.4 (18.9)	46.9 (17.4)	50.5 (17.9)	56.8 (19.1)	51.6 (18.9)
Picture	Masculine	51.0 (18.8)	58.3 (21.7)	74.0 (20.2)	86.5 (16.5)	80.2 (20.8)	94.8 (10.4)
	Feminine	57.3 (30.8)	70.8 (24.1)	75.0 (27.6)	83.3 (22.9)	84.4 (20.6)	90.6 (14.4)
	Unbiased endings[a]	51.6 (16.6)	52.6 (15.6)	53.1 (14.9)	56.3 (14.7)	56.8 (16.9)	56.3 (13.8)

Note. Standard deviations are in parentheses.
[a] To compute percentages of ending-consistent responses for unbiased nonwords, we arbitrarily assigned a gender class (masculine or feminine) according to which participants' responses were scored. The corresponding percentages are presented in the table.

One-tailed *t* tests performed on these values revealed that performance was greater than chance for the feminine pseudowords ($p<.05$ at 3 years of age and $p<.001$ at 4 years,of age), but the corresponding values were not significant for the masculine items. As children grew older, they tended to reach equivalent levels of ending-consistent responses for the masculine- and feminine-biased pseudowords (the difference between the masculine and feminine items did not reach significance at any level). The results so far confirm our first hypothesis dealing with the development of sensitivity to word ending. Sensitivity to noun endings could be detected as early as 3 years of age and then increased regularly up to 9 years of age. Sensitivity to endings was found to emerge earlier for the feminine endings than for the masculine endings. The second goal of our study was to assess when and the extent to which the phonological cues carried by the endings could bias a categorization based on semantic features. This question was explored by comparing the two types of response conditions (determiner vs. picture). Table 1 presents the percentages of ending-consistent responses in the two response conditions according to age level and the pseudoword bias (masculine, feminine, or neutral). An ANOVA that included the factors described above revealed an effect of response type that was significant both by participants and by items, $F1(1,138)D14.95$, $p<.001$, $F2(1,29)D5.73$, $p<.05$. In this analysis, no interaction involving this factor was found to be significant. Obviously, any potential effect due to the manipulation of the response condition was examined more properly by restricting the analysis to the biased pseudowords. Indeed, the inclusion of the neutral condition, which led to random performance for both response conditions, might result in underestimating any interaction effect involving response condition. To explore the effect of this factor more precisely, we conducted a new ANOVA that included age level, response condition, and ending bias restricted to the masculine and feminine pseudowords. In this analysis, the main effect of response type was significant both by participants and by items, $F1(1,138)D11.75$, $p<.001$, $F2(1,14)D12.27$, $p<.01$. More endingconsistent responses were given when pictures were used than when orally spoken determiners were used (75.5 vs. 69.1%). The interaction between response type and age was close to significance, $F1(5,138)D2.05$, $pD.075$, $F2(5,70)D2.14$, $pD.071$. This interaction is depicted in Fig. 1. As shown in Fig. 1, the higher sensitivity to endings exhibited in the picture condition was observed from 4 to 9 years of age. The only departure from this proWle was observed at 3 years of age. To analyze this eVect more precisely, we conducted a new analysis that included response condition, bias of pseudoword, and age level restricted to 3 and 4 years of age. Fig. 2 shows the percentages of ending-consistent responses as a function of response condition and pseudoword bias (masculine vs. feminine) for 3- and 4-year-olds. Two significant effects emerged. The main effect of gender bias was significant both by participants and by items, $F1(1,46)D8.15$, $p<.01$, $F2(1,14)D13.27$, $p<.01$. As described previously, this effect revealed a higher percentage of consistent responses to feminine pseudowords (64.3%) than to masculine pseudowords (53.1%). The interaction between response type and age level was significant only by participants, $F1(1,46)D4.56$, $p<.05$, $F2(1,14)D3.28$, $pD.09$. In addition, 3-year-olds tended to make more ending-consistent responses when responses consisted in giving a determiner, whereas 4-year-olds gave more consistent responses when using the picture

condition. One-tailed *t* tests performed on these data revealed that at 3 years of age performance was greater than chance only for the feminine pseudowords in the determiner condition ($p<.05$). At 4years of age, percentages were significant for both the masculine and feminine pseudowords in the picture condition ($p<.05$ for the masculine pseudowords and $p<.001$ for the feminine pseudowords), whereas only the feminine pseudowords resulted in above-chance results in the determiner condition ($p<.001$).
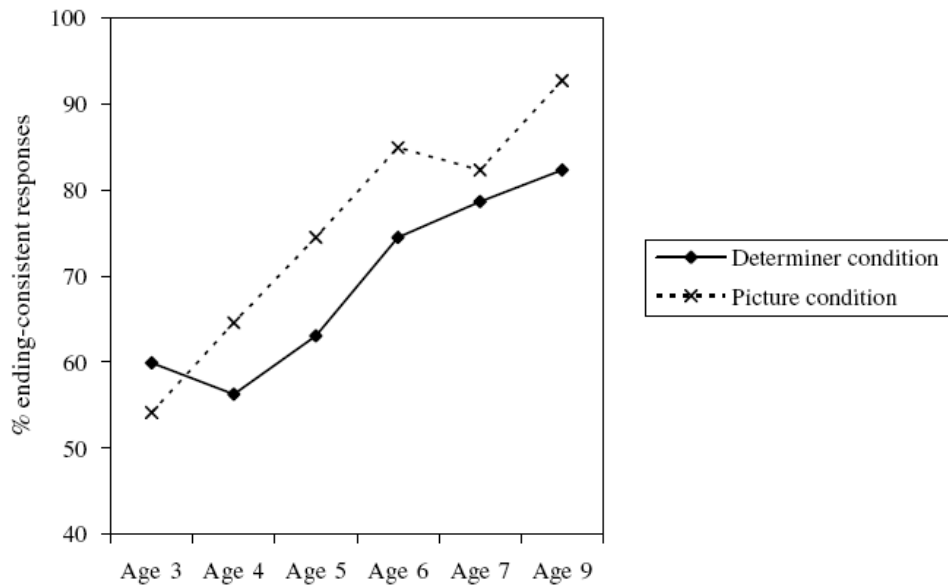

Fig. 1. Percentages of ending-consistent responses for biased pseudowords as a function of response condition and age.
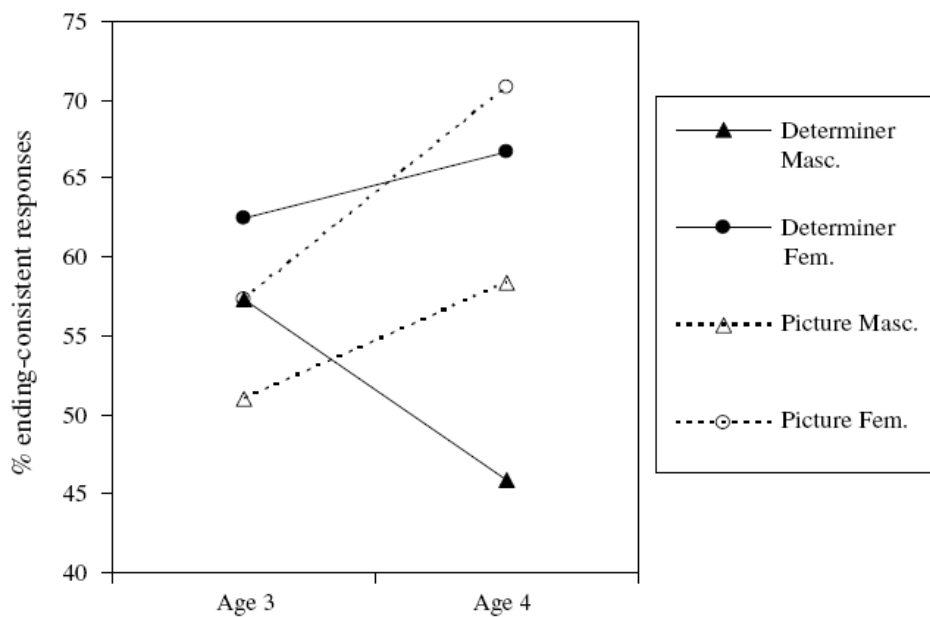

Fig. 2. Percentages of ending-consistent responses as a function of gender bias and response condition at 3 and 4 years of age. Masc., masculine; Fem., feminine.

Discussion

Our study aimed specifically to examine the sensitivity to noun endings of French-speaking 3- to 9-year-olds. The first goal was to describe the acquisition of the quasi-regular system of noun endings in French. Using a gender categorization task with invented nouns, we have clearly shown an increase in ending-consistent performance from 3 to 9 years of age. Higher percentages of ending-consistent responses were given as children grew older, with the youngest group exhibiting performance greater than chance. Another goal of this study was to explore whether the system of phonological gender cues could influence categorization implying semantic features. In other words, we tested Sera and colleagues' (2002) hypothesis that grammatical gender can affect cognition. In the determiner condition, responses relied solely on intralinguistic information as they consisted in associating a phonological cue carried by the ending and a syntactic cue provided by the determiner. In the picture condition, responses required children to associate phonological cues to figures according to their perceptual natural gender. Our results show that phonological cues constitute powerful biases that affect categorization. Masculine endings led to selecting a male picture, and feminine endings led to selecting a female picture. This effect tended to increase with age. Its onset was observed at 4 years of age—at least 1 year after the sensitivity to noun endings could be detected. What can be concluded from our results is that as young as 4years, children have acquired a probabilistic system of phonological gender cues that is intimately connected to semantic cues. Our study was motivated by the fact that no systematic study had been carried out on the acquisition of sensitivity to gender-ending cues by young French-speaking children.

This phenomenon, however, could enlighten researchers on some fundamental mechanisms of language acquisition. The only available reference was KarmiloV-Smith's (1979) study that raised several questions. The major concern dealt with the paradigm that was used, which confounded assessment of gender assignment and gender agreement. Our task was devised to selectively measure the ability to classify items irrespective of agreement abilities. Our results showed that this task was particularly appropriate. Developmental effects were observed throughout the age range. An important advantage of this task was that masculine or feminine answers made comparable demands, whereas a gender agreement paradigm made a heavier demand for a feminine response concord that required adding a suffix to the masculine form. One of the results observed in KarmiloV-Smith's study was that percentages of consistent responses were lower for the feminine phonological cues, particularly for 9-year-olds. This effect could be due to a strategic adaptation to the task by favoring masculine answers that reduced task demand. We did not replicate this tendency using a categorization task. On the contrary, our results showed that more ending-consistent responses were given with feminine-ending pseudowords for the youngest groups, suggesting that feminine cues were potentially more powerful clues to gender. The gender categorization task also allowed us to detect interaction between language and cognition at an early age. Using a "voices" task, Sera and colleagues (2002) found that grammatical gender influenced categorization at 7 years of age. In our study, phonological cues affected picture classification from 4 years of age. Thus, as suspected by Sera and colleagues, these subtle eVects emerged at an earlier point during language acquisition. What our results also suggest is that the onset of this effect is delayed compared with the sensitivity to phonological cues. The 3-year-olds were able to provide the

gender of a determiner on the basis of the phonological clues at a greater than chance level. However, they were not able to use this knowledge to associate corresponding semantic features. As suggested by Sera and colleagues, a time lag of at least 1 year between grammatical gender acquisition and its observed influence on cognition seems to be necessary. Our results raise two types of questions. First, what are the mechanisms responsible for the developmental increase of sensitivity to gender endings? A second issue concerns the nature of the gender representation that is acquired. We address these two questions in turn. A major result of our study was the developmental increase of sensitivity to gender endings in French-speaking children from 3 to 9years of age. What kind of learning mechanism can explain this developmental trajectory? This question deals more specifically with the acquisition of gender information in French. To learn grammatical gender for a word, several kinds of information are available. One source of gender cues is provided by the words syntactically related to the noun. The most ubiquitous is the article. Two other sources of gender information are carried by the nouns themselves. One is sublexical, coming from gender-typical endings. The other is semantic, coming from natural gender. Most theories concerned with the acquisition of grammatical categories have given a central role to the learning of correlated grammatical markers (Braine, 1987; Carroll, 1989, 1995; KarmiloV-Smith, 1979; Tucker et al., 1977). Learning grammatical gender categories can be described as a distributional analysis that involves computing cooccurrences of linguistic classes and markers (Braine, 1987). To induce gender category, Braine (1987) emphasized the role of phonological or semantic cues on the nouns. The role of these markers would be to draw attention to the correlated grammatical morphemes and to guide the learner in the induction of linguistic gender (for corroborative results using artificial language, see Taraban, 2004). In this framework, the role given to the phonological cues could explain the sensitivity to noun endings that was revealed in our study. The process by which the goal of these markers is achieved can be described as statistical learning. This form of acquisition is compatible with recent research carried out to explore the learning mechanisms underlying the beginning of language learning (SaVran, 2001). This process involves detecting linguistic units by tracking patterns of sounds in the input. Results strongly suggest that infants are able to detect the sequential probabilities that characterize auditory sequences. So far as the acquisition of grammatical gender is concerned, the description of this multiple-cue linguistic system reveals a number of dependency relations between phonological or semantic cues on the nouns and subsets of grammatical morphemes. Gender acquisition is an example of skills we learn through experience that can be characterized by sets of complex rules concerning sequences of events. Connectionism is able to address learning sequential structure. Connectionist models have been used to simulate ways in which sensitivity to word endings might arise through language exposure. Neural network models are particularly suitable to simulate learning of quasi-regular systems of linguistic associations with regularities and exceptions such as the relations between word endings and gender. In the German language, which has a grammatical gender system comparable to that in French, MacWhinney, Leinbach, Taraban, and McDonald (1989) showed that a network could be trained to correctly assign the appropriate article to German nouns on the basis of semantic, morphological, and phonological cues. Sokolik and Smith (1992) applied a connectionist model to a corpus of 450 French nouns whose orthographic structure served as inputs. After a training period, the model could accurately assign the correct articles of both used and unstudied nouns with a high degree of

reliability. This was accomplished in the absence of explicit rules by relying solely on information inherent in the structure of nouns. Several factors may be responsible for the developmental increase observed in our study. The relevance of noun ending cues clearly would increase as a child's vocabulary expands, resulting in more opportunities to note regularities across words. The efficiency in detecting and using these relations may also depend critically on the processing capacity to access all of the elements involved in the relation. Increased processing efficiency or a greater amount of available cognitive resources may contribute to the developmental increase of sensitivity to gender ending. Processing limitations may constrain not only length but also the ability to relate constituents or propositions to each other (Santelmann & Jusczyk, 1998). The exploration of the exact factors and their respective weights in the development of sensitivity to gender cues may constitute a challenging issue for further studies. The other important result of our study was observed by varying response condition. More ending-consistent responses were given in the picture condition than in the determiner condition. The age at which the eVect clearly emerged was 4years. When presented with a nonword with a gender-typical ending, children would activate a gender representation that incorporates association with semantic features. This process may potentially be mediated by the retrieval of a syntactic grammatical marker. This result suggests that by as early as 4years of age, a complex multiple-cue linguistic system is acquired. This could reflect the fact that both markers carried by the nouns themselves, phonological and semantic cues, may contribute conjointly to gender category induction (Braine, 1987). Our results are compatible with the view postulating that there exists an interaction between linguistic and semantic gender cues during language acquisition. Our data are not sufficient to validate a semantic theory of gender acquisition positing that grammatical gender induction stems from a distinction between the two natural genders. However, the result showing a tendency for higher percentages of ending-consistent responses in the determiner condition compared with the picture condition for 3-year-olds may indicate that this is not the case. The result demonstrating greater percentages of ending-consistent responses in the picture condition was not expected. The picture condition and the determiner condition differed on several dimensions that could explain the advantage observed in the picture condition. One of them is the language skills involved in both conditions. The picture condition can be described as a receptive task that required children to point to one figure. In contrast, the determiner condition can be seen as a production task that required children to produce a word orally. It has often been argued that some language functions can be present receptively without being present expressively. That is explained by the fact that in most cases children first acquire a receptive form before using an expressive form (Keenan & Mac- Whinney, 1987). Thus, this difference between tasks may partially explain differences in performance favoring the picture condition. However, it can be observed that the determiner task involved a very low level of expressive skills given that children needed only to "point orally" to a spoken determiner. Stronger weight of expressive skills would have been given to performance if an entire noun phrase with a grammatical agreement had been required. Another difference between the two response conditions is the level of attractiveness that the task may have. In the picture condition, children were introduced to imaginary persons that needed to be named. This condition may have sounded more attractive to the children. Consequently, they may have allocated more attention to this condition. Both types of arguments emphasizing differences between tasks potentially contribute to the explanation of

the higher ending sensitivity observed in the picture condition compared with the determiner condition. However, the performance of the youngest children who performed better on the determiner condition remains to be explained. One interpretation is that only the linguistic system would be eVective at that age and that a certain amount of time would be necessary for linguistic gender cues to inXuence categorization by associating corresponding semantic features. Future work will need to explore this issue more deeply. One of our results was that endings were not equally able to bias responses. More precisely, in the determiner condition, the feminine endings were the earliest cues to be taken into account by the youngest children. This result may be important to furtherexplore the way in which grammatical gender acquisition takes place. A final comment can be added concerning the response conditions. The advantage of the picture condition from a certain stage during acquisition leads to a methodological recommendation for further studies with young children. Using a picture condition instead of a classical determiner condition is more likely to reveal the ability to take phonological gender cues into account. Similar developmental trajectories from 4 to 9 years of age suggest that similar underlying mechanisms are implied. To conclude, it must be kept in mind that showing an influence of word endings in gender attribution to words or nonwords does not imply that this type of information plays a major role in gender retrieval during "normal" comprehension. Several results indicate that the role of word endings would be only subsidiary compared with the lexical information associated with the representation of the nouns, such as the articles, and would depend on the task requirement (Holmes & Dejean de la Bâtie, 1999; Holmes & Segui, 2004; Taft & Meunier, 1998). Several findings suggest that adults' performance on gender assignment relies on a general lexical expertise involving the rapid retrieval of lexical associations in which gender-ending correspondences would have only a secondary impact. Our study, rather, points to an implicit acquisition in natural language whose goal ultimately was to contribute to better understanding how natural language learning works.

Acknowledgment

Appendix A

List of pseudowords

Pseudowords with neutral endings	Pseudowords with masculine endings	Pseudowords with feminine endings
Chonlige	Pliquachon	Tamunine
Gounale	Bloukeau	Viramette
Birguiste	Nousatier	Rodaisotte
Fradique	Forzin	Possidelle
Liavrole	Vadanguier	Tanline
Rachire	Bilacron	Sinourette
Zulole	Golcheau	Braivotte
Vouchiste	Savouguin	Maudrelle
Baratole		
Spadique		
Brounale		
Couvirache		
Raplichole		
Lénousale		
Blanochiste		
Bicatique		

Note. The actual spellings of the items are irrelevant given that they were presented orally.

Percentages of ending-consistent responses as a function of response condition and word endings within each category of pseudowords

Ending bias	Ending	Response condition				Mean	
		Determiner		Picture			
Unbiased[a]	-ige	44.9	44.9	56.5	56.5	50.7	50.7
	-ale	49.8	50.2	36.5	63.5	43.1	56.8
	-iste	52.5	44.1	63.4	58.5	57.9	51.3
	-ole	52.9	48.7	57.2	52.8	55.0	50.7
	-ire	49.6	49.6	58.0	58.0	53.8	53.8
	-ique	45.3	45.3	66.4	66.4	55.8	55.8
	-ache	52.5	47.5	33.3	66.7	42.9	57.1
Masculine	-on	70.8		73.4		72.1	
	-eau	67.2		83.2		75.2	
	-ier	66.3		63.9		65.1	
	-in	69.5		76.4		72.9	
		78.6		80.3		79.4	
Feminine	-ine	73.7		84.4		79.0	
	-ette	61.7		64.3		63.0	
	-otte	66.1		79.3		72.7	
	-elle						

[a] For the unbiased pseudowords, two percentages are given for each ending corresponding to two scoring procedures. The first value was obtained by randomly assigning a gender class to the pseudowords. The second value...

References

Braine, M. (1987). What is learned in acquiring word classes: A step toward an acquisition theory. In B. Mac- Whinney (Ed.), *Mechanisms of language acquisition* (pp. 65–87). Hillsdale, NJ: Lawrence Erlbaum.

Carroll, S. (1989). Second-language acquisition and the computational paradigm. *Language Learning, 39*, 535–594.

Carroll, S. (1995). The hidden dangers of computer modelling: Remarks on Sokolik and Smith's connectionist learning model of French gender. *Second Language Research, 11*, 193–205.

Clahsen, H., & Almazan, M. (1998). Syntax and morphology in Williams syndrome. *Cognition, 68*, 167–198.

Clark, E. V. (1985). The acquisition of romance, with special reference to French. In *The cross-linguistic study of language acquisition* (pp. 687–782). Hillsdale, NJ: Lawrence Erlbaum.

Content, A., Mousty, P., & Radeau, M. (1990). Brulex: Une base de données lexicales informatisée pour le français écrit et parlé. *L' Année Psychologique, 90*, 551–556.

Desrochers, A., & Brabant, M. (1995). Interaction entre facteurs phonologiques et sémantiques dans une épreuve de catégorisation lexicale. *Revue Canadienne de Psychologie Expérimentale, 49*, 240–262.

Desrochers, A., Paivio, A., & Desrochers, S. (1989). L'effet de la fréquence d'usage des noms inanimés et de la valeur prédictive de leur terminaison sur l'identification du genre. *Revue Canadienne de Psychologie, 43*, 62–73.

Holmes, V. M., & Dejean de la Bâtie, B. (1999). Assignment of grammatical gender by native speakers and foreign learners of French. *Applied Psycholinguistics, 20*, 479–506.

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

KarmiloV-Smith, A. (1979). *A functional approach to child language: A study of determiners and reference*. Cambridge, UK: Cambridge University Press.

Keenan, J., & MacWhinney, B. (1987). Understanding the relation between comprehension and production. In H. W. Dechert & M. Raupach (Eds.), *Psycholinguistic models of production* (pp. 149–156). Norwood, NJ: Ablex.

MacWhinney, B., Leinbach, J., Taraban, R., & McDonald, J. (1989). Language learning: Cues or rules? *Journal of Memory and Language, 28*, 255–277.

Monnery, S., Seigneuric, A., Zagar, D., & Robichon, F. (2002). A linguistic dissociation in Williams syndrome: Good at gender agreement but poor at lexical retrieval. *Reading and Writing, 15*, 589–612.

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

Saffran, J. R. (2001). Words in a sea of sounds: The output of infant statistical learning. *Cognition, 81*, 149–169.

Santelmann, L. M., & Jusczyk, P. W. (1998). Sensitivity to discontinuous dependencies in language learners: Evidence for limitations in processing space. *Cognition, 69*, 105–134.

Séguin, H. (1969). Les marques du genre dans le lexique français écrit et contemporain: Compilation des cas et essai de classement. Mémoire de DES, Département de Linguistique, Université de Montréal, Québec.

Sera, M. D., ElieV, C., Forbes, J., Burch, M. C., Rodriguez, W., & Dubois, D. P. (2002). When language affects cognition and when it does not: An analysis of grammatical gender and classification. *Journal of Experimental Psychology: General, 131*, 377–397.

Sokolik, M. E., & Smith, M. E. (1992). Assignment of gender to French nouns in primary and secondary language: A connectionist model. *Second Language Research, 8*, 39–58.

Taft, M., & Meunier, F. (1998). Lexical representation of gender: A quasiregular domain. *Journal of Psycholinguistic Research, 27*, 23–45.

Taraban, R. (2004). Drawing learners' attention to syntactic context aids gender-like category induction. *Journal of Memory and Language, 51*, 202–216.

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

Tucker, G. R., Lambert, W. E., Rigault, A. A., & Segalowitz, N. (1968). A psychological investigation of French speakers' skill with grammatical gender. *Journal of Verbal Learning and Verbal Behavior, 7*, 312–316.