Gender-number dissociations in sentence production in Spanish

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In this study, we present evidence from various sources to support the claim that gender and number have different processing loci in Spanish. After a short review of current linguistic accounts of the representation of gender and number in Spanish, we argue for a dissociation in the processing of gender and number information during sentence production, on the assumption that gender information is lexically specified whereas number information is retrieved and used in structure-building processes. Drawing on a taxonomy proposed for gender in Spanish nouns and adjectives, we report an analysis of speech error patterns and a study of word exchanges by instruction that provide converging evidence for our claims on dissociation. We also discuss the implications of our results for linguistic accounts of the representation of gender and number and for current psycholinguistic models of sentence production. *

1. Introduction

The aim of this paper is to explore the processes involved in encoding agreement relations among sentence constituents in Spanish, particularly those concerning gender and number agreement within noun phrases. Our major claim is that gender and number are represented and assigned in a different fashion during sentence production. In addition, we will examine some representational and processing differences among various types or categories of gender that have recently been proposed in a taxonomy of the Spanish gender system. A final aim of our study was to assess the role of a conceptual variable, namely plausibility, in the assignment of gender and number in complex noun phrases, in order to find out whether or not the processing of noun inflections is sensitive to conceptual constraints. In order to substantiate our claims, we will report two studies of sentence production in Spanish. First, an analysis of speech error patterns in Spanish involving gender and number misassignments will provide evidence of a different distribution of gender and number features in slips of the tongue. Second, an experiment of elicited word exchanges in complex NPs will show that gender and number morphemes behave quite differently when subjects are asked

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to exchange the head nouns of a complex NP. Moreover, the results of this experiment seem to indicate that plausibility does not play a significant role in gender and number processing.

In this introduction, we will first provide a brief description of agreement processes within the framework of current models of grammatical enconding in sentence formulation (Bock & Levelt 1994). Next, we will review some critical facts about the representation of gender and number in Spanish that lend support to our "dissociation" hypothesis. We will also present a taxonomy of Spanish gender recently proposed on linguistic and psycholinguistic grounds by Elías-Cintrón (1994), which we use in the experiment reported later on. In Section 2, we will present the analysis of a subset of spontaneous speech errors selected from a Spanish corpus (Del Viso, Igoa & García-Albea 1987), including gender and number deletions, additions, substitutions and misplacements, that was carried out to provide some evidence for processing dissociations between gender and number. In Section 3, we will report the results of our experiment on gender and number assignment with a word exchange task. Finally, we will make some concluding remarks on the implications of our studies for the representation and processing of gender and number information in Spanish.

1.1. Agreement processes in sentence production

Agreement can be defined as a structural relation that holds between two or more grammatical units in a sentence by virtue of their sharing a set of common features (Quirk, Greenbaum, Leech & Svartvik 1972; Elías-Cintrón, 1994). In the case of Spanish, these shared features are "person" and "number" in subject-verb agreement relations (see example 1), and "gender" and "number" in agreement relations between the head of an NP and other constituents within that NP (e.g. determiner and modifiers, as in example 2a) or between an NP and an adjunct predicate of that NP, as shown in example 2b.

(1) $[[\text{La niña}]_{NP}\ [[\text{ha}]_{I}\ [[\text{comido}]_{V}\ [\text{pan}]_{NP}]_{VP}]_{IP}$

3 SG

'The girl has eaten bread'

(2) a. $[[\text{La}]_{D}\ [[\text{profesora}]_{N}\ [\text{alemana}]_{MOD}]_{N'}]_{NP}$

F.SG

'The german [female] teacher'

b. $[\text{Los niños}]_{NP}\ [\text{jugaban}]_{V}\ [\text{contentos}]_{PRED}$

M.PL

'The children played happy'

Agreement relations in Spanish are usually signalled by inflectional suffixes, which are commonly, though by no means always, a vowel for gender marking (/o/ for masculine, and /a/ for feminine), and consonant /s/ (sometimes preceded by the epenthetical vowel /e/) for number marking. However, as will shortly be shown, over and above this morpho-phonological marking, gender and number features are represented at other levels as well. For instance, there is a conceptual representation of gender for animate entities which derives from the semantic feature of sex, and a syntactic representation of gender that is reflected in the gender marking of syntactic constituents such as determiners and modifiers. As for number, we also find a conceptual feature of "numerosity", also called "notional number", which, to some extent, is independent of morpho-phonological marking by a number suffix, and a syntactic feature of "plurality" that is represented as part of a word's grammatical features and reflected in agreement relations.

The issue we want to tackle in this article is the question of how the inflectional features of gender and number are retrieved and assigned in the course of sentence formulation. In language production theories, inflectional processing is usually thought to include both the processes involved in generating closed class or function words (i.e. free morphemes) associated with grammatical phrases, and the generation of bound inflections (Garrett 1982, in press; Bock & Levelt 1994). Agreement processes like those addressed in this paper involve both kinds of elements, insofar as determiners of NPs belong to the closed class vocabulary and carry gender and number information in Spanish, as do inflectional suffixes of nouns and adjectives. A noncontroversial claim concerning inflectional processing is that the retrieval of all inflected forms from the lexicon and their assignment to phrasal frames are carried out independently from the selection and insertion of open class words in the syntactic frame of the sentence (Garrett 1980a, García-Albea, del Viso & Igoa 1989). This means that gender and number information are retrieved in an abstract form prior to both the insertion of content words in the sentence and the phonological specification of closed class words and inflectional suffixes. Two pieces of evidence from speech error analysis that support this claim are (1) the stranding of inflectional suf-

fixes found in many words exchange errors, in which word stems are misplaced while their inflectional suffixes remain stranded in their original position (like the stranding of the plural suffix in example (3a), and the stranding of tense, person and number suffixes of the verbs in example (3b)) (Garrett 1980a, 1991, García-Albea *et al.*, 1989); and (2) the accomodation of inflectional features of words located in the grammatical environment of another word which has undergone a misplacement operation (as the gender and number adjustment, from masculine singular (*el*) to feminine plural (*las*), shown by the determiner of the first noun in example (4) (Garrett 1980b, Berg 1987, Igoa 1996). However, it should be stressed that strandings and accomodation do not occur at the same stage of grammatical encoding (Garrett 1980, in press). Rather, the stranding of inflections is usually taken as evidence of early assignment of inflectional features to the sentence frame, while accomodation are regarded as adjustment processes that occur after word insertion and modify the inflectional features previously assigned to the frame.

(3) a. Esas *bocas* no han salido de mi *palabra* (Esas palabras no han salido de mi boca)
Those mouths haven't come out of my word (Those words haven't come out of my mouth)

b. No *quiero* que *crea* (no creo que quiera) I don't want he'll think (I don't think he'll want)

(4) Las *manecillas* sin *reloj* (el reloj sin manecillas)
The hands without clock (the clock without hands).

In addition to this evidence, the fact that phonological errors involving individual sounds equally affect open and closed class words and suffixes demonstrates that phonological encoding is ignorant of these grammatical distinctions (Dell 1990).

A different issue concerns how the processes of retrieval and assignment of inflectional features are exactly carried out during grammatical encoding, and moreover, to what extent gender and number undergo the same sort of processes. According to the received view (Chomsky 1965, Garrett 1976, Kempen & Hoenkamp 1987, Bock & Levelt 1994), grammatical features of nouns such as gender and number are retrieved from the *lemma*, that is the abstract representations of lexical concepts containing information about the meaning, the syntactic class and other grammatical properties of lexical

items (Kempen & Huijbers 1983, Levelt 1989). Once this information has been retrieved, phrase structure building procedures are called to operate, in order to provide a syntactic representation of the sentence. In the course of these processes, the grammatical features of open class words are projected from the lemmas of phrasal heads (gender and number in NPs, person and number, and, in some cases, gender, in VPs) to other constituents within phrases, or to constituents of other phrases, as is the case in subject-verb agreement operations. More specifically, this procedure has been described as one consisting of the "percolation" of grammatical features from lemmas up to phrasal nodes and down again to specifiers and modifiers within NPs, and up to the subject-NP and the IP nodes, and from there down to the VP and the INFL nodes in subject-verb agreement (see Figure 1).

However, this percolation process can occur in two different ways. According to the standard view of subject-verb agreement operations (Kempen & Hoenkamp 1987), the grammatical features of the subject noun are copied to the VP and its constituents, such that the subject of the sentence controls the assignment of number (and person) to the verb. An alternative model claims that grammatical features are not copied from the controller noun to the controlled verb, but rather retrieved and assigned independently within both phrases and "unified" at a higher level of the syntactic tree (Vigliocco, Butterworth & Semenza 1995, Vigliocco, Butterworth & Garrett 1996). Regardless of which version turns out to be correct, the underlying assumption is that the inflectional information is carried with the lemma, hence the retrieval and assignment of gender and number features are lexically driven processes (Levelt 1989).

Most of the evidence bearing on this issue comes from studies of induced subject-verb agreement errors in number (Bock & Miller 1991, Bock & Cutting 1992, Bock & Eberhard 1993). In these experiments, subjects are presented with sentence preambles which they have to complete. In the critical conditions, the preambles consist of a complex NP like those in examples (5), which has an embedded constituent (a phrase modifying the first NP in (5a), and a complement clause in (5b)).

(5) a. The claim [about the stolen babies] ...
b. The claim [that wolves were stealing the babies] ...

This sentence completion task is expected to induce subject-verb

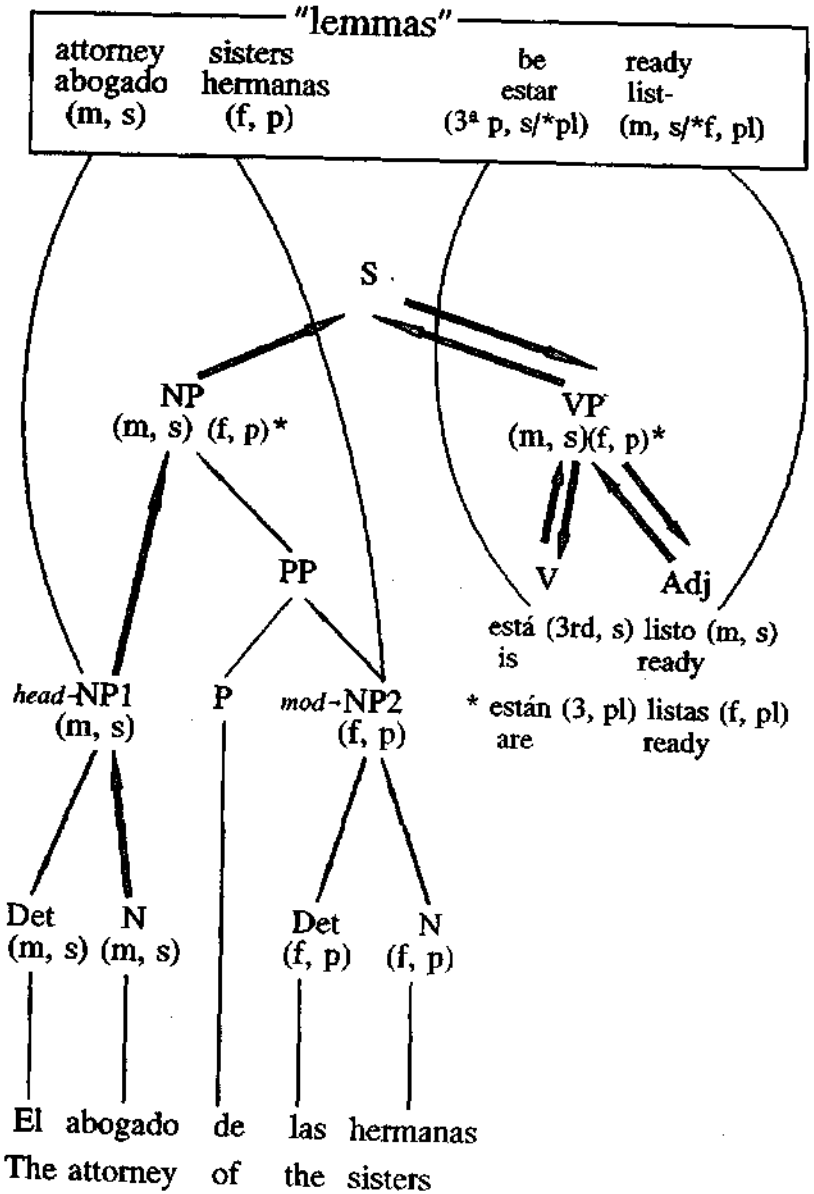

Figure 1. Diagram representing the processes of gender and number agreement in grammatical encoding. The examples show both agreement within the constituents of an NP and between the subject and the verb of a sentence.

agreement errors whenever the number of the two head nouns, the subject-NP and the final noun in the embedded constituent, mismatch, due to the proximity of a conflicting cue in the latter noun. The errors thus induced have been termed "attraction errors", since the second noun is thought to attract the number feature that is supposed to be assigned to the verb, or also "proximity errors", due to the proximity of the interfering noun to the verb. The attraction process can be traced in the model shown in Figure 1 above. In a complex NP like the subject-NP in Figure 1, the grammatical encoder is supposed to copy or unify the features of person and number from the head noun of the first NP; that is, the grammatical features of the NP projection are inherited from the head noun of NP1, while those of the head noun of NP2 remain blocked within this NP. Eventually, however, a failure in the copying (or unifying) mechanism may result in the transmission of the wrong features (those of NP2) to the verb, resulting in an attraction error like the one shown in the figure with an asterisk.

The aim of the studies of agreement errors is manifold, just as the number of variables that can be manipulated in these experiments. For example, Bock & Miller (1991) tested the role of conceptual variables in agreement errors and found that the probability of making such errors is not sensitive to the conceptual number of the subject-NP, but only to its grammatical number. Thus, the same amount of errors are obtained regardless of whether there is a mismatch between the notional or conceptual number of the head NP and its grammatical number (as in (6a)) or both types of number match (as in (6b)). Note that (6a) admits a "distributive" interpretation whereby each bottle has a different label, whereas a distributive reading is not possible in (6b) (i.e. there is only one baby on the blankets).

(6) a. The label on the bottles
b. The baby on the blankets.

In contrast, Vigliocco *et al.* (1995, 1996) have found cross-linguistic evidence of an effect of notional number on agreement errors, such that when the subject-NP's notional number differs from its grammatical number, the error rate raises significantly. Thus, errors like (7a) (Italian) and (8a) (Spanish), which have a distributive reading, were much more common than (7b) and (8b), which only admit a nondistributive interpretation.

(7) a. Il disegno sui quaderni sono colorati
The$_{M.SG}$ drawing$_{M.SG}$ on the$_{M.PL}$ exercise bookse$_{M.PL}$ are$_{3PL}$ colored$_{M.PL}$
b. La danza delle sirene sono fantastiche
The$_{F.SG}$ dance$_{F.SG}$ by the$_{F.PL}$ sirens$_{F.PL}$ are$_{3PL}$ fantastic$_{F.PL}$

(8) a. La puerta de las casas están pequeños
The$_{F.SG}$ door$_{F.SG}$ of the$^{F.PL}$ houses$_{F.PL}$ are$_{3PL}$ small$_{M.PL}$
b. El debate sobre las drogas fueron ayer
The$_{M.SG}$ discussion$_{M.SG}$ about the$_{F.PL}$ drugs$_{F.PL}$ were$_{3PL}$ yesterday.

Another factor that has been shown to influence the percentage of induced agreement errors is the nature of the linguistic unit in which the attractor noun is located. However, the results in this respect are also contradictory. Bock & Cutting (1992) found that in English, modifier phrases induce a greater number of errors when compared to complement clauses (see examples in (5) above), irrespective of the length of the interfering constituent. Conversely, Nicol (1995) has recently reported the opposite result, that is, an effect of constituent length on the proportion of errors. According to Bock & Cutting, phrases induce more agreement errors than clauses because clauses are encoded hierarchically and independently from one another in language production, whereas phrases are not. Hence the assignment of verb inflections can be distorted by interferences ocurring within the same clause, but not from another clause, even if it is an embedded clause.

A very consistent effect found in studies of induced number agreement errors concerns the asymmetry of the number mismatch between the two head nouns of the preamble. It has been consistently reported that attraction errors are far more common when the head noun is singular and the attractor is plural than the reverse (Bock & Miller 1991). This has been interpreted as showing that plural is the marked value of the number feature, and hence more salient than singular, which is unmarked (Eberhard 1996).

Finally, the controversy between models based on a copying mechanism and those supporting a unification procedure for agreement operations seems to have been lately settled in favor of the latter view. In a series of recent studies, Vigliocco and coworkers have reported an effect of notional number on agreement errors in languages such as Spanish and Italian (Vigliocco, Butterworth & Garrett 1996), and Dutch and French (Vigliocco, Hartsuiker, Jarema & Kolk

1996). They argue that this effect can be better explained if one assumes that, at least in the above languages, agreement features regarding number can be retrieved from various sources of information, instead of being controlled only by the subject of the sentence. One of these sources is the discourse information that happens to be active at a given time during sentence planning. On this account, the effect of notional number in languages other than English could reflect the greater availability of semantic information from the discourse or message level and the fact that semantic information can simultaneously guide the selection of number information when the verb and the subject-noun lemma become activated. In this connection, the semantic influence on number retrieval and assignment appears to be facilitated by the richer verbal morphology found in certain languages, particularly by the fact that number is explicitly reflected in the verb phrase in those languages.

1.2. On the representation of gender and number in Spanish

Genders are referred to as classes of nouns that are reflected in the behavior of associated words (Corbett 1991). Agreement is but one of these possible behaviors. This broad definition is intended to cover different criteria for the various gender classifications found across languages. For instance, agreement systems have been classified into three types, namely trivial, invariant and variant (Elías-Cintrón 1994). The variant agreement systems, such as that of Spanish, can show morphophonological and syntactic evidence of a given agreement feature. Morphophonological evidence refers to the surface marking of words by an inflectional suffix; syntactic evidence concerns the correspondence in a given feature among words within a syntactic domain. In Spanish, the gender feature can be determined by the semantics of words or by their morphology. In the former case, nouns standing for animate entities have an inherent semantic gender depending on whether they are male or female, and a derived syntactic and morphophonological gender that is usually, though not systematically, marked by means of a vowel. Inanimate entities show the same morphophonological and syntactic gender properties as animate ones, but of course they lack semantic gender.

Number, on the other hand, shows a different behavior from gender, to the extent that it is more often than not predictable from the semantics of phrases, and as such, independent from individual lexical items. This is to say that whereas gender can (and, in languages like Spanish, must) be specified for certain grammatical classes of

words, such as nouns, adjectives and some pronouns, number information is not lexically specified in general terms. There are only a few exceptions which will be indicated below. Therefore, it can be assumed that the grammatical feature number (which we term 'plurality') is derived from a semantic feature of 'numerosity' for a vast majority of cases, whereas the grammatical feature gender is usually an arbitrary feature of lexical items. Hence, the statement that 'singular' is the default value for the number feature of Spanish words amounts to the claim that words are represented as singular in the mental lexicon. On the contrary, it can be argued that Spanish words include a specification of their grammatical gender.

On the basis of the regularities found in the Spanish gender system, Elías-Cintrón has devised a taxonomy for Spanish gender in which words (mostly nouns) are stratified in four levels, based on their morphophonological, syntactic and semantic gender properties (Elías-Cintrón 1994). Type-A gender (see example (9a)) includes all word pairs which accept both feminine and masculine values for morphophonological, syntactic and semantic gender, and whose meaning across the word pair varies only in the biological sex of the referent. Type-B words (see example (9b)) comprise word pairs which accept both feminine and masculine values for semantic and syntactic gender but have invariant morphophonological gender, and whose meaning across the word pair varies only in biological sex. Type-C words (see example (9c)) are those word pairs which only accept different feminine and masculine values for semantic gender on the basis of sex, but have invariant morphophonological and syntactic gender. Types A, B and C, thus, include only animate entities. The fourth gender class, Type-D (see examples in (9d)), includes words which have invariant gender at all three levels, either masculine or feminine.

(9) a. **el**$_{M}$ vecino$_{M}$ / **la**$_{F}$ vecina$_{F}$
the male neighbor / the female neighbor

b. **el**$_{M}$ estudiante / **la**$_{F}$ estudiante
the male student / the female student

c. **la**$_{F}$ víctima$_{F}$
the victim (male or female)

d. **el**$_{M}$ puerto$_{M}$
the harbor
la$_{F}$ puerta$_{F}$
the door

Unlike the previous three categories, the Type-D category is formed by singleton words (i.e. words that have no counterpart in gender),

which can denote either an animate or an inanimate entity. Example (9d), shows two words which are semantically, syntactically and morphologically unrelated, but happen to share the same form (excluding the gender suffix). We have chosen to use this example here because this kind of 'false pairs' are relevant for the purposes of the studies reported in this paper. Nevertheless, Type-D category includes words which have morphophonological gender marking (as (9d)) and words which do not. In fact, most Spanish nouns belong to this category.

The gender taxonomy described thus far provides explicit processing claims concerning the way gender is retrieved and assigned in sentence production processes. On this account, gender is retrieved together with lemmas when these representations are activated. However, only an abstract specification of gender is available at this processing stage, that is, no syntactic and morphophonological gender properties are yet assigned to lexical items. Gender assignment takes place at a later stage, when word forms are activated and retrieved. This process is carried out by a gender-assigning mechanism which triggers the syntactic and morphological processes that secure agreement relations among words. Whenever a noun carries an invariant gender value at some processing level, the gender-assigning mechanism remains inactive at that level.

Elías-Cintrón has proposed an extension of his theory of Spanish gender to account for the Spanish number system. On this account, the number system is organized along the same dimensions provided for gender, that is, a distinction is drawn between morphophonological, syntactic and semantic number features. Accordingly, there are four categories of number. Type-W number includes those words that have variable morphophonological, syntactic and semantic number (like (10a)). Type-X words are those with invariant morphophonological number and variable syntactic and semantic number (10b). Type-Y words have invariant morphophonological and syntactic number (10c). Type-Z words have invariant number across all three dimensions (10d).

(10) a. **el**$_{SG}$ vecino$_{SG}$ / **los**$_{PL}$ vecinos$_{PL}$
the neighbor / the neighbors

b. **el**$_{SG}$ aguafiestas / **los**$_{PL}$ aguafiestas
the party pooper / the party poopers

c. **la**$_{SG}$ policía$_{SG}$
the police (singular or plural)

d. nadie$_{SG}$
nobody.

Although Elías-Cintrón is not explicit on this issue, it is assumed that number retrieval and assignment processes follow the same stages as those described for gender features in sentence production. Contrary to this assumption, there is some evidence to support the claim that gender and number are represented, and most likely processed, in a different fashion. Most evidence in this regard comes from the linguistic literature (Harris 1991, Ritter 1991, see also Ambadiang, 1993, for a review).

Harris' generative-based theory of Spanish gender (Harris 1991) provides indirect support for the gender-number dissociation claim. Harris begins by criticizing the traditional view that vowels /a/ and /o/ are genuine gender-marking suffixes in Spanish. Rather, words ending in these vowels form two 'purely formal' declensional classes with no semantic or functional import. Furthermore, Harris assumes that the distribution of gender in Spanish cuts across four autonomous domains, of which the first three correspond to the representation levels of Elias-Cintrón's taxonomy: biological/semantic sex, syntactic gender, morphophonological words classes, and phonological relations. The only exception to this autonomy is found in the class of nouns referring to human entities (Elias-Cintrón's Type-A words), which do have a phonological gender marker (*-a* for feminine and *-o* for masculine) and are derived by specific rules. Otherwise, there is a single lexical mark for feminine gender; in other words, there is no 'masculine' grammatical gender in Spanish as such. Gender assignment processes are assumed to occur in the lexicon, whereas number assignment is not.

Another linguistic analysis more directly bearing on the dissociation hypothesis is Ritter's account of number (and gender) representation in the syntactic derivation of determiner phrases (Ritter 1991). Ritter's original proposal was intended to account for the derivation of genitive constructions in Hebrew, but it could eventually be extended to NPs in general. She argues that NPs should be reanalyzed in terms of the projection of two functional categories. One is the Determiner (DET), following a previous suggestion that all NPs can be construed as maximal projections of the functional category DET (Abney 1987); the other one is Number (NUM.PL), which emerges as the maximal projection of the complement of DET, instead of the NP. Under this analysis, an NP should be construed as a DP that takes a Number phrase (NUM.PL) as its complement. Thus, at D-structure (see (11a)), the number inflection is represented under the head node of NUM', while at S-structure (11b), the lexical head of N' (the noun) is raised and attached to the number inflection, leaving a trace behind.

(11) a. $[_{DP}\,[_{D'}\,D\,[_{NUM.PL}\,[_{NUM'}\,[_{NUM}\,\pm PL\,[_{NP}\,[_{N'}\,N\,]]]]]]]$
b. $[_{DP}\,[_{D'}\,D\,[_{NUM.PL}\,[_{NUM'}\,[_{NUM}\,N_i\,\pm PL\,[_{NP}\,[_{N'}\,t_i\,]]]]]]]$

On the other hand, Ritter claims that gender should be regarded as a derivational suffix, given the fact that the morphology of gender markers for nouns (which are only feminine in Hebrew, just as they are in Spanish, according to Harris' proposal) is unpredictable. This leads to the conclusion that gender markers, as opposed to number markers, are generated in the lexicon. This representational difference between gender and number seems to be particularly true for languages in which gender and number features are marked with different exponents, as it happens in Spanish.

Alternatively, it has also been claimed that both number and gender project onto two distinct syntactic functional categories, NUM.PL and GEN.PL, respectively, the latter's maximal projection being the complement of NUM, as is shown in the schema in (12) (Picallo 1991). Successive cyclic movement of the noun head applied to the D-structure in (12a) would yield an S-structure (12b), with the noun inflected for gender and number. Two traces, one within N' and the other within GEN, would result from these movement operations.

(12) a. $[_{DP}\,[_{D'}\,D\,[_{NUM.PL}\,[_{NUM'}\,[_{NUM}\,\pm PLUR\,[_{GEN.PL}\,[_{GEN'}\,[_{GEN}\,\pm FEM\,[_{NP}\,[_{N'}\,N\,]]]]]]]]]$
b. $[_{DP}\,[_{D'}\,D\,[_{NUM.PL}\,[_{NUM'}\,[_{NUM}\,N_i\,\pm PLUR\,[_{GEN.PL}\,[_{GEN'}\,[_{GEN}\,t_i\,\pm FEM\,[_{NP}\,[_{N'}\,t_j\,]]]]]]]]]$

1.3. The dissociation hypothesis

On the basis of the arguments laid down in the previous section, we will now address the central question of this paper, namely, to what extent do gender and number information share the same processing *loci* in sentence production. By *locus* we understand the processing domain under which these grammatical features are selected, retrieved and assigned during sentence production. The null hypothesis is that the operations underlying the retrieval and assignment of inflections are the same for all sorts of inflectional features the processor deals with. An attempt has been made in some studies (see, for example, Vigliocco *et al.* 1995) to test whether gender follows the same processing constraints as number in agreement processes. However, the error-inducing paradigm that proved to be quite fruitful for number turned out to be unproductive in the generation of gender errors. As for the gender-number comparison, it might be the case

that both gender and number features are retrieved and projected from the lemmas of phrasal heads, and thus subjected to the same kind of processes. Alternatively, one might hypothesize that gender features are retrieved and assigned from lemmas, while number features are independently assigned to lemmas and later to word forms through phrase structure building operations. We will argue in favor of the latter view, which we have termed the 'dissociation hypothesis'.

The dissociation hypothesis stands on certain differences concerning the status of gender and number as grammatical features. As we anticipated in the previous section, the grammatical feature of number (or 'plurality', as it was called above) is usually derived from the conceptual or notional feature of number (or 'numerosity'). The only known exceptions to this regularity are the distributive interpretation of certain linguistic expressions (like the one in example (6a), mentioned above), the collective and mass nouns, like *troop*, *blood*, *sugar* or *furniture*, and a few cases of nouns that are conceptually singular but have a plural inflection (for example, *scissors* or *glasses*). In all but the latter case, the asymmetrical relation between the notional and the grammatical plural amounts to a notional plural expressed by a grammatical singular. On the contrary, gender as a grammatical feature in Spanish is more often than not arbitrary. Grammatical gender is dependent on notional gender only in the case of animate entities, with the exception of Type-C words, as shown above (see example (9c), and comments therein). Given the dependence of grammatical number on notional number, it seems reasonable to claim that number inflections are not necessarily retrieved with lemma representations, but by other means. We will argue that number features are specified at a preverbal conceptual level, and assigned as an abstract feature to the phrase structure tree during the encoding of grammatical functions. Grammatical gender, on the other hand, can be directly retrieved and assigned from lemmas, especially in those cases in which this grammatical feature cannot be specified on conceptual grounds. Thus, the abstract specification of gender features in the phrase structure tree might only occur in some gender types, but not in all of them.

Some relevant representational differences between gender and number were discussed in the previous section. In principle, these differences were thought to affect gender and number as two distinct categories. However, similar differences might hold between certain gender categories, for instance Type-A and Type-D words. Recall that gender is semantically motivated in the former category and arbi-

trary in the latter. In either case, such representational differences should be reflected in the processing of gender and number inflections in sentence production. There are a few pieces of evidence supporting the gender-number dissociation in language production. Vigliocco *et al.*'s finding, reported earlier, that very few gender attraction errors are generated as compared to number attraction errors can be taken as *prima facie* evidence for a processing asymmetry between gender and number. A similar finding is reported by Nicol (this volume), who used a sentence completion task with tag questions in order to induce attraction errors on agreeing pronouns. She found an effect of number mismatch between an NP and a pronoun with which the NP must agree, in pairs of sentences like (13a-b) ((13b) is the mismatch condition). However, no effect of gender mismatch was obtained (again, (14b) is the mismatch condition).

(13) a. The girl behind the teacher got punished, didn't ... ? (1% errors)
b. The girl behind the teachers got punished, didn't ... ? (7.4% errors)

(14) a. The girl behind the headmistress got punished, didn't ... ? (0.7% errors)
b. The girl behind the headmaster got punished, didn't ... ? (4% errors).

Turning to the study we report in the next sections, we propose the following hypotheses. First, the distributional properties of speech errors in Spanish involving gender and number suffixes should show a different overall pattern. Second, if the assumption that gender features are retrieved and assigned with lemmas while number features are directly specified in the phrase structure tree is correct, we should find that in a phrase elicitation task involving word exchanges in complex NPs, the probability of detaching inflectional markers from word stems and stranding them should be higher for number inflections than for gender inflections in general, and for certain gender types as compared with others. Specifically, it should be harder for gender features to get stranded in Type-D words than in other gender types, since gender is seldom specified at the conceptual level, and is consequently more arbitrary, in this category of words. In the following sections, we will provide some evidence from Spanish in support of our hypotheses on gender-number dissociation.

2. Speech error analysis

725 errors involving gender and number were selected for analysis from the Corpus of Spanish Slips of the Tongue (Del Viso *et al.* 1987, Del Viso 1990). These errors were classified in four categories according to the underlying mechanism that was supposed to cause the error. There were 100 gender and number substitutions (i.e. gender *-a/-o* suffixes or number *ø/-s* suffixes of words replace each other, respectively), 34 gender and number exchanges (i.e. gender and/or number suffixes of adjacent or nearby words are exchanged), 131 movement errors with gender or number stranding (i.e. word stems are exchanged while their gender/number suffixes remain in place), and 460 noncontextual errors (i.e. word substitutions and blends) where there could be a gender or number mismatch between the words involved in the slip. In the first two categories, gender and number suffixes were the targets of the errors; in the last two categories, errors involving the misplacement, substitution or blend of two words could have consequences on the assignment of gender and number features to those words. Table 1 shows several examples of each category.

Table 1. Examples of error categories involving gender and number used in the speech error analysis of this study. The error segment is underlined. The intended utterance is given between brackets. Inflectional features are subindicized (M = masculine; F = feminine; SG = singular; PL = plural). Error source: Del Viso, Igoa & García-Albea 1987.

SUBSTITUTIONS

Gender
FEMININE FOR MASCULINE
Su rendimiento en esta prueba no está asociada$_F$ con...
'His/her performance in this task is not associated with...'
MASCULINE FOR FEMININE
Es el que más pinto$_M$ / más pinta de chino tiene
'He's the one that looks more chinese'

Number
PLURAL FOR SINGULAR
Lleva once años casados$_{PL}$ con...
'He/she's been eleven years married to...'
SINGULAR FOR PLURAL
A tan sólo unos centenares de metro$_{SG}$
'At only a few hundreds of meter_'

EXCHANGES

Gender
He cantado líneo$_M$ y binga$_F$ (línea y bingo)
'I cried line and bingo'

Number
Y pagamos a media$_{SG}$ las$_{PL}$ cuotas$_{PL}$ (a medias la cuota)
'We'll pay half fare each'

MOVEMENT ERRORS WITH STRANDING

Gender
Una cuera$_F$ de suelo$_M$ (suela de cuero)
'leather sole'

Number
Esas bocas$_{PL}$ no han salido de mi palabra$_{SG}$
'Those words haven't come out of my mouth'

NONCONTEXTUAL ERRORS

Form-based word substitutions
Hay dos apóstoles$_M$ (epístolas$_F$)
'There are two apostles (letters)'

Meaning-based word substitutions
Toma sólo tres tenedores$_M$ (cucharadas$_F$)
'Take just three forks (spoonfulls)'

Context-based word substitutions
El estómago de las uñas$_F$ (rumiantes$_M$)
'The nails' stomach (ruminants')'

Word blends
Hubo un confrontamiento$_M$ (confrontación$_F$ / enfrentamiento$_M$)
'There was a confrontation/fight'

The analysis of gender and number substitutions may reveal whether there is an effect of 'markedness' in gender or number assignment, that is, whether there is any trend towards substituting the hypothetically marked value for the unmarked value of these inflectional features. The studies on number agreement errors reported earlier have shown that plural substitutes for singular more often than the reverse, and this has been interpreted as showing that plural is the marked value for number (Eberhard 1996). Our own data on substitutions show a clearly similar trend for number: in 32 out of 41 substitutions, the plural replaced the singular form of the word.

However, the markedness effect was not found in gender substitutions: there were 30 feminine for masculine and 24 masculine for feminine substitutions. The remaining 4 cases of gender substitutions involved an ambiguous gender marker, vowel /e/, which sometimes applies to masculine nouns (*padre father*) and sometimes to feminine nouns (*madre mother*) in Spanish. Interestingly, there were no simultaneous substitutions of gender and number suffixes in our error sample.

As for gender and number exchanges, we found that number exchanges were almost twice as frequent in our corpus as gender exchanges (22 number vs. 12 gender exchanges). Moreover, of the 22 number exchanges, 13 involved nouns, while only 2 of the 12 gender exchanges did. Even though raw frequency scores are not quite informative in speech error analysis, this asymmetry in exchanges is worth noting. Similar to substitutions, there were no simultaneous exchanges of gender and number suffixes in our sample of speech errors.

The results on suffix stranding are much more relevant to the case in point. The frequency of gender and number strandings were computed on the basis of all movement errors involving words or stems in which a suffix stranding could be made, that is excluding those cases in which either gender or number features were identical in the words involved in an error. The distribution of strandings for gender and number suffixes was significantly asymmetrical. Gender suffixes were stranded on 40 out of 71 possible cases, while number suffixes (plurals, in this case) were stranded on 56 out of 60 possible cases. This asymmetrical distribution was highly significant by *chi* square analysis [*chi* sq. (1) = 22.73, $p<0.001$]. We reported very similar results in a previous paper (García-Albea *et al.* 1989), in which we found that gender stranding never occurred in isolation, that is without number stranding, whenever both gender and number suffixes could be stranded.

Finally, the analysis of noncontextual errors was carried out with the aim of finding out whether the words involved in these errors match or mismatch in gender or number. The noncontextual errors examined were 'paradigmatic' lexical errors, that is, errors in which an intended word of the utterance plan interacts with an unintended word outside the utterance plan, which may result in a word substitution or in a word blend (see Table 1 for examples). A comparison was drawn between errors with a conceptual *locus*, where the interacting words are semantically or associatively related, like context-based and meaning-based word substitutions and word blends,

and errors with a formal (or phonological) *locus*, such as form-based word substitutions (see examples on Table 1 above). If gender features are retrieved with the word's lemma, conceptually-based lexical errors should show a greater amount of gender mismatches between the words involved than form-based errors. The underlying assumption here is that lemma retrieval operations are oblivious to the gender features of a word, and thus it is fairly likely that lemma retrieval errors will result in the selection of a noun with a different gender as compared with that of the intended word. On the other hand, if number is assigned through syntactic encoding operations, there should be no influence of the kind of relationship between words, whether conceptual or formal, on the amount of number mismatches. In fact, there should be very few number mismatches, since number is retrieved at the conceptual level and assigned to the sentence frame independently from lexical selection procedures. An analysis of 460 noncontextual lexical errors revealed a contrast between conceptually-based and form-based errors. Although gender mismatch was fairly rare in both error categories, it was significantly higher in the former category than in the latter (see Table 2). This distribution of gender mismatches turned out to be significant in *chi* square analyses performed on all pairwise comparisons between conceptually-based and form-based errors [form-based vs meaning-based word substitutions: *chi* sq.(1) = 20.16, $p<0.0001$; form-based vs. context-based word substitutions: *chi* sq.(1) = 13.23, $p<0.0001$; form-based word substitutions vs. word blends: chi sq.(1) = 25.91, $p<0.0001$]. Conversely, number mismatches were quite rare in all the error categories tested.

Table 2. Percentages of gender and number mismatches between interacting words across four categories of lexical noncontextual errors. The first category includes only form-based errors, while the other three categories comprise conceptually-based errors.

	Gender	Number	Neither
Form-based substitutions	4	0	96
Meaning-based substitutions	17	2	81
Context-based substitutions	17	6	77
Blends	26	0	74

The results reported in this section support the general claim that gender and number are processed in a different fashion during

sentence formulation. Not only were the patterns of distribution of gender and number errors different across various error types, but these patterns square with the predictions laid down separately for gender and number errors. The most compelling evidence in this respect are the unequal distribution of gender and number strandings in word movement errors, and the uneven distribution of gender and number mismatches across meaning-based and form-based lexical errors. These results are compatible with the view that gender features are retrieved via lemma representations while number features are processed independently of lemmas, as part of the grammatical encoding operations in sentence formulation. However, the speech error analysis reported here fails to provide information about possible differences among gender types, as our hypotheses have predicted, and about the role of plausibility in agreement processes. The experiment on word exchanges we will report in the next section will help clarify these issues.

3. *Experiment on word exchanges*

The purpose of this experiment was to explore the behavior of gender and number inflections in complex NPs by means of a language production task. Subjects were shown complex NPs with two nouns (like that in example (15) below) and instructed to produce a spoken response by exchanging the nouns of the NP and leaving the other words in place. By using this task, we expected subjects to inadvertently separate the gender or number inflections of the nouns from the stems, thereby stranding the inflectional suffixes, and accommodate the gender or number features of the nouns' determiners to the stranded suffixes. However, subjects were not explicitly told anything about strandings or accommodations. With this procedure, the probability of stranding gender and number features could be compared. Example (15) shows possible responses with different outcomes in terms of gender and number strandings and accommodations. Note that in the examples below, inflection stranding precludes accommodations at the determiners (no gender accommodation is applicable in (15b), no number accommodation in (15c), and no accommodation of either gender or number in (15d)). Conversely, accommodation is mandatory in the word exchange task when there is no stranding, as in example (15a).

(15) [[Una niña]$_{N'}$ [de los gatos]$_{PP}$]$_{NP}$ (A girl of the male cats)
fem sing *masc plur*

a.	Unos gatos$_{M.PL}$	de la niña$_{F.SG}$	no stranding
b.	Unas gatas$_{F.PL}$	del niño$_{M.SG}$	gender stranding
c.	Un gato$_{M.SG}$	de las niñas$_{F.PL}$	number stranding
d.	Una gata$_{M.PL}$	de los niños$_{M.PL}$	gender + number stranding

Furthermore, we manipulated the mismatch between the two nouns of the NP in gender and number features, and tested three of the four gender categories of the taxonomy of Spanish gender, namely, types A, B and D. Type-C words were excluded from our experiment because there were not enough words of this category to fit in the design. Thus, the experimental design included three independent variables, namely gender/number mismatch between nouns (with four levels: gender and number match, gender mismatch, number mismatch and gender and number mismatch), gender type (with three levels: Types A, B and D), and plausibility (with two levels: plausible and implausible outcomes in the word exchange task). Plausibility was manipulated as follows: two versions were created of each stimulus NP by altering the order of the two nouns; the two versions of each NP pairs were then compared for relative plausibility. Table 3 shows examples of each of these variables. The combination of these variables rendered 24 experimental conditions (4 mismatch conditions x 3 gender types x 2 plausibilities).

It should be noted that words of gender categories A and D allow the stranding of inflectional suffixes, as well as the accommodation of the determiners' gender and number features. Type-A words have always overt gender marking (see example (15a) above). As for Type-D words, some have and some do not. However, all Type-D words selected for this experiment were gender marked (had *-o* or *-a* ending) and were grouped in pairs where both members of each pair shared a common stem but had unrelated meanings (for example, *libr-o* 'book' and *libr-a* 'pound', as shown in Table 3). Moreover, complex NPs containing Type-D words were constructed in such a way as to make a plausible fit with either member of a pair. An example of responses involving the pair *libro-libra* is *Los libros del alumno* ('The books of the male student') and *Las libras del alumno* (*The pounds of the male student*). On the contrary, Type-B words do not allow suffix stranding, since these words lack overt gender marking. Hence, for this category of words, the stranding of inflectional features can only surface at the determiner. Even though Type-B words are similar to

Type-A words in the relation that holds between conceptual and grammatical gender, they differ in overt gender marking. Thus, any difference between these two word categories should be attributed to superficial morphophonological factors.

Table 3. Examples of the independent variables used in the word exchange experiment.

1. GENDER/NUMBER MISMATCH	
(a)	GENDER/NUMBER MATCH Un hermano$_{M.SG}$ del abogado$_{M.SG}$
(b)	GENDER MISMATCH Un hermano$_{M.SG}$ de la abogada$_{F.SG}$
(c)	NUMBER MISMATCH Un hermano$_{M.SG}$ de los abogados$_{M.PL}$
(d)	GENDER/NUMBER MISMATCH Un hermano$_{M.SG}$ de las abogadas$_{F.PL}$
2. GENDER TYPE	
(a)	A: + morphophonological, + syntactic, + semantic Example: *El niño - La niña* 'the boy - the girl'
(b)	B: - morphophonological, + syntactic, + semantic Example: *El amante - La amante* 'the male/female lover'
(c)	C: - morphophonological, - syntactic, - semantic Example: *El libro - La libra* 'the book - the pound'
3. RESPONSE PLAUSIBILITY	
(a)	PLAUSIBLE Una prima de la camarera 'A cousin of the waitress'
(b)	IMPLAUSIBLE Una camarera de la prima 'A waitress of the cousin'

As we stated in the Introduction, we expected number strandings to be more frequent than gender strandings in general terms. Furthermore, the frequency of gender strandings in Type-D words should be lower than in Type-A and Type-B words, whereas we anticipated no differences among these three word types in number strandings. As for plausibility, our claim was that grammatical encoding processes, like those involved in the assignment of inflections, are not sensitive to conceptual variables. Consequently, the processes of gender and number assignment should be oblivious to the plausibility of the subject's response. A similar pattern of strandings for plausible and implausible responses was thus expected.

Ten subjects of both sexes participated in the experiment. The overall percentages of responses with inflection stranding are shown in Figure 2.

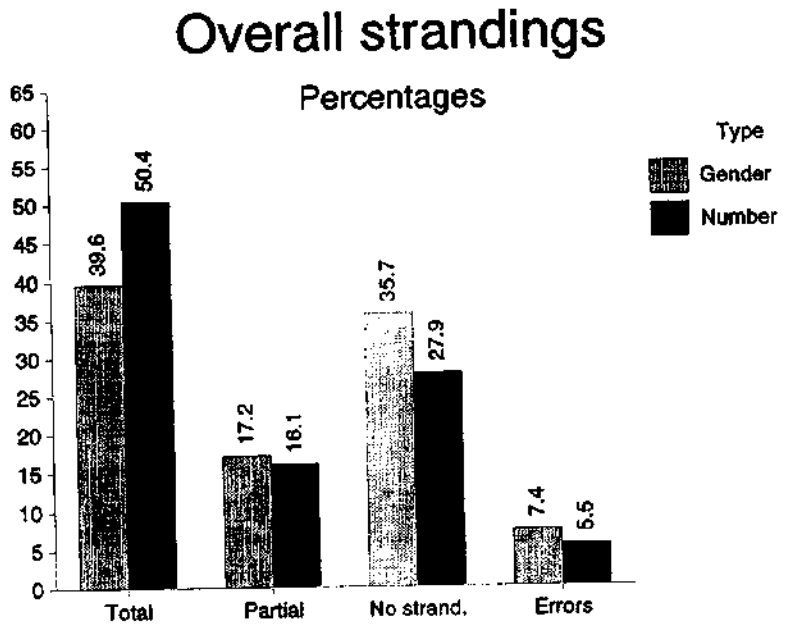

Figure 2. Overall percentages of responses with inflection stranding found in the experiment. The figures include total and partial strandings, as well as no strandings and errors.

The most relevant comparison must be drawn between responses with "total" stranding, that is, responses in which the inflections of both nouns of the complex NP were stranded in place, and responses with no stranding at all. An intermediate category is that of "partial strandings", in which only one of the nouns of the NP undergoes a stranding operation. As can be seen in Figure 2, the distribution of responses with no stranding and with total stranding show the opposite pattern across gender and number inflections, and this inverse distribution was highly significant in a *chi* square analysis [*chi* sq. (1) = 20.17, $P<0.0001$]. In other words, for number, strandings exceeded nonstrandings, whereas for gender, nonstrandings exceeded strandings to a highly significant degree. These results square with our predictions.

A separate analysis of gender and number strandings rendered the following patterns:

(1) 'Gender strandings' were unevenly distributed across the three gender categories, as the frequency data depicted in Figure 3 show. Pairwise statistical comparisons revealed significant differences among all three categories. The proportion of strandings was greatest for Type-B gender words, followed by Type-A gender words, while the opposite pattern was true for strandings in Type-D words, that is more non-strandings than total strandings in this gender category (with the following *chi* square values: [Type-A vs. Type-B: *chi* sq. (1) = 4.22, $p<0.05$; Type-A vs. Type-D: *chi* sq. (1) = 21.44, $p<0.0001$; Type-B vs Type-D: *chi* sq. (1) = 41.25, $p<0.0001$]).

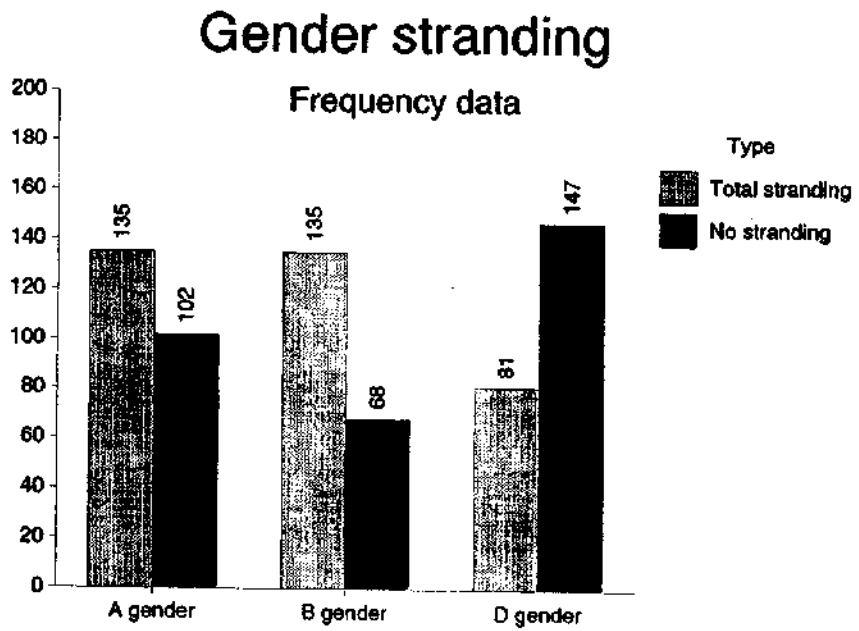

Figure 3. Frequencies of gender strandings across the three gender categories used in the experiment. Only total strandings and nonstrandings are included.

(2) The pattern for 'number strandings' was slightly different (see Figure 4). Gender types A and B showed a similar distribution of number strandings (more strandings than non-strandings), while these two response types were almost balanced in Type-D words. Pairwise statistical comparisons revealed no significant differences in

the distribution of number strandings between gender types A and B (*chi* square [*chi* sq. (1) = 1.7, $p>0.05$]), while both Type-A and Type-B words had significantly different distributions of number strandings from Type-D words ([Type-A vs. Type-D: *chi* sq. (1) = 5.58, $p<0.05$; Type B vs. Type-D: *chi* sq. (1) = 12.57, $p<0.0001$]). Therefore, the probability of number strandings is significantly lower in Type-D words than in either Type-A or Type-B words, with no substantial differences between the latter.

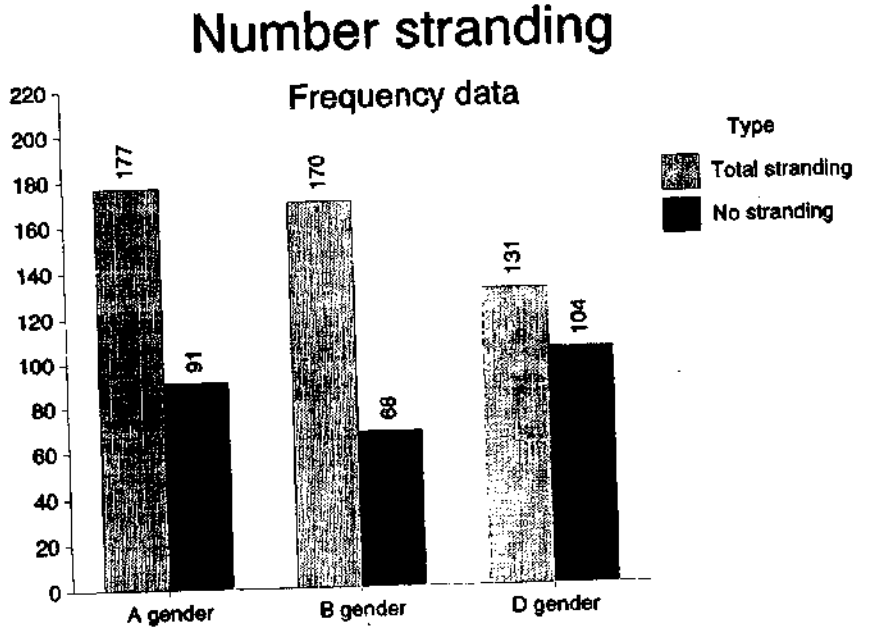

Figure 4. Frequencies of number strandings across the three gender categories used in the experiment. Only total strandings and nonstrandings are included.

If we look at these results from within the three gender categories, we find different distributions of gender and number strandings. (The following percentages are computed from the sum of responses with total strandings and with no strandings; thus, partial strandings and error responses are excluded.) For Type-A words, number strandings were more frequent than gender strandings (68 % number strandings vs. 56 % gender strandings). This distribution was just statistically significant in a *chi* square analysis [*chi* sq. (1) = 3.83, $p=0.05$]. For Type-B words, gender and number strandings were simi-

larly distributed (71 % number vs. 68 % gender strandings), without reaching statistical significance. Finally, Type-D words behaved in a similar fashion as Type-A words, though by no means identically, since this gender category showed only 63 % of number strandings and 34 % of gender strandings. This uneven distribution was highly significant in the *chi* square analysis [*chi* sq. (1) = 21.65, p<0.0001].

Some of the results reported in this experiment run counter to our predictions. For 'gender strandings', we expected Type-A and Type-B words to behave similarly, and both categories to show more gender strandings than Type-D words (i.e. D < A = B). However, Type-A words depart from this prediction: even though they show more gender strandings than Type-D words, as expected, they show less strandings than Type-B words, which is not what we had anticipated (i.e. D < A < B). As for 'number strandings', we also found some unexpected results. We had predicted no differences in number strandings across the three gender types (i.e. D = A = B), but instead found Type-D words to be resistant to number strandings as compared with the other two gender types (i.e. D < A = B). Thus, there remains to be explained why Type-A words showed less gender strandings and why Type-D words showed less number strandings than we had expected.

The reason why Type-A words yielded less gender strandings than expected lies in the different behavior that these words show in plausible and implausible conditions. Plausible responses with Type-A words showed a decrease in gender strandings when compared to implausible responses containing these words [*chi* sq. (1) = 5.75, p<0.05]. This, however, was neither the case for number strandigs with Type-A words, nor for gender or number strandings in plausible and implausible responses in the other two word categories. In other words, plausibility appears to 'block' gender stranding for Type-A words, but has no influence whatsoever on gender or number stranding in the other two classes of words. As yet, we have no satisfactory answer to the unexpected pattern followed by gender inflections of Type-A words in plausible responses.

As for the reduction in number strandings for Type-D words, it might be the case that gender assignment processes exert an inhibitory influence on number assignment for this word category. Since gender is mostly arbitrary (and supposedly retrieved with lemmas) in this kind of words, it is considerably difficult to detach gender inflections from word stems, even though the word exchange task allowed subjects to do so. Hence, the low frequency of gender strandings for Type-D words (see Figure 3 above). This, in turn, might have caused number inflections to become more attached to the word stem as well,

thereby inhibiting the stranding of number features. If the assignment of number inflections for Type-D words (as it was presumed for all other gender types) had actually taken place via structure building operations, this inhibitory effect should not have occured, and gender and number should have behaved in a different fashion, as we predicted. However, the observed reduction of number strandings in Type-D words seems to show that gender and number assignment processes are not entirely independent for this word class.

In spite of this, the pattern of gender and number strandings in Type-D words remains consistent with the claim that number inflections are easier to separate from word stems than gender inflections, and are thus assigned independently from lemma representations. We might speculate that whereas in Type-D words gender inflections are carried with lemmas, number features are retrieved from lemmas and from the phrase structure frame in parallel, and then matched when the lemmas are inserted into the frame. When number morphemes are reassigned to the slots in the frame in the word exchange task, the number features can either remain attached to the word stem and move around with it, or get attached to the phrase frame and remain stranded in place. This would account for the reduction of number strandings found in this word category, as compared with the other two.

4. Conclusions

Two main conclusions may be drawn from the results reported in this paper. First, gender and number information are not processed in the same manner during sentence production. The different overall patterns of distribution of gender and number errors, together with the asymmetrical results found in the stranding of gender and number features in the word exchange task, indicate that gender information is more likely retrieved with, and assigned from, the lemma representation of words, whereas number information appears to be retrieved and assigned through the grammatical encoding operations that assemble the phrase structure frames of the sentence (Bock & Levelt 1994).

There are three sets of results consistent with this conclusion. First, the analysis of movement speech errors revealed an asymmetrical pattern of exchanges and strandings in spontaneous speech errors involving gender and number features, where number features were found to be more easily exchanged and stranded than gender

features. Second, the analysis of speech errors involving the substitution of gender and number inflections revealed a markedness effect in number substitution (plural suffixes more often substitute for singular suffixes than otherwise) which was not found in gender substitutions; similarly, noncontextual lexical errors which are conceptually-based (i.e. meaning-based and context-based word substitutions, and word blends - see Table 2) show an above chance probability of gender mismatch, when compared to form-based errors of this kind (i.e. form-based word substitutions), which indicates that the process of lemma selection, where the former errors originate, is not always sensitive to the gender features of the word to be selected, whereas the process of word-form selection, which is the 'locus' where the latter kind of errors arise, appears to be sensitive to those features. Third, the pattern of stranding of inflectional features in the word exchange task used in our experiment was substantially different for gender and number: gender features were found to remain attached to word stems (and move along with them) more frequently than number features, which quite often got stranded in their original position in the frame. As we have already argued, this can be interpreted as showing that gender is assigned from features that are retrieved with the lemma, while number is independently retrieved from the conceptual representation of the message and assigned through the syntactic frame of the utterance.

The second conclusion we want to highlight is that the gender-number dissociation in processing does not equally apply to all gender categories of the Spanish lexicon. Based on the distinctions among the three gender categories used in our experiment, we can state that gender information is first selected at the conceptual level for categories A and B on the basis of the feature sex (male-masculine vs female-feminine), since these two categories comprise only words denoting animate entities. On the contrary, for Type-D words denoting inanimate entities, there is no selection of conceptual gender, for grammatical gender is arbitrary in this kind of words. From the results of our experiment, it seems safe to assume that gender features are retrieved with lemma representations for Type-D words and projected to the other phrasal constituents in the process of inflection assignment. Conversely, gender features of Type-B words (and probably of Type-A words as well) are perhaps retrieved with lemmas, but seem to be assigned through phrase structure assembly processes. These conclusions are based on the fact that words of types A and D show relatively fewer gender strandings than number strandings, while Type-B words had similar strandings of each kind. The

unsteady behavior of Type-A words across plausibility conditions weakens any firm conclusion concerning this word class.

As for number retrieval and assignment, our results allow us to conclude that number is selected at the conceptual level for all three word categories, and retrieved and assigned through phrase structure assembly processes. The only possible exception to this general rule may be found in the assignment of number to Type-D words, as was previously noted. In this regard, we hypothesize that the attenuation found in number strandings of Type-D words might reflect a parallel procedure of number assignment from lemmas and from the phrasal frames of the utterance.

Finally, the effects of plausibility were negligible, and only apparent for gender assignment to Type-A words. This can make some sense, given the assumption that grammatical encoding processes need not be sensitive to a general conceptual feature of the message such as plausibility. Despite the conceptual basis of gender and number features in most words, a reasonable conclusion of our study is that the processes of retrieval and assignment of nominal inflections (like gender and number, in the case of Spanish) are immediately controlled by syntactic processes, and not by conceptual features of the message.

There are a number of issues that have not been addressed in this paper and should deserve some attention in future investigations. One is the processing differences that could be expected to arise among the different categories of number. We should recall that number types were not manipulated as an independent variable in our experiment; all the words employed in our materials belonged to the default number category labelled W (with variable morphophonological, syntactic and semantic number), in which notional and grammatical number always match. In this regard, we might hypothesize that the process of number assignment for word categories where notional and grammatical number mismatch (such as categories X and Y as described in the first section of this paper -see examples in (8)) might be somewhat different from that for Type-W words. For instance, number features for Type-X and Type-Y words might be retrieved with lemmas, contrary to what seems to be the case in Type-W words.

Another issue that has not been tackled in our study is the sensitivity of reaction time measures to the processing differences between gender and number and within gender types. We are currently investigating this issue in an experiment using a similar word exchange task with a set of materials similar to those employed in

our present experiment. One of the aims of this research with latency measures is to explore the extent to which gender and number strandings are independently or jointly induced, that is to compare the frequency and latency of gender and number strandings when the two nouns in a complex NP mismatch only in one of these features or simultaneously in both. By so doing, we expect to obtain additional evidence concerning the dissociation of gender and number inflections. In addition, the gender-number dissociation hypothesis could be extended to cover other inflection assignment processes in Spanish, such as those involving verb inflections in coordinate and subordinate clauses, or subject-predicate agreement in gender and number in cases in which the predicate is overtly marked with gender.

A final question that we have not addressed explicitly in our study concerns the debate between copying models and unification models of agreement processing. In principle, neither the speech error analysis methodology nor the experimental procedure we employed in this study were intended to throw light on this issue. However, a possible source of evidence bearing on it might lie on the data on partial strandings. Partial strandings occur whenever the inflectional features of EITHER the first OR the second noun of the complex NP get stranded, instead of both (see example (16a), for partial gender stranding, and example (16b), for partial number stranding). A relevant property of partial strandings is whether the stranded features are those of the first noun (N1) or those of the second noun (N2) of the complex NP. In both examples, the inflection of the first noun is stranded.

(16) a. Un maestro de la estudiante → *Un estudiante* del maestro
$A_{M.SG}$ $teacher_{M.SG}$ of $the_{F.SG}$ $student_{F.SG}$ → $A_{M.SG}$ $student_{M.SG}$ of $the_{M.SG}$ $teacher_{M.SG}$

b. Unas monas de la rama → *Unas ramas* de las monas
$Some_{F.PL}$ $monkeys_{F.PL}$ of $the_{F.SG}$ $branch_{F.SG}$ → $Some_{F.PL}$ $branches_{F.PL}$ of $the_{F.PL}$ $monkeys_{F.PL}$.

If our understanding of agreement models is correct, a copying model should expect partial strandings in the first noun to outnumber partial strandings in the second noun, provided that the inflection assignment operation proceeds from the controller constituent to the target constituent through the phrase structure tree. In contrast, a unification model would predict no difference between both kinds of partial stranding, insofar as inflectional features are assigned independently across different phrases, according to this model.

Our results show that partial strandings on N1 were much more frequent than partial strandings on N2, for both gender (78 % Vs 22%) and number (73 % vs 27 %), which seems to support the copying model. Given that the NP headed by N1 dominates the NP headed by N2, the former can be regarded as the controller and the latter as the target. As for the distribution of partial strandings across gender types, there was a significant contrast among the three categories. Partial strandings on Type-A words were almost balanced for gender and number. As for Type-B words, partial gender strandings were more common than partial number strandings, while the opposite was the case for Type-D words (see frequency data in Figure 5). This distribution was highly significant [*chi* sq. (2) = 24.64, $p<0.0001$]. Interestingly, the fact that for Type-D words partial number strandings were more than twice as frequent as partial gender strandings may help understand the unexpected reduction of complete number strandings that was observed in this category of words. It seems as though in some of the trials, subjects had failed to carry out a complete stranding of the number features of both nouns, which resulted in a partial stranding of number at N1. This can be understood as a reflection of the inhibitory effect that was mentioned in the previous section.

The processing of inflections is a relatively new topic in language production research. In its origins, this topic was confined to the investigation of processing distinctions between vocabulary types (i.e. open vs closed class vocabularies) (Bradley & Garrett 1980, Garrett 1976, 1982, Sánchez-Casas 1982, Sánchez-Casas & García-Albea 1986, Stemberger & MacWhinney 1986, Del Viso 1990) mostly through the analysis of speech error patterns. However, the analysis of spontaneous speech errors *per se* has offered a limited understanding of the complexities of inflectional processing. As yet, little is known about differences in the processing of free and bound grammatical morphemes, or about the processing of various kinds of inflections (e.g. verb vs noun inflections, or gender, number and case features). However, new experimental procedures which directly manipulate the language production processes have been put forward in the last years, and have contributed to provide a more detailed description of the processes involved in the assignment of inflectional features which underlie agreement relations. Hopefully, these methods will allow us to gain more insight about grammatical encoding operations, and to test the psychological validity of linguistic constructs. Cross-linguistic research will surely broaden our understanding of these complex processes.

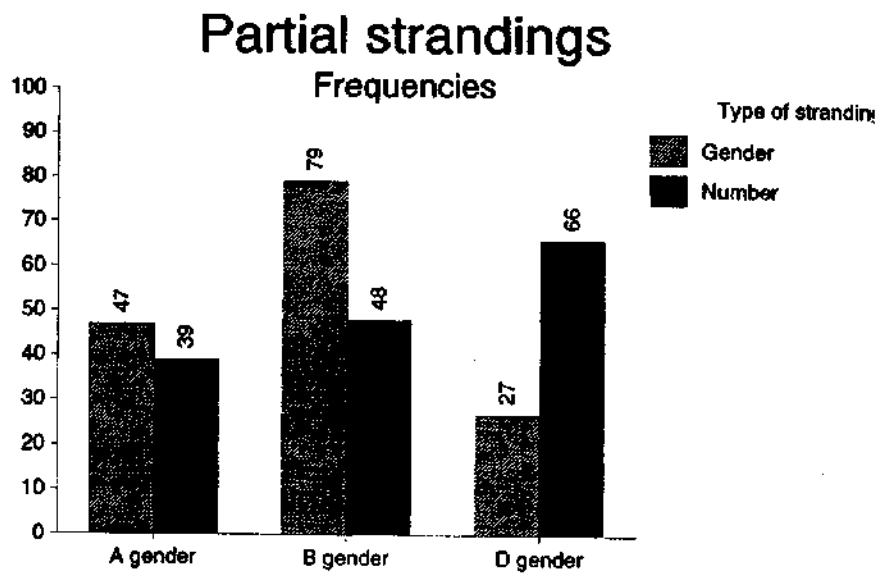

Figure 5. Frequencies of partial strandings of gender and number across the three gender categories used in the experiment.

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