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The morpheme gender effect

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Abstract

In three experiments we explored the mental representation of morphologically complex words in French. Subjects were asked to perform a gender decision task on morphologically complex words that were of the same gender as their base or not. We found that gender decisions were made more slowly for morphologically complex words made from a base with an opposite gender compared to words for which the gender of the base matches that of the derived noun. Similar results were obtained for words that are pseudo-morphologically complex while no effect was observed for non-morphological embedded words. Our results suggest that during gender identification of derived and pseudo-derived words, morpheme and pseudo-morpheme lexical representations are activated, as well as their gender information. Also our results suggest that the noun ending predictability effect observed in previous experiments could in fact reflect decomposition into morphemes.

Keywords: Lexical access; Morphology; Grammatical gender

The purpose of this study is twofold: first, we aimed to provide information about the lexical processing and representation of morphologically complex nouns in French by using a gender decision task and second, we aimed to look at gender activation during word identification. These issues are addressed by exploring the gender assignment of derivationally suffixed French nouns whose bases have a gender opposite to that of the noun.

The way morphologically complex words are stored and accessed has been widely studied. Several models have been proposed, which make claims about the processing of complex words and the kind of representation that is accessed. It is now well established that base-morphemes are activated during morphologically complex word identification. The current debate concerns the timing of activation and the implication of full-word and morpheme representations for identification.

Recent theoretical proposals include a specific morphemic level of representation that is distinct from the lexical level that features the whole-word representations; these two levels being bidirectionally linked. In these models, the morphemic level is conceived as being either prelexical or supralexical. The prelexical hypothesis postulated that a word like *fatalism* is decomposed into *fatal* and *-ism* prior to the activation of its full lexical representation (Colé, Segui, & Taft, 1997; Taft, 1994, 2003), while the supralexical hypothesis postulated that the whole-word representation of *fatalism* is acti-

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vated first, followed by the activation of the morphemic units *fatal-* and *-ism* (Giraudo & Grainger, 2001, 2003). Beside these models that postulate a successive activation of morphemes and whole-word representations (and vice versa), some authors have hypothesized that these representations could be accessed in parallel (Caramazza, Laudanna, & Romani, 1988; Frauenfelder & Schreuder, 1992; Schreuder & Baayen, 1995). Following these latter type of models, two routes can lead to morphologically complex word identification: a direct route that makes use of whole-word representations, and a decompositional route that goes through morphemic units. Linguistic and distributional properties of words, such as frequency, formal and semantic transparency, morpheme productivity and lexicality determine which of these routes leads to identification (see Schreuder & Baayen, 1995).

Recently, the investigation of the visual identification of morphologically complex words took one more step forward with the repeated demonstration that prelexical decomposition was achieved on every letter string that could be fully parsed into existing morphemes, including real derived words like *gardener*, pseudo-derived words like *corner*, or derived pseudo-words like *quickify*. This early morpheme activation has been shown by several authors and in different languages by running visual masked priming experiments with a 47 ms prime duration (see Forster & Davis, 1984). Facilitation effects on the (pseudo-)base are observed whenever the prime is morphologically decomposable at the surface level. For instance in French and in English, both derived words like *departure* and pseudo-derived words like *brother* primed their (pseudo-)base *depart* and *broth*. The word *brother* accidentally contains the base *broth* and the suffix *-er*, but is neither etymologically nor semantically related to its pseudo-base. By contrast, words containing an embedded pseudo-base but no suffix, such as *brothel* (*-el* is not a suffix in English), do not prime their embedded words, in this case *broth* (see also Diependaele, Sandra, & Grainger, 2005; Longtin, Segui, & Hallé, 2003; Rastle & Davis, 2003; Rastle, Davis, Marslen-Wilson, & Tyler, 2000; Rastle, Davis, & New, 2004).

It remains to identify the morpheme properties that are activated through the decomposition process. A morpheme property that has attracted a lot of interest is frequency as it has been used as an evidence of decomposition. Different types of frequency measures can characterize morphologically complex words: surface frequency, cumulative frequency and base frequency, for example. The surface frequency of a word form refers to the word's frequency of occurrence in language as a free lexical item, i.e., the token frequency (e.g., the word *florist*). The cumulative frequency, also called family frequency, refers to the sum of the frequency of the base plus all its affixed forms (*florist* + *flower* + (*to*) *flower* + *floral* + (*to*) *deflower*...). The base frequency is equal to the sum of the frequencies of all inflections of a word (e.g., for an English noun, it is the sum of the singular and the plural word forms). The general idea is that effects of surface, cumulative and base frequencies can reveal the work of whole-word and decomposition procedures. Several authors have shown that the recognition time for most polymorphemic words, such as suffixed words, is generally sensitive to surface, base and cumulative frequencies (for more details see Baayen, Dijkstra, & Schreuder, 1997; Bertram, Schreuder, & Baayen, 2000; Colé, Beauvillain, & Segui, 1989; Meunier & Segui, 1999; New, Brysbaert, Segui, Ferrand, & Rastle, 2004). The presence of base and cumulative frequency effects for suffixed words has been taken as an evidence of decomposition, showing that access to their lexical representations takes place via the representation of the base. Using a multiple regression approach, Wurm (2000) put the light on various factors related to lexical decision times and gating performance (such as prefix frequency, judged prefixedness, semantic transparency, and prefix likelihood), demonstrating involvement of decompositional procedures. In the experiments presented in this paper we looked at a property of morphemes that has not been exploited previously: morpheme gender.

French is a language in which nouns are classified into two genders: each noun is either feminine (such as *lune* "moon") or masculine (such as *soleil* "sun"). Gender systems are language-specific. For example, in English the assignment of nouns to gender classes is restrained to the animate nouns as revealed in phenomena such as anaphoric pronouns like in "Molly and Thomas played all day. She said he was tireless". Across languages, the gender categorization of the animate nouns is mostly semantic, as nouns referring to males are generally masculine and nouns referring to females generally feminine, for example *le garçon* "the$_{\text{masculine}}$ boy" and *la fille* "the$_{\text{feminine}}$ girl". In French, only 10.5% of nouns have a grammatical gender that is semantically motivated. For languages such as French or Italian, in which inanimate nouns are also assigned to a masculine or feminine gender, speakers have to learn the arbitrary assignment of gender by heart. Indeed words with very similar meaning can have different gender. For example, in French, the noun *revue* "magazine, journal" is feminine, while *magazine* "magazine" is masculine, and similarly, *tasse* "cup" is feminine, but *bol* "bowl" is masculine. It also happens that changing the gender of a word changes its meaning, as for *le mémoire* "memoir" and *la mémoire* "memory", however these cases are very rare. For inanimate nouns, the assignment of a gender category seems not based on any general rule. French gender as in many other languages, is a property described as showing no sign of any systematicity, and generative linguists have often

described gender as a lexical property which has to be learned.

Gender is not widely explored and has never been taken into account in morphological centered studies. However, in languages where a gender grammatical system exits, such as French, it could provide a fruitful paradigm to explore morpheme activation.

Two general questions have been addressed regarding gender processing during comprehension: a first issue that we will not develop in this article concerns the syntactic function of gender and explores the gender processing involved in gender agreement. In languages that have grammatical gender, words modifying nouns, such as articles or adjectives are marked depending on the gender of the noun. Most studies have explored this point using primarily priming paradigm to test effects of grammatical congruency or incongruency (e.g. between a noun and an adjective or article). Overall most studies provide evidence for an influence of a gender-marked context on the activation of lexical candidates and reveal that access to grammatical gender is automatically triggered by a grammatical prime marked for gender whereas the task itself does not require such processing, such as in a primed lexical decision task (Bates, Devescovi, Hernandez, & Pizzamiglio, 1996; Colé & Segui, 1994; Grosjean, Dommergues, Cornu, Guillelmon, & Besson, 1994; Holmes & Segui, 2004; Spinelli & Alario, 2002; Taft & Meunier, 1998; see however Spinelli, Meunier, & Seigneuric, 2006).

The second interest of gender in comprehension is how it is lexically represented and accessed during word recognition. Using gender decision tasks or grammaticality judgments, several studies have highlighted the role of two types of cues to retrieve grammatical gender, i.e., sublexical and lexical cues (Holmes & Segui, 2004; Taft & Meunier, 1998). Sublexical cues derive from the fact that the endings of many nouns in French are associated more often with one gender than the other. For example, all nouns ending in *-isme* are masculine (e.g., *cynisme* "cynicism"), whereas all nouns ending in *-esse* are feminine (e.g., *sagesse* "wisdom"). Other endings have a strong but not perfect association with one gender, for example *domaine* "domain" is one of the few masculine words ending in *-aine*. Some endings are associated with both genders, for example, nouns ending in *-ique* are feminine about 60% of the time. Lexical cues come from the other words with which the noun co-occurs systematically and which mark gender unambiguously. The most ubiquitous of these are the indefinite articles $un_{masculine}$ and $une_{feminine}$ "a, an". Other less frequently occurring form classes such as adjectives and pronouns would also play some role. Globally the empirical results show that classification of nouns leads to longer response times when both sublexical and lexical cues are uninformative than when one or both cues are informative about gender.

In our experiments we tested whether the gender of morphologically complex words derived from a base with an opposite gender is more slowly retrieved compared to a condition where the gender of the base matches that of the derived noun. Such results would suggest that during morphologically complex word decomposition, the base is activated enough to activate its gender. This rationale is close to the one used by Schreuder, Neijt, van der Weide, and Baayen (1998) who asked participants to make a number decision in order to see if Dutch compound linking sequences that were homographic and homophonic to affixes were activating the affixes and their meanings. We used the same rationale with morpheme gender.

In the first experiment we compared pairs of derived words matched on suffix, frequency and length. For one member of the pair the base had the same gender as the derived word such as $maison\text{-}ette_{feminine}$ "small house" (base: $maison_{feminine}$ "house") while for the other, genders were opposite such as $camionette_{feminine}$ "small truck" (base: $camion_{masculine}$ "truck"). In the second experiment we compared pairs of derived words sharing the same base but having two different genders such as $chemisier_{masculine}$ "long-sleeved shirt" and $chemisette_{feminine}$ "short-sleeved shirt" (base: $chemise_{feminine}$ "shirt"). The third experiment was designed to assess whether the effects were due to decomposition *per se* or if orthographic overlap could explain these effects.

Experiment 1

In the first experiment, we investigated whether morphologically complex words are decomposed during a gender identification task. In order to assess decomposition in word access, we used a visual gender decision task. We presented nouns to the participants and they had to decide whether they were feminine or masculine. The main factor manipulated was the congruency between the gender of the base from which the complex word was derived and the gender of the morphologically complex word itself. If gender decision is affected by the gender of the base-morpheme this would imply that morphologically complex words are decomposed into morphemes and that their gender is activated.

Methods

Participants

Twenty-one students of the University Pierre Mendes France (Grenoble), participated in the experiment for course credit. All participants were native speakers of French and had normal or corrected vision.

Stimuli

Thirty pairs of morphological complex suffixed words were selected such that both members of the pairs were of the same gender (*maisonette*$_{\text{feminine}}$ "small house"–*camionnette*$_{\text{feminine}}$ "small truck") but one member of the pair was derived from a masculine word: e.g., *camion*$_{\text{masculine}}$ "truck" in *camionette* and the other member of the pair was derived from a feminine word: e.g., *maison*$_{\text{feminine}}$ "house" in *maisonette* (see Appendixes A and D). There were 16 feminine word pairs (e.g., *maisonette*$_{\text{feminine}}$–*camionette*$_{\text{feminine}}$), and 14 masculine word pairs (e.g. *poivrier*$_{\text{masculine}}$ "pepper mill"–*cendrier*$_{\text{masculine}}$ "ash tray") individually matched in type of suffix, surface frequency (1.3 vs 2.5 occurrences per million, $t(29) = 1.7$, n.s.), number of syllables (2.5 vs 2.6, $t < 1$) and number of letters (8.3 vs 8.2, $t < 1$). Half of the suffixed words were gender congruent with their base (gender congruent condition) and the other half were gender incongruent with their base (gender incongruent condition). Sixty filler words (28 feminine and 32 masculine words) were also included in the experimental list. Hence, there were equal numbers of feminine and masculine words in the experiment.

Procedure

Participants were tested individually in a quiet room. Stimuli were displayed at the center of a computer screen and participants were required to perform a gender decision task on the visual targets by pressing as accurately and as quickly as possible one of two response buttons. Half of the subjects were required to press the "feminine" button with their left forefinger and the "masculine" button with their right forefinger. It was the reverse for the other half of the subjects. The experiment was controlled by E-prime Software (E-prime Psychology Software Tools Inc.; Pittsburgh, USA). The computer clock was triggered by the presentation of the target on the screen and stopped by the subjects' response. Response latencies and errors were collected. The session began with 10 practice trials; then the 120 items were presented in a randomized order for each participant. The session lasted approximately 10 min.

Results and discussion

Incorrect responses (3% of responses), and RTs longer than 1500 ms (0.4%) were removed. Here and in the following analyses, reaction times were logarithmically transformed in order to normalize their distribution. We ran a mixed-effect analysis (see Baayen, 2007) on the data, with log reaction times as the dependent variable, Participants and Items as random variables and Congruency (congruent vs incongruent) as a fixed effect. Mean RTs and mean error rates are presented in Table 1.

RTs data showed faster response times in the gender congruent condition than in the gender incongruent condition. This effect of 37 ms (95% CI = 11.56) is significant ($F(1, 57.392) = 8.260$, $p < .01$). Analyses conducted on errors showed a trend for the gender congruency effect ($F(1, 58) = 3.004$, $p = .09$) with fewer errors in the gender congruent condition (1.1%) than in the gender incongruent condition (1.9%).

Table 1
Average RT (ms) and error rates by gender congruency condition (standard deviations in brackets) for each experiment

	Congruent	Incongruent	Effect
Experiment 1			
maisonette–camionnette	655 (93)	693 (111)	38**
	1.1%	1.9%	0.8
Experiment 2			
chemisette–chemisier	696 (86)	727 (106)	31*
	1.1%	3.4%	2.3*
Experiment 3			
auberge–seringue	716 (91)	720 (76)	4
	1.4%	1.6%	0.2
vignette–chouette	666 (66)	709 (82)	43*
	0.5%	0.3%	−0.2

* Indicates significance at the 0.05 level.
** Indicates significance at the 0.01.

These results suggest that morphologically complex words are decomposed into their constituent morphemes during identification and that their morpheme genders are activated. However, as mentioned in the introduction for morphologically complex words, two types of frequency estimates are relevant, surface frequency and cumulative frequency. In our experiment, words in each pair were matched on surface frequency but not on cumulative frequency. Looking at the cumulative frequency of each group, it happened that words in the gender congruent condition have an average cumulative frequency of 79 per million and the incongruent one, 91. However, the difference between the log of the two values is not significant ($t < 1$).

Another factor that we also checked for a potential effect was the frequency of the base itself. Indeed it could be that higher frequency bases are more easily extracted from derived words than low frequency ones. Words in the gender congruent condition have on average a base frequency of 2 per million and the incongruent ones, 38; the difference between the group means of the logarithmically transformed frequencies of words in the two congruency conditions is significant ($t(29) = 8.743$; $p < .0001$). As indeed most bases in the congruent condition had a lower frequency than the ones in the incongruent one, we reran analyses including the log of the frequency of the base as a covariate. We observed that the Congruency effect was still significant ($F(1, 57.365) = 7.672$, $p < .05$, 95% CI = 18.83), while the Frequency effect and the interaction between the two factors were not significant (Fs < 1).

A more direct way to control for an effect of the cumulative frequency and the base frequency is to com-

pare words belonging to the same morphological family and sharing the same base. This was the rationale of the second experiment using pairs of words sharing the same base, hence having the same cumulative frequency and base frequency, in which one was masculine and the other feminine, e.g., *chemisier* "long-sleeved shirt"/ *chemisette* "short-sleeved shirt", both derived from the same base *chemise*.

Experiment 2

Methods

Participants

Thirty students of the University Pierre Mendes France (Grenoble) and University Lumière (Lyon), participated in the experiment for course credit. All participants were native speakers of French and had corrected to normal vision. None of them had participated in Experiment 1.

Stimuli

Nineteen pairs of morphological complex suffixed words were selected such that both members of the pairs were derived from the same base (e.g. $chemisette_{\text{feminine}}$–$chemisier_{\text{masculine}}$ both derived from $chemise_{\text{feminine}}$ "shirt") but one member of the pair was masculine and the other member was feminine (see Appendixes B and D). There were 10 word pairs derived from a feminine base (e.g. $chemisette_{\text{feminine}}$–$chemisier_{\text{masculine}}$), and 9 word pairs derived from a masculine base (e.g. $citronnade_{\text{feminine}}$ "lemonade"–$citronnier_{\text{masculine}}$ "lemon tree" both derived from $citron_{\text{masculine}}$ "lemon"). The pairs were individually matched in surface frequency (1.7 vs 3.4 occurrences per million, $t < 1$), number of letters (8.5 vs 7.9, $t(18) = 1.5$, n.s.) and number of syllables (2.4 vs 2.3, $t < 1$). As in Experiment 1, half of the suffixed words were gender congruent with their base (gender congruent condition) and the other half were gender incongruent with their base (gender incongruent condition). Thirty-eight filler words (19 feminine and 19 masculine words) were also included in the experimental list. Hence, there were equal numbers of feminine and masculine words in the experiment.

Procedure

The procedure was the same as the one used in Experiment 1. However, as words in each pair shared the same base, in order to avoid short lag priming between the two members of the pairs, the stimuli were divided into two blocks so that the two members of one pair did not appear in the same block. Participants were presented to both blocks and the order of block presentation was counterbalanced.

Results and discussion

Incorrect responses (4.6% of responses), and RTs longer than 1500 ms (1.1%) were removed. We ran a mixed-effect analysis on the data, with log reaction times as the dependent variable, Participants and Items as random variables and Congruency (congruent vs incongruent) as a fixed effect. Mean RTs and mean error rates are presented in Table 1.

The analysis of the reaction times showed faster response times in the gender congruent condition than in the gender incongruent condition. This effect of 31 ms (95% CI = 19.84) is significant ($F(1, 35.901) = 6.495$, $p < .05$). Analyses conducted on errors showed a significant effect of gender congruency ($F(1, 36) = 5.467$, $p < .05$) with fewer errors in the gender congruent condition (1.1%) than in the gender incongruent condition (3.4%).

These results corroborate those found in Experiment 1. They suggest that morphologically complex words are decomposed into their constituent morphemes during identification and that the gender of the base morpheme is activated.

An issue that needs to be checked in this experiment concerns the relationship between gender consistency and semantic relations between the derived words and their base. Within a morphological family, individual family members vary in semantic transparency, i.e., the extent to which their meaning is related to the meaning of their base. For example, the meaning of *allow* is more transparent in the meaning of *allowable* than in the meaning of *allowance*, as another example *sweaty* is more close in meaning to *sweat* than *sweater* is. In recent years, the effect of semantic transparency on morphological facilitation has been a focus of interest (Feldman & Pastizzo, 2003; Feldman & Soltano, 1999; Feldman, Soltano, Pastizzo, & Francis, 2004). In a series of priming experiments Feldman et al. (2004) demonstrated a transparency effect such that semantically transparent forms are recognized faster than opaque derived forms. If it happens that words in the congruent condition are more semantically transparent than words in the incongruent condition thus this difference could have influenced gender decision times. To control for this factor we ran a post-test checking for the semantic relation between the derived words used and their bases.

Post-test

Nineteen participants were asked to rank the semantic relatedness between the derived words and their base on a 7 points scale. For the congruent derived words, the semantic relatedness rating shows a mean rating of 6.5 compared to a mean rating of 5.8 for incongruent ones. The difference is significant ($t(18) = 2.79$, $p < .05$). However, a careful check to the data reveals that this effect was mainly due to four pairs (*brassard–brassière*; *chiffon-*

nier–chiffonnade; *pétrolier–pétrolette*; *oreillette–oreiller*) for which the difference of semantic-relation rate between the two derived words was over 1. For example *pétrolier* has a semantic-relation rate of 6.8 and *pétrolette* of 3.7 with a difference of 3.1. All other items show a difference in the range of $[-1, 1]$ ($m = 0.7$, $SD = 0.98$). For example, *jupette* has a meaning rate of 6.8 and *jupon* of 6.6, with a difference of 0.2. We reran analyses including the semantic relatedness rate as a covariate and the Congruency effect was still significant for RTs ($F(1, 35.901) = 6.493$, $p < .05$) and error rates ($F(1, 35.785) = 6.913$, $p = .01$). These results demonstrate that the congruency effect observed is not due to semantic factors.

It remains to be seen whether the gender effect observed is indeed morphemic and not only orthographic, i.e., due to the presence of a noun embedded within another noun irrespective of the morphemic status of the units in the target noun. The third experiment was designed to test the morphemic nature of the effect observed in the two previous experiments. Indeed an interesting recent study by Bowers, Davis, and Hanley (2005) shows that shorter words embedded within longer words (*crow* in the written word *crown*) are activated during the course of visual word identification and even more when they are processed at the level of meaning. In their experiments the authors used a semantic competition paradigm, in which participants were presented with target words that contain shorter words that are members of a specific semantic category (e.g. *hatch*, in which the subset *hat* is a member of the "item of clothing" category). They looked at the effect of congruency between the answers required by the embedded word and the target word. For example, if the target is *hatch* and the question is "Is it a piece of clothing", the shorter word, *hat*, leads to a YES answer and the target, *hatch*, to a NO answer, while if the question is "Is it a human body part?", both words require a NO answer. This study shows that people are slower to reject *hatch* as a piece of clothing compared to rejecting *hatch* as a human body part, suggesting that visual embedded words are activated to the level of form and meaning during the task. This study can clearly be linked to our experiments as both rationales are closed to those we are looking at, that is, the congruency of the answers required by target words and embedded words. Bowers et al. (2005) observed an effect of the semantic relatedness between the embedded word and the target word, so it could be that the effect that we observed has nothing to do with morphology but is just reflecting the activation of embedded words as in Bowers et al. (2005).

Experiment 3

The goal of the third experiment was to assess whether the effect obtained with morphologically complex words was due to orthographic overlap between two words, rather than morphological decomposition *per se*. In this experiment, we used non-morphological words that included an initial embedded word that looks like a base plus a non-morphemic ending of French. For example, we compared the effect of gender congruency for non-morphological words like *seringue* "syringe". The ending *-gue* is not a suffix in French, but appears at the end of existing words like *mangue* "mango", *dingue* "fool", etc. If the effect previously observed is not morphological but orthographic, then we should obtain a gender effect for these words as well (as *serin* "serin" is masculine and *seringue* feminine in French). In other words, if the effect observed in Experiments 1 and 2 is due to the embedded words being the first part of the experimental whole-words, then we should observe an equivalent effect as in the previous experiments.

We also tested another type of words: pseudo-derived words like *baguette* "French bread, chopsticks", which can be parsed into the base-morpheme *bague* "ring" and the suffix *–ette*, but is not semantically related to *bague*. This type of word has the same morphological surface structure (a noun and the suffix *–ette*) as truly morphologically complex words such as the ones used in Experiments 1 and 2 but are not considered as morphologically complex nouns by participants. We used this type of words in order to see if decomposition occurs when words look like morphologically complex but do not have any semantic relations with their pseudo-base. We did not control here for historical and etymological links as previous studies have shown that words related by etymological links without synchronic semantic relations behave as pseudo-morphemic words in conscious paradigms. Indeed, conscious priming experiments done on concatenative languages such as French and English globally show a morphological priming effect only when prime and target are semantically related. No effect is observed for opaque pairs even if etymologically related: a semantically opaque word like *apartment* does not prime its etymological base *apart* (Feldman & Soltano, 1999; Longtin et al., 2003; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Rastle et al., 2000; but see for different results on languages with non-concatenative morphology, Boudelaa & Marslen-Wilson, 2001; Frost, Deutsch, Gilboa, Tannenbaum, & Marslen-Wilson, 2000; Frost, Forster, & Deutsch, 1997).

Methods

Participants

Twenty-one students of the Institut des Sciences Politiques and of the Lumière-Lyon2 University (Lyon), were paid to participate in the experiment. All participants were native speakers of French and had normal or corrected vision. None had participated in any of the previous experiments.

Stimuli

Seventeen pairs of orthographically related words were selected such that both members of the pairs were of the same gender (*seringue*$_{\text{feminine}}$–*auberge*$_{\text{feminine}}$ "inn") but one member of the pair contained an embedded masculine word (e.g., *serin*$_{\text{masculine}}$ in *seringue*) and the other member of the pair contained an embedded feminine word (e.g., *aube*$_{\text{feminine}}$ "paddle" in *auberge*) (see Appendixes C and D). There were 8 feminine word pairs (e.g., *seringue*$_{\text{feminine}}$–*auberge*$_{\text{feminine}}$), and 9 masculine word pairs (e.g., *amiral*$_{\text{masculine}}$ "admiral"–*bulletin*$_{\text{masculine}}$ "bulletin") matched in frequency of the word (26.2 vs 20.1 occurrences per million, $t < 1$), number of syllables (2 vs 1.8, $t < 1$), number of letters (6.7 vs 5.9, $t(16) = 1.61$, n.s.), frequency of the base (71.7 vs 49, $t < 1$) and cumulative frequency of the embedded word, i.e., the sum of the frequency of the embedded word plus all its affixed forms (114 vs 78.6, $t < 1$). Half of these orthographic words were gender congruent with their embedded word (gender congruent condition) and the other half were gender incongruent with their embedded word (gender incongruent condition). Seventeen pairs of pseudo-morphological complex suffixed words were selected such that both members of the pairs were of the same gender (*vignette*$_{\text{feminine}}$ "label"–*chouette*$_{\text{feminine}}$ "owl") but one member of the pair contained a masculine word as a pseudo-base, e.g., *chou*$_{\text{masculine}}$ "cabbage" in *chouette* and the other member of the pair contained a feminine word as a pseudo-base, e.g., *vigne*$_{\text{feminine}}$ "vine" in *vignette*. There were 7 feminine word pairs (e.g., *vignette*$_{\text{feminine}}$–*chouette*$_{\text{feminine}}$), and 10 masculine word pairs (e.g., *peuplier*$_{\text{masculine}}$ "poplar"–*sanglier*$_{\text{masculine}}$ "wild boar") matched in type of suffix, frequency (3.9 vs 10.2 occurrences per million, $t(16) = 1.68$, n.s.), number of syllables (2.1 vs 2, $t < 1$), number of letters (6.9 vs 7, $t < 1$), frequency of the base (25.2 vs 15.8, $t(16) = 1.42$, n.s.) and cumulative frequency of the embedded word (79.9 vs 45.8, $t(16) = 1.54$, n.s.). Half of these pseudo-suffixed words were gender congruent with their pseudo-base (gender congruent condition) and the other half were gender incongruent with their base (gender incongruent condition). Eight masculine filler words and sixteen feminine filler words were also included in the experimental list. Hence, there were equal numbers of feminine and masculine words in the experiment.

Procedure

The procedure was the same as the one used in Experiments 1 and 2. The only difference was that the third experiment was controlled by DMDX software (Forster & Forster, 2003).

Results and discussion

Incorrect responses (3.7% of responses) and RTs slower than 1500 ms and faster than 300 ms (2.5%) were removed. We ran a mixed-effect analysis on the data, with log reaction times as the dependent variable, Participants and Items as random variables and Congruency (congruent vs incongruent) and Word type (pseudo-suffixed vs orthographic words) as a fixed effect. Mean RTs and mean error rates are presented in Table 1.

Overall we observed a significant effect of Word type ($F(1, 61.847) = 15.587$, $p < .001$), with pseudo-morphological complex words being responded to 31 ms more rapidly than orthographic items (95% CI = 20.87). Congruency analyses showed an effect of 24 ms with congruent words being responded to faster than incongruent ones (95% CI = 17.52). This effect was not significant ($F(1, 61.849) = 1.802$, n.s.), while the interaction between these two factors was significant (95% CI = 13.34; $F(1, 61.865) = 3.945$, $p = .05$). Planned comparisons showed that for the pseudo-morphological complex suffixed words, the gender congruent condition led to faster response times than the gender incongruent condition. This 43 ms effect (95% CI = 15.77) was significant ($F(1, 31.660) = 6.230$, $p < .05$). For the orthographic controls no significant difference was observed (effect of 4 ms; $F < 1$).

The effect of Word type was the only significant effect in the analyses conducted on errors ($F(1, 64) = 7.116$, $p = .01$) with fewer errors in the pseudo-morphological word condition (0.8%) than in the orthographic condition (3%).

In sum, RTs of this experiment showed an effect of gender congruency only for pseudo-derived words like *baguette*. No effect was observed for non-morphological carrier words like *seringue*.

General discussion

We carried out three experiments to study the decomposition of morphological complex words by testing whether gender categorization of morphologically complex nouns is affected by the gender of their embedded morphemes. By varying the gender congruency of short words embedded in longer carrier ones, we observed a gender congruency effect for morphologically complex words and for pseudo-morphological words. Gender decision was faster when the base or the pseudo-base had the same gender as the derived or pseudo-derived noun. By contrast no gender congruency effect was observed when the target nouns were not made of morpheme-like parts and more precisely, were not ending with a suffix. For words in which orthographic overlap is partial, i.e., when a short word is included in the longer word but the rest of the longer word is not or does not look like a morpheme, no effect was observed. For true or pseudo-morphologically complex words, an incongruency between the gender of the base or pseudo-

base and the gender of the target noun delayed gender access. Altogether these results suggest that words that are (or look like) morphologically complex are decomposed during a task requiring grammatical gender identification, and that the gender of the extracted morphemes is activated.

The result suggesting that morphological decomposition occurs even when the target noun is pseudo-morphologically complex is very interesting. As said in the introduction, recent masked priming studies have demonstrated the existence of an early blind decomposition process that starts as soon as the target looks morphologically complex, irrespective of whether its morphological structure is real or only superficial. Researchers also reported a lack of priming effects for orthographically related words such as *brothel* which contains *broth* but where *–el* is not a morpheme suggesting that this decomposition is not a left-to-right process but rather a parallel mapping of the input to the available morphemic units, both bases and affixes (Feldman & Soltano, 1999; Longtin et al., 2003; Rastle et al., 2004). Unmasked priming experiments showed that the reality of morphological structures is taken into account later on during word identification. Indeed, when an auditory or unmasked visual prime is used, a priming effect is observed only for real morphologically related words: a word like *messy* primes *mess*, but a word like *message* does not (Feldman & Soltano, 1999; Longtin et al., 2003; Marslen-Wilson et al., 1994; Meunier & Longtin, 2007; Rastle et al., 2000). The morpheme gender effect we observed in our experiments follows a pattern similar to the one observed when targeting this very early decomposition process. However, it seems difficult to postulate they are directly linked as the gender categorization task is usually not considered as tapping into very early stages of word processing (see Holmes & Segui, 2004 but see Colé, Pynte, & Andriamamonjy, 2003).

To our knowledge, it is the first time that a gender decision task is used to highlight morphological decomposition. Previous results that were obtained using this task are relevant for the interpretation of our own data. This task has been found to be sensitive to sublexical factors, such as the predictive value of the noun ending related to gender classes (see for example Desrochers, Paivio, & Desrochers, 1989). As mentioned in the introduction, in French there are phonological regularities that occur on noun endings: many noun endings are associated more often with one gender than the other, such as the ending *–ette* like in *fourchette* "fork" or *cigarette* "cigarette" that is predominantly feminine at 98%, meaning that only 2% of the words ending in *–ette* are masculine. Corpus analyses done on the 31616 noun entries of the Petit Larousse French Dictionary showed that using ending predictability would ensure correct gender categorization at 85% (Tucker, Lambert, & Rigault, 1977). Empirical evidence has been reported to support this first observation. Tucker and collaborators observed that native French speakers were able to identify several gender-typical endings and could assign gender to spoken pseudo-words varying on their gender predictability endings according to statistical properties of the endings. For example, 67% of nouns ending in /*k*/ are masculine, and 65% of the subjects categorized pseudo-words with that ending as masculine (Tucker et al., 1977; Tucker, Lambert, Rigault, & Sigalowitz, 1968; see also Holmes & Dejean de la Bâtie, 1999). Moreover, several studies have shown that native speakers of French take the ending into account by a very early age: for example Karmiloff-Smith (1979) found that 3-year-olds already relied on phonological ending to attribute a gender to pseudo-words (see also Seigneuric, Zagar, Meunier, & Spinelli, 2007). Using visually presented words, Taft and Meunier (1998) and Holmes and Dejean de la Bâtie (1999) showed that words with typical gender-marked endings were classified as masculine or feminine more quickly than words whose gender was exceptional given their ending (such as *squelette* "skeleton" which belongs to the 2% of words that end in *–ette* and are masculine). Words with gender-typical endings are also classified more rapidly as masculine or feminine than words with gender-neutral endings, in both French (Desrochers et al., 1989) and Italian (Bates et al., 1996). Overall, experimental studies have shown that nouns with predictive gender endings are categorized faster than nouns with unpredictive gender endings. These results suggested that comprehenders, particularly readers, might focus first on word's ending, given that gender information is present explicitly in the stimulus and continues to be available while the word is being fixated.

Coming back to our results, if we look at the predictability values of the endings, it reaches 91% ($SD = 22$) in Experiment 1, 89% ($SD = 22$) in Experiment 2 and in Experiment 3, 79% ($SD = 33$) in the pseudo-morphological condition and 69% ($SD = 30$) in the orthographical condition for which we did not find any effect. These observations point to a critical feature of the decomposable nouns: morpheme-like endings are highly correlated with a gender class. Indeed, predictive gender endings often correspond to suffixal morpheme such as *–ette*. When a suffix is added to a base, while its effect on the meaning is not always straightforward, its effect on the whole-word gender is always the same. For example adding *–ette* to a noun will modify the meaning of that noun by the idea of smallness and the resulting derived noun will always be feminine whatever the gender of the base noun (Fradin, Hathout, & Meunier, 2003). However, our results

cannot simply be explained by the predictive value of the endings as in Experiment 1 suffixes—with very predictive endings (91%)—were matched within pairs, so if the effect observed was only due to the predictability of the endings then no morphological effect should have been observed in this case. What our results suggest however is that the gender morpheme effect is only observed with gender predictive morpheme-like units. Thus, it could be that the gender morpheme effect does reflect the conflict between the activation of the base-morpheme gender and gender predictive noun endings. This interpretation would also explain the lack of effect observed for non-morphological pairs, i.e., the orthographical condition in Experiment 3 where endings are less predictive (69%). In this condition words may not be decomposed either because (1) they are not morphologically complex even superficially or (2) the gender information carried by the endings is not informative enough to produce a gender ending effect. Indeed if our morphological gender effect is the combination of the morphological decomposition enhanced by the predictability ending effect, thus it explains why Bowers et al. (2005) observed a semantic activation for every embedded word while we observed an effect only when the target word is decomposable into morphemes or morpheme-like parts.

Overall our results clearly show that during gender identification, nouns made of morpheme-like units are decomposed. When the units carry conflicting gender information, gender decisions are delayed. Our results also allow to define more precisely the nature of the information chunk that is extracted and that have been previously called "endings": morphological suffixes.

Our results raise a last issue concerning the predictive gender ending effect previously reported by other authors: could this effect be due to the morphological status of ending units? If we take a careful look at what the authors call 'noun endings', it can be observed that the definition is rather fuzzy. While Bates and collaborators in Italian simply contrasted the high probability *–a* ending for feminine nouns and *–o* ending for masculine nouns with the final vowel *–e* as the single gender-opaque ending, Tucker et al. (1968) in their study did not provide a clear definition of what a noun ending is. To establish their probabilistic tables, they used as corpus an inverse dictionary that gives heterogeneous endings such as a phoneme, a syllable, and longer unit (e.g., *–o*, *–rce*, *-sthme*, *-ssion*, *-stion*, *-illon* and *–leau*). Similarly Taft and Meunier (1998) used sometimes one letter (such as the ending *–t*), sometimes two (*-ie*) or more, without providing any rationale for it. Colé et al. (2003) defined their endings as the orthographic form of the word-final phoneme, "*whose transcription is usually, a bigram*". Holmes and Segui (2004) used endings defined either as suffixes (e.g., *-ité*, *-ment*), or as rimes of final syllables that were orthographically similar to suffixes (e.g., *-ate*, *-ile*), or as simple final phoneme (e.g., *-ie*, *-eau*). These authors also noted that *most gender-typical endings have derivational morphemic status*. Overall, it seems that without being explicit it is often suffixes that are chosen as ending. This supports the idea that the gender predictive ending effect could in fact reflect a morphological effect. Further experiments should be done in order to test this possibility.

A special case of ending that has been the focus of more interest is the final phoneme /e/. It occurs in masculine and feminine nouns in approximately equal proportions in French, so its predictive value is low (42% masculine vs 58% feminine). However, it so happens that *–e* is the suffix morpheme for feminine agreement marking: for example the adjective *vert* "green" becomes *verte* when referring to a feminine noun. The noun *lapin* "male rabbit" becomes *lapine* when naming a female rabbit. Even if *–e* is an ending in masculine and feminine nouns in nearly equal proportions, 73% of the feminine nouns end with it, while this is the case only for 33% of masculine nouns. In their study, Holmes and Segui (2004) suggested that despite a low predictive value, *-e* is treated as a feminine ending. Accordingly, Colé et al. (2003) demonstrated the use of the last letter *–e* as a cue to gender. These authors claimed that two types of orthographic regularities associated with gender are likely to influence RTs, one operating in the ending-to-gender direction that would allow to predict gender from ending and a second one operating in the gender-to-ending direction that would allow to predict the last letter from gender (see for details Colé et al., 2003). Our results suggest that the effect of the last letter *-e* could in fact be due to the morphological status of this letter. It follows that gender cue should not be defined in terms of number of letters or phonemes, but rather in terms of morphological unit.

In sum, results observed in the present experiments clearly indicate that morphologically and pseudo-morphologically complex words are decomposed during a gender decision task and that the gender of the base-unit is activated. Also our experiments suggest that the noun ending predictability effect observed in the literature could in fact reflect decomposition into morphemes.

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Appendix A

Test words used in Experiment 1

Congruent	Incongruent
bottine$_f$	feutrine$_f$
chemisette$_f$	amourette$_f$
clochette$_f$	savonnette$_f$
cordelette$_f$	fourgonnette$_f$
courbure$_f$	jointure$_f$
crémerie$_f$	lingerie$_f$
droguerie$_f$	rêverie$_f$
épaulette$_f$	talonnette$_f$
épicerie$_f$	argenterie$_f$
grenadine$_f$	caféine$_f$
horlogerie$_f$	fromagerie$_f$
maisonnette$_f$	camionnette$_f$
mousseline$_f$	nougatine$_f$
orangeade$_f$	fusillade$_f$
tartelette$_f$	opérette$_f$
voilure$_f$	toiture$_f$
beurrier$_m$	rosier$_m$
bustier$_m$	plumier$_m$
chaton$_m$	glaçon$_m$
chéquier$_m$	boîtier$_m$
citronnier$_m$	bananier$_m$
lardon$_m$	cordon$_m$
muret$_m$	feuillet$_m$
ourson$_m$	chaînon$_m$
pétrolier$_m$	saladier$_m$
plafonnier$_m$	balancier$_m$
poivrier$_m$	cendrier$_m$
sablier$_m$	encrier$_m$
serpentin$_m$	crottin$_m$
sucrier$_m$	poudrier$_m$

Notes. The columns indicate congruent items (items for which the gender of the stem and the gender of the whole-form are the same) and incongruent items (items for which the gender of the stem and the gender of the whole-form are different). The whole-word gender is noted with a subscript$_f$ for Feminine and a subscript$_m$ for Masculine.

Appendix B

Test words used in Experiment 2

Congruent	Incongruent
boisement$_m$	boiserie$_f$
boulette$_f$	boulier$_m$
brassard$^*_m$	brassière$^*_f$
chaînette$_f$	chaînon$_m$
chaton$_m$	chatière$_f$
chemisette$_f$	chemisier$_m$
chiffonnier$^*_m$	chiffonnade$^*_f$
citronnier$_m$	citronnade$_f$
clochette$_f$	clocher$_m$
cordelette$_f$	cordage$_m$
fourneau$_m$	fournaise$_f$
glacière$_f$	glaçon$_m$
jupette$_f$	jupon$_m$
muret$_m$	muraille$_f$
orangeade$_f$	oranger$_m$
oreillette$^*_f$	oreiller$^*_m$
pétrolier$^*_m$	pétrolette$^*_f$
planchette$_f$	plancher$_m$
sachet$_m$	sacoche$_f$

Notes. The columns indicate congruent items (items for which the gender of the stem and the gender of the whole-form are the same) and incongruent items (items for which the gender of the stem and the gender of the whole-form are different). The whole-word gender is noted with a subscript$_f$ for Feminine and a subscript$_m$ for Masculine. Pairs for which the difference of semantic-link rate between the two derived words is over 1 have been marked with a *.

Appendix C

Test words used in Experiment 3

Pseudo-suffixed words		Orthographic control	
Congruent	Incongruent	Congruent	Incongruent
tartine$_f$	usine$_f$	auberge$_f$	seringue$_f$
baguette$_f$	brouette$_f$	merguez$_f$	moto$_f$
carpette$_f$	fauvette$_f$	pierre$_f$	loupe$_f$
aubergine$_f$	angine$_f$	visite$_f$	troupe$_f$
margelle$_f$	flanelle$_f$	amende$_f$	laitue$_f$
vignette$_f$	chouette$_f$	minerve$_f$	gelule$_f$
cannelle$_f$	écuelle$_f$	corneille$_f$	gondole$_f$
peuplier$_m$	sanglier$_m$	foire$_f$	épice$_f$
chantier$_m$	escalier$_m$	abricot$_m$	épine$_f$
bolet$_m$	cornet$_m$	amiral$_m$	bulletin$_m$
volet$_m$	brochet$_m$	déficit$_m$	merle$_m$
fouet$_m$	billet$_m$	platane$_m$	loisir$_m$
gazon$_m$	piston$_m$	feutre$_m$	glucide$_m$
laiton$_m$	mouflon$_m$	sacre$_m$	ciment$_m$
moineau$_m$	poireau$_m$	article$_m$	cimetière$_m$
fardeau$_m$	cerneau$_m$	écureuil$_m$	pied$_m$
poteau$_m$	pinceau$_m$	aveugle$_m$	visa$_m$

Notes. The columns indicate first the type congruent items (items for which the gender of the stem and the gender of the whole-form are the same) and incongruent items (items for which the gender of the stem and the gender of the whole-form are different). The whole-word gender is noted with a subscript$_f$ for Feminine and a subscript$_m$ for Masculine.

Appendix D

Properties of lexical items by gender congruency condition for each experiment

	Congruent	Incongruent
Experiment 1		
Mean surface frequency of the endings	3034	3104
Predictive value of the endings	90	90
Surface frequencies of the root	2	38
Frequency of the experimental items	1	3
Cumulative frequency of the embedded word	2360	2725
Experiment 2		
Mean surface frequency of the endings	1986	4355
Predictive value of the endings	94	84
Surface frequencies of the root	58	58
Frequency of the experimental items	2	3
Cumulative frequency of the embedded word	1911	1911
Experiment 3		
Orthographic ending words		
Mean surface frequency of the endings	1728	2379
Predictive value of the endings	80	65
Surface frequencies of the root	72	49
Frequency of the experimental items	26	20
Cumulative frequency of the embedded word	1940	1336
Opaque words		
Mean surface frequency of the endings	3409	3308
Predictive value of the endings	88	88
Surface frequencies of the root	25	16
Frequency of the experimental items	4	10
Cumulative frequency of the embedded word	1357	778

References

Baayen, R. H. (2007). *Analyzing linguistic data. A practical introduction to statistics*. London: Cambridge University Press.

Baayen, R. H., Dijkstra, T., & Schreuder, R. (1997). Singulars and plurals in Dutch: Evidence for a parallel dual-route model. *Journal of Memory and Language, 37*, 94–117.

Bates, E., Devescovi, A., Hernandez, A., & Pizzamiglio, L. (1996). Gender priming in Italian. *Perception & Psychophysics, 58*, 992–1004.

Bertram, R., Schreuder, R., & Baayen, R. H. (2000). The balance of storage and computation in morphological processing: The role of word formation type, affixal homonymy and productivity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 489–511.

Boudelaa, S., & Marslen-Wilson, W. D. (2001). Morphological units in the Arabic mental lexicon. *Cognition, 81*, 65–92.

Bowers, J. S., Davis, C. J., & Hanley, D. A. (2005). Automatic semantic activation of embedded words: Is there a 'hat' in 'that'? *Journal of Memory and Language, 52*, 131–143.

Caramazza, A., Laudanna, A., & Romani, C. (1988). Lexical access and inflectional morphology. *Cognition, 28*, 297–332.

Colé, P., Beauvillain, C., & Segui, J. (1989). On the representation and processing of prefixed and suffixed derived words: A differential frequency effect. *Journal of Memory and Language, 28*, 1–13.

Colé, P., Pynte, J., & Andriamamonjy, P. (2003). Effect of grammatical gender on visual word recognition: Evidence from lexical decision and eye movement experiments. *Perception & Psychophysics, 65*, 407–419.

Colé, P., & Segui, J. (1994). Grammatical incongruency and vocabulary types. *Memory & Cognition, 22*, 387–394.

Colé, P., Segui, J., & Taft, M. (1997). Words and morphemes as units for lexical access. *Journal of Memory and Language, 37*, 312–330.

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

Diependaele, K., Sandra, D., & Grainger, J. (2005). Masked cross-modal morphological priming: Unravelling morpho-orthographic and morpho-semantic influences in early word recognition. *Language and Cognitive Processes, 20*, 75–114.

Feldman, L. B., & Pastizzo, M. J. (2003). Morphological facilitation: The role of semantic transparency and family size. In R. H. Baayen & R. Schreuder (Eds.), *Morphological structure in language processing*. Berlin: Mouton de Gruyter.

Feldman, L. B., & Soltano, E. G. (1999). Morphological priming: The role of prime duration, semantic transparency, and affix position. *Brain and Language, 68*, 33–39.

Feldman, L. B., Soltano, E. G., Pastizzo, M. J., & Francis, S. E. (2004). Semantic transparency influences morphological processing. *Brain and Language, 90*, 17–30.

Forster, K. I., & Davis, C. (1984). Repetition priming and frequency attenuation in lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10*, 680–698.

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers, 35*, 116–124.

Fradin, B., Hathout, N., & Meunier, F. (2003). La suffixation en –ET et la question de la productivité. *Langue Française, 140*, 56–78.

Frauenfelder, U. H., & Schreuder, R. (1992). Constraining psycholinguistics models of morphological processing and representation: The role of productivity. In G. Booij & J. van Marle (Eds.), *Yearbook of morphology 1991*. Netherlands: Kluwer Academic Publishers.

Frost, R., Deutsch, A., Gilboa, O., Tannenbaum, M., & Marslen-Wilson, W. D. (2000). Morphological priming: Dissociation of phonological, semantic, and morphological factors. *Memory & Cognition, 28*, 1277–1288.

Frost, R., Forster, K. I., & Deutsch, A. (1997). What can we learn from the morphology of Hebrew? A masked-priming investigation of morphological representation. *Journal of*

Experimental Psychology: Learning, Memory, and Cognition, 23, 829–856.

Giraudo, H., & Grainger, J. (2001). Priming complex words: Evidence for supralexical representation of morphology. *Psychonomic Bulletin & Review, 8*, 127–131.

Giraudo, H., & Grainger, J. (2003). A supralexical model for french derivational morphology. In D. Sandra & H. Assink (Eds.), *Reading complex words*. Amsterdam: Kluwer.

Grosjean, F., Dommergues, J.-Y., Cornu, E., Guillelmon, D., & Besson, C. (1994). The gendermarking effect in spoken word recogntion. *Perception & Psychophysics, 56*, 590–598.

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.

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

Longtin, C.-M., Segui, J., & Hallé, P. A. (2003). Morphological priming without morphological relationship. *Language and Cognitive Processes, 18*, 313–334.

Marslen-Wilson, W. D., Tyler, L. K., Waksler, R., & Older, L. (1994). Morphology and meaning in the English mental lexicon. *Psychological Review, 101*, 3–33.

Meunier, F., & Longtin, C.-M. (2007). Morphological decomposition and semantic integration in word processing. *Journal of Memory and Language, 56*, 457–471.

Meunier, F., & Segui, J. (1999). Morphological priming effect: The role of surface frequency. *Brain and Language, 68*, 54–60.

New, B., Brysbaert, M., Segui, J., Ferrand, L., & Rastle, K. (2004). The processing of singular and plural nouns in French and English. *Journal of Memory and Language, 51*, 568–585.

Rastle, K. G., & Davis, M. H. (2003). Reading morphologically complex words: Some thoughts from masked priming. In S. Kinoshita & S. J. Lupker (Eds.), *Masked priming: State of the art*. Hove, UK: Psychology Press.

Rastle, K., Davis, M. H., Marslen-Wilson, W. D., & Tyler, L. K. (2000). Morphological and semantic effects in visual word recognition: A time-course study. *Language and Cognitive Processes, 15*, 507–537.

Rastle, K., Davis, M. H., & New, B. (2004). The broth in my brother's brothel: Morpho-orthographic segmentation in visual word recognition. *Psychonomic Bulletin & Review, 11*, 1090–1098.

Schreuder, R., & Baayen, R. H. (1995). Modeling morphological processing. In L. B. Feldman (Ed.), *Morphological aspects of language processing*. Hillsdale, NJ: Lawrence Erlbaum.

Schreuder, R., Neijt, A., van der Weide, F., & Baayen, R. H. (1998). Regular plurals in Dutch compounds: Linking graphemes or morphemes? *Language and Cognitive Processes, 13*, 551–573.

Seigneuric, A., Zagar, D., Meunier, F., & Spinelli, E. (2007). The relation between language and cognition in 3- to 9-year-olds: The acquisition of grammatical gender in French. *Journal of Experimental Child Psychology, 96*, 219–246.

Spinelli, E., & Alario, F. X. (2002). Gender context effects on homophone words. *Language and Cognitive Processes, 17*, 457–469.

Spinelli, E., Meunier, F., & Seigneuric, A. (2006). Spoken word recognition with gender-marked context. *The Mental Lexicon, 1*, 277–297.

Taft, M. (1994). Interactive-activation as a framework for understanding morphological processing. *Language and Cognitive Processes, 9*, 271–294.

Taft, M. (2003). Morphological representation as a correlation between form and meaning. In E. Assink & D. Sandra (Eds.), *Reading complex words* (pp. 113–137). Amsterdam: Kluwer.

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

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

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

Wurm, L. H. (2000). Auditory processing of polymorphemic pseudowords. *Journal of Memory and Language, 42*, 255–271.