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FRANCK, Julie, *et al*.

Reference

FRANCK, Julie, *et al*. The interplay of syntax and form in sentence production: A cross-linguistic study of form effects on agreement. *Language and cognitive processes*, 2008, vol. 23, no. 3, p. 329-374

DOI : 10.1080/01690960701467993

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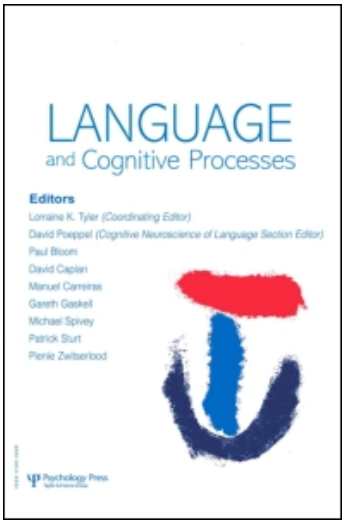

Language and Cognitive Processes
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713683153

The interplay of syntax and form in sentence production: A cross-linguistic study of form effects on agreement

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Online publication date: 01 February 2008

To cite this Article Franck, Julie , Vigliocco, Gabriella , Antón-Méndez, Inés , Collina, Simona and Frauenfelder, Ulrich H.(2008) 'The interplay of syntax and form in sentence production: A cross-linguistic study of form effects on agreement', Language and Cognitive Processes, 23: 3, 329 — 374
To link to this Article: DOI: 10.1080/01690960701467993
URL: http://dx.doi.org/10.1080/01690960701467993

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LANGUAGE AND COGNITIVE PROCESSES
2008, 23 (3), 329–374

Psychology Press
Taylor & Francis Group

The interplay of syntax and form in sentence production: A cross-linguistic study of form effects on agreement

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We report four cross-linguistic experiments (in Spanish, Italian and French) testing the influence of morphophonological gender marking in the subject noun phrase on the production of gender agreement. Agreement errors are elicited using a methodology in which participants are required to complete, with a predicative adjective, a sentence preamble. Results confirm a role for morphophonological gender marking in agreement. More precisely, we show that this role varies with two factors of different nature. The first factor is structural and has to do with the position of the marker in the noun phrase (article vs. noun). The second factor is distributional and has to do with the validity of the marker in the language. A model of agreement production is

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The research reported here was supported by grant number 1114-068250.02 of the Fonds National de la Recherche Suisse to Julie Franck and Uli Frauenfelder, and by the NSF grant SBR 9729118 to Gabriella Vigliocco. We would like to thank Kay Bock, Fernanda Ferreira, Matt Goldrick, Rob Hartsuiker, Luigi Rizzi and Dave Vinson for insightful discussions and comments on previous versions of the manuscript.

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http://www.psypress.com/lcp DOI: 10.1080/01690960701467993

proposed in which two functionally distinct processes are identified: Feature selection, the locus of the morphophonological influences, and Feature copy, operating under strict syntactic guidance.

Across languages, syntactic features such as gender, number, tense and case are mapped on word forms with various degrees of regularity. A small range of studies has explored whether the regularity with which syntactic features are marked in the morphophonology of the words influences syntactic aspects of language production. They revealed that, at least under some circumstances, grammatical agreement shows sensitivity to morphophonological markers or cues to gender and number (e.g., Meyer & Bock, 1999; Vigliocco, Butterworth, & Semenza, 1995; Vigliocco & Zilli, 1999). The present study goes beyond establishing that morphophonological markers influence agreement, and brings new insights into how to characterise this influence:

1. Is this influence modulated by the structural position of the morphophonological marker in the subject noun phrase? And is it finely modulated by the statistical distribution of the morphophonological marker in the language?
2. What is the functional locus of the morphophonological influence on agreement, and does it invalidate the hypothesis of syntactic modularity?

We addressed these questions in four crosslinguistic experiments (in Spanish, Italian, and French) by manipulating different morphophonological gender markers, and examined their influence on predicative adjective agreement. Across languages, we considered markers whose distribution shows different degrees of consistency in expressing gender; within a language, we considered gender markers occupying different structural positions in the subject noun phrase (the article and the noun). A new theoretical model of agreement with a precise hypothesis as to the functional locus of morphophonological influences is proposed in the General Discussion, based on the data presented and the existing literature.

AGREEMENT IN LANGUAGE PRODUCTION

Models of language production typically involve three functionally distinct levels of representation and processing: a level at which a conceptual message is prepared for linguistic expression; a level of grammatical encoding at which lexical units (lemmas) corresponding to the concepts are selected with their bundles of grammatical features and structured hierarchically to express syntactic dependencies; and a level of phonological encoding at

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which the form of the words (lexemes) is retrieved together with the prosody and other surface characteristics of the sentence (e.g., Bock, 1982; Garrett, 1982; Levelt, 1989; Levelt, Roelofs, & Meyer, 1999).

Although this decomposition in broad levels of integration is widely shared, models differ as to the assumptions about the influences that levels exert on one another. The traditional view in language production adopts a strong premise of modularity in the system (e.g., Bock & Levelt, 1994; Garrett, 1980, 1982, 2000; Levelt, 1989; Levelt et al., 1999). Modularity is characterised by informational encapsulation and is implemented in the model in terms of limitations on information flow between levels. Each level operates on the basis of the output provided by the immediately preceding level. The relative processing autonomy of levels resulting from informational encapsulation is in fact tightly linked to the concept of timing: information flows in a sequential, feedforward manner, from conceptual elaboration to grammatical encoding to phonological encoding. That is, grammatical encoding provides the input to phonological encoding, but phonological encoding does not affect processes involved in grammatical encoding.

Models assuming interactivity between production levels have also been proposed from early on (e.g., Dell, 1986; Dell & Reich, 1981; Stemberger, 1985), and gained acceptance as the results from a variety of empirical traditions accumulated in studies of single word production. The best fit to the data on lexical selection appears to be provided by models that assume cascading activation between levels (e.g., Dell, 1986; Goldrick, 2006; Rapp & Goldrick, 2000; Vigliocco & Hartsuiker, 2002). That is, level n + 1 starts as level n is still operating, allowing for feedback to occur locally, that is, for local interaction between levels n and n + 1. Cascading activation is a minimal condition for phonological level representations to feed back to the process of lexical selection.

However, with few exceptions (e.g., Vigliocco & Hartsuiker, 2002), the discussion of interactivity in production has been limited to single word production. In contrast to single word production, producing sentences involves the computation of syntactic dependencies like agreement. Agreement provides an ideal test case to examine modularity in sentence production (e.g., Bock & Miller, 1991). Agreement is a typical syntactic phenomenon by which two (or more) words in a sentence share the same feature in virtue of the syntactic relation that links them. For example, in English, the verb must have the same number feature as the subject. In French, the adjective must have the same number and gender as the noun it qualifies. Being a syntactic operation, agreement is typically assumed to take place at the level of grammatical encoding (e.g., Bock & Miller, 1991).

Is agreement influenced by the conceptual and/or phonological representation of the agreement feature, or is it only guided by its lexico-syntactic

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representation, at the level of grammatical encoding? This question yielded an important amount of experimental research after the seminal work by Bock and Miller (1991) showing that agreement errors can easily be elicited experimentally. In these experiments, participants are presented with sentence preambles and their task is to repeat and complete the preamble in order to produce a full sentence involving agreement. The experimental preambles for these studies have subjects that consist of complex noun phrases made of a subject head noun and an 'intervener' or 'local noun' (e.g., The key *to the cabinets*). The presence of an intervener mismatching in number and/or gender with the head noun generates interference in agreement, similarly to 'attraction' errors commonly observed in spontaneous speech (e.g., *The key to the cabinets ARE lost).

Most of the experimental work on agreement has been concerned with the claim that agreement is affected by the conceptual representation of agreement features. Although initial studies failed to show any effect of the semantics of the subject number (e.g., Bock & Eberhard, 1993; Bock & Miller, 1991), these effects have now been widely acknowledged in a variety of test cases and languages (e.g., Bock, Eberhard, & Cutting, 2004; Bock, Eberhard, Cutting, Meyer, & Schriefers, 2001; Bock, Nicol, & Cutting, 1999; Eberhard, 1999; Haskell & MacDonald, 2003; Solomon & Pearlmutter, 2004; Vigliocco & Franck, 1999, 2001; Vigliocco, Hartsuiker, Jarema, & Kolk, 1996). Crucially, whereas conceptual properties of the head noun influence agreement, those of the intervener fail to affect agreement via attraction. The agreement model developed by Eberhard, Cutting, and Bock (2005) elaborates on this asymmetry, a point we will come back to in the General Discussion.

Whether agreement is affected by morphophonological factors, the topic of the present paper, is addressed in the next section.

MORPHOPHONOLOGICAL EFFECTS ON AGREEMENT

Agreement features are expressed in the noun's morphology by way of morphophonological markers. For example, the final -s marks the plural on the noun in English; the final -o marks masculine gender while the final -a marks feminine gender in Italian. However, these markers can be absent (e.g., irregular plurals like *mice* do not have the plural -s; the final -e in Italian can be carried by both feminine and masculine nouns), or even inconsistent (e.g., the final -a which usually marks feminine in Spanish can occasionally be carried by a masculine noun). A few experiments have investigated whether regularity in morphophonological marking affects agreement.

Vigliocco, Butterworth, and Semenza (1995) manipulated number marking of the subject head noun in Italian. In Italian, nouns ending in -o are

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singular (e.g., il-S chiodo-S)[1] and usually take -i as plurals (I-P chiodi-P). However, there is a class of nouns for which the same word form is used for the singular and the plural (e.g., il-S bar-0, I-P bar-0). The authors found that subject-verb agreement errors in number were more common with such head nouns that do not mark number than with nouns that mark it.

Gender markers were also found to play a role in agreement in Italian. Vigliocco and Zilli (1999) investigated predicative adjective agreement with subject head nouns whose gender was either marked in the word form (-o/-a endings marking masculine and feminine respectively) or unmarked (-e). Again, the authors found that language impaired and unimpaired speakers produced more agreement errors with subject nouns ending with unmarked than with marked endings.

In a study conducted in Dutch, Meyer and Bock (1999) found more errors in antecedent-pronoun gender agreement when the antecedent was preceded by the morphophonologically unmarked indefinite determiner (*een*), than when it was preceded by the marked definite determiner (*de*/*het*). Agreement in number between the subject and the verb was also found to be sensitive to the morphophonological marking of the subject head noun's determiner in Dutch. Significantly more agreement errors were reported when the determiner was unmarked for number (*de* which is used for both the singular and the plural) than when it was marked (*het*) (Hartsuiker, Schriefers, Bock, & Kikstra, 2003).

In contrast to the clear effects of morphophonology reported when manipulated on the head noun, the picture appears quite different when the morphophonology of the intervening noun is manipulated. Bock and Eberhard (1993) were first to report that the regularity of number marking on the intervener (e.g., cats vs. mice) does not modulate interference in subject-verb agreement in English. Even more compelling evidence comes from the study in Italian by Vigliocco and colleagues (1995) described above in which the authors not only manipulated morphophonological number marking on the subject head noun but also on the intervener. In contrast to the significant effect found for the head noun, no difference was found between interveners marked for number (e.g., Il ristorante *delle borgate*, the-S restaurant-S of-the-P suburb-P) and interveners unmarked for number (e.g., Il ristorante *delle citta'*, the-S restaurant-S of-the-P town-0). That is, the very same variable that plays a role on agreement when manipulated on the head noun does not influence it when manipulated on the intervening noun.

Aside these null effects, two studies have reported a significant role of the intervener's morphophonology on agreement. However, closer examination

[1] Throughout the text, P refers to plural, S refers to singular, M refers to masculine, F refers to feminine, while 0 refers to the absence of a morphological marker.

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raises doubts about the interpretation of the effects reported. In the study on Dutch by Hartsuiker et al. (2003) mentioned earlier, effects of the morphophonological transparency of number and gender on the intervener were reported. However, these effects were only found when the intervening word was ambiguously marked for case. Nicol & Antón-Méndez (2006) reported a significant effect of the case marking of the intervening pronoun in English. Hence, the morphophonological effect reported in Hartsuiker et al. (2003) could actually be due to the ambiguous case marking of the intervener. Case ambiguity could influence functional assignment during the comprehension phase of the experiment, i.e., when the preamble is presented, and therefore indirectly influence agreement production.

Finally, in a study by Haskell and MacDonald (2003), the first experiment replicated the absence of an effect of the intervener's morphophonological regularity in subject verb agreement in English (Bock & Eberhard, 1993). However, another experiment showed that in the presence of conflicting conceptual and grammatical number representation on the head noun (collective nouns that are grammatically singular but conceptually plural), the morphological regularity of number on the intervener had a small but detectable influence on agreement. But phrases with regular interveners had significantly higher mean plurality ratings than phrases with irregular interveners, which made the authors suggest that the effect may not be directly attributable to the morphophonology of the intervener but to the conceptual number of the subject phrase.

Thus, previous research suggests that the morphophonological marking of the subject head noun phrase does influence predicative adjective agreement, even though the marking of the intervener does not. However, the heterogeneity of these studies makes it hard to generalise across them; indeed, the experiments involved different morphophonological markers (on the determiner, the noun and the pronoun), different agreement relations (in gender and number) and different languages (in Italian, Dutch, and English). The present studies provide a systematic investigation of morphophonological influences on gender agreement. Gender markers on the article and on the noun were manipulated in four experiments with the same experimental setup. Three Romance languages were tested: Italian, Spanish, and French. This cross-linguistic approach will allow us to examine whether the respective influence of those markers varies within the language, and across languages.

The theoretical interpretation of morphophonological influences on agreement, and the question of whether they invalidate the hypothesis of modularity of syntax, are discussed in the framework of a model of agreement production proposed in the General Discussion.

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GENDER MARKING IN THE TEST LANGUAGES

The three Romance languages examined (Italian, Spanish, and French) have a dual gender system with masculine and feminine nouns. Gender is associated with morphophonological markers on the noun and on the article that precedes it. However, the languages differ as to the regularity of these markers and their distribution in the language.[2]

Italian is the most regular system with respect to the relation between morphophonological marking and gender. In that language, all nouns ending in -o are masculine while all nouns ending in -a are feminine. These nouns constitute about 80% of the Italian lexicon for nouns. Apart from these nouns, a small number of masculine nouns (17%) and feminine nouns (19%) end in -e (e.g., *ponte*, bridge-M; *febbre*, fever-F). That is, -e can mark both masculine and feminine gender. Gender is also expressed on the singular definite article: *il* precedes masculine nouns while *la* precedes feminine nouns. Nevertheless, when the noun starts with a vowel, the article is elided, that is, contracted to the single consonant *l'* independently of the noun's gender (e.g., *l'armadio*, the wardrobe-M; *l'aria*, the air-F). In such cases, which represent about 25% of the nominal lexicon, the article is ambiguous with respect to gender in its morphophonology. Hence, when the noun ends in -e and starts with a vowel (e.g., *l'allarme*, the alarm-F), the noun phrase provides no gender markers.

The Spanish gender system is similar to Italian, but slightly less regular. Nouns ending in -o are usually masculine while nouns ending in -a are usually feminine. Together, this group of regular nouns constitutes 68% of all nouns in the language (Teschner, 1987). Moreover, a small group of nouns show the reversed association: 0.1% of the feminine nouns end in -o (e.g., *mano,* hand-F) while 2.7% of the masculine nouns end in -a (e.g., *problema*, problem-M) (Teschner & Russell, 1984). The gender of the remaining nouns is not so clearly marked in the word form: nouns ending in -e can be masculine or feminine (although there is a prevalence of masculine nouns), nouns ending in -r or -l are more likely to be masculine, while nouns ending in other consonants (s, z, n) are more or less equally associated with one or the other gender. The definite article marks gender rather consistently: *el* accompanies masculine nouns while *la* accompanies feminine nouns. Hence, nouns with misleading endings are still marked in the morphophonology of the noun phrase by the article (e.g., *la mano*). Article elision does not exist in Spanish. However, another phenomenon similar in nature concerns the article preceding feminine nouns starting with the vowel a- and stressed on

[2] At the linguistic level, the three languages differ as to the morphological status of the gender marker on the noun: whereas in Italian and in Spanish it is inflectional in nature, the status of nouns' endings in French is strictly phonological.

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the word onset. These nouns, rather than taking the feminine article *la*, take the regular masculine article *el* (e.g., *el agua*, the-M water-F); that is, the article marks for the opposite gender. Note that these cases represent no more that 0.05% of all nouns.

French does not mark gender on the noun as clearly as Italian or even Spanish. Except for animate nouns whose gender is often morphologically marked on the suffix, gender is typically unmarked for inanimate nouns with grammatical gender. Corbett (1991) identified 21 assignment rules to derive gender from nouns' endings, with a substantial number of exceptions. However, the absence of an inflectional suffix on most inanimate nouns considerably complicates the problem since the ending can be defined in many different ways (final phoneme, two final phonemes, final syllable, etc.). Leaving aside this difficulty and considering arbitrarily 2-phoneme endings, some endings are consistently, though not strictly, associated with one gender (e.g., 93% of the nouns ending [mĩ] are masculine whereas 93% of the words ending in [ad] are feminine). In contrast, some endings are equally associated to both genders (e.g., [ik]). These nouns, together with nouns whose ending has a weak association with one gender (below 80%), represent the vast majority of the lexicon. Hence, in contrast to Italian and Spanish, it is extremely difficult to provide a statistical estimate of the proportion of the nouns that have a marked ending. Nevertheless, in spite of the difficulty to provide an objective estimate of the predictivity of the ending in French, Tucker, Lambert, and Rigault (1977) reported that French speakers have good implicit knowledge of these indexes. In contrast to the blurry gender markers on the noun, the definite article provides a clear cue: *le* always precedes masculine nouns while *la* always precedes feminine nouns. As in Italian, the definite article preceding vowel-initial nouns is elided and reduced to the unmarked form *l'* (e.g., *l'artichaut*), which concerns about 20% of the lexicon.

A summary of the distribution of gender markers on the noun and the determiner in the three test languages is provided in Table 1.

TABLE 1
Percentage of gender markers on nouns and determiners in the three test languages

	Nouns			*Determiners*		
	Marked consistent	*Unmarked*	*Marked inconsistent*	*Marked consistent*	*Unmarked*	*Marked inconsistent*
Italian	80	20	0	75	25	0
Spanish	68	29.2	2.8	99.9	0	.05
French	–	–	–	80	20	0

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It appears from this selective description of the gender systems of Italian, Spanish, and French that the mapping between grammatical gender and morphophonological markers on the noun and the definite article varies along a continuum that goes from consistent to inconsistent. Whereas nominal markers are extremely predictive of gender in Italian (80% of the nouns have a consistent marker, 0% have an inconsistent marker), they are less predictive in Spanish (66.7% have a consistent marker, 2.8% have an inconsistent marker) and even less so in French. Whereas Italian and French definite articles preceding nouns starting with a vowel are unmarked (representing about 20–25% of the lexicon), virtually all articles are consistently marked in Spanish, aside a small percentage of articles marking the opposite gender (< 1%). The mapping between gender and markers also varies within the language. Whereas the association between the ending and gender is similar to that between the article and gender in Italian (80% vs. 75% respectively), in French, the ending is only weakly associated to gender while the article is strongly associated to it (in about 80% of the cases). In Spanish, the asymmetry is less salient than in French, but articles are still more reliably associated to gender than endings (99% vs. 66.7% consistent marking respectively).

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OVERVIEW OF THE EXPERIMENTS

Four cross-linguistic experiments were designed to assess the differential role of morphophonological markers on predicative adjective gender agreement, making use of this variability across languages and across gender markers within languages. Two questions guided our work. First, does the sensitivity of agreement to morphophonology depend upon the *structural position* of the marker in the nominal phrase, that is, its presence on the noun or on the article that precedes it? Gender is a feature of the noun, and it is commonly assumed in linguistic theory that the determiner receives its gender feature from the noun by some operation of agreement or concord (e.g., Carstens, 2000). Hence, morphophonological information on the noun provides a direct cue to gender available as soon as the noun is being encoded, and is therefore expected to exert a primary role on agreement (other factors being equal). Second, does the sensitivity of agreement to morphophonology depend upon the *distribution* of the marker in the language? That is, does it depend on the strength of its association with a particular gender feature (its reliability) and the frequency of this association in the language? We will refer to the combination of these two distributional factors as the 'validity' of the marker (Bates & MacWhinney, 1989). If the system responsible for computing agreement is finely attuned to the validity of the marker, more

valid markers are expected to have a stronger influence on agreement than less valid markers.

Our work aimed to provide a systematic body of evidence by (1) limiting the study to one particular agreement relation: gender agreement between the subject head noun and the predicative adjective; (2) comparing the impact of different morphophonological markers (noun and article) within the same language; and (3) comparing the impact of the same morphophonological marker in different languages in which it is differently distributed.

EXPERIMENT 1: GENDER MARKING ON THE NOUN IN SPANISH

The aim of Experiment 1 was to replicate, in Spanish, the finding in Italian that nominal gender marking plays a role on agreement (Vigliocco & Zilli, 1999). Spanish nouns mark gender in a similar way to Italian. Hence, if the effect reported in Italian is not language-specific, it is expected to arise in Spanish speakers.

Method

Participants. Thirty-two students from the University of Arizona, all native speakers of Spanish, were paid to participate in this experiment.

Materials. The variables manipulated were: (a) the gender marking of the noun (marked vs. unmarked); (b) the gender match between the head and intervener (match vs. mismatch). Half the head nouns were masculine, the other half feminine. Although the gender of the head noun was initially introduced as a variable in the design, it was later dropped from the analyses since it failed to show any effect and was not relevant to the issues investigated here.

Materials consisted of 32 experimental items made of preamble-adjective pairs. The preambles were made up of a subject head noun and an intervener embedded in a modifying prepositional phrase. The noun's gender marking was manipulated by contrasting marked nouns whose ending is consistently associated with one gender feature (-o marks the masculine; -a marks the feminine) with unmarked nouns whose endings does not mark gender. All the interveners' endings were gender marked. All nouns (head and intervener) had grammatical gender. Each preamble was accompanied by an adjective. All adjectives expressed gender in their morphophonology.

Plausibility of the sentence fragments was rated on a 7-point scale by a separate group of 16 native Spanish speakers. None of the variables manipulated showed an effect in those plausibility ratings: consistently marked preambles were as plausible as unmarked preambles (4.8 vs. 4.9

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respectively); gender match preambles were as plausible as gender mismatch preambles (both 4.8); preambles with feminine head nouns were as plausible as preambles with masculine heads (4.8 and 4.9 respectively).

Eight versions of the 32 experimental items were created and counterbalanced across eight experimental lists (see Table 2 and Appendices for the complete list of items). Each list contained 8 items in each of the 4 experimental conditions.

There were 72 filler items. Forty of them had plural and inanimate head nouns. Of these, half had a masculine, and half a feminine head noun. Some variability in the structure of the preambles was introduced (adjective phrases and compounds). The remaining 32 filler items were singular animate nouns, equally distributed in the gender match and mismatch conditions.

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Procedure. Participants were tested individually. Trials consisted of the visual presentation of the adjectives on a computer screen for 600 ms followed with a blank screen for 400 ms and by the preamble that remained in view until participants responded. Both the masculine and feminine forms of the adjective were presented, one above the other in a counterbalanced manner across items. The participants' task was to repeat the preamble and complete it using the adjective provided. The instructions emphasised rapid speech. The experimenter presented the following item as soon as the participant had produced the sentence. Eight practice trials were performed before the experimental trials. Experimental sessions were tape-recorded.

Scoring criteria. Utterances were transcribed and scored according to the following criteria. (1) Correct responses were scored when the participant correctly repeated the preamble and completed it using the correct form of

TABLE 2
Example of sentence preambles used in Experiment 1 (Spanish)

Condition	*Item*
Gender match Marked ending	El castillo del pueblo – VIEJO (The castle of the village, OLD)
Gender mismatch Marked ending	El castillo de la aldea – VIEJO (The castle of the hamlet, OLD)
Gender match Unmarked ending	El reloj del pueblo – VIEJO (The clock of-the village, OLD)
Gender mismatch Unmarked ending	El reloj de la aldea – VIEJO (The clock of the hamlet, OLD)

the adjective. (2) Agreement errors were scored when the completion met the criteria above but the adjective failed to agree in gender with the subject of the sentence. (3) Miscellaneous responses were scored when the participant failed to repeat the preamble or the adjective (or parts of it), when he/she failed to repeat some words in the preamble, or when he/she produced a completion lacking the main verb. If two different utterances were produced in succession, only the first was scored, including those cases in which an agreement error was produced and immediately corrected.

Design and data analysis. Analyses of variance with both subjects and items as random factors were carried out using as dependent measure the arcsine transformation of the proportion of agreement errors and miscellaneous responses (given the Bernoulli distribution of the data, data were first drifted to 0 by applying a 2× -1 transformation before applying the arcsine transform). The variables manipulated (gender marking on the noun and gender match) were part of a within-participant, within-item design.

Results and discussion

One of the unmarked feminine nouns was often used as masculine (*sartén*, frying pan). The whole item to which this noun belonged was eliminated from the analyses, leaving 62 experimental items per list. There were 1653 (83.3%) correct responses, 84 (4.2%) agreement errors, and 247 (12.5%) miscellaneous responses. The distribution of agreement errors and miscellaneous responses is illustrated in Table 3.

TABLE 3
Distribution of agreement errors and miscellaneous responses (percentages in parentheses) in the different experimental conditions in Experiment 1 (Spanish)

	Agreement errors	
	Marked ending	*Unmarked ending*
Gender match	1 (.2)	6 (1.2)
Gender mismatch	27 (5.5)	50 (10.1)
	Miscellaneous errors	
	Marked ending	*Unmarked ending*
Gender match	60 (12.1)	63 (12.7)
Gender mismatch	61 (12.3)	67 (13.5)

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Distribution of agreement errors. Errors were more common when the ending did not mark gender than when it did mark it consistently, $F_1(1, 31) = 11.6$, $p = .002$; $F_2(1, 30) = 8.0$, p = .008. More errors were produced when the head and intervener had different gender than when their genders matched, $F_1(1, 31) = 62.7$, $p < .001$; $F_2(1, 30) = 47.7$, $p < .001$. The interaction between these two factors was not significant, $F_1(1, 31) = 3.5$, $p = .07$; $F_2 < 1$.

Distribution of miscellaneous responses. Miscellaneous responses were equally distributed across conditions (Fs < 1).

This experiment replicates in Spanish the results reported by Vigliocco and Zilli (1999) in Italian: speakers produce fewer agreement errors when the ending on the subject head noun is morphophonologically marked for gender than when it is not. Does the morphophonological effect reported lie in the process responsible for producing agreement or in some more general device at play in sentence production? Two arguments suggest that it is specifically linked to agreement production. First, plausibility ratings of our materials did not show any difference between the two experimental conditions. Second, the morphophonological variable did not influence miscellaneous errors.

EXPERIMENT 2: GENDER MARKING ON THE NOUN AND ON THE ARTICLE IN ITALIAN

Experiment 2 crossed the manipulation of gender markers on the noun and on the article in Italian. The two variables were introduced within the same design in order to determine their respective impact on agreement. Given the strong validity of both markers in the language, the two are expected to influence agreement.

Method

Participants. Forty-eight students from the University of Trieste, all native speakers of Italian, volunteered to participate in the experiment.

Materials. The variables experimentally manipulated were: (a) the gender marking of the head noun (consistent with the gender feature vs. opaque); (b) the gender marking of the head noun's article (marked vs. unmarked); (c) the gender match between the head and intervener (match vs. mismatch). Half the head nouns were masculine, the other half were feminine.

Thirty-two experimental items were built consisting of preamble-adjective pairs. The preambles consisted of a subject head noun and an intervener embedded in a modifying prepositional phrase. All nouns used in the

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experimental materials were singular and had grammatical gender. The manipulation of the gender marker on the noun was obtained as in Experiment 1, by contrasting nouns with gender marked endings (-o and -a) to nouns with an unmarked ending (-e). The manipulation of gender marking on the article was done by contrasting definite articles marked for gender (il/la) to the elided article (l') unmarked for gender. All interveners had gender marked endings. Adjectives expressed gender in their morphophonology, so both the masculine and feminine forms were presented one above the other (balanced). Examples of experimental items are reported in Table 4 (see Appendix B for the full list of items).

Two lists were created in which each of the two variants of an experimental item appeared only once, such that each list contained the eight experimental conditions. Each condition was represented by four items in each list. In each list, items were arranged in a semi-random order, with the constraint that no more than three experimental items could occur consecutively.

A group of 16 native Italian speakers that did not take part in the experiment were asked to rate the plausibility of the sentence fragments on a scale from 1 (highly implausible) to 7 (highly plausible) scale. Mean

TABLE 4
Examples of materials used in Experiment 2 (Italian)

Condition	*Item*
Gender match Marked article, Marked ending	Il premio del torneo – AMBITO (The trophy of the tournament, SOUGHT AFTER)
Gender mismatch Marked article, Marked ending	Il premio della partita-AMBITO (The trophy of the game, SOUGHT AFTER)
Gender match Marked article, Unmarked ending	Il confine dello stato-CUSTODITO (The boundary of the state, GUARDED)
Gender mismatch Marked article, Unmarked ending	Il confine della zona-CUSTODITO (The boundary of the region, GUARDED)
Gender match Unmarked article, Marked ending	L'aereo dell'esercito – GUASTO (The aircraft of the army, BROKEN)
Gender mismatch Unmarked article, Marked ending	L'aereo della compagnia – GUASTO (The aircraft of the company, BROKEN)
Gender match Unmarked article, Unmarked ending	L'abete del bosco – VECCHIO (The pine-tree in the woods, OLD)
Gender mismatch Unmarked article, Unmarked ending	L'abete della foresta-VECCHIO (The pine-tree in the forest, OLD)

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plausibility ratings did not differ for preambles with head nouns with high and low predictivity (5.7 vs. 5.8, respectively); they did not differ for marked and unmarked articles (5.8 vs. 5.9, respectively), and for matching and mismatching preambles (5.7 and 5.9, respectively).

There were also 32 filler items consisting of preamble-adjective pairs. All the nouns used in the filler items were plural. Half of them had a masculine head and a masculine intervener; the other half had a feminine head and a feminine intervener. Half of the filler items referred to animate entities, the other half to inanimate entities.

Procedure. The procedure was the same as in Experiment 1 except that the two forms of the adjective were presented visually for 800 ms and replaced by a blank screen for 500 ms. The preamble was then displayed for 900 ms. Also, the presentation was self-paced. Participants were instructed to press the spacebar on the computer keyboard in order to move to the next trial.

Scoring criteria and design. Same as Experiment 1.

Data analysis. ANOVAs were conducted on the arcsine transformation of error proportions (agreement and miscellaneous errors). The three variables manipulated were part of a within-participant design, gender marking of the noun and gender marking of the article were part of a between-item design, and gender match was part of a within-item design.

TABLE 5
Distribution of agreement errors and miscellaneous responses (percentages in parentheses) in the different experimental conditions in Experiment 2 (Italian)

	Agreement errors			
	Marked article		*Unmarked article*	
	Marked ending	*Unmarked ending*	*Marked ending*	*Unmarked ending*
Gender match	2 (1.0)	6 (3.1)	1 (0.5)	12 (6.2)
Gender mismatch	10 (5.2)	19 (9.9)	8 (4.2)	21 (10.9)
	Miscellaneous errors			
	Marked article		*Unmarked article*	
	Marked ending	*Unmarked ending*	*Marked ending*	*Unmarked ending*
Gender match	15 (7.8)	10 (5.2)	7 (3.6)	11 (5.7)
Gender mismatch	8 (4.2)	12 (6.3)	13 (6.8)	15 (7.8)

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Results and discussion

There were 1366 (88.9%) correct responses, 79 (5.1%) agreement errors and 91 (5.9%) miscellaneous responses. Table 5 reports the distribution of these errors in the different experimental conditions.

Distribution of agreement errors. Agreement errors were more common for nouns with unmarked endings than for nouns with marked endings, $F_1(1, 47) = 18.74$, $p < .001$; $F_2(1, 28) = 4.93$, $p = .03$. More agreement errors were produced in the condition of gender mismatch between the head and intervener than in the condition of gender match, $F_1(1, 47) = 6.65$, $p < .01$; $F_2(1, 28) = 15.54$, $p < .001$. The interaction between markedness on the ending and on the article was not significant, $F_1(1, 47) = 1.69$, $p = .20$; $F_2(1, 28) = 0.93$, $p = .34$. No other main effects or interactions were significant (Fs < 1).

Distribution of miscellaneous responses. The interaction between the marking of the article and the gender match was found significant in the analysis using participants as random factor, $F_1(1, 47) = 4.24$, $p = .05$; $F_2(1, 28) = 2.19$, $p = .15$. Gender match was not significant, $F_1 < 1$; $F_2(1, 28) = 2.22$, $p = .15$, and did not significantly interact with the ending, $F_1 < 1$; $F_2(1, 28) = 1.53$, $p = .23$. Other Fs were < 1.

The influence of the noun's ending on agreement is in line with the results reported by Vigliocco and Zilli (1999) with different materials, and with the results of Experiment 1 in Spanish.

Interestingly, no influence was found for the gender marker on the article. Given the strong validity of gender marking on the article in Italian (75% of the definite determiners consistently mark gender, and the definite determiner never marks it inconsistently), we expected it to influence agreement. But we also entertained the possibility that the system not only integrates morphophonological information according to its distribution in the language, but also to its structural position in the phrase. The data suggest that these two constraints are not independent of one another: in the presence of a highly valid nominal gender marker (frequent in the language and maximally consistent with grammatical gender), the agreement system remains blind to any other cue. Such a prevalence of nominal marking finds a natural explanation in the fact that the source of agreement is the noun, not the article; hence, when all the necessary information is directly available on the noun, the system can immediately proceed to agreement.

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EXPERIMENT 3: GENDER MARKING ON THE NOUN AND ON THE ARTICLE IN FRENCH

The design of Experiment 3 in French is identical to that of Experiment 2. French differs from Italian in that the nominal marker has a much lower validity, and the article provides by far the most important cue to gender. If morphophonological information finely modulates agreement, article marking is expected to have an influence on agreement, while the ending may show a reduced or even no effect.

Method

Participants. Forty native French speakers studying Psychology at the University of Louvain participated in the study.

Materials. The manipulated variables were identical to those used in Experiment 2: (a) the gender marking of the head noun (consistent with the gender feature vs. opaque); (b) the gender marking of the head noun's article (marked vs. unmarked); (c) the gender match (match/mismatch) between the head and intervener. Half the head nouns were masculine, the other half were feminine.

Materials for the experiment were 32 experimental items consisting of preamble-adjective pairs. All experimental preambles contained a subject head and a modifier noun embedded in a prepositional phrase. The manipulation of the noun's gender marking provided the contrast between a condition in which the nouns' endings were correlated with one gender in more than 80% of the cases (considered marked) and a condition in which they were only correlated in less than 70% with one gender (considered unmarked). The selection of the endings was made on the basis of Tucker and colleagues' work (Tucker et al., 1977). The mean correlation between the ending and gender was 0.91 (SD = 0.09) in the marked condition and 0.59 (SD = 0.14) in the unmarked condition. The difference between the two scores is statistically significant, $t(30) = -7.33$; $p = .0001$. The manipulation of the gender marking on the article was realised by contrasting nouns starting with a vowel that are preceded with the unmarked, elided article (e.g., *l'assiette*) with nouns starting with a consonant that are preceded with a gender marked article (e.g., *le bureau*). Adjectives were selected such that their gender was marked in the spoken format and both forms were presented one above the other (balanced).

Gender of the head noun was balanced throughout the experimental lists. All nouns used in the experimental materials had grammatical gender. Interveners had unmarked endings with respect to gender. Examples of items are illustrated in Table 6 and the full list of items is reported in Appendix C.

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TABLE 6
Examples of experimental materials used in Experiment 3 (French)

Condition	*Item*
Gender match Marked article, Marked ending	Le manoir du hameau- ATTIRANT (The manor of the village – ATTRACTIVE)
Gender mismatch Marked article, Marked ending	Le manoir de la bourgade-ATTIRANT (The manor of the township – ATTRACTIVE)
Gender match Marked article, Unmarked ending	Le cortège du carnaval – AMUSANT (The suite of carnival – AMUSING)
Gender mismatch Marked article, Unmarked ending	Le cortège de la procession – AMUSANT (The suite of the procession – AMUSING)
Gender match Unmarked article, Marked ending	L'ancêtre du violon – PRECIEUX (The ancestor of the violin – PRECIOUS)
Gender mismatch Unmarked article, Marked ending	L'ancêtre de la trompette – PRECIEUX (The ancestor of the trumpet – PRECIOUS)
Gender match Unmarked article, Unmarked ending	L'élastique du paquet-NOUVEAU (The rubber band of the pack – NEW)
Gender mismatch Unmarked article, Unmarked ending	L'élastique de la boite – NOUVEAU (The rubber band of the box – NEW)

Two lists were created by the combination of the 8 experimental conditions. Each condition was represented by four items in each list. As in the previous experiments, items were arranged in each list in a pseudo-random order with the constraint that no more than three experimental preambles could occur consecutively. The pseudo-random order was fixed in each list.

A separate group of 10 native French speakers rated the plausibility of the items on a 7 point scale. Mean plausibility ratings did not differ between preambles with marked and unmarked head nouns (3.7 vs. 3.5 respectively), between preambles with marked and unmarked articles (3.7 vs. 3.5 respectively), and between preambles with matching and mismatching gender (3.6 for both conditions).

Thirty six filler items were introduced, also made of preamble-adjective pairs. One third of them were composed of a single head noun; one third included a subordinate clause modifier; and one third included a prepositional phrase modifier. In two-thirds of the filler items, the head nouns and interveners referred to animate entities, equally distributed in the three syntactic structures. In half of these filler items, the head and intervener matched in gender, and they mismatched in the other half.

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TABLE 7
Distribution of agreement errors and miscellaneous responses (percentages in parentheses) in the different experimental conditions in Experiment 3 (French)

	Agreement errors			
	Marked article		*Unmarked article*	
	Marked ending	*Unmarked ending*	*Marked ending*	*Unmarked ending*
Gender match	1 (.5)	1 (.5)	10 (5.2)	18 (9.4)
Gender mismatch	6 (3.1)	16 (8.3)	20 (10.4)	33 (17.2)
	Miscellaneous errors			
	Marked article		*Unmarked article*	
	Marked ending	*Unmarked ending*	*Marked ending*	*Unmarked ending*
Gender match	12 (6.3)	20 (10.4)	26 (13.5)	31 (14.1)
Gender mismatch	18 (9.4)	29 (15.1)	21 (10.9)	26 (13.5)

Procedure, scoring criteria, design and data analysis. Same as Experiment 2.

Results and discussion. There were 992 (77.5%) correct responses, 105 (8.2%) gender agreement errors and 183 (14.3%) miscellaneous responses. Table 7 reports the distribution of agreement errors and miscellaneous responses in the different experimental conditions.

Distribution of agreement errors. Agreement errors were more frequent with unmarked than with marked endings, $F_1(1, 39) = 12.4$, $p = .001$; $F_2(1, 28) = 6.4$, $p = .017$. Errors were also more frequent when the article was unmarked than when it was marked, $F_1(1, 39) = 64.6$, $p < .001$; $F_2(1, 28) = 15.5$, $p = .001$. Gender mismatch between the head noun and the intervener generated more errors than gender match, $F_1(1, 39) = 18.8$, $p < .001$; $F_2(1, 28) = 30.8$, $p < .001$. The interaction between the ending and the article did not reach significance, $F_1(1, 39) = 1.5$, $p = .225$; $F_2 < 1$, neither did the interaction between the ending and gender match, $F_1(1, 39) = 1.9$, $p = .179$; $F_2(1, 28) = 3.0$, $p = .093$. Other Fs were < 1.

Distribution of miscellaneous responses. Moderate effects of article and ending marking were found in the analyses using participants as random factor; respectively $F_1(1, 39) = 6.9$, $p = .012$; $F_2(1, 28) = 1.8$, $p = .185$ and $F_1(1, 39) = 3.9$, $p = .06$; $F_2(1, 28) = 2.6$, $p = .120$. The interaction between gender

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match and article marking was also significant in the participant analysis, $F_1(1, 39) = 8.2$, $p = .007$; $F_2(1, 28) = 1.69$, $p = .204$. Other Fs were < 1.

Experiment 3 replicated in French the finding in Spanish (Experiment 1) and in Italian (Experiment 2) that when a noun has an ending that is associated to one gender, agreement is more often correct as compared to when the ending does not provide a cue to gender. However, the French data contrast with the Italian data in that the presence of a gender-marked article renders agreement more secure whereas this was not the case in Italian.

In the discussion of Experiment 2 we proposed that because gender is a property of the noun, highly valid nominal markers suffice, so that the agreement system does not take other cues into account. In contrast to Italian, French nouns' endings are only weakly associated with gender. Hence, the agreement system would take into account the other cue present in the noun phrase, the article, which provides infallible gender information for 80% of the nouns. In line with the hypothesis that the system is modulated by the statistical distribution of gender markers, comparison t-tests conducted on the arcsine transformation of error proportions show that in French, the article plays a stronger role than the ending, $t(39) = -2.69$, $p < .01$. Still, the system considers the morphophonology of the noun given its primacy to agreement, which explains the coexistence of both influences, from the noun and from the article.

The finding that miscellaneous errors also showed sensitivity to article marking (as well as some sensitivity to the ending) in the analysis of variance using participants as the random factor raises the possibility that the effect found on agreement errors may not be specific to agreement production. One first possibility that can be ruled out straightforwardly is that the effect be attributed to the plausibility of the items. As reported in the Materials section, similar plausibility ratings were found in the article marked and unmarked conditions. Two more substantial pieces of evidence suggest that elision plays a specific role on agreement. The first comes from a control experiment using the same materials in which the definite article (le/la) was replaced by the indefinite article (un/une) (unpublished data). The indefinite article differs from the article in that it always marks gender in its form, even in front of vowel-initial nouns. Whereas the effect of the ending was replicated, there was no effect of the article, suggesting that the critical factor underlying agreement errors in Experiment 3 is the absence of a gender marker on the elided definite article.

The second piece of evidence comes from a study we conducted using a technique of agreement elicitation in on-line picture naming (Franck & Frauenfelder, 2005). In this procedure, agreement is produced on the basis of non-linguistic stimuli, which eliminates the comprehension phase of the experimental procedure. A cost in reaction times was observed in agreement production involving unmarked articles as compared to marked articles,

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again suggesting the existence of a direct effect of article marking on agreement production.

EXPERIMENT 4: INCONSISTENT GENDER MARKING ON THE NOUN AND ON THE ARTICLE IN SPANISH

Experiment 4 differs from Experiments 1–3 in that rather than manipulating nouns or articles that are morphophonologically unmarked, we manipulated nouns and articles that are inconsistently marked; they point to the wrong gender feature. Such a manipulation was only possible in Spanish. If the system is finely tuned to the distributional properties of the syntax-to-form relation, inconsistent markers are expected to disrupt agreement.

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Method

Participants. Thirty-two native Spanish speakers from the University of Arizona, different from Experiment 1, were paid to participate.

Materials. The variables manipulated in this experiment were: (a) the gender marking of the head noun (consistent vs. inconsistent); (b) the gender marking of the head noun's article (consistent vs. inconsistent); (c) the gender match between the head and intervener (match/mismatch).

Manipulation of the marker on the noun involved using nouns whose ending points to the incorrect gender feature: these nouns end in -a but are masculine (e.g., *el enigma*). The gender of these nouns is correctly marked on the article which marks the masculine (*el*). Manipulation of the marker on the article was done by using nouns whose article points to the incorrect gender feature: these nouns are preceded by the article *el* although they are feminine (e.g., *el agua*). The gender of these nouns is nevertheless marked on the ending which marks the feminine (-a).

Since the number of such words in the language is small, we had only small groups of each type. There were 14 masculine nouns inconsistently marked on the noun's ending and 10 nouns incorrectly marked on the article (see Appendix D). These 24 irregular nouns were paired with a regular control word matched in frequency (Julliand & Chang-Rodriguez, 1964), sharing the same gender, the same number of syllables, and consistently marked both on the ending and the article. Examples of experimental items are presented in Table 8.

Experimental materials consisted of 24 experimental items and 24 control nouns used as head nouns. Only two of them were animate nouns but with surface gender, that is, a gender feature that is not dependent on the sex of the referent and which is used to refer to both sexes (*águila*, eagle and *ave*, bird). As in Experiments 1–3, preambles consisted of a subject head noun

TABLE 8
Examples of experimental materials used in Experiment 4 (Spanish)

Condition	*Item*
Gender match Consistent ending	El miedo al fracaso-EXTENDIDO (The fear of failure, EXTENDED)
Gender mismatch Consistent ending	El miedo a la ruina-EXTENDIDO (The fear of ruin, EXTENDED)
Gender match Inconsistent ending	El tema del artículo-POLÉMICO (The theme of the article, POLEMIC)
Gender mismatch Inconsistent ending	El tema del columna-POLÉMICO (The theme of the column, POLEMIC)
Gender match Consistent article	La lista de la compra-COMPLETO (The list for the shopping, COMPLETO)
Gender mismatch Consistent article	La lista del mercado-COMPLETO (The list for the market, COMPLETO)
Gender match Inconsistent article	El ala de la avioneta – DAÑADO (The wing of the aircraft, DAMAGED)
Gender mismatch Inconsistent article	El ala del pájaro-DAÑADO (The wing of the bird, DAMAGED)

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and a modifying prepositional phrase and were paired with adjectives. All the interveners had gender marked endings and articles.

There were also 32 fillers with the same overall form as the experimental items. The fillers all had plural heads. Half of them had a masculine head, the other half a feminine head. As in Experiment 1, some variability in the structure of the preambles was introduced (adjective phrases and compounds).

Procedure, scoring criteria, design and data analysis. ANOVAS on the arcsine transformation of error proportions were conducted separately for gender marking and article marking; both variables were crossed with gender match. All variables were part of a within-participant design, gender marking and article marking were part of a between-item design while gender match was part of a within-item design.

Results and discussion

Of a total of 1536 responses, there were 1081 (70.4%) correct responses, 192 (12.5%) gender agreement errors, and 263 (17.1%) miscellaneous responses.

TABLE 9
Distribution of agreement errors and miscellaneous responses (percentages in parentheses) in the different experimental conditions in Experiment 4 (Spanish)

	Agreement errors			
	Marked ending: Consistent	*Marked ending: Inconsistent*	*Marked article: Consistent*	*Marked article: Inconsistent*
Gender match	7 (3.1)	13 (5.8)	2 (1.3)	27 (16.9)
Gender mismatch	26 (11.6)	49 (21.9)	8 (5.0)	60 (37.5)
	Miscellaneous errors			
	Marked ending: Consistent	*Marked ending: Inconsistent*	*Marked article: Consistent*	*Marked article: Inconsistent*
Gender match	36 (16.1)	45 (20.1)	22 (13.8)	27 (16.8)
Gender mismatch	36 (16.1)	43 (19.2)	30 (18.8)	25 (15.6)

The distribution of agreement errors and miscellaneous responses in the experimental conditions is illustrated in Table 9.

Distribution of agreement errors. The ANOVA involving article marking and gender match shows that errors were more frequent with inconsistent than with consistent articles, $F_1(1, 31) = 99.2$, $p < .001$; $F_2(1, 9) = 61.1$, $p < .001$, and they were more common in the mismatch condition than in the match condition, $F_1(1, 31) = 19.4$, $p < .001$; $F_2(1, 9) = 19.9$, $p = .002$. These two variables showed an interaction in the analysis with participants as random factor, $F_1(1, 31) = 4.7$, $p = .037$, but not in the analysis by items, $F_2(1, 9) = 1.7$, $p = .228$. The ANOVA involving noun marking and gender match shows that errors were significantly more common with inconsistent endings than with the consistent controls, although the analysis using items as random factor fails to reach significance, $F_1(1, 31) = 9.5$, $p = .004$; $F_2(1, 13) = 2.6$, $p = .130$. Errors were more common in the mismatch condition, $F_1(1, 31) = 29.9$, $p < .001$; $F_2(1, 13) = 23.8$, $p < .001$. These two variables did not interact, $F(1, 31) = 2.7$, $p = .109$; $F_2(1, 13) = 1.1$, $p = .301$.

Distribution of miscellaneous responses. None of the effects were significant (Fs < 1).

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Experiment 4 shows that inconsistent markers, whether on the noun or on the article, substantially increase agreement error rate. This result reinforces and extends the findings of the previous experiments that gender marking influences agreement. Moreover, Spanish speakers, like French speakers but in contrast to Italian speakers, appear sensitive to the morphophonological markers present on the article to compute agreement.

Inconsistent articles were statistically more disturbing to the agreement system than inconsistent endings, $t(31) = -7.37$, $p < .001$, replicating the advantage for the article found in Experiment 3 in French. Whereas the ending provides a reliable gender marker for about 70% of the nouns in Spanish, the article marks gender in virtually 100% of the cases. Thus, the agreement system appears to take this difference into account, by giving more weight to the morphophonological gender information carried by the article than to that carried by the noun ending.

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GENERAL DISCUSSION

The results of the four experiments in Spanish, Italian, and French converge in demonstrating the role of morphophonological gender markers in agreement production. Differences were reported between languages as well as between gender markers within languages, suggesting that morphophonology affects agreement under precise conditions. We start with a summary of these effects and an attempt to identify factors modulating them. In the second part of the General Discussion, we discuss these effects in the framework of a functional model of agreement production.

What modulates morphophonological influences on agreement?

Two factors of a different nature but closely interrelated were found to modulate morphophonological influences on agreement. The first factor, structural in nature, is the position of the marker in the subject noun phrase (on the noun vs. on the determiner). The second factor, distributional in nature, is a combination of the reliability of the marker and its frequency in the language, which we referred to as its validity (Bates & MacWhinney, 1989).

How do these factors show up in the data? We manipulated markers in two different structural positions, the noun ending and the definite article, and found differential effects for these two markers within and between languages. In Italian, a strong effect of the ending was reported, while no effect of the article was observed. In Spanish, significant effects of both the ending and the article were found. In French, a weak effect of the ending was found, together with a strong effect of the article.

We suggested that the difference between Italian, which did not show an effect of the article, and French and Spanish, which did, lies in the validity of the nominal marker. In Italian, the -o and -a nominal inflections not only are infallible markers of masculine and feminine features, they are also present on more than 80% of the nouns (see Table 1). In Spanish, -o and -a inflections are good markers of gender too, however, in contrast to Italian, a small proportion of nouns have an ending that is inconsistent with the gender feature. Moreover, 30% of the nouns end with inflectional markers that are not associated to one gender, which is more than in Italian. The relationship between gender and the nouns' endings is even cloudier in French. As stated in the Introduction, the definition of the ending in French is extremely difficult since there is no inflectional morpheme like in Italian and Spanish. However, some phoneme combinations are associated statistically with one gender or the other. Hence, even though no clear statistical estimate of the frequency of those associations exists in French (it varies with the number of phonemes considered in the ending), it is obvious that the ending provides a weaker cue to gender than in Italian or Spanish. We hypothesised, in line with the widely shared assumption in linguistic theory that the determiner receives its feature from the noun via an operation of agreement or concord within the NP, that morphophonological information on the noun plays a primary role in agreement since it is directly available as the noun is being encoded. Our data suggest that, indeed, in a language where the noun provides valid morphophonological gender information, like Italian, the agreement system proceeds on the sole basis of the nominal marker, independently of the presence of other potentially good markers in the noun phrase. In contrast, in a language where the noun provides only poor morphophonological information, the agreement system still shows significant sensitivity to the nominal marker.

In Spanish and in French, in which the nominal marker would be too weak to drive the agreement system alone, morphophonological information on the definite article was found to make a contribution to agreement. Critically, in these languages, the article provides a more valid cue to gender than the ending, which is not the case in Italian (see Table 1). In Spanish, the articles *el* and *la* mark gender consistently in more than 99% of the cases, and there is no phenomenon of elision which means that virtually all nouns are preceded by a consistent gender-marked article. In French, the articles *le* and *la* provide infallible gender markers, and precede about 80% of the nouns, while the remaining 20% of vowel-initial nouns take the unmarked, elided article (*l'*). Our data suggest that the agreement system of these languages takes particular advantage of this information. This interpretation is in line with the report in the literature on subject-verb number agreement showing an influence of the head noun's article in languages in which nominal markers only provide limited morphophonological cues to number (Dutch

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and German; see Hartsuiker et al., 2003; Antón-Méndez & Hartsuiker, 2007).

In sum, the system responsible for computing agreement is finely tuned to the distribution of gender markers in the language. This observation fits well with statistical approaches of language processing like those developed in the framework of constraint satisfaction models (MacDonald, Pearlmutter, & Seidenberg, 1994; Trueswell & Tanenhaus, 1994; the competition model of Bates & McWhinney, 1982). In those models, processing is determined by multiple probabilistic factors in interaction. Recently, MacDonald and colleagues extended this view to language production, in particular agreement (Thornton & MacDonald, 2003; Haskell & MacDonald, 2003). Haskell and MacDonald proposed that the production of subject-verb agreement be described by: (1) competition between verb forms and (2) interaction between information sources (including semantics and phonology). Although a statistical model based on general processing mechanisms like competition and interaction can provide a fine description of how much conceptual and morphophonological factors weigh on agreement respectively, it does not explain the agreement process itself which requires identifying a structural dependency between two elements in the sentence.

In the next section, a new model of the functional architecture of the agreement process is proposed. It integrates both principles of statistical processing and interactivity between information sources, in line with the constraint satisfaction and the maximalist approach (Vigliocco & Franck, 1999; Vigliocco & Hartsuiker, 2002), and principles of syntactic operation adopted in linguistic theory (e.g., Chomsky, 1995).

A NEW FUNCTIONAL MODEL OF AGREEMENT

Before presenting our model, we start by briefly describing the models of agreement that have been proposed in the psycholinguistic literature, underlining their shortcomings which our model aims to address. The first model is the Unification model, proposed by Vigliocco and her colleagues (e.g., Vigliocco, Butterworth, & Garrett, 1996). In this model, features on the subject head noun and features on the verb (or adjective) are both directly retrieved from the conceptual representation and agreement amounts to unifying these features at the level of grammatical encoding. An additional assumption was added to the model, called the 'Maximal input hypothesis' according to which not only conceptual information, but also morphophonological information influences the unification process (e.g., Vigliocco & Franck, 1999; Vigliocco & Hartsuiker, 2002). In this view, morphophonological effects on agreement are interpreted as the direct consequence of

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feedback connections from phonological encoding to grammatical encoding (e.g., Dell, 1986).[3]

Although Unification provides an account for conceptual effects, it is less clear how morphophonological effects come about. The Maximal Input hypothesis accounts for morphophonological effects on grammatical encoding in terms of interactivity between these levels. Although interactivity may characterise the relationship between the morphophonological and grammatical levels, the Maximal Input hypothesis does not provide a model of how this interaction influences agreement. Another difficulty with the Unification model is its assumption that the same process ensures the specification of features on the agreement source and on the target. This view is incompatible with most modern linguistic accounts of agreement which, in order to account for a number of syntactic phenomena, assume a fundamental difference between the way features are specified on the noun and on the verb or adjective. Whereas features on the noun are closely tied to the semantic representation (they are said to be interpretable because they contain information relevant for semantic interpretation) and therefore have to be specified with the noun from the semantics, features on the verb or adjective are uninterpretable; they are copied from the noun and consist in duplications which only play a role within the syntax (e.g., Chomsky, 1995).

In the Marking and Morphing model proposed by Bock and colleagues (Bock et al., 2001Bock et al., 2004; Eberhard et al., 2005), agreement is more finely decomposed in two functionally distinct components. Marking is the process that imports notional number from the semantics into the syntax. It operates at the interface between the message level and grammatical encoding, and is assumed to be the locus of conceptual influences on agreement. Morphing is a set of interrelated operations. Its first role is to match number-relevant features from the syntax (number marking) and the lexicon (number specifications). Morphing also binds morphological information to structural positions. Finally, morphing transmits number features to structurally controlled constituents (e.g., to verbs). Attraction is assumed to occur at the level of Morphing, independently of conceptual representations, in line with the experimental report that conceptual properties of the head noun modulate agreement, but those of the

[3] As Vigliocco and Hartsuiker (2002) discussed it, a strictly feedforward model can also account for the data if it includes the assumption of an internal monitoring component (e.g., Levelt, 1983, 1989). However, the empirical criteria recently proposed by Hartsuiker (2006) to distinguish feedback from monitoring rather support an interpretation of morphophonological effects on agreement in terms of feedback.

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intervening noun fail to modulate attraction.[4] With respect to morphophonological properties, given the interrelations between morphophonological specification and feature transmission at the level of Morphing, attraction is expected to show sensitivity to morphophonological information: 'Phonology may influence the process with which we are concerned (Vigliocco & Hartsuiker, 2002), particularly morphophonology (Hartsuiker, Schriefers, Bock & Kikstra, 2003; Haskell & MacDonald, 2003)' (Eberhard et al., 2005, p. 9).

At the theoretical level, the inclusion of the transmission of agreement features and their morphological realisation within the single process of Morphing contradicts a number of arguments in the linguistic literature. One of these is that agreement has been shown to be a condition for nominative case assignment (e.g., Cardinaletti, 1997; for psycholinguistic evidence in language development see Schutze, 1997, and Guasti & Rizzi, 2002). Hence, the existence of languages that assign case without expressing agreement in the morphology (e.g., the past tense in English) suggests that agreement has been realised syntactically, independently of morphology. At the experimental level, psycholinguistic research on attraction does not seem to fit the model's prediction that morphophonology influences attraction at the level of Morphing. As discussed in the Introduction, the effects reported by Hartsuiker et al. (2003) and by Haskell and MacDonald (2003) can both be interpreted without assuming morphophonological influences on attraction (erroneous function assignment and general conceptual representation of the subject phrase). In contrast, the study allowing for a straightforward interpretation of the results in Italian (Vigliocco et al., 1995), together with the initial report in English (Bock & Eberhard, 1993) showed that the morphophonological properties that influence agreement when manipulated on the head noun do not influence attraction when manipulated on the intervener. Hence, in line with syntactic theory, psycholinguistic data suggest that two separate components underlie the morphophonological and syntactic operations involved in agreement.

The processing model of agreement we propose here is theoretically anchored in modern theoretical syntax (e.g., Chomsky, 1995) and in psycholinguistic models of single word production (e.g., Rapp & Goldrick, 2000). It aims to provide a good fit of the agreement phenomena reported

[4] Hupet, Fayol, and Schelstraete (1998) and Thornton & MacDonald (2003) reported significant effects on agreement of the plausibility of the intervener. That is, whether the intervener could be plausibly used as subject of the sentence affects agreement. This effect may be taken to suggest that agreement is influenced by the conceptual properties of the intervener. However, these effects may straightforwardly be accounted for in terms of occurring during functional assignment processes, rather than agreement processes: the more plausible as a subject the intervener, the more likely it could be erroneously assigned the subject function.

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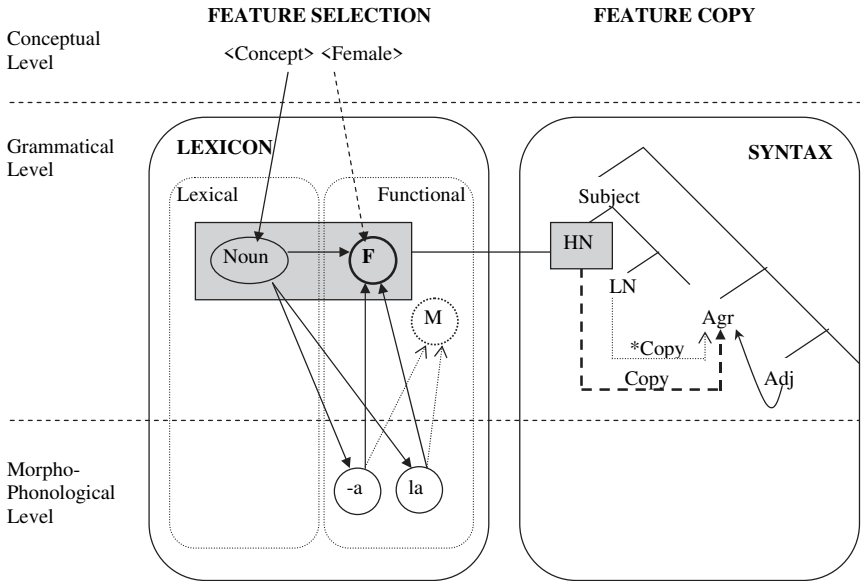

Figure 1. Components involved in the Feature Selection and Copy model of agreement. The Figure illustrates gender agreement of a predicative adjective with a feminine noun in a language like Spanish. Feature selection takes place in the Lexicon. The feminine gender node (F) receives activation from the Female notion at the Conceptual level if the concept to be expressed is animate, from the Noun lemma at the Grammatical level, and from the feminine suffix (*-a*) and feminine article (*la*) at the Morphophonological level via feedback connections within the Functional lexicon. These connections also weakly activate the masculine gender node (M) due to the few grammatically masculine Spanish nouns taking the suffix *-a* or the article *la*.

The gender feature, once selected in the Functional Lexicon, serves as input to the operation of Feature copy, which takes place in the Syntax. The feature on the head noun (HN) is copied to a gender agreement node (Agr) to which the adjective (A) moves to get valued. If a local noun (LN) is present, its feature (selected in the same way) is occasionally erroneously copied to Agr, triggering attraction.

both in the psycholinguistic and linguistic literature. The model provides a finer functional decomposition of agreement than that assumed in the Unification/Maximal input hypothesis (in order to integrate assumptions from syntactic theory), but a different decomposition from that assumed in the Marking and Morphing model (in order to account for the lack of conceptual/morphophonological influences from the intervening noun on attraction). The model implements the fundamental distinction between interpretable features (on the noun) and uninterpretable features (e.g., on the verb or adjective) proposed in theoretical syntax by assuming two different processing components that ensure feature specification at these two syntactic positions: Feature selection and Feature copy (see Figure 1).

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The first component, feature selection, is responsible for selecting nominal features within the lexicon (left side of Figure 1). From the syntactic viewpoint, number is like an entry in the functional lexicon: a head which ends up 'agglutinated' to the noun or the article, much like tense is a separate head which ends up 'agglutinated' to the verb. Gender too is assumed to be the head of its own projection in the syntactic tree (e.g., Picallo, 1991), under some accounts as part of the number phrase (conceptual gender) or as part of the lexical entry (grammatical gender; see Ritter, 1993). Thus, nominal features are lexical units that are selected from the functional lexicon on the basis of the message (number and conceptual gender), or directly from the lexicon as a property of the lemma (grammatical gender). Feature selection is conceived of as a process of lexical selection which selects an entry in a memory store of functional units. Such a view is in line with the hypothesis that grammatical features are retrieved automatically as part of the lexical selection process (Caramazza, Miozzo, Costa, Schiller, & Alario, 2001; Finocchiaro & Caramazza, 2006).

Feature selection is assumed to be the locus of conceptual and morpho-phonological effects on agreement. Research on lexical selection has provided ample evidence of phonological influences on lemma selection, validating the hypothesis of local interactivity in the process of lexical selection (e.g., Dell, 1986; Rapp & Goldrick, 2000; Goldrick, 2006). Similarly, local interactions within the functional lexicon take place during the process of feature selection, and are responsible for the morphophonological influences we reported on agreement. A syntactic feature strongly associated to a morphophonological marker would be more likely to be selected than a feature only weakly associated to such a marker given the activation feedback that it receives from the morphophonological level. Experimental reports of conceptual and morphophonological effects on agreement therefore find a natural explanation in the view that feature selection is similar in nature to lexical selection, or even part of it.[5] In sum, the relative contribution to feature selection of conceptual and morphophonological information is a

[5] The output of feature selection is an abstract, syntactic feature that is not available directly and has to be inferred. What is the syntactic feature when the conceptual and morphophonological representations differ (e.g., 'label' in 'the label on the bottles' or 'eggs' in 'the scrambled eggs in the corner')? In our view, the syntactic feature is the one that shows up on the agreement target, by definition of agreement. If the speaker says 'the label on the bottles is green', the singular feature has been selected in line with its morphological realisation; if the speaker says 'the label on the bottles *are* green' or 'the scrambled eggs in the corner *wants* more coffee', the feature has been selected in line with its conceptual representation. That is, the lack of a mapping between the different levels of representation is at the lexical level of feature selection, not at the syntactic level of feature copy which blindly transmits the selected feature to the agreement target.

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probabilistic variable affecting the process along the lines of what we suggested in the previous section.

The second component, feature copy, is responsible for transmitting the feature selected to the agreement target and takes place within the syntax (right side of Figure 1). In syntactic theory, feature copy in subject-verb agreement involves the operation of AGREE that links the subject in its initial position within the verb phrase and a position dedicated to agreement (AgrS) where the agreement target moves in order to be valued (e.g., Chomsky, 1995). The verb then moves to this node in order to get valued. An additional Spec-head operation is then assumed to take place when the subject has moved out of its initial position inside the verb phrase to its position of specifier of AgrS (Guasti & Rizzi, 2002; see Franck, Lassi, Frauenfelder, & Rizzi, 2006, for a psycholinguistic approach of those operations). A similar operation is assumed to take place for gender agreement: the feature selected is copied (via AGREE and/or Spec-head) onto a gender agreement node to which the adjective moves in order to get valued. In contrast to feature selection which operates at the lexical level, guided by principles of activation and feedback, feature copy operates at the syntactic level, guided by configurational constraints like hierarchical structure and c-command which were found to play a critical role in attraction (see Franck et al., 2006, for experimental evidence).

Attraction occurs as the feature of a word structurally intervening on the agreement relationship is incorrectly copied to the agreement position (see Figure 1). Hence, feature copy is the locus of attraction effects in agreement. Experimental reports have shown that attraction depends on the position of the intervener in the hierarchical structure, not on its final, surface position (Bock & Cutting, 1992; Franck et al., 2004; Franck, Vigliocco, & Nicol, 2002; Hartsuiker, Antón-Méndez, & van Zee, 2001; Vigliocco & Nicol, 1998). Finer structural variables identified in syntactic theory like the type of intervention relation (precedence vs. c-command) and the involvement of subject movement in the specifier of AgrS were also found to modulate attraction (Franck et al., 2006). These observations, together with reports that conceptual and morphophonological properties of the local noun do not influence attraction, find a natural explanation in the view that the intervener's feature comes into play at this stage (feature copy) of the agreement process where features are being copied under the strict guidance of syntactic principles, along the lines of what is expected of a modular component.

We stressed that the major empirical argument against the assumption of a single process combining feature transmission and morphophonological expression in the Marking and Morphing model was the lack of a morphophonological influence from the intervener (Vigliocco et al., 1995). However, in our model, feature selection operates on the intervening noun exactly like it does on the head noun, allowing for conceptual influence and

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local feedback from its morphophonological representation. But any morphophonological or conceptual influence from the intervener can only be observed when its feature is incorrectly copied onto the agreement target, i.e., when attraction takes place, which considerably 'dilutes' the possibility of observing such influences due to the low probability of attraction. For example, if a morphophonological effect from the head noun produces a difference of 5% vs.10% agreement errors (for marked and unmarked nouns respectively), the same difference should be observed for the intervener. However, since the intervener's effect shows up only when there is attraction, the morphophonological effect of an intervener attracting agreement in 6% of the cases amounts to 5% vs. 10% out of 6%, which is 0.6% vs. 0.3%, an effect which has little chance of showing up experimentally.

The explanation for the absence of an effect of the intervener we propose here could possibly be adopted by the Marking and Morphing model. Nevertheless, in addition to providing a better fit to syntactic theory and a parsimonious hypothesis of a feature selection process assimilated to lexical selection, our Feature Selection and Copy model is supported by two empirical arguments. First, in the four experiments we reported, statistical independence was found between the effect of the morphophonological representation of the head noun and the attraction effect: the morphophonology of the head noun modulates attraction independently of the presence of a gender matching or mismatching intervener. This lack of interaction supports our hypothesis that two separate components underlie morphophonological effects (feature selection) and attraction effects (feature copy), contra the assumption of the Marking and Morphing model. Second, results by Antón-Méndez and Hartsuiker (2007) show an interaction between conceptual and morphophonological manipulations of the head noun phrase on agreement. Such an interaction would be expected if the two information sources were integrated in the process of feature selection, as in our model. In contrast, no interaction should arise under the view that morphophonology is encoded at a stage (Morphing) that strictly follows the integration of conceptual information (Marking).

Why would morphophonology influence agreement?

Agreement can be computed easily without gender markers, as attested by the high rate of correct agreement when neither the noun nor the article is marked for gender (see Experiments 2 and 3). Vigliocco and colleagues (Vigliocco & Franck, 1999, 2001; Vigliocco & Hartsuiker, 2002) discussed the conceptual and morphophonological effects on gender agreement in terms of 'benefits' to the system. They suggested that the system takes these levels of representation into account because they provide an additional pointer to gender or number. But answering the 'why' question in terms of 'finality' (benefits) for the system

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is tricky. The reason 'why' may, at a more limited level of explanation, be sought in the architecture of the language system. In our view, morphophonological influences reported in the adult system are rooted in the role these markers play in language development, and its consequences on the organisation of the lexicon. Sensitivity to phonological markers of gender has been established in language development and language comprehension. They were shown to be used by children to determine gender classes in Hebrew (Levy, 1983), in French (Karmiloff-Smith, 1978), and in Spanish (Cain, Weber-Olsen, & Smith, 1987; Peres-Pereira, 1991). In experiments with adults learning a second language or an artificial language, participants were found to successfully acquire and generalise word subclass knowledge if the subclasses were marked by morphophonological cues, whereas purely arbitrary categories were not learnable (Brooks, Braine, Catalano, Brody, & Sudhalter, 1993; Frigo & MacDonald, 1998; Holmes & Dejean de la Batie, 1999; Taraban & Kempe, 1999).

All these studies show that phonological markers are used by the learning system to identify the abstract linguistic categories with which they correlate. The fact that a mature agreement system can realise agreement without these markers shows that gender is an abstract feature represented syntactically, independently of phonology. Nevertheless, syntactic features and phonological markers would remain tightly linked, and those links, initially useful for language learning, create the grounds for the effects found in production.

It is important to underline that in our framework it is not syntax, that is, the principles that constrain the relationships between words in sentences, which is linked to phonology, but syntactic features, that is, units of the (functional) lexicon. The lexicon is conceived of as a network linking lexical units to their conceptual, syntactic, and phonological representations. Those links between levels of representation are permanent (off-line) connections in the lexical long-term memory store established during language development, but they are known to be activated on-line in the process of lexical selection (see Goldrick, 2006), and in the process of feature selection which we identified here.

CONCLUSION

Empirical evidence from four experiments conducted in three Romance languages converges in attesting to the role of morphophonological gender marking in agreement production. The data show that morphophonological influences are modulated by two closely intertwined factors of a different nature. The first factor is structural and concerns the position of the marker in the nominal phrase. The asymmetry reported between the use of nominal and article markers suggests that nominal markers play a primary role, a

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natural consequence of the fact that gender is a property of the noun. The second factor is distributional and concerns the validity of the marker defined as a combination of the strength of its connection to gender and its frequency in the language. At present, the approach we proposed is mostly qualitative; future research, for example using computer modelling, may provide a quantified estimate of the respective roles of these two factors.

We then provided theoretical and experimental arguments in support of a functional decomposition of agreement into two successive processes involving different operating modes: a process responsible for the selection of agreement features and a process responsible for copying them on the agreement target. Feature selection is the locus of morphophonological effects. It is part of the lexical selection process and operates in local interaction with conceptual and phonological levels of representation, depending on their statistical distribution in the language. Feature copy is the locus of attraction effects. In contrast to feature selection, feature copy operates in isolation from conceptual and phonological levels, under the guidance of modular syntactic principles.

Manuscript received February 2007
Revised manuscript received May 2007
First published online February 2008

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APPENDIX A

Items used in Experiment 1 (Spanish). Each preamble is shown in its eight different conditions derived from crossing four different head nouns (masculine/unmarked ending, feminine/unmarked ending, masculine/marked ending, and feminine/marked ending) and two interveners (matched in gender and mismatched in gender)

Adjective	*Preamble*
VIEJO Old	El reloj/torre/castillo/iglesia del pueblo/aldea The clock/tower/castle/church of the village/hamlet
MOJADO Wet	El puente/calle/camino/carretera detrás del rancho/casa The bridge/street/path/road behind the ranch/house
SUCIO Dirty	El picaporte/pared/suelo/puerta del baño/cocina The doorhandle/wall/floor/door of the bathroom/kitchen
BARATO Cheap	El diamante/cruz/oro/plata en el anillo/cadena The diamond/cross/gold/silver on the ring/chain
ASUSTADO Afraid	El faisán/perdiz/canario/paloma en el nido/jaula The pheasant/partridge/cannary/dove in the nest/cage
LIMPIO Clean	El tenedor/llave/vaso/copa en el fregadero/mesa The fork/key/glass/goblet in the sink/table
PODRIDO Rotten	El tomate/nuez/plátano/manzana en el armario/alacena The tomato/walnut/banana/apple in the cupboard/pantry
DESESPERADO Desperate	El mensaje/voz/recado/nota del despacho/oficina The message/voice/message/notice from the bureau/office
CERRADO Closed	El salón/habitación/cuarto/recámara del palacio/casa The livingroom/bedroom/room/chamber of the palace/house
HORROROSO Horrible	El olor/peste/aspecto/vista del establo/cuadra The smell/stench/aspect/look of the stable/cowshed
ROJO Red	El clavel/flor/crisantemo/rosa en el tiesto/maceta The carnation/flower/chrysanthemum/rosa in the flowerpot/pot
MUERTO Dead	El árbol/flor/arbusto/planta en el campo/huerta The tree/flower/shrub/plant in the field/vegetablegarden
BONITO Pretty	El sol/nube/astro/luna en el cielo/distancia The sun/cloud/star/moon in the sky/distance
RENOVADO Renovated	El cine/fuente/monumento/estatua en el zócalo/plaza The movietheater/fountain/monument/statue in the square/square
RAPIDO Fast	El yate/nave/barco/barca del consulado/embajada The yatch/ship/boat/boat of the consulate/embassy
EXTRAÑO Weird	El color/luz/fondo/figura en el cuadro/pintura The colour/light/background/figure in the picture/painting
GROTESCO Grotesque	El perfil/nariz/cuello/boca en el retrato/caricatura The profile/nose/neck/mouth in the portrait/caricature
DELICIOSO Delicious	El pastel/carne/pescado/torta en el mercado/tienda The pie/meat/fish/cake in the market/shop
PEQUEÑO Small	El país/nación/estado/zona detrás del río/frontera The country/nation/state/area behind the river/border

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APPENDIX A (*Continued*)

Adjective	*Preamble*
INEXACTO Inaccurate	El tonelaje/longitud/peso/altura del cargo/carga The tonagge/lenght/weight/height of the cargo/load
MOLESTO Annoying	El calor/humedad/viento/lluvia en el verano/primavera The heat/humidity/wind/rain in the summer/spring
INTENSO Intense	El fervor/fe/culto/creencia del pueblo/raza The ardour/faith/cult/belief of the people/race
CONOCIDO Known	El nombre/denominación/sello/marca del vino/bebida The name/denomination/seal/mark of the wine/drink
EMBARRADO Muddy	El pez/red/anzuelo/caña en el cesto/cesta The fish/net/hook/fishingrod in the basket/basket
FAMOSO Famous	El resplandor/brillantez/brillo/belleza del trono/corona The shine/brightness/brightness/beauty of the throne/crown
QUEMADO Burnt	El pote/sartén/cazo/olla sobre el fuego/cocina The pot/fryingpan/pan/saucepan on the fire/stove
NECESARIO Necessary	El orden/ley/equilibrio/estructura en el gobierno/república The order/law/balance/structure in the government/republic
NUEVO New	El hospital/carcel/sanatorio/penitenciaria en el suburbio/colonia The hospital/jail/clinic/penitentiary in the slums/colony
ABANDONADO Abandoned	El hotel/pensión/asilo/posada en el camino/carretera The hotel/pension/shelter/inn in the way/road
QUEBRADO Broquen	El farol/señal/semáforo/farola en el crucero/avenida The streetlamp/sign/trafficlight/lamppost
ABIERTO Open	El portal/clase/cerrojo/puerta del colegio/escuela The hall/classroom/lock/door of the college/school
OXIDADO Rusted	El muelle/espiral/tornillo/tuerca del aparato/máquina The spring/spiral/screw/bolt of the device/machine

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APPENDIX B
Items used in Experiment 2 (Italian)

Adjective	*Preamble*
Unmarked article, Marked ending	
GUASTO	L'aereo dell'esercito/della compagnia
Broken	The airplane of the army/company
CHIUSO	L'ingresso del palazzo/della casa
closed	The entrance of the building/house
ANTICO	L 'anello del matrimonio/ della promessa
antique	The ring of the wedding/engagement
LUNGO	L'orlo del vestito/ della gonna
long	The hem of the dress/skirt
ASPRA	L'uva del vigneto/ della ditta
sour	The grapes from the vineyard/maker
FREDDA	L'acqua del lago/della grotta
cold	The water in the lake/cave
BLOCCATA	L'elica del volano/della turbina
blocked	The air-screw of the flywheel/turbine
ALTA	L'ombra del muro/della statua
high	The shadow of the wall/statue
Unmarked article, Unmarked ending	
VECCHIO	L'abete del bosco/della foresta
old	The pine tree in the woods/forest
AFFOLLATO	L'ospedale del villaggio/della città
crowded	The hospital of the village/town
PICCOLO	L'errore del compito/della verifica
small	The mistake of the task/control
SBAGLIATO	L'esame del fegato/della milza
inaccurate	The check of the liver/kidney
INGIUSTA	L'indagine del governo/ della polizia
unfair	The investigation by the government/police
LUSSUOSA	L'automobile nella vetrina/ parco
expensive	The car in the shop window/park
IMPEGNATIVA	L'arte del massaggio/della tessitura
challenging	The art of massaging/weaving
OPACA	L'immagine del quadro/della fotografia
opaque	The image in the painting/ photograph
Marked article, Marked ending	
AMBITO	Il premio del torneo/della partita
desirable	The trophy from the tournament/game
PERICOLOSO	Il chiodo del soffitto/ della scrivania
dangerous	The nail in the ceiling/desk

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APPENDIX B (*Continued*)

Adjective	*Preamble*
APERTO	Il cancello del parco/della tenuta
open	The gate of the park/property
ROTTO	Il coperchio del bollitore/della pentola
broken	The cover of the steamer/pot
CARICA	La pila del registratore/ della sveglia
loaded	The battery of the tape recorder/ alarm clock
FASTIDIOSA	La goccia del rubinetto/ della valvola
Annoying	The drip of the tap/ tube
BIANCA	La piuma del cuscino/della coperta
white	The feather of the pillow/blanket
PREZIOSA	La perla del gioiello/ della collana
preziosa	The pearl of the jewel/necklace
Marked article, Unmarked ending	
SEGRETO	Il codice dell'ufficio/della banca
secret	The code of the office/bank
SPENTO	Il fanale del motorino/della macchina
switched off	The light of the scooter/car
DELIMITATO	Il confine dello stato/ della zona
delimitated	The boundary of the state/area
VUOTO	Il bidone di petrolio/ della benzina
empty	The tank of petrol/ gas
NERA	La cenere del camino/ della cappa
black	The ash of the chimney/cowl
INATTESA	La fine dello spettacolo/ della commedia
abrupt	The end of the show/ comedy
AMBIGUA	La frase del discorso/ della lettera
ambiguous	The sentence in the talk/ letter
INTENSA	La luce del faro/ della lampada
intense	The light of the lighthouse/lamp

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APPENDIX C
Items used in Experiment 3 (French)

Adjective	*Preamble*
Unmarked article, Marked ending	
DEGOUTANT	L'abreuvoir de la volaille/du troupeau
Disgusting	The watering place of the chicks/the herd
PRECIEUX	L'ancêtre du violon/de la trompette
Precious	The ancestor of the violin/the trumpet
PRECIS	L'examen de la demande/du document
Precise	The examination of the requirement/the document
PUISSANT	L'aimant de la machine/du mécanisme
Powerful	The magnet of the machine/the mechanism
INTERDITE	L'émission de la saison/du matin
Forbidden	The show of the season/the morning
GRANDE	L'estrade du local/de la salle
Big	The platform of the office/the room
GENANTE	L'antenne du pavillon/de la mairie
Annoying	The antenna of the bungalow/the town hall
AMBITIEUSE	L'élite du pays/de la nation
Ambitious	The elite of the country/the nation
Unmarked article, Unmarked ending	
FATIGUANT	L'exposé de la situation/du raisonnement
Tiring	The presentation of the situation/the reasoning
NOUVEAU	L'élastique de la boite/du paquet
New	The rubber band of the box/the pack
HONTEUX	L'arrêté de la justice/du tribunal
Shameful	The decision of justice/the court
CONFUS	L'énoncé de la devinette/du dicton
Confused	The statement of the riddle/the saying
MAUVAISE	L'optique du gouvernement/de la commission
bad	The viewpoint of the government/the commission
IMPORTANTE	L'unité du mouvement/de la patrie
important	The unity of the movement/the country
LUMINEUSE	L'applique du couloir/de la cuisine
bright	The lamp of the corridor/the kitchen
DÉLICATE	L'éthique du laboratoire/de la médecine
tricky	The ethics of the laboratory/medicine
Marked article, Marked ending	
BOUEUX	Le chemin dans la vallée/dans le marais
muddy	The way in the valley/the marsh
ATTIRANT	Le manoir de la bourgade/du hameau
attractive	The manor of the township/the village
BRUYANT	Le moteur de la chaloupe/du bateau
noisy	The engine of the launch/the boat

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APPENDIX C (*Continued*)

Adjective	*Preamble*
ODORANT smelling	Le bouleau dans la rocaille/dans le jardin The birch in the rock work/the garden
EPATANTE amazing	La réussite du gâteau/de la recette The success of the cake/the recipe
PLAISANTE pleasant	La balade dans le bosquet/dans la prairie The walk in the wood/the meadow
EVIDENTE obvious	La raison du conflit/de la bataille The reason of the conflict/the fight
SECRETE secret	La mission du bataillon/de la brigade The mission of the battalion/de brigade
Marked article, Unmarked ending	
ANCIEN old	Le portique de la bâtisse/du château The porch of the building/the castle
SINUEUX sinuous	Le refuge dans la tranchée/dans le souterrain The refuge in the trench/the underground
AMUSANT amusing	Le cortège du carnaval/de la procession The suite of the carnival/the procession
ELEGANT elegant	Le décolleté de la chemise/du tailleur The neck opening of the shirt/the suit
FAMEUSE famous	La qualité du produit/de la récolte The quality of the product/the gathering
PRECIEUSE precious	La réplique du monument/de la statuette The copy of the monument/the statue
PAYANTE Charged for	La boutique du palais/de la galerie The shop of the palace/the gallery
VIEILLE old	La façade du bâtiment/de la clinique The front wall of the building/the hospital

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APPENDIX D
Items used in Experiment 4 (Spanish)

Adjective	*Preamble*
Inconsistent endings	
ANTIGUO Old	El lema del instituto/academia The motto of the institute/academy
INTENSO Intense	El aroma del geranio/rosa The bouquet of the geranium/rose
HUMEDO Humid	El clima en el puerto/isla The climate in the harbour/island
NUBLADO Cloudy	El día del partido/boda The day of the match/wedding
ENTRETENIDO Entertaining	El drama sobre el incendio/piratería The drama about the fire/piracy
MISTERIOSO Mysterious	El enigma del tesoro/corona The enigma about the treasure/crown
CORRECTO Correct	El mapa del desierto/jungla The map of the desert/jungle
SUCIO Dirty	El pijama en el suelo/cama The pyjamas on the floor/bed
EMOTIVO Emotional	El poema sobre el concierto/mina The poem about concert/mine
SOLUCIONADO Solved	El problema del aparato/máquina The problem of the device/machine
DOLOROSO Painful	El síntoma en el codo/rodilla The symptom in the elbow/knee
COMODO Comfortable	El sofá en el vestíbulo/sala The sofa in the hall/room
POLEMICO Polemic	El tema del artículo/columna The theme of the article/column
UNICO Unique	El trauma del mundo/historia The trauma of the world/history
Controls for inconsistent endings	
RECTO Straight	El tallo del lirio/rosa The stem of the iris/rose
ENCENDIDO Lighted	El cigarro en el cenicero/caja The cigar on the ashtray/box
MOLESTO Annoying	El ruido del festejo/fiesta The noise of the celebration/party
RECORDADO Remembered	El año del terremoto/guerra The year of the earthquake/war
TIERNO Tender	El beso en el cuello/mejilla The kiss on the neck/cheek

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APPENDIX D (*Continued*)

Adjective	*Preamble*
RAPIDO Fast	El contagio del catarro/rubeola The contagion of the cold/rubella
DESAFINADO Out-of-tune	El piano en el teatro/cafetería The piano in the theatre/cafeteria
INJUSTO Unfair	El decreto sobre el comercio/mercadería The decree about the commerce/merchandising
BUENO Good	El impulso contra el abuso/injusticia The impulse against the abuse/unjustice
OPRESIVO Oppressive	El gobierno del estado/república The government of the state/republic
ALTO Tall	El impuesto sobre el sueldo/renta The tax on the salary/income
PREPARADO Ready	El horno para el pescado/torta The oven for the fish/cake
EXTENDIDO Extended	El miedo al fracaso/ruina The fear of the failure/ruin
BELLO Beautiful	El himno en la misa/servicio The hymn in the mass/service
Inconsistent articles	
DAÑADO Damaged	El ala del pájaro/avioneta The wing of the bird/aircraft
ASUSTADO Frightened	El ave en el nido/jaula The bird in the nest/cage
MAJESTUOSO Mayestic	El águila en el zoológico/reserva The eagle in the zoo/reservation
HUMEDO Wet	El azúcar en el plato/taza The sugar in the plate/cup
ANIMADO Jolly	El alma del grupo/fiesta The soul of the group/party
AFILADO Sharp	El hacha sobre el tronco/madera The hatchet on the trunk/wood
PURO Pure	El agua en el pozo/olla The water in the well/pot
ESCONDIDO Hidden	El arca con el tesoro/joyería The chest with the treasure/jewellery
LIMITADO Limited	El área del piso/casa The surface of the flat/house
PEQUEÑO Small	El aula en el colegio/escuela The classroom in the college/school

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APPENDIX D (*Continued*)

Adjective	*Preamble*
Controls for inconsistent articles	
DURO Hard	La silla en el despacho/oficina The chair in the bureau/office
COMPLETO Complete	La lista del mercado/compra The list for the market/shopping
VACIO Empty	La cartera en el bolso/bolsa The wallet in the purse/bag
ROTO Broken	La muñeca en el suelo/mesa The doll on the floor/table
GANADO Won	La guerra contra el despotismo/tiranía The war against the despotism/tyranny
ALTO Tall	La tapia del convento/escuela The wall of the convent/school
BONITO Beautiful	La vista del río/montaña The view of the river/mountain
CERRADO Closed	La vaina del cuchillo/espada The sheath of the knife/sword
SOLEADO Sunny	La esquina del zócalo/plaza The corner of the square/square
ROJO Red	La tinta en el tintero/botella The ink in the inkpot/bottle

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