Subject–verb agreement in Spanish and English: Differences in the role of conceptual constraints

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Abstract

This paper reports studies of subject–verb agreement errors with speakers of Spanish and English; we used a sentence completion task, first introduced by Bock and Miller (1991). In a series of four experiments, we assessed the role of semantic information carried by the sentential subject in the induction of subject–verb agreement errors. For Spanish speakers, a sentence preamble such as la etiqueta sobre las botellas (the label on the bottles), which is usually interpreted to denote several labels, induced more agreement errors than preambles that normally denote a single entity. This finding replicates previous research with Italian (Vigliocco et al., 1995). English speakers, on the other hand, were not sensitive to this semantic dimension, as was found earlier by Bock and Miller (1991).

This cross-linguistic difference is discussed in the framework of a modified version of the computational model of grammatical encoding proposed by Kempen and Hoenkamp (1987). In this version of the model agreement is computed through a unification operation instead of feature-copying, allowing for an independent retrieval of agreement features from the conceptual representation for the subject and the verb. We propose that languages differ in the extent to which the selection of the verb is controlled by features on the subject and features from the conceptual representation.

1. Introduction

Agreement phenomena are very widespread in the world’s languages, with subject–verb agreement being, perhaps, the most widespread. A theory of
grammatical encoding in speech requires an account of how agreement is constructed.

In *A grammar of Contemporary English*, agreement is defined "as the relationship between two grammatical units such that one of them displays a particular feature (e.g., plurality) that accords with a displayed feature on the other" (Quirk et al., 1972, p. 755). They defined *grammatical concord* as the rule according to which a singular subject requires a singular verb and a plural subject requires a plural verb; but they also noted that "Difficulties over concord arise through the occasional conflict between this [grammatical concord] and other two principles: the principle of *proximity* and *notional concord*" (p. 756).

The principle of *proximity*, also termed "attraction", denotes agreement of the verb with a closely preceding noun phrase (NP) in preference to agreement with the head of the NP that functions as subject (1):

(1) *A good knowledge of English, Russian and French are required for this position*  
(From Quirk et al., 1972, p. 757)

*Notional concord* refers to agreement of a verb with the subject according to the notion of number rather than with the actual grammatical marker on the subject. In British English, for example, collective nouns such as *government* are often treated as notionally plural, as in (2).

(2) The government *has/have* broken all its/their promises  
(From Quirk et al., 1972, p. 757)

Agreement errors, of course are not confined to English as examples (3)–(5) in Dutch, French and Italian, respectively, show:

(3) *Hij weet niet wat de volgorde van de gangen horen te zijn.  
(He doesn’t know what the order of dishes ought (pl) to be).  
(Levelt, personal communication)

(4) *Le préjugé que nos habitudes morales fait peser sur la pureté de leurs amour enlève quelque chose à leur noblesse d’âme.  
(The prejudice that our moral habits influences their love elevate something to their noble spirit).  
(From R. Davril, *Le drame de John Ford*, 1954, p. 254)

(5) *La spiegazione di questi risultati sono complessi.  
(The explanation of these results are complex).  
(From Vigliocco et al. (1995))

Bock and her colleagues (Bock and Eberhard, 1993; Bock and Miller, 1991) explored experimentally the role of proximity and notional concord in speech production. In a series of studies, they presented speakers with sentence preambles
such as (6) and (7). Participants were asked to produce a full sentence starting with the preamble.

(6) The picture on the postcards
(7) The road to the lakes

In these experiments, agreement errors were most common when the subject noun (*picture* or *road*) and the local noun (*postcards* or *lakes*) were mismatched in number. This is an effect of "proximity concord".

They assessed the role of notional number by manipulating the number of "tokens" in the preferred conceptual interpretation of the preamble. Thus in (6) there will be a picture on each of several postcards, and hence multiple tokens denoted by the singular head noun; while in (7) there will likely be just one road – a single token – to the several lakes. Bock and Miller (1991) found errors equally likely after both types of preamble, and concluded that once the syntactic number of the subject NP is determined, the effects of the number of tokens referred to was no longer relevant to the computation of agreement. This finding is consistent with the idea that the construction of agreement is an encapsulated syntactic process.

In our experimental work on Italian (Vigliocco et al., 1995), we replicated the role of proximity, but we also found that the number of tokens referred to by the preamble influenced the distribution of agreement errors. Thus we found more errors in (8), where a multiple token reading was preferred, than in (9), where a single token reading was preferred.

(8) L'etichetta sulle bottiglie (The label on the bottles)
(9) Il viaggio verso le isole (The journey to the islands)

In that paper, we hypothesized that the contrasting results for the two languages could be related to structural differences between the two languages. One potentially relevant difference is that, in Italian, the subject of the sentence can either be pre- or post-verbal, so that verbs may be uttered before their subject, with possibility that the verb form has to be selected before the subject NP has been worked out. A second potentially relevant difference is that the subject can be omitted altogether, and, according to Bates (1976), is in fact omitted in up to 70% of declarative sentences. If there is no subject, this raises the possibility that the verb conjugation can be selected by reference to an understood, rather than an explicit, subject. Finally, Italian differs from English in the fact that the verb form is marked for person and number in every conjugation. In English it is marked for person and number in the third person singular in the present tense for regular verbs and in the past tense only for the verb "to be". We also described how a model should be constrained in order to give a computational account of agreement that allows for cross-linguistic variation in the contribution of semantic factors such as the number of tokens denoted by the subject.

In the present paper, we attempt a more detailed description of a model of
grammatical encoding that allows for cross-linguistic variation, and we provide further evidence to support our arguments. We will start by reviewing the linguistic literature about semantic/conceptual agreement in different languages, and then turn to the operations that have been proposed to account for subject–verb agreement. We then present the model, and report results from four experiments, two in Spanish and two in English, that provide evidence in favor of our proposal.

2. Semantic issues in subject–verb agreement

2.1. The principle of notional concord

Some aspects of English subject–verb agreement depend strictly on grammatical number. Thus, *pluralia tantum* nouns such as *binoculars* and *scissors*, that denote a single object but are grammatically marked as plural, require a plural verb. However, as mentioned above, there are other cases in which agreement is controlled by the conceptual features of the sentential subject. As it is shown in examples (2) and (10), collective nouns in British English can take either singular or plural verbs:

(10) The faculty wants/want a raise

This does not mean that the subject NP is unspecified for number, since agreement with a reflexive still depends on the number implied by the verb, hence the pattern in (11), from Pollard and Sag (1988).

(11) The faculty is voting itself a raise
The faculty are voting themselves a raise
*The faculty is voting themselves a raise
*The faculty are voting itself a raise

From the existence of examples of this sort, Pollard and Sag (1988) concluded that the number of the subject depends on the specification of a “referential parameter”, which roughly means the number of objects designated by the NP.

If we consider other languages, a whole range of partially syntactic, partially semantic agreement patterns emerges. Tzotzil, Hungarian and Turkish allow *comitative constructions* in which an understood plurality of reference rather than plurality of any plausible subject constituent seems to determine verb number, as in example (12) in Tzotzil.

(12) Libabototikotik xchiʔuk liXune
went-1p,P with DEF Xun
I went with Xun
(or: We went with Xun)
In this example there is a first person plural verb, but the usual understood reading is that the "I", the speaker, went with the (singular person) Xun. There is no surface nominal constituent with a plural feature. Aissen (1989) argues that there is a deep constituent which has we as one of its components and the NP containing the proper name Xun as the other. Since Tzotzil is a null-subject (or pro-drop) language, this deep constituent can inherit the plural feature from the dropped pronoun. An alternative might be for the referent, Xun and me, to donate the plural feature directly to the verb.

In two unpublished experiments on comitative expressions, we have used sentence preambles such as (13) in English and (14) in Spanish, with their potential completions in square brackets.

(13) John together with Mary [was/?were going to the beach]
(14) Juan junto con Maria [?va/van a la playa]
     Juan together with Mary?goes/go to the beach

English speakers produced 5% plural verbs, while Spanish speakers produced about 60%. It seems therefore that languages can differ in the "preferred" agreement pattern for certain constructions: Syntactic agreement in English and semantic agreement in Spanish, at least in the described case.

In general, semantic influences on agreement appear to depend on the hierarchical ordering of relations between the subject (controller) and the element it agrees with (target). From an analysis of Slavic languages, Corbett (1979) Corbett (1983) argued that semantic agreement is related to a hierarchy of agreement targets: Attribute modifier, predicate, relative pronoun, personal pronoun. If a language allows semantic agreement at a certain agreement position (for instance, relative pronoun) in the hierarchy, it will allow semantic agreement for all positions to the right (personal pronoun, in the example above). An example of such a hierarchical ordering taken from British English is reported in (15).

(15) (a) The committee believes/believe
     (b) This/*these committee sat late
     (From Corbett, 1983, p. 9)

In this case, the collective head noun can take a plural verb, but not a plural modifier. Comrie (1975) has noticed an agreement hierarchy within the predicate. In Czech, for example, the polite second person plural, vy, takes a plural form of the finite verb but the singular form of the participle and predicate adjective, as in (16).

(16) Vy jste(pl) byla(sg.) dobrá(sg.) "You were good."
     (Comrie, 1975, p. 408)
The same pattern holds for French and some Italian dialects, including standard pre-war Italian.

According to this hypothesis, it is not surprising that semantic influences on subject–verb agreement may be found in a given language and not in another, since languages may occupy different positions in the agreement hierarchy.

2.2. Distributivity

The difference in the number of tokens referred to in (17a) and (17b) can be addressed in terms of the relative scope of the quantifiers implicit in the subject NP and in the NP embedded in the prepositional phase (PP).

(17) (a) The (each) label on the (several) bottles
     (b) The (single) journey to the (several) islands

Fiengo and Higginbotham (1981) and May (1985) have dealt with the different interpretations that can be derived by the assigned scope of the implicit quantifiers in sentences. The multiple token reading of (17a) comes about because in (17a) the number of bottles (NP2) has been assigned wide scope over the subject NP (NP1) – the label, while for (17b) NP1 – the journey – is assigned wide scope over NP2.

From a purely structural point of view, however, both (17a) and (17b) can receive one or the other interpretation, since both are introduced by the determiner "the". Furthermore, recently Kurtzman and MacDonald (1993) reported a study showing that even for NP–PP structures introduced by different explicit quantifiers there was a strong tendency to assign wide scope to NP2 over NP1, regardless of the type of quantifier expression introducing NP1 and NP2, in the comprehension of English. Therefore, it seems most likely that the reason why a distributed reading is preferred for the "label–bottles" example, and a non-distributed reading is preferred for the "journey–islands" example, has to do not with structural properties of the NPs, but with what we know about the typical relations between bottles and labels (i.e., that is very unlikely that a unique label can be attached to several bottles), and islands and journeys (i.e., that a single journey to several islands is both plausible and likely).

3. The agreement relation

It is generally uncontroversial that agreement consists in a relation between two (or more) elements in a sentence. Subject–verb agreement, for example, is a relation between the subject of the sentence and the verb. The controversy starts when we try to define this relation. In the literature, two possibilities have been proposed: Feature-copying and unification.
3.1. The feature-copying approach to agreement

Traditional treatments of agreement, distinguish between an agreement source or controller and an agreement target. In subject–verb agreement, the subject is treated as the source and the verb as the target. More generally, it had been proposed that the source corresponds to the argument, and the target to the function in the semantic structure of the sentence (Gazdar et al., 1985). Agreement consists in a redundancy relation (an identity function) that holds between the fully specified nominal source and the agreement target. The agreement relation will ensure that the target (the verb) will be specified for the same features as the source. In terms of information, we may say that the agreement marking on the verb adds nothing to the specification of the noun (Barlow, 1993). Pollard and Sag (1988) also noted the directionality implicit in this approach: The agreement features of the controller are inherent and logically prior to those of the target. Thus, syntactic features like person, number, and gender will be inherited (Gazdar et al., 1985) or copied (Chomsky, 1965; Akmajian and Heny, 1975) from the source to the target. This feature-copying had been variously realized for instance as an “affix-hopping” (Chomsky, 1965; Vanek, 1977) or a “coindexing relation” (Chomsky, 1981).

3.2. The unification (feature-merging) approach to agreement

According to this view (Barlow, 1988, 1993; Pollard and Sag, 1988) the two elements which participate in the agreement relation specify partial information about a single linguistic object. Unification involves the merging of information located in two compatible structures. It is based on the notion of subsumption (i.e., an ordering of feature structures expressing their compatibility and specificity). The question of compatibility is resolved in a computational manner by attempting to build a new structure compatible with both original structures (Kay, 1979, 1985). For example, [plural = −] subsumes [plural = −, person = 1]: It carries less information and contains no differing or conflicting information. In the case of differing but compatible information, there exists a more specific structure that is subsumed by both structures. For example, [plural = −, person = 1] subsumes both [plural = −] and [person = 1] (D = D' U D") (Shieber, 1986) (i.e., unification will consists of computing the union of all features in both nodes and for each feature the intersection of the values in both nodes). Fig. 1 (taken from De Smedt, 1990a, p. 47) schematically represents the unification treatment of subject–verb agreement.

Features are not copied or transported from one element to another, but are unified so that they are shared by elements of different branches of the tree structure. A basic assumption implicit in this approach is that the lexical representation for the verb contains not only information about its meaning and phonology but also about the structures it can be combined with. Unification is not directional in nature, though if one of the elements contributes all the information, that might be interpreted in terms of directionality.
Fig. 1. Agreement by means of Unification (from De Smedt, 1990a, p. 47, with permission). The features Person and Number are specified in S-subject–NP and in S-head–FINITE V. This operation implies the unification of the features in the two elements and the intersection of the values of each feature. The result is a set of features compatible with both elements.

4. A model for grammatical encoding

The model we will outline in this section is derived from a version of the Incremental Procedural Grammar (IPG) first proposed by Kempen and Hoenkamp (1987).

In this model, grammatical encoding is conceived as incremental and lexically driven. Incrementality implies that a surface structure is, by and large, generated from left to right. As successive fragments of the message become available each surface unit (roughly corresponding to a syntactic constituent) is generated and immediately sent to the Phonological Encoder. The model adopts the essentials of Garrett’s (Garrett, 1976; Garrett, 1980; Garrett, 1982) proposal (Kempen and Hoenkamp, 1987, p. 208). The tree formation component is supposed to be conceptually and lexically driven (Bresnan, 1982). The order in which grammatical encoding proceeds depends on the order in which lemmas become available, therefore on the order in which message fragments are generated. Lemmas are conceived as semantically and syntactically specified lexical items. For example, the lemma for a noun specifies its meaning, its grammatical category (N), and an address to its phonological specification (Butterworth, 1989). Furthermore, if it is a count noun, the number feature will be set as a parameter that can assume one of two values (singular or plural), if it is a mass noun the value singular will be given. After a fragment is delivered from the Conceptualizer (Levelt, 1989; De Smedt, 1990a), corresponding to the Message Level in Garrett’s theory, the processing of the sentence is computed in two major steps. At the Lexico-Syntactic Stage (corresponding to the Functional Level in Garrett’s model) an ordered tree structure, consisting of constituents and their functional relations, is constructed.

¹ The number value will be specified also in those cases in which the number feature is idiosyncratic, as for example pluralia tantum nouns.
The terminal nodes of the syntactic tree (both content and function words) are lemmas retrieved from the lexicon. At the Morpho-Phonological Stage (corresponding to the Positional Level), the word form of the lemma is retrieved from the lexicon, and word order and phonological phrasing of the sentence are computed.

The model is called Procedural because the syntactic tree formation is carried out by a set of procedures, "experts" in building one type of syntactic constituent that function in a highly modular fashion. Two kinds of procedure are proposed: Categorical Procedures are specialists in building certain syntactic structures (e.g., $S \rightarrow$ clause). They can be both phrasal ($S, NP, PP, AP$) or lexical ($N, V, A, P$). Functional Procedures take care of the grammatical (functional) relations between structures built by categorical procedures. They are: Vfin, Vinf, Subj, DObj, IObj, SMod. Another interesting aspect of the model is that, in order to account for fluency in speech production, different procedures are supposed to work in parallel.

The surface structure of a sentence is generated through a series of computational steps. In order to describe how agreement is carried out in the model we give the example of the sentence: "The baby on the blankets is crying." First, a categorical procedure for the NP with the lemma for baby as its head, accesses the conceptual representation, and since baby is a count noun, the procedure inspects the concept for number and comes up with the feature $[-\text{plural}]$. Also, since the syntactic category is N, the value third person is derived. These diacritic parameters (Levelt, 1989) are transmitted by procedure NP to both the head N lemma and the Det lemma. Next, a procedure assigns a "functional destination" for the composed NP, where the default destination for the initial NP is subject of S. In parallel with the retrieval of the lemma for baby and the construction of the subject NP, the lemma for blanket is retrieved, and the parameter $[+\text{plural}]$ inserted. A functional procedure then will assign NPMod function to this second NP. During a subsequent step, the features $[-\text{plural}, \text{third person}]$ of the subject are transmitted to the highest NP projection. Procedure S will then be called and the conceptual representation will be inspected in search for a predicate. The lemma for the verb to cry will be accessed. In the original model, the number feature of the subject NP would then be transferred to the verb lemma via the S procedure. Thus, the agreement relation would be realized through a feature-copying operation from the source to the target, as it is depicted in Fig. 2. This version of the model, therefore, does not allow for conceptual effects on agreement: only the grammatical number of the subject matters, since it is copied onto the verb. In our proposal features like number, person (and gender, if relevant) can be independently retrieved from the conceptual representation by both the NP and main Verb procedures. The agreement relation would then consist in the unification of these two sets of features, as it is shown in Fig. 3. This version allows for conceptual effects on subject–verb agreement. In those cases in which

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Following De Smedt (1990a), we prefer to use "±plural" than "singular" and "plural" because of the different psychological status of these two values (Tiersma, 1982).
there is a mismatch between the grammatical and the notional number of the subject, when the number for the verb is retrieved from the conceptual representation, then the verb will agree with the notional number. This yields more opportunities for errors when there is a mismatch between grammatical and notional number, and also for acceptable semantic agreement, such as plural agreement with singular collective nouns in British English.

We propose that cross-linguistic variability in semantic agreement is the result of how much information is retrieved from the conceptual representation by the main verb procedure. Thus, in English the most information would be carried by the subject NP; in Italian we proposed (Vigliocco et al., 1995) that the verb procedure would retrieve not only the tense parameter but also person and number (and gender, when it is relevant) from the conceptual representation.

In IPG, grammatical encoding is supposed to be incremental, that is, the choice of a particular structure is largely dependent upon the order in which lemmas are retrieved (Levelt, 1989). Thus, word order would also depend on the order in which lemmas are retrieved. Of course, how much of this "order-of-retrieval" will

Fig. 2. Agreement as a feature-copying operation in Incremental Procedural Grammar (Kempen and Hoenkamp, 1987). The thick lines with arrows show the flow of information, the thin lines show the points in which number information is retrieved. The [-plural] feature is retrieved from the conceptual representation by the NP procedure in order to build NP1. It is then copied to NPx. From there it is copied to S and finally to FINITE V.
appear in the surface form will depend upon the structure of the language. In strictly subject–verb–object (SVO) languages, such as English, non-canonical orders (e.g., questions or topicalization) are obtained by means of a word order rule. Following Kempen and Hoenkamp (1987) and De Smedt (1990a) when the sentence to-be-uttered is, for example, a question, a “pragmatic” marker will be retrieved from the conceptual representation by the S procedure and this will either force the “do” insertion or the NPSubj-auxiliary inversion. The application of a word order rule in English is tested in one of the experiments reported below. Since in the model agreement is computed prior to and independently of word order computation, it follows that no semantic (i.e., distributivity) effect should be found in questions with noun-auxiliary inversion. Fig. 4 outlines the application of the word order rule for a question in English.

It seems plausible that the order of lemmas’ retrieval plays a much greater part in determining word order in languages like Italian and Spanish where constituents will be produced as much as possible in order of arrival. The verb lemma may be retrieved before the noun lemma for the subject, and the word order rule would then allow for a VS order; this in turn may force an independent retrieval of
Fig. 4. Application of the Word Order Rule to an English question. In IPG the linearization process is carried out by a Word Order Rule, responsible for *do-insertion* or *subject-auxiliary inversion* (in question) in case the S procedure finds a mood marker in the message. Since syntactic structures are constructed in a piecemeal fashion, it seems natural to assign word order incrementally as well. As soon as a node has been lexicalized and attached in a structure constituents will try to occupy a slot in the corresponding *c-structure* (i.e., a structure representing surface constituency and word order; De Smedt, 1990: 25). In English the subject NP always tries to occupy the first slot. In questions, a pragmatic marker (depicted as a "?"') is placed in this slot and this will force the subject NP to occupy the third slot, since the second one will be occupy by *do* or the auxiliary verb.

agreement features for the two constituents from the conceptual representation, so that the verb lemma can start to be phonologically encoded before the subject head noun lemma.

To summarize, our revised version of IPG allows pragmatic and semantic effects on subject verb agreement depending upon the information retrieved from the conceptual representation when the verb lemma is encoded, thus allowing cross-linguistic variability.

4.1. Overview of the experiments

The main goal of this series of experiments was to test if the distributivity effect we previously reported for Italian can be generalized to another language structurally similar to Italian, and furthermore to replicate the original experiment
in English. It is worth emphasizing that if agreement is generally computed through a feature-copying operation we should not find a difference between single and multiple token preambles both in Spanish and in English. If we find a distributivity effect in Spanish (as we found in Italian) then we can conclude that, at least in these languages, agreement is computed through a unification operation. In the following, we report four separate experiments each designed to test the effects of distributivity on subject–verb agreement error rates. In the first two experiments, we used Spanish as the test language. In the first experiment, we manipulated the number and gender of the head and local noun, as well as the number of tokens referred to by the preambles. The second experiment replicated our results for distributivity using a different paradigm designed to increase the overall proportion of agreement errors. We turned to English in the third and fourth experiments. The third experiment replicated Bock and Miller's (Bock and Miller, 1991) original study, in which they found that English speakers were not sensitive to distributivity. In the fourth experiment, English speakers were required to produce questions, in order to assess whether distributivity effects can be induced when the verb is uttered before the subject.

4.2. Some relevant features of Spanish (and Italian)

Spanish is a Romance language, like Italian, and the features we will describe below are common to both languages.

Spanish is characterized as a null-subject language with no strict SVO word order. Verbal morphology is complex: Tense, person and number are always marked. It is not a completely free word order language and grammatical mobility is an attribute of subjects, not a general property of NPs (and for this reason we prefer to talk about post-verbal subjects instead of free word order). Furthermore, negatives and interrogatives have virtually no freedom of word order (Green, 1990). In negatives and interrogatives both VS and SV are found, but VS cannot be assumed as the result of a syntactic inversion, since VS is usually acceptable in the corresponding statement. Both Spanish and Italian have clitic pronominal objects in addition to full pronouns.

In Table 1, examples of sentences in Spanish and Italian showing the features discussed in this section are reported.

SPANISH: EXPERIMENT 1

5. Method

5.1. Subjects

Thirty-two Mexican subjects ranging from 19 to 24 years old participated in the experiment. Most of them were students of the Center for English as a Second Language at the University of Arizona in Tucson. They were selected according to
<table>
<thead>
<tr>
<th>Spanish</th>
<th>Italian</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rich verbal infectional system</strong></td>
<td></td>
</tr>
<tr>
<td>trabajo</td>
<td>lavoro</td>
</tr>
<tr>
<td>trabajas</td>
<td>lavori</td>
</tr>
<tr>
<td>trabaja</td>
<td>lavora</td>
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<tr>
<td>trabajamos</td>
<td>lavoriamo</td>
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<tr>
<td>trabajais</td>
<td>lavorate</td>
</tr>
<tr>
<td>trabajan</td>
<td>lavotano</td>
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<tr>
<td><strong>Null subject</strong></td>
<td></td>
</tr>
<tr>
<td>trabajan</td>
<td>lavorano</td>
</tr>
<tr>
<td>vamos</td>
<td>andiamo</td>
</tr>
<tr>
<td>trabaja todo el día</td>
<td>lavora tutto il giorno</td>
</tr>
<tr>
<td><strong>Postverbal (as well as preverbal subjects)</strong></td>
<td></td>
</tr>
<tr>
<td>Trabaja Juan</td>
<td>Lavora Giovanni</td>
</tr>
<tr>
<td>Juan trabaja</td>
<td>Giovanni lavora</td>
</tr>
</tbody>
</table>

Table 1

Some features of Spanish and Italian

their level of proficiency in the language. A questionnaire was presented before starting the experiment. As a general criterion, Spanish had to be not only the first language acquired but also subjects had to have attended high school in Mexico in order to be included in the sample. They were paid for their participation.

5.2. Materials

The basic materials for this experiment consisted of sentence preambles composed of a subject NP followed by a prepositional phrase.

The variables experimentally manipulated were: (1) number of the head noun (singular vs. plural); (2) number (match vs. mismatch) between the head and the local noun; (3) distributivity (single token vs. multiple token) of the preamble.

The preferred semantic reading of the preambles was evaluated by three independent judges, who were native Spanish speakers with training in linguistics. Only those preambles unambiguously evaluated as single or multiple token by all three judges were included in the experimental materials.

Four 128-item lists were created; in each list there were 64 experimental items and 64 fillers. There were four versions of the same item in each of the four lists (singular head noun, singular local noun; singular head noun, plural head noun; plural head noun, plural local noun; and plural head noun and singular local noun). In each list there were eight single token and eight multiple token items. The gender of the head noun, the gender of the local noun as well as the agreement/disagreement in gender between the head and the local noun were balanced.

In addition to the experimental items, 64 filler preambles were constructed. All were simple NPs (determiner–noun–adjective). Sixteen fillers were singular and
Examples of sentence preamble in Experiment 1 (items are given in the singular head noun, plural local noun version)

<table>
<thead>
<tr>
<th>Single token</th>
<th>El paseo por los lagos</th>
<th>El maestro de las chicas</th>
<th>La autora de las novelas</th>
<th>The-F.S el maestro de las chicas</th>
<th>La casa de mis primos</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>por los</td>
<td>for the-F,P</td>
<td>de las</td>
<td>por los</td>
<td>de mis</td>
</tr>
<tr>
<td></td>
<td>los</td>
<td>to the-M,P</td>
<td>las</td>
<td>los</td>
<td>mis</td>
</tr>
<tr>
<td></td>
<td>lagos</td>
<td>lakes-M,P</td>
<td>chicas</td>
<td>novels-F,P</td>
<td>primos</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple token</td>
<td>El nombre de los niños</td>
<td>El número de las tarjetas</td>
<td>The-M,S number-M,S</td>
<td>The-F.S la falda del las mujeres</td>
<td>La pasta de los libros</td>
</tr>
<tr>
<td></td>
<td>de los</td>
<td>de las</td>
<td>on the-F,P</td>
<td>del las</td>
<td>de los</td>
</tr>
<tr>
<td></td>
<td>niños</td>
<td>tarjetas</td>
<td>car/plates-F,P</td>
<td>mujeres</td>
<td>libros</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples of sentence preambles are given in Table 2. The complete list of the experimental materials is reported in Appendix A.

Every list started with four fillers; the arrangement of the remaining filler and experimental preambles was semi-random, with the constraint that no more than three experimental items could occur consecutively. The individual fillers and experimental items occupied different positions in the four lists.

5.3. Procedure

The experimental sessions were conducted entirely in Spanish.

The lists were presented visually on a computer screen. Subjects were tested individually. They were told they would see a series of sentence beginnings and that their task was to repeat each one along with a completion for the sentence. They were asked to respond quickly with the first complete sentence that came to mind, and to speak as fast as they were able. No other constraints were put on the form or content of the completions. The items were presented in the center of the computer screen preceded by a warning signal. Each item remained on the screen for 1 second and then disappeared. The presentation rate was self-paced: Subjects were instructed to press the space bar after completing a sentence in order to proceed to the following one.
At the beginning of the testing session, eight preambles were presented to the participants as practice items.

The experimental sessions were tape-recorded.

5.4. Scoring

The recorded completions were transcribed and then assigned to one of five scoring categories. A completion was scored as Correct Response when a participant repeated the preamble correctly, said it only once, and produced a correctly inflected verb form in his/her completion. Completions were scored as Agreement Errors when the participant correctly repeated the preamble but produced a wrongly inflected verb form. Responses in this category were further divided into: (i) errors in the agreement of number when the verb form produced mismatched the subject of the sentence in number (i.e., when a third person plural verb followed a singular subject or a third person singular verb followed a plural subject); (ii) other agreement errors when the predicate or a pronoun in the completion mismatched the subject of the sentence in number and/or gender. The third scoring category included Errors in the Repetition of the number (and/or gender) marking of the head noun. In this category were thus included all those cases in which the participant said something like: "Los abuelos de los niños son viejos" [The uncles of the children are old] when the target was "El abuelo de los niños" [The uncle of the children]. The fourth category included those cases in which an agreement error occurred after a repetition error. Finally, completions were scored as Miscellaneous Responses if the participant failed to repeat the whole preamble, substituted some words with extraneous words, completed the sentence without producing a verb, or failed to read the preamble at all. A sample of four completions for each scoring category is reported in Appendix B.

5.5. Design and data analyses

The number of agreement errors constituted the dependent variable for the statistical tests. Two analyses of variance (both with subjects and items as random factors) were carried out. The first analysis of variance was performed in order to assess the general distribution of agreement errors in Spanish according to those factors that have been shown as influential in English and Italian (Bock and Miller, 1991; Vigliocco et al., 1995). The factors orthogonally combined were: (1) number of the head noun (singular vs. plural); (2) number (match vs. mismatch) between the head and the local noun. In this analysis we also included (3) gender of the head noun (masculine vs. feminine) and (4) gender (agreement vs. disagreement) between the head and the local noun. The orthogonal combination of these four factors yielded 16 conditions; every participant received four items representing each of the 16 conditions. The second analysis of variance was performed on preambles with singular head noun and plural local noun, to assess the effect of distributivity. In this second analysis the only experimental factor was distri-
butivity with two levels: single token versus multiple token. Every participant received eight items for each of the two conditions.

6. Results

Application of the scoring criteria yielded 1659 (81%) correct responses; 110 (5.37%) agreement errors, of which 103 were errors in the agreement of number; 4 were errors in the agreement of gender and 3 were errors in the agreement of number and gender. There were 110 (5.37%) errors in the repetition of the head noun; 15 (0.73%) agreement errors after a repetition error and 154 (7.52%) miscellaneous responses.

Errors were most common when the head and the local noun mismatched in number, supporting the findings reported in Bock and Miller (1991) and Vigliocco et al. (1995) for English and Italian, respectively. In the number mismatch condition errors were more common after a singular head noun, showing an asymmetry between singular and plural head nouns, again widely attested for English (Bock and Miller, 1991) and to a lesser extent for Italian (Vigliocco et al., 1995). The distributivity manipulation affected the error rates in the direction predicted on the basis of Italian data. Distributivity seems to be relevant in the computation of subject verb agreement at least in these two romance, null-subject languages.

Table 3 shows the distribution of number agreement errors. The first analysis of variance conducted on agreement errors showed a main effect of number (match vs. mismatch) between the head and the local noun ($F_1(1, 31) = 17.82, p < 0.001$; $F_2(1, 60) = 28.45, p < .001$). It also showed a significant interaction between number of the head noun (singular vs. plural) and number (match vs. mismatch) ($F_1(1, 31) = 15.41, p = .001$; $F_2(1, 60) = 22.64, p < .001$).

The gender of the head noun as well as the gender agreement/disagreement between the head and local noun had no effect on the distribution of errors in the agreement of number (all $F$s $\leq 1$).

We found an effect of distributivity: Errors in the single token condition were 19 (7.42%) while there were 40 (15.62%) errors in the multiple token condition. This difference was significant both in the analysis by subjects ($F_1(1, 31) = 9.00, p = .005$) and by items ($F_2(1, 62) = 7.15, p = .01$).

Table 3
Distribution of errors in the agreement of number in Experiment 1 (Spanish)

<table>
<thead>
<tr>
<th>Number of the local noun</th>
<th>Number of the head noun</th>
<th>Singular</th>
<th>Plural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Plural</td>
<td>59</td>
<td>17</td>
</tr>
</tbody>
</table>
7. Discussion

The results of the first experiment give a general overview of the distribution of agreement errors in Spanish. The presence of a mismatching local noun is the strongest determinant of agreement errors, as has been documented for English (Bock and Cutting, 1992; Bock and Eberhard, 1993; Bock and Miller, 1991) and Italian (Vigliocco et al., 1995). There was an asymmetry between singular and plural head noun, preambles with singular head nouns inducing the most errors; this result also replicates the findings for English and Italian. Finally, error rates were influenced by distributivity, that is, by whether the singular head noun had a preferred single or multiple token reading. This result replicates the finding on Italian (Vigliocco et al., 1995) and contrasts with the English data (Bock and Miller, 1991).

SPANISH: EXPERIMENT 2

This second study was designed to replicate the results concerning distributivity in subject-verb agreement errors found in the preceding experiment. In order to increase error rates we used a technique first employed by Vigliocco et al. (1995) in their study of Italian. This technique takes advantage of the fact that in Spanish, as well as in Italian, predicates agree in number (and gender) with the sentential subjects as it is shown in (18).

(18) (a) El abuelo de los niños es viejo
(b) Los abuelos de los niños son viejos

We therefore presented to the participants an adjective (singular or plural) immediately followed by the preamble on a computer screen. The participants' task was to complete the preamble using the adjective they had just seen. For instance, the subject saw “viejo” and then “El abuelo de los niños”, and his/her task was to say “El abuelo de los niños es viejo” [The uncle of the children is old]. The adjective could be “congruent” in that it had the same number as the head noun (adjective singular, head noun singular or adjective plural, head noun plural), or “incongruent”, with a different number (adjective singular, head noun plural or adjective plural, head noun singular). In the incongruent case, subjects were implicitly required to change the form of the adjective, in order to get agreement right.

8. Method

8.1. Subjects

The participants were 32 Mexican native Spanish speakers ranging from 19 to 25 years old, most of them students at the Center for English as a Second Language of the University of Arizona. Their proficiency in Spanish was assessed using the same criteria used in Experiment 1. They were paid for their participation in the experiment.
8.2. Materials

The basic materials for the present experiment were the experimental sentence preambles used in Experiment 1. Four 64-item lists were created. In each list there were 32 experimental items and 32 filler preambles. All the experimental preambles had a singular head noun and a plural local noun. The same experimental items were repeated in two different lists, with a singular adjective in one list and with a plural adjective in the other list. The filler preambles were 32 NP–PP items, 24 of which had a plural head noun and a plural local noun, eight of which had a singular head noun and a singular local noun. They were matched with singular or plural adjectives in two different lists. Thus, in lists one and two, 32 of the 64 experimental items created for experiment 1 were used as experimental items while the remaining 32 were used as filler items. In lists three and four the items that were used as experimental preambles in the other lists were used as fillers, while the filler items in lists one and two were now used as experimental items. Table 4 gives an overview of the organization of experimental and filler items in the four lists.

Table 4
Examples of experimental sentence preambles and fillers in Experiment 2

<table>
<thead>
<tr>
<th>Experimental preambles</th>
<th>Fillers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LIST 1</strong></td>
<td></td>
</tr>
<tr>
<td>Single token</td>
<td></td>
</tr>
<tr>
<td><em>adj: genial (creative, sing.)</em></td>
<td><em>adj: distraídos (distracted, plur.)</em></td>
</tr>
<tr>
<td>La trampa para los ratones</td>
<td>Los maestros de las chicas</td>
</tr>
<tr>
<td>(The trap for the mice)</td>
<td>(The teachers for the girls)</td>
</tr>
<tr>
<td>Multiple token</td>
<td></td>
</tr>
<tr>
<td><em>adj: verdes (green, plur.)</em></td>
<td><em>adj: rectangular (rectangular, sing.)</em></td>
</tr>
<tr>
<td>El uniforme de los soldados</td>
<td>Las pastas de los libros</td>
</tr>
<tr>
<td>(The uniform of the soldiers)</td>
<td>(The covers of the books)</td>
</tr>
<tr>
<td><strong>LIST 2</strong></td>
<td></td>
</tr>
<tr>
<td>Single token</td>
<td></td>
</tr>
<tr>
<td><em>adj: geniales (creative, plur.)</em></td>
<td><em>adj: distraído (distracted, sing.)</em></td>
</tr>
<tr>
<td>La trampa para los ratones</td>
<td>Los maestros de las chicas</td>
</tr>
<tr>
<td>(The trap for the mice)</td>
<td>(The teachers for the girls)</td>
</tr>
<tr>
<td>Multiple token</td>
<td></td>
</tr>
<tr>
<td><em>adj: verde (green, sing.)</em></td>
<td><em>adj: rectangulares (rectangular, plur.)</em></td>
</tr>
<tr>
<td>El uniforme de los soldados</td>
<td>Las pastas de los libros</td>
</tr>
<tr>
<td>(The uniform of the soldiers)</td>
<td>(The covers of the books)</td>
</tr>
<tr>
<td><strong>LIST 3</strong></td>
<td></td>
</tr>
<tr>
<td>Single token</td>
<td></td>
</tr>
<tr>
<td><em>adj: distraído (distracted, sing.)</em></td>
<td><em>adj: geniales (creative, plur.)</em></td>
</tr>
<tr>
<td>El maestro de las chicas</td>
<td>Las trampas para los ratones</td>
</tr>
<tr>
<td>(The teacher for the girls)</td>
<td>(The traps for the mice)</td>
</tr>
<tr>
<td>Multiple token</td>
<td></td>
</tr>
<tr>
<td><em>adj: rectangulares (rectangular, plur.)</em></td>
<td><em>adj: verde (green, sing.)</em></td>
</tr>
<tr>
<td>La pasta de los libros</td>
<td>Los uniformes de los soldados</td>
</tr>
<tr>
<td>(The cover of the books)</td>
<td>(The uniforms of the soldiers)</td>
</tr>
<tr>
<td><strong>LIST 4</strong></td>
<td></td>
</tr>
<tr>
<td>Single token</td>
<td></td>
</tr>
<tr>
<td><em>adj: distraídos (distracted, plur.)</em></td>
<td><em>adj: genial (creative, sing.)</em></td>
</tr>
<tr>
<td>El maestro de las chicas</td>
<td>Las trampas para los ratones</td>
</tr>
<tr>
<td>(The teacher for the girls)</td>
<td>(The traps for the mice)</td>
</tr>
<tr>
<td>Multiple token</td>
<td></td>
</tr>
<tr>
<td><em>adj: rectangular (rectangular, sing.)</em></td>
<td><em>adj: verdes (green, plur.)</em></td>
</tr>
<tr>
<td>La pasta de los libros</td>
<td>Los uniformes de los soldados</td>
</tr>
<tr>
<td>(The cover of the books)</td>
<td>(The uniforms of the soldiers)</td>
</tr>
</tbody>
</table>
8.3. Procedure

Each subject was tested individually. The adjective was presented at the center of a computer screen for 600 ms, then after an interval of 600 ms the preamble was presented for 1 second. For example, they saw "extranjeros" [foreign] and then "El nombre de los niños" [The name of the children]. They had to produce a sentence such as: "El nombre de los niños es extranjero" [The name of the children is foreign] thus changing the number of the adjective. The written instructions emphasized rapid speech and gave many examples of possible sentences both with a match or a mismatch between the number of the adjective and the number of the subject head noun. Subjects had, in fact, to be ready to find incongruence between the number feature of the adjective and of the noun but no mention of grammatical number was made. Participants were instructed to press the space bar to move from one item to the next one. If the participant forgot the adjective the experimenter repeated it to him/her. At the beginning of the experimental session, a set of eight preambles similar to the filler items were presented for the subjects to complete. The experimental sessions were tape-recorded.

8.4. Scoring

Scoring was the same as in Experiment 1.

8.5. Design and data analysis

The number of agreement errors constituted the dependent variable for all statistical tests. An analysis of variance was performed (both with subjects and items as random factor). The factors orthogonally combined were: (1) distributivity of the preamble (single vs. multiple token); and (2) number marking on the adjective (singular vs. plural). There were four conditions, and every participant received eight items in each condition.

9. Results

Application of the scoring criteria yielded 746 (73.0%) correct responses; 184 (17.8%) errors in number agreement; there were 43 (4.2%) repetition errors and 51 (5.0%) miscellaneous responses. Thirty-six errors in the filler items were also found.

The error rate was higher than in the previous experiment due to the interfering effect of the mismatching adjective. This interfering effect also explains the high error rate obtained for the filler items (NP–PP preambles with number match between the head and the local noun). When the number of the predicate (that is processed first) mismatched with the number of the sentential subjects, it is more difficult to get agreement right.
As evident from Table 5, errors were more common for multiple token items than for single token items. There were in fact 67 (13.08%) errors in the single token condition and 117 (21.87%) in the multiple token condition.

The analysis of variance showed a main effect of distributivity ($F_1(1, 31) = 20.32, p < .001$; $F_2(1, 62) = 6.24, p = .015$); a main effect of the number of the adjective ($F_1(1, 31) = 25.32, p < .001$; $F_2(1, 62) = 23.46, p < .001$). The interaction between distributivity and number of the adjective was significant by subjects ($F_1(1, 31) = 11.73, p = .002$) but not by items ($F_2(1, 62) = 1.84, p = 0.18$).

The errors in the filler items were far more common when the preceding adjective mismatched in number with the subject head noun (34/36). We found 11 (4.3%) when both the head and the local noun were singular and 25 (3.26%) errors when the head and local noun were plural.

10. Discussion

The results of the present study replicate the results obtained in Experiment 1 using a slightly different methodology.

In Fig. 5, data from these two experiments in Spanish are reported along with data from two similar experiments in Italian. Overall error rates are higher for

![Graph showing proportions of errors in single and multiple token conditions in Experiments 1 and 2 in Spanish and in two equivalent experiments in Italian (data from Vigliocco et al., 1995). Proportions are computed as the ratio between the number of errors in the condition and the total number of items in that condition.](image)
Spanish than for Italian, which may be due to certain differences in the methodology, such as the fact that preambles were presented visually in the first experiment in Spanish and auditorily in the first experiment in Italian.

Spanish as well as Italian speakers are thus sensitive to distributivity. In our model, these results can be accounted for in terms of independent retrieval of the number feature for the NP and for the verb. Agreement will then consist in the unification of these features. When the features of the noun and the features of the verb mismatch, unification may fail or may produce an error.

However, we can still ask if English speakers are really insensitive to distributivity or some other differences in the experimental management can account for the different results.

ENGLISH: EXPERIMENT 3

This third experiment consisted in the replication of Bock and Miller’s (Bock and Miller, 1991) study, which found no effects of distributivity. Given that the focus of attention was on the distributivity dimension, we included in the experiment only items with a singular head noun and a plural local noun without number matching control condition. The preambles used by Bock and Miller (1991) were judged along the distributivity dimension by three independent judges with a training in linguistics. Only those preambles judged as unambiguously single or multiple token by all the three judges were included. Two of the original multiple token items were replaced.

11. Method

11.1. Subjects

Fifty-six first-year undergraduate students of the University of Arizona participated in the present experiment to fulfill a course requirement. All were native US English speakers.

11.2. Materials

One 80-item list was created. In the list there were 16 experimental items (8 single token and 8 multiple token) and 64 fillers. All the experimental preambles had a singular head noun and a plural local noun. The filler preambles were of different type. There were 16 long single NP preambles, 8 with a singular head noun and 8 with a plural head noun; 16 preambles with two prepositional phrases after the head noun (eight with a singular and eight with a plural head noun) and 32 NP–PP preambles introduced by “That” and “Those”. The sentence beginnings were recorded on a digital tape-recorder by a female speaker. The speech rate was kept as high as possible without compromising clarity. The experimental sentence preambles used in the experiment are reported in Table 6.
11.3. Procedure

Participants were tested individually. They were told they would hear a series of sentence beginnings and their task was to repeat them back along with a completion. Instructions emphasized rapid speech. No restrictions on the form or content of the completions were made. The experimenter presented the recorded preambles one at a time. If the participant failed to apprehend an item, the experimenter repeated it back. At the beginning, a practice set composed of six items was presented. The experimental sessions were tape-recorded.

11.4. Scoring

To the scoring categories used in Experiments 1 and 2, we added a further category: Uninflected Verb Responses that were scored when the participant produced a verb form uninflected for number (e.g., a past tense of a regular verb).

11.5. Design and data analysis

The statistical tests were carried out using agreement errors as the dependent variable. An analysis of variance was performed with distributivity (single vs. multiple token) as experimental factor and subjects or items as random factors. Each participant received eight items for each of the two experimental conditions.
Table 7
Distribution of errors for the single and Multiple token conditions in Experiment 3

<table>
<thead>
<tr>
<th></th>
<th>Single token</th>
<th>Multiple token</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement errors</td>
<td>36</td>
<td>34</td>
</tr>
<tr>
<td>Repetition errors</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Repetition + agreement errors</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Miscellaneous responses</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>(uninflected</td>
<td>93</td>
<td>78</td>
</tr>
</tbody>
</table>

12. Results

Application of the scoring criteria yielded 594 (66.29%) correct responses, 70 (7.81%) agreement errors, 50 (5.58%) repetition errors, 5 (0.56%) agreement errors after a repetition error, 6 (0.67%) miscellaneous responses and 171 (19.08%) uninflected verb responses. A sample of four responses for each scoring category is reported in Appendix C.

We found 36 (4.02%) agreement errors in the multiple token condition and 34 (3.80%) in the single token condition. The difference failed to reach significance both in the analysis by subjects ($F_1(1, 55) = .005$) and by items ($F_2(1, 14) = .007$). Data are reported in Table 7.

13. Discussion

In the present experiment we replicated Bock and Miller (1991) results and in Fig. 6 we report data from this experiment along with data from their study. The presence/absence of a distributivity effect in the different languages cannot be explained in terms of differences in experimental management. In the framework
of the model proposed in the Introduction, a last question concerning English is still open and it is addressed in the last experiment.

**ENGLISH: EXPERIMENT 4**

In IPG, a word-order rule is supposed to assign constituents to their left-to-right order during phonological encoding (see Fig. 4). Incremental production requires that, in languages with post-verbal subjects, the constituents would be assigned to their linear position as far as possible in the order in which they are retrieved. A further test of the model, therefore, consists in looking for distributivity effects in English sentence types in which the produced utterance starts with the verb instead of the subject, such as questions. A distributivity effect would imply that the number feature can be retrieved from the conceptual representation, even in English, if the verb lemma is the first element to be uttered. This in turn implies that the order in which words are uttered in the sentence strictly corresponds to the order in which lemmas are retrieved, and hence in conflict with the word order rule, or any rule that moves constituents from their generated position (e.g., Move-alpha, Chomsky, 1981).

In the present experiment, the sentential preambles were the same as in Experiment 3. Participants were asked to make up a question using the preamble and a predicate (an adjective) presented on a computer screen immediately before the preamble.

**14. Method**

14.1. **Subjects**

Thirty-six first-year undergraduate students of the University of Arizona participated in the present experiment to fulfill a course requirement. All were native US English speakers.

14.2. **Materials**

Each of the 16 preambles used in Experiment 3 were matched with a semantically plausible adjective to be used in the completions. One 32-item list was created in which there were 8 items in the single token condition, 8 items in the multiple token condition, and 16 fillers. All the experimental preambles had a singular head noun and a plural local noun. The filler items were simple NP preambles (Det-Noun); 12 had a plural subject and 4 had a singular subject.

14.3. **Procedure**

Each participant was tested individually. They were told they would see on the computer screen an adjective immediately followed by a sentence beginning and
that their task was to make up a question using the sentence beginning and the adjective. Participants saw, for example, "threatening" and then "The letter from the lawyers" and their task was to say "Is/Was the letter from the lawyers threatening?". Each trial (adjective–preamble pair) was composed of a warning signal, immediately followed by the adjective presented for 600 ms and after an interval of 600 ms, the preamble was presented for 1 second. A few examples, given in the written instruction, and eight practice trials at the beginning of the experimental sessions ensured that participants understood the task.

14.4. Scoring

Scoring was as in the preceding experiment, with the exception that no uninflected verb responses were produced.

15. Results

Application of the scoring criteria yielded 392 (68.06%) correct responses; 45 (7.81%) agreement errors, 94 (16.31%) repetition errors and 45 (7.81%) miscellaneous responses.

There were 25 (4.34%) agreement errors in the single token condition and 20 (3.47%) in the multiple token condition. The difference between single and multiple token failed to reach significance in the analysis by subjects ($F1(1, 35) = 0.78$) and by items ($F2(1, 14) = 0.27$).

The data are summarized in Table 8.

16. Discussion

Data from the present experiment extend and confirm the results of the preceding one. English speakers are not sensitive to the notional number of the subject NP no matter if the first element uttered is the subject NP or the verb. The present data also support the existence in English of a rule for arranging constituents in their left to right order, such as the "Word Order Rule" in IPG, that arranges syntactic constituents according to pragmatic constraints (or, more

<table>
<thead>
<tr>
<th></th>
<th>Single token</th>
<th>Multiple token</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement errors</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Repetition errors</td>
<td>45</td>
<td>49</td>
</tr>
<tr>
<td>Miscellaneous responses</td>
<td>19</td>
<td>26</td>
</tr>
</tbody>
</table>
generally with whatever account in which linearization is achieved through the application of a movement rule). Therefore word order seems to be, at least partially, independent of the order in which lemmas are retrieved and syntactic encoding is carried out in English.

GENERAL DISCUSSION

The three key findings of this series of experiments are as follows. (1) The distributivity effect in Spanish speakers: This replicates the finding of Vigliocco et al. (1995) in Italian, a language very similar to Spanish from both a lexical and a syntactic point of view. (2) The absence of a distributivity effect in English: This replicates the results reported by Bock and her collaborators (Bock et al., 1992; Bock and Miller, 1991). (3) English speakers were not sensitive to distributivity even when they were required to produce utterances starting with the verb. In incremental formulation, this should have increased the likelihood of independent retrieval of agreement features for the verb and the NP from the conceptual representation, as we have previously proposed.

This last fact points to the existence of a process for ordering words or constituents that is separate from the process of constructing dominance relations. This separation has been independently proposed on linguistic grounds by Gazdar and Pullum (1981).

In the next sections we discuss the most important theoretical implications of the results. The discussion is divided in two main sections. In the first part we deal with the structural differences among the languages studied that may be responsible for the cross linguistic difference we found. In the last section we argue that the present findings support a model of incremental grammatical encoding in which agreement is constructed via unification and not feature-copying.

17. The cross-linguistic variability

As we pointed out in the Introduction, many cases of conflict between semantic and grammatical agreement have been described in the linguistic literature, and crucially, languages seem to differ from one another in whether and where they permit (or require) semantic agreement.

The agreement hierarchy proposed by Corbett (1979, 1983) can be considered as an attempt to give a systematic description of this variability. Starting from the study of Slavic languages, Corbett (1979, 1983) postulated that the probability of semantic agreement, rather than syntactic agreement, increases as the agreement target occupies a rightward position in the following series of syntactic positions: attributive modifier, predicate, relative pronoun, personal (anaphoric) pronoun.

Spanish, Italian, and English may occupy different positions in this hierarchy.
According to this hypothesis semantic agreement could be found in English for targets in a position further on the right of the hierarchy. Evidence in favor of this view (as applied to agreement errors) comes from another finding by Bock et al. (1992) showing that speakers of English were sensitive to distributivity manipulations in the construction of subject–anaphoric pronoun agreement. In that experiment, participants listened to sentences such as: "The road to the lakes deteriorated" or "The picture on the postcards fell" and they had to repeat the sentence and to add a tag question at the end (e.g., "The road to the lakes deteriorated. Didn't it?"). The authors found a distributivity effect on errors in the tag questions. This result seems to be particularly important since it shows that English speakers can be sensitive to the distributivity dimension. Additional data showing a conceptual influence on the relation between subject and anaphoric pronoun in English and Spanish comes from work by Gernsbacher and colleagues (Gernsbacher, 1991; Carreiras and Gernsbacher, 1992; Oakhill et al., 1992). These authors reported a series of experiments exploring the comprehension of "conceptual anaphors", such as "I think I'll order a frozen margarita. I just love THEM" both in English and Spanish. They found that conceptual anaphors are quickly read and easily understood in both languages.

In the framework of a processing model, the agreement hierarchy may represent the points at which the conceptual representation is inspected in the search for agreement features.

It is not surprising that the conceptual representation, or discourse model, is checked when a subject pronoun has to be grammatically encoded. Given for example the sentence: "John went to the theatre, but he did not see a movie", he agrees with John, but the pronoun is part of a different sentence (considered as a separate encoding unit (Bock and Cutting, 1992)), and hierarchical models of speech production (as Bock, 1987; Garrett, 1980; Levelt, 1989) would require features for the second sentence being directly retrieved from the conceptual representation. Our results are problematic because they show that the conceptual specification of number can affect grammatical encoding of two elements within the same clause in some languages and not in others.

Which are the properties of a language that determine its position on the agreement hierarchy and, therefore, allow an independent retrieval of number specification from the conceptual representation for the controller and the target? We have already introduced some structural differences between Spanish and English that may contribute to the cross-linguistic difference we reported. These features were: (i) a rich verbal inflectional system versus a poor verbal morphology; (ii) the presence of post-verbal as well as pre-verbal subjects versus a fixed SVO order; (iii) the possibility of dropping subject pronouns versus mandatory pronouns.

In Spanish the verb form is always marked for tense, person and number, while in English only tense is systematically marked. Third person singular and third person plural are always differently marked in Spanish whereas in English, third person singular is marked in the present tense (for the verb "to be") also in the past
tense), while third person plural is always unmarked. The unambiguous presence of subject's features such as number and person (and sometimes gender) in the verb phrase seems to be a general feature of Romance languages and in the history of languages, agreement markers are considered as closely related to pronominal elements, evolving as reduced forms of those elements (Givón, 1976). Perhaps, Corbett's agreement hierarchy reflects the presence or absence of pronominal features in different syntactic positions (such as subject–verb agreement, subject–relative pronoun agreement) in a certain language. In terms of the processing model we outlined, features such as number would be retrieved from the conceptual representation in the construction of the verb phrase only if they represent pronominal features. Spanish as well as other Romance languages still preserve these features in the verb phrase, while they have been lost in the evolution of modern English. According to this very speculative hypothesis, the likelihood of semantic agreement would be related to the presence of pronominal features in the agreement target.

The second difference concerns the possibility of having post-verbal subjects. During incremental production, the lemma for the verb could be encoded and sent to the Phonological Encoder (Levelt, 1989) prior to the lemma for the subject head noun when the sentence has a VS order. The time pressure of incremental formulation would therefore force an independent retrieval of agreement features for the verb and for the subject. This does not seem to be a general mechanism since there was no distributivity effect in experiment 4 in English, when the task required speakers to use a VS order.

Finally, in most sentences in Spanish, the subject pronoun is dropped, so that the speaker has to encode the verb in sentences lacking a subject. It is often assumed that sentences lacking an explicit subject nevertheless contain a syntactic element specified for agreement features, the so-called “little pro” proposed by Rizzi (1982) among others. Our data, however, would appear to create problems for this position if subject's features are assumed to be copied to the verb.

Independent evidence comes from the observation that in some Romance languages like French (or Italian dialects as Triestino and Vicentino, among others), subject's features are mandatorily (or optionally) expressed by subject clitics in preverbal position, if the verbal inflection does not give information about number, as it is shown in the example below from spoken French.

Mon père il dit que ...

(my father he says that ...)

(From Harris, 1990, p. 232)

Note, however, that in certain dialects of Black English, sentences such as in the example below are grammatical. In this example the number marking in the verb phrase is guaranteed by the presence of a resumptive pronoun.

The man he-came to dinner

(From Givón, 1976, p.170)
18. The construction of agreement during grammatical encoding

In the linguistic literature, as we outlined in the introduction, subject–verb agreement has been treated in two ways: feature-copying and unification. Both options can be implemented within the framework of a general computational model of grammatical encoding as the one described in the Introduction.

A feature-copying approach to agreement construction in a model, such as IPG (Kempen and Hoenkamp, 1987), would not predict any semantic or pragmatic effects as the result of an independent retrieval of agreement features by verb procedure. However, in IPG, features are supposed to percolate up and down different branches of the syntactic tree (as it is schematically represented in Fig. 2). In the model, semantic agreement could be explained as the result of an increased probability of transferring the wrong features to the highest NP projection. With multiple token items, there would be competition between semantic plurality and grammatical singularity in the head NP and sometimes the semantic features would be copied instead of the grammatical features. This view, however, would not allow cross-linguistic variability.

The unification point of view would predict a distributivity effect as a consequence of independent retrieval of agreement features from the conceptual representation at different points during incremental production. Given a sentence such as “The baby on the blankets is crying” the grammatical encoder would start retrieving the lemma for the head of the subject NP, baby, from the mental lexicon and the feature [-plural] will be inserted. In parallel, the lemma for the head of the local NP, blanket is also retrieved and the feature [+plural] inserted$. The number feature is then passed to the S procedure, while the verb lemma cry is retrieved. The conceptual representation is checked in search for features to specify the verb lemma and person and number (and maybe gender) will be retrieved along with tense – in some languages. These features will then be passed to S procedure in order to be unified to features of the subject NP. In this framework cross-linguistic variability could be accounted for assuming that the features of the verb, that will be shared with the features of the subject, are specified in some languages while is left unspecified in others.

In a more recent version of IPG (called Incremental Parallel Formulator, De Smedt, 1990a and De Smedt, 1990b) unification (as feature-sharing) has been used for tree-building construction in general. Unification is in fact a useful tool for an incremental generator because it does not necessarily involve whole sentences. Kempen (1987) developed a new formalism called Segment Grammar (SG) in which syntactic segments constitute the basic units that allows the construction of subportions of syntactic trees through unification, in an incremental fashion. According to this view, each syntactic segment consists of two nodes representing grammatical categories and an arc representing a grammatical function (e.g., S–subject–NP, NP–head–N). Syntactic segments represent immediate dominance

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$ Here, there is a first computational possibility of errors: the wrong [+ plural] feature competes with the correct [− plural] feature at NPx level.
relations. They are supposed to join to form a syntactic structure by mean of unification. To each node, a set of features is attached: For example, NP nodes may have: ± nominative, ± plural, ± feminine. Features are merged when two nodes are unified. Unification in this framework can be realized as concatenation (e.g., S-subject–NP U NP–head–N) or furcation (e.g., NP–subject–S U S–head–V) as depicted in Fig. 7.

A problem that arises assuming that the whole tree building is realized through a series of unifications of segments is how to explain the error-free character of language production. To overcome this problem, De Smedt (1990a, 1994) assumed a completely error-free unification operation: Either unification succeeds, in which case the constituent will be built, or it fails, in which case there is no merging of separate segments. This approach however, would never predict the occurrence of speech errors, and agreement errors in which the wrong number feature is selected for the verb. Perhaps a way to overcome these problems (and therefore to have a system that guarantees correct speech but at the same time allows errors to occur) consists in assuming activation levels for unification, along the lines proposed by Kempen and Vosse (1989) for the parsing system.

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**Appendix A**

**Experimental items used in Experiments 1 and 2**

*Multiple token*

- El nombre de los niños
- El cascabel de los gatos
- El gorro de los hombres
- El seguro de los coches
- El timbre de los portales
- El uniforme de los soldados
- El dibujo de los carteles
- El conductor de los autobuses
- La etiqueta de las botellas
- La falda de las mujeres
- La grúa de las canteras
- La puerta de las casas
- La estela de las embarcaciones
- La medalla de las niñas
- La chimenea de las casas
- La computadora de las oficinas
- El sello de las cartas
- El alcade de las ciudades
- El abrigo de las señoras
- El bolso de las chicas
- El color de las flores
- El número de las tarjetas
- El embarazo de las mujeres
- El malo de las películas
- La pasta de los libros
- La raza de los perros
- La corbata de los payasos
- La agenda de los profesores
- La orilla de los ríos
- La residencia de los presidentes
- La nota de los estudiantes
- La avería de los aviones
Single token

El derecho de los trabajadores
El testigo de los abogados
El regalo para los bebés
El aviso de los expertos
El olor de los almendros
El paseo por los lagos
El responsable de los incendios
El atentado contra los ministros
La madre de las niñas
La casa de las colinas
La autora de las novelas
La queja de las estudiantes
La chica de las fotografías
La ofensa a las mujeres
La recompensa a las ganadoras
La luz sobre las mesas
El maestro de las chicas
El médico de las enfermas
El mecánico de las motocicletas
El abuelo de las niñas
El director de las películas
El debate sobre las drogas
El niño con las muletas
El pescador con las redes
La casa de mis primos
La fotografía de los turistas
La enfermedad de los hombres
La canción de los cantantes
La sugerencia a los directores
La demanda contra los propietarios
La teoría de los liceciados
La trampa para los ratones

Appendix B

Random sample of responses for the different scoring categories

Correct responses

Los derechos del trabajador son justos y necesarios
The M,P rights M,P of the M,S worker M,S are 3p,P right M,P and necessary M,P

El debate sobre la droga es muy peligroso
The M,S discussion M,S about the F,S drug F,S is 3p,S very difficult M,S

Las faldas de las mujeres son muy cortas
The F,P dresses F,P of the F,P women F,P are 3p,P very short F,P

La raza de los perros es muy especial
The F,S race F,S of the M,P horses M,P is 3p,S very particular o,S

Agreement errors

La residencia de los presidentes son muy bonitas
The F,S residence F,S of the M,P presidents M,P are 3p,P very nice F,P

Los maestros de la chica es de psicología
The M,P teachers M,P of the F,S girl F,S is 3p,S of psychology

El conductor del autobús usan siempre uniforme azul
The M,S driver M,S of the M,S bus M,S wear 3p,P always uniform M,S blue o

La puerta de las casas están pequeños
The F,S door F,S of the F,P houses F,P are 3p,P small M,P

Repetition errors

La(s) chica(s) de la(s) fotografía(s) es muy bella
The F,S girl F,S in the F,S picture F,S is 3p,S very beautiful F,S

La(s) residencia(s) del presidente es en la casa blanca
The F,S residence F,S of the M,S president M,S is in the F,S house F,S white F,S

El (Los) médico(s) de las enfermas es muy enfadados
The M,S doctor M,S for the F,P invalid F,P is 3p,S very tired M,S

El (Los) aviso(s) del esperto se debe de escuchar
The M,S warning M,S from the M,S expert M,S CL-o must 3p,S of listen INF

Agreement errors after a repetition error

El(Los) dibujo(s) del cartel son bonitos
The M,S slogan M,S of the M,S poster M,S are 3p,P nice M,P
La + s corbata + s del payaso está chichosa
The-F,P dress-F,P of-the-M,S clown-M,S is-3p,S elegant-F,S

La + s madre + s de las niñas es buena
The-F,P mother-F,P of the-F,P children-F,P is-3p,S good-F,S

El debate sobre la + s droga + s fueron ayer
The-M,S discussion-M,S about the-F,P drugs-F,P were-3p,P

Miscellaneous responses

Las demandas contra las mujeres (el proprietario) son feas
The-F,P claim-F,P against the-F,P women-F,P (the owner) are-3p,P nasty-F,P

Los paseos largos (por los lagos) son peligrosos
The-M,P roads-M,P large-M,P (to the lakes) are-3p,P dangerous-M,P

Las luces sobre la tierra (las mesas) son muy brillantes
The-F,P lights-F,P on the-F,S earth-F,S (the tables) are3p,P very bright-φ,P

El debate sobre la gente (las drogas) confunde
The-M,S discussion-M,S on the-F,S people-F,S (the drugs) confounds-3p,S

Appendix C

Random sample of responses for the different scoring categories
(Experiment 3)

Correct responses

ST The memo from the accountants was bad
ST The bridge to the islands was closed
MT The date on the coins was 1956
MT The name on the billboard was very hard to read

Agreement errors

ST The entrance to the laboratories were very well hidden
ST The bridge to the islands were long
MT The slogan on the posters were interesting
MT The picture on the postcards were beautiful
Repetition errors

ST The letter + s from the lawyer were disappointing
ST The key to the cabinet(s) is underneath the drawer
MT The picture + s on the postcards were of lakes
MT The latch on the window(s) was closed

Agreement errors after a repetition error

ST The letter + s from the lawyers says that you own us money
MT The label + s on the bottles was missing
MT The slogan + s on the posters was very clever
MT The picture + s on the postcard(s) was very scenic

Miscellaneous responses

ST The warning from the experts that there was going to be a fire
ST The letter from the woman (lawyers) was long
MT The label on the bottles “Do not touch”
MT The date on the coins “1974”

Uninflected verb responses

ST The check from the stockbrokers bounced
ST The key to the cabinets didn’t work
MT The picture on the postcards showed a sunset
MT The latch on the windows broke during the storm

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