

## Constructing Subject–Verb Agreement in Speech: The Role of Semantic and Morphological Factors

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A sentence completion task, first introduced by Bock and Miller (1991) with English speakers, is employed here with Italian to explore the issue of interactivity of different levels of processing in sentence production. In a series of three experiments, we tested the effects of three variables on the number of subject–verb agreement errors. Like Bock and Miller, we found that mismatching singular and plural features between the subject head noun and a local noun in a complex NP increased the number of errors. It was also found that ambiguous morphophonological marking on the subject noun increased errors. The most striking result was that the preferred interpretation of the complex NP had a significant influence. Singular heads, normally taken to denote several tokens, such as *the label on the bottles*, tend to induce incorrect plural verb completions. This is in contrast to the findings for English speakers and raises the question as to whether the construction of subject–verb agreement is a purely syntactic process in all languages. A modified version of a model of syntactic encoding (Kempen & Hoenkamp, 1987) is proposed that can satisfactorily deal with the number mismatching effect and crucially the presence/absence of semantic effects on verbal agreement in different languages. © 1995 Academic Press, Inc.

Errors of grammatical encoding can be quite revealing of the underlying mechanisms.

(Levelt, 1989; p. 235)

Agreement phenomena can be found in some three-quarters of the world's languages (Mallinson & Blake, 1981), and

agreement of subject and verb is perhaps the most widespread type. An understanding of how speakers or hearers construct subject–verb agreement would clearly be an important component of any account of grammatical processing.

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In spontaneous speech, agreement errors involving complex Subject Noun Phrases (NPs), like (1), are widely attested. They have been designated *proximity concord* (Quirk, Greenbaum, Leech, & Svartvik, 1972) and *attraction* (Zandvoort, 1961) to distinguish them from other slips of the tongue and to draw attention to the putative role of the local noun—*forces*, *college*—rather than the subject noun—*readiness*, *skills*—in the determination of the form of the verb.

- (1) a. The readiness of our conventional forces *are* at an all time low.  
 b. The learning skills people have entering college *is* less than it should be.

(Cited by Bock & Miller, 1991)

Subject Verb Agreement errors are perhaps not very frequent as a proportion of all opportunities (Butterworth, Panzeri, Semenza, & Ferreri, 1990: Table 6), and it may well be that complex subject NPs help induce them.

In a series of experiments, Bock and her colleagues used sentence fragments with complex subject NPs in which the subject head noun was followed either by a prepositional phrase (as in 2a) or by a relative clause (as in 2b) postmodifier, in a sentence completion task. Subjects were required to repeat the fragments which they heard (or read) and then to complete them in any way they chose. Agreement errors were just those which followed the exact repetition of the fragments.

- (2) a. The slogan on the posters  
 b. The boy that liked the snakes

Bock and Cutting (1992) found that errors were more likely following structures like 2a than 2b, because, they maintained, in 2b the local noun is separated from the subject NP by clause boundaries. Therefore, the local NP is likely to "attract" or interfere with the computation of agreement between Subject and verb more frequently when it is part of the same clause than when it is embedded in a different clause.

Bock and Eberhard (1993) also found that the phonological realisation of the local noun played no role in inducing errors. Errors were more likely to occur after a "real" plural (as in 3a) than after a "pseudo" plural (as in 3b).

- (3) a. The problem with the gaps  
 b. The problem with the gas

Bock and Miller (1991) assessed the role of the notional number expressed by a sin-

gular NP by manipulating the number of "tokens" in the preferred semantic interpretation of the fragments. They called "multiple tokens" those fragments whose preferred semantic interpretation implied a plurality of tokens of the same objects. Thus in 4a, there will be a label on each of the several bottles, and hence multiple tokens will be referred to by the grammatically singular NP1. Single token items instead had a preferred interpretation in which a single exemplar of a given object is understood, as in 4b where just one journey to the several islands is the likely interpretation.

- (4) a. The label on the bottles  
 b. The journey to the islands

The difference between 4a and 4b can be described in terms of *distributivity*. The NPs in 4a and b are structurally identical, but nevertheless the distribution of the implicit quantifiers in the fragments is different (Fiengo & Higginbotham, 1981; May, 1985). The distributed reading of 4a comes about because the number of bottles (NP2) has been determined first and assigned wide scope over NP1, *the label*. For 4b the scope of NP1, *the journey*, is determined first and assigned wide scope over NP2, *the lakes*. Quantifier scope in the interpretation of a sentence is not guaranteed by the syntax or by the lexical content of the sentence, but seems to be a *preferred* reading, though a particular lexical content may favor one scope relation over the other (Johnson-Laird, 1969; Kurtzman & MacDonald, 1993).

Bock and Miller (1991) found errors equally likely after both types of preamble, and concluded that once the grammatical number of the head noun has been determined, the effects of the number of tokens referred to was no longer relevant to the computation of agreement with the verb. Semantic factors like animacy play a role in selecting NP as a Subject (Bock & Miller, 1991; Bock et al., 1992), but broken agreements in English were solely determined by

the syntactic properties of head and local nouns. This conclusion is consistent with many linguistic treatments of agreement (Chomsky, 1965; Akmajian & Heny, 1975; Gazdar et al., 1985), according to which, agreement consists in copying features (Person, Number, and Gender) from a Source or Controller (the Subject) to a Target (the Verb) and those psycholinguistic models of speech production that assume the same copying operation (Garrett, 1980; Kempen & Hoenkamp, 1987; Levelt, 1989).

Evidence from word exchanges in spontaneous speech is consistent with the view that agreement is computed after lexical heads have been exchanged and on the basis of the syntactic features specified in the "wrong" subject noun phrase. In (5), the verb's inflection accommodates to the word that ends up as the subject.

- (5) a. *Most cities are true of that*  
(intended: That is true of most cities)  
b. *You're too good for that!*  
(intended: That's too good for you)  
from Stemberger (1985), pp. 154

In 5a, it is possible that the semantic plurality of "cities" is critical; however, the "you" in 5b, seems to refer to a single per-

verb. At a subsequent stage the appropriate morpho-phonological form of the noun and the verb are retrieved. Since number has already been computed, the phonological form of the noun cannot influence agreement computation.

We believe there are significant difficulties in assessing the generality of Bock's results across languages, since English is not a language well suited to detailed exploration of these issues.

First, a problem with the use of English as the test language is its inflectional poverty. In standard U.S. and British dialects, verbs are not marked for number, apart from the third person singular present, and for some conjugations of the verb "to be." In the Bock and Miller (1991) study, 18.8% of responses had indeterminable number and the proportion of agreement errors was very low: 4.9% in their first experiment, 2.3% for their second experiment. It is possible that the observed proportions underestimate the true incidence of subject-verb agreement errors. In Italian, on the other hand, the number of the verb is readily determinable for all conjugations, as can be seen from the following paradigms of the verb *parlare* (to speak):

(6)	<i>Present</i>	<i>Imperfect</i>	<i>Past definite</i>	<i>Future</i>
Singular	<i>parlo</i>	<i>parlavo</i>	<i>parlai</i>	<i>parlerò</i>
	<i>parli</i>	<i>parlavi</i>	<i>parlasti</i>	<i>parlerai</i>
	<i>parla</i>	<i>parlava</i>	<i>parlò</i>	<i>parlerà</i>
Plural	<i>parliamo</i>	<i>parlavamo</i>	<i>parlammo</i>	<i>parleremo</i>
	<i>parlate</i>	<i>parlavate</i>	<i>parlaste</i>	<i>parlerete</i>
	<i>parlano</i>	<i>parlavano</i>	<i>parlarono</i>	<i>parleranno</i>

son, and hence it must be its syntactic plurality that controls agreement.

To summarize, results reported by Bock and colleagues are consistent with a strictly hierarchical model of speech production in which agreement is solely determined by the abstract syntactic features of the subject while its semantic interpretation plays no further part. Once number is established on the noun, features are just copied to the

In English, one cannot tell whether, for example, *spoke* was intended as a singular or a plural, but in Italian one can.

Second, English may not be the language most susceptible to semantic influences on agreement. New developments in syntactic theory (Barlow, 1988; Pollard & Sag, 1988) and recent research on Tzotzil (Aissen, 1989), suggest to us that Null Subject languages—that is, languages in which the

subject pronoun is usually omitted—may be more susceptible, for reasons that will be outlined below. In Italian, Bates (1976) estimated that the subject is omitted up to 70% of the time in free standing declarative sentences. Moreover, the grammatical position of the subject may be less important, and lexico-semantic influences correspondingly more important, when the language has freer word-order. In Italian, SVO, VOS, and OVS orders are allowed in conversational speech (Vincent and Harris, 1989), and VSO is permitted in written prose.

- (7) a. Giovanni ha mangiato la mela  
Giovanni has-3p,S eaten- $\emptyset$   
the-F,S, apple-F,S  
(SVO)
- b. Ha mangiato la mela Giovanni  
Has-3p,S eaten- $\emptyset$  the apple  
Giovanni  
(VOS)
- c. L'ha mangiata Giovanni  
CL-F,S has-3p,S eaten-F,S  
Giovanni  
(OVS)

- d. Ha mangiato Giovanni la mela  
Has-3p,S eaten- $\emptyset$  Giovanni the  
apple  
(VSO)

Third, plurality of nouns in English is almost always morphologically marked, with the rare exception of words like *sheep*. In Italian it is possible to find a greater range of words which have the same form in both singular and plural (Invariant Nouns). For example, we find *la città* (the-F,S town- $\emptyset$ ) and *le città* (the-F,P town- $\emptyset$ ), *il cinema* (the-M,S cinema- $\emptyset$ ), and *i cinema* (the-M,P cinema- $\emptyset$ ), etc. Table 1 shows the major categories in which Italian nouns can be divided according to the kind of inflections used for singular and plural forms as well as for masculine and feminine forms. Bock and Eberhard (1993) have not tested whether the morphology of the subject noun has an effect on the probability of Subject-Verb Agreement errors.

Italian may not be the most suitable language to study experimentally agreement features like gender if we focus on Subject-Verb agreement, because transitive verbs show only Person and Number concord in

TABLE 1  
FORMATION OF PLURAL NOUNS IN ITALIAN<sup>a</sup>

Nouns	Singular		Plural	Examples
(1) Regular				
Masculine	-o	-i		libr-o, libr-i (book/s)
Feminine	-a	-e		cas-a, cas-e (house/s)
(2) Gender ambiguous				
i.				
Masculine	-e	-i		fium-e, fium-i (river/s)
Feminine	-e	-i		luc-e, luc-i (light/s)
ii.				
Masculine	-a	-i		problem-a, problem-i (problem/s)
(3) Invariant				
i. Italian invariant				
Masculine	Gorilla	Gorilla	Gorilla (gorilla/s)	
Feminine	Radio	Radio	Radio (radio/s)	
ii. Borrowed				
Masculine	Film	Film	Film (movie/s)	
Feminine	Star	Star	Star (star/s, referred to a person)	

Note. Italian nouns can be divided in three major categories as far as the formation of plural forms are concerned.

<sup>a</sup> Adapted from Lepschy and Lepschy (1994, Chapter V).

the different tenses. Gender agreement is found between a subject and the past participle in passive forms and in compound forms of intransitive verbs that select the auxiliary *essere* (to be), instead of *avere* (to have), called by Perlmutter (1978) and Burzio (1986) *Unaccusative Verbs*. An example of an intransitive verb with "to be" is given in 8a and 8b; an example of a verb selecting "to have" is given in 8c and 8d.

- (8) a. La ragazza è andata  
The-F,S girl-F,S is-3p,S  
gone-F,S  
The girl has gone
- b. Il ragazzo è andato  
The-M,S boy-M,S is-3p,S  
gone-M,S  
The boy has gone
- c. La ragazza ha parlato  
The-F,S girl-F,S has-3p,S  
spoken- $\emptyset$   
The girl has spoken
- b. Il ragazzo ha parlato  
The-M,S boy-M,S has-3p,S  
spoken- $\emptyset$   
The boy has spoken

Nevertheless, although the occasions for gender errors are much fewer than for errors in number agreement we believe that it is interesting to see if a sentence completion task may induce some of these errors, and if manipulations of the gender agreement between the head and local nouns as well as manipulations of the morphological expression of gender by the head noun influence error rates. In fact, parallel to invariant nouns, in Italian there is a set of words that are ambiguously marked for gender in their affixation, such as *la luce-e*, *le luc-i* (the-F,S, light- $\emptyset$ ,S, the-F,P lights- $\emptyset$ ,P) and *il fium-e*, *i fium-i* (the-M,S river- $\emptyset$ ,S, the-M,P rivers- $\emptyset$ ,P) (see Table 1).<sup>1</sup>

#### AGREEMENT IN PSYCHOLINGUISTIC MODELS

In this paper we are concerned with what features of sentential subjects are accessi-

<sup>1</sup> Note that Invariant Nouns are unmarked both for number and gender, Gender ambiguous Nouns are marked for number.

ble to the agreement operation. More generally the issues raised address the problem of interactivity or isolability of syntactic processing. The general question in production is how a speaker casts a to-be-communicated non-verbal thought or *message* into a lexically and syntactically elaborated utterance. In the transition from one to the other, the ability of the features of the message to exert a fine control over the features of the utterance represents one test of the extent to which there are open versus highly restricted interactions among the information sources involved. In production, the existence of feedback from a lower to a higher level is another crucial test of interactivity.

Hierarchical models of speech production (Bock, 1987; Garrett, 1976; Kempen & Hoenkamp, 1987; Levelt, 1989) presuppose a strictly sequential organisation of stages. Features of the conceptual representation do not massively influence grammatical encoding and there is no feedback between one stage and the next. Once a lexical head has been selected as "Subject" and its number has been determined, no further semantic information about the head will influence agreement computation (Bock & Eberhard, 1993; Bock & Miller, 1991; Kempen & Hoenkamp, 1987; Levelt, 1989). Similarly, the morphological or phonological form of the lexical head will not feed back to influence agreement with the verb.

We will describe in the following pages the computational model of grammatical encoding proposed by Kempen and Hoenkamp (1987) and the Competition Model developed by Bates and MacWhinney (1982) to exemplify a hierarchical and an interactive activation approach and in order to derive predictions to be tested in the experiments reported in the next section of the paper.

An important and attractive feature of Incremental Procedural Grammar (IPG) (Kempen & Hoenkamp, 1987) is that each phrase may be fully processed, and output, while the next phrase is still being constructed. This is meant to mimic the temporal properties of real speech planning.

Levelt (1989, Chapter 7) offers a psychological version of IPG which we follow here.

In this model subject-verb agreement is computed in a number of separate steps. Levelt gives the example of the computation of the sentence, *The child gave the mother the cat*. Stepping through the relevant stages of this example will clarify how this works. Suppose the concept CHILD is the first message fragment delivered from the Conceptualizer, the corresponding lemma (abstract representation of the word) is retrieved and its syntactic category calls a *categorical procedure* (namely a building instruction for the phrasal category in which the lemma can fulfill the function of head). This categorical procedure for the NP with the lemma for *child* as its head inspects the concept for number and, since, *child* is a count noun, comes up with the parameter "singular," and since the syntactic category is Noun (N), the parameter value third person is also derived. These diacritical parameters are copied into the NP and hence to both the head noun lemma and the determiner lemma. Next, a procedure assigns a "functional destination" for the composed NP, where the default destination for the initial NP is Subject of Sentence (S). Stage three copies the parameter values into S, which then copies them into the main Verb.<sup>2</sup> If the head-of-phrase procedure retrieves the wrong lemma, then the resulting form should be the correctly inflected form of the wrong word. The errors involving the exchange of elements between NPs tend to strand their agreement features (Garrett, 1980; Stemberger, 1985), as in (9):

- (9) A hole full of floors  
(instead of a "floor full of holes,"  
Fromkin, 1973)

However, the whole phrase could be sent to the wrong functional destination, so that the diacritical parameters will be carried with it, as in Fromkin's (1971) example.

<sup>2</sup> Kempen and Hoenkamp (1987), but not Levelt (1989), employ V rather than VP procedures, in order to handle more easily sentences in which the subject is post verbal.

- (10) examine the horse of the eyes  
(instead of "examine the eyes of  
the horse")

In IPG the computation of agreement is carried out *before and independently* of the retrieval of the head noun *lexeme*—the phonological form of the noun stem. Subject-Verb agreement will, therefore, depend on the diacritical parameters computed on the basis of head-of-NP procedure retrieving number information from the conceptualisation.

In the Competition Model (Bates & MacWhinney, 1982; 1989) only two broad levels of informational structure are specified: a *Functional Level* (where all the meanings and intentions to be expressed in an utterance are represented) and a *Form Level* (where all the surface forms or expressive devices available in the language are represented). The mapping between these two levels is stated to be as direct as possible and governed by a system of parallel activation with strength-based resolution (Bates & MacWhinney, 1989, p. 50). Two key features of the model are *cue validity* and *cue cost*. Cue Validity refers to the availability and reliability of a cue (such as word-order or agreement) in a given language (i.e., the most valid cues are those that are available when needed and that are not ambiguous or misleading). Cue cost refers to the processing limitations of the system (i.e., perceptibility and memory load).

On the basis of the computation of cue validity and cost, the model is able to describe the cross-linguistic data found using a sentence interpretation paradigm in which subjects were required to choose "off-line" or "on-line" the subject/agent of a sentence with a structure like (11) (from MacWhinney, Bates & Kliegl, 1984, p. 139).

- (11) a. Licks the cow the goat  
b. Lecca la mucca la capra  
c. Leckt die Kuh die Ziege

In these experiments, the authors manipulated and put in "competition" different cues (such as agreement, animacy, stress, and word order) to establish which cues would be most relevant for speakers of dif-

ferent languages. MacWhinney, Bates, and Kliegl (1984) found that Italian speakers relied on agreement to make decisions about the subject/agent of the sentence while English speakers relied overwhelmingly on word order. In fact the number of marking on the verb in Italian is a highly valid cue: it is always present, and it is never misleading. Furthermore, given that most of the time the subject is dropped, marking can be the only cue to features like person number and gender. On the other hand the agreement marking on the verb in English is low in validity (it is a quite reliable cue but it is often not available), while the SVO order is by and large the most valid cue.

It is worth noting at this point that the Competition Model is the only interactive activation model which directly deals with agreement phenomena, although in comprehension and not in production.

#### THE PLAN OF THIS STUDY

In this study, we applied Bock's basic methodology to speakers of Italian. Four main questions were addressed.

First, is the error rate found for English by Bock and colleagues (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991) a reflection of the poverty of opportunities for errors, or will it generalize to richly inflected languages like Italian with correspondingly more opportunities? These data will provide a better estimate of the true incidence of broken agreements.

Second, is the "attraction" by the local noun the strongest determinant of agreement error? Bock's results, along with errors collected in spontaneous English speech, indicate that the presence of a local attractor is by and large the most important determinant of agreement errors.

Third, will there be an effect of notional number (Bock & Eberhard, 1993; Bock & Miller, 1991), in the sense of distributivity, on the incidence of agreement errors? An answer to this question would clarify the issue of interactivity of message-level or semantics and the first stage of formulating the linguistic output.

Finally, will the morphological marking of number (and gender) of the head noun in the Subject NP affect the incidence of agreement errors? This will help clarify the importance of the presence of a reliable cue for agreement (such as the word ending) in the subject NP, as claimed by the Competition Model or if there is feedback from the selection of morphophonological forms to the computation of agreement at higher/earlier stages, as implied by a multistage model.

What predictions can be derived from the models described above? IPG would not predict any cross-linguistic differences: Agreement is computed in both languages through the same feature copying operation; the number of features copied as well as the type of features (i.e., if the features are conceptual, as for distributivity or lexical as for gender in Italian) is irrelevant as far as the computation is concerned. This model would not predict any effect either of distributivity or morphological marking.

The Competition Model would predict the existence of cross-linguistic differences: Agreement marking on the verb is a far more important cue in Italian than English. It would predict an effect of morphological marking. Invariant nouns (like *città*) have no strong cue validity for singular or plural, being essentially neutralized, whereas marked nouns have higher cue validity. In addition, given that the task at hand required subjects to listen and to repeat the sentence fragments, there may be some cost in the processing of the fragments containing invariant nouns. The perceptual discernibility of *la città/le città* (the town/s) is lower than *la sedia/le sedie* (the chair/s), introducing additional problems. According to this reading of the model, a greater number of errors would be expected if: (a) the head noun is invariant and (b) the mismatching local noun has a greater cue validity (i.e., the head noun is invariant while the local noun is marked). The same reasoning holds for gender ambiguous nouns.

Finally the two models explain in a different way the *attraction effect*—the num-

ber mismatch effect between the head and the local noun widely attested in Bock's experiments as well as in spontaneous speech errors. In IPG, the effect of the mismatching local noun is not explained in terms of local constraints or processing limitations, but in terms of the number of procedure calls (roughly speaking equivalent to the number of nodes the features are travelling through) necessary to transfer the number feature from the subject NP (or of the local NP, in case of error) to the highest NP node (NPx), from there to the S node, and finally to the verb. In Fig. 1, the basic feature-copying mechanism in IPG is outlined along with the mechanism for attraction by the local, mismatching noun.

According to our reading of the Competition Model, the explanation of the attraction effect would be in terms of processing limitations (memory load and interference). This explanation resembles the traditional ones (Quirk et al., 1972; Strand, 1966; Zandvoort, 1961) that described the phenomenon in terms of proximity of the local noun to the verb.

We will also examine for the first time in a systematic way whether the fragment

completion task taps just the sentence generation process, or whether some of the effects observed should be attributed to the comprehension of the fragments. For each production experiment, errors in the repetition of the number of the head noun will be analyzed along the same dimensions as agreement errors.<sup>3</sup> This seems to be a very important issue in light of the kind of variables manipulated here: Distributivity may not influence agreement error rates but it may influence repetition errors (i.e., subjects may favor a distributed reading of the subject NP, producing a plural head noun more often for multiple token items than for single token ones). If an effect of the morphological form of the subject head noun is found (as, anticipating the results, we found), it is necessary to be able to exclude the possibility that the result is determined only by the fact it is more difficult to perceive the number marking when an invariant noun is used than when a marked noun is used.

#### AN OVERVIEW OF THE EXPERIMENTS

A series of four experiments is reported below in which semantic and/or morphological attributes of the sentential subjects are manipulated. The first experiment was designed to explore the factors affecting agreement errors in Italian. The basic methodology introduced by Bock and Miller (1991) was used. Single and Multiple token items were included as well as morphologically different forms of the head noun. The number and the gender agreement/disagreement between the head and the local noun were systematically varied to try to elicit errors of number agreement, errors of gender agreement and errors of number and gender agreement as in (12), (13), and (14), respectively, taken from spontaneous speech.

<sup>3</sup> Bock and Miller (1991) did not analyze these errors separately from other forms of repetition errors. They showed however a correlation between speaking span, number of repetition errors and length of the postmodifier, suggesting that it is important to check the distribution of these errors in order to clearly differentiate production effects from effects related to processing load or discernability of the items.

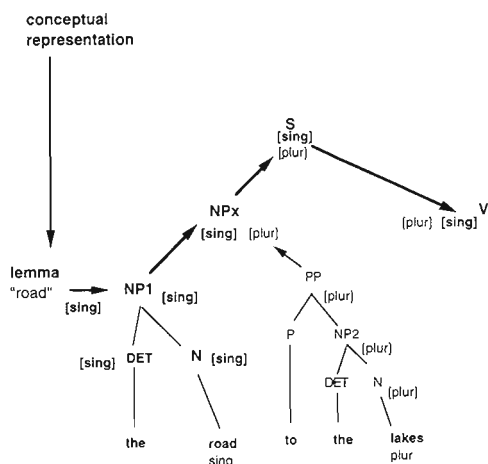


FIG. 1. Feature copying in Incremental Procedural Grammar (Kempen and Hoenkamp, 1987). The heavy arrows represent the direction of copying from NP1 to NPx, from there to S and finally to V. A possible mechanism for the attraction effect of the local noun N2 is depicted. The feature [plur] is copied correctly into NP2 and thence, erroneously into NPx.



- (12) La maggior parte delle spese sono fatte . . .  
 The-FS, larger-Ø part-F,S of-the-F,P purchase-F,P are-3p,P made-F,P . . .

instead of:

La maggior parte delle spese è fatta . . .  
 The-F,S larger-Ø part-F,S of-the-F,P purchase-F,P is-3p,S made-F,S . . .  
 (The larger part of the purchase are made . . .)

- (13) Stanze che sono anni e anni- che sono chiusi  
 Rooms-F,P that are-3p,P years-M,P and years-M,P that are-3p,P shut-M,P

instead of:

Stanze che sono anni e anni- che sono chiuse  
 Rooms-F,P that are-3p,P years-M,P and years-M,P that are-3p,P shut-F,P  
 (Rooms that are shut for years and years)

- (14) La spiegazione di questi risultati sono complessi  
 The-F,S explanation-F,S of these-M,P results-M,P are-3p,P complex-M,P

instead of:

La spiegazione di questi risultati è complessa  
 The-F,S explanation-F,S of these-M,P results-M,P is-3p,S complex-F,S  
 (The explanation of these results are complex)

In this first study, we found that the technique effectively generated errors in the agreement of number while it failed to induce enough errors in the agreement of gender. Both the semantic and morphological manipulations introduced affected error rates, therefore in the subsequent experiments, we dealt only with number agreement errors trying to confirm the effects found in this preliminary study.

The second experiment aimed to clearly differentiate the effect of the semantic number of the subject from the morphological expression of number. A new technique, employing a required adjective, was used to magnify the effect of "attraction."

In the last experiment, we systematically manipulated the morphological marking of the head and local nouns in order to assess if the morphological marking on the local noun contribute to the attraction effect.

## EXPERIMENT 1

### Method

*Participants.* Sixty subjects were from the north of Italy, ranging from 25 to 40 years old and with a educational level of 8–13 years.

*Materials.* Examples of the experimental sentence preambles (sentence fragments composed of a subject NP followed by a modifying NP embedded in a PP) are presented in Table 2.

The experimental variables were: (a) Distributivity of the head noun (single token vs multiple token). This was combined with (b) Morphological marking of the head noun (marked vs unmarked for number and ambiguously marked for gender); (c) Number (match vs mismatch) between the head and the local noun and (d) Gender (agreement vs disagreement) between the head and the local noun. There were thus six conditions in all.

Distributivity applied to singular head noun and plural local noun sentential preambles where it is possible to contrast a singular to a plural reading of the sentential subject (e.g., one single road to several islands, or a label for each of several bottles); for plural head noun fragments (with singular or plural local noun) the preferred reading is congruent with the syntactic characteristics of the subject (e.g., "The roads to the island" or "The labels on the bottle"). The preferred semantic interpretation of the preambles was evaluated by three inde-

TABLE 2  
EXPERIMENT 1: EXAMPLES OF SENTENCE PREAMBLES IN THE "NUMBER MISMATCH" CONDITION

	Number of the head noun	
	Singular	Plural
Marked		
Single token (in the singular)	Il gatto sui tetti (the cat on the roofs)	I gatti sul tetto (the cats on the roof)
Multiple token	Il numero sulle targhe (the number on the plates)	I numeri sulla targa (the numbers on the plate)
Invariant		
Single token (in the singular)	La città sulle colline (the town on the hills)	Le città sulla collina (the towns on the hill)
Multiple token	Il menu dei ristoranti (the menu of the restaurants)	I menu del ristorante (the menus of the restaurant)
Gender ambiguous		
Single token (in the singular)	L'interprete dei teleromanzi (the performer in the soap operas)	Gli interpreti del teleromanzo (the performers in the soap opera)
Multiple token	L'illustrazione sui libri (the picture on the books)	Le illustrazioni sul libro (the pictures on the book)

pendent judges with training in Psychology. Only those preambles unambiguously judged to be in one or the other category were included.

Four 92-item lists were created. Each list was composed of 32 experimental items and 60 fillers. Each list contained one of the four possible combinations (singular head noun, plural local noun; singular head noun, singular local noun; plural head noun, singular local noun; plural head noun, plural local noun) of the same item. In each list there were 4 single token preambles and 4 multiple token ones; 16 had a morphologically marked head noun (like: "La Strada" [the-F,S road-F,S], "Le Strade" [the-F,P roads-F,P]); 8 had an "invariant" head noun (such as "La città" [the-F,S town- $\emptyset$ ] "Le città" [the-F,P towns- $\emptyset$ ]); and a further 8 had a gender ambiguous head noun ("L'emozione" [the-F,S emotion- $\emptyset$ ,S], "Le emozioni" [the-F,P emotions- $\emptyset$ ,P]). In half of the preambles, the head noun and the local noun agreed in gender (gender agreement condition) and in the other half they disagreed in gender (gender disagreement conditions).

The fillers were simple NP preambles such as: "Il libro interessante" [The interesting book] or "Il ladro improvvisamente"

[The thief suddenly]. Half were singular and half plural; half of the Ns were feminine and half were masculine; there were also complex NPs with explicit quantifiers.

Every list began with 8 fillers the arrangement of the remaining fillers and experimental preambles was semirandom with the constraint that no more than two experimental items could occur consecutively.

The lists were recorded on audio-tape by a female speaker. The rate at which each preamble was produced during recording was kept as high as possible without compromising clarity.

*Procedure.* The participants were run individually. They were told they would hear a series of sentence beginnings and their task was to repeat them and supply endings. No instructions were given about the form of the completion, so the participants were free to complete them as they chose. The experimenter presented the recorded preambles one at the time. After each preamble, the participant repeated it back as rapidly as possible along with its completion. If the participant failed to apprehend the preamble, the experimenter repeated it. The instructions emphasized rapid speech. The experimental sessions were recorded

on audio-tape. At the beginning of the experimental session a training set composed of eight preambles was performed.

*Scoring.* First, the taped recordings of the sessions were transcribed. Two additional independent judges evaluated all the cases of uncertainty, and all the cases in which the three judges did not reach an agreement were disregarded.<sup>4</sup> Next, completions were placed in one of five scoring categories according to the following criteria. (1) *Correct Responses* were scored when participants repeated the preamble correctly, and produced an inflected verb form in a complete sentence. (2) *Agreement Errors* were scored when an utterance met all of the criteria for a correct response except that the verb form failed to agree in number or/and gender of the subject of the sentence. This scoring category was further divided into: (i) number agreement errors, (ii) gender agreement errors, and (iii) number and gender agreement errors. (3) Agreement errors *after* an error in the repetition of the head noun. (4) *Repetition Errors* were scored when the participant failed to correctly repeat the preamble; number errors in the head noun were noted separately. (5) *Miscellaneous Responses* were scored for all the other possible responses. In this category were also included all those completions that the judges failed to classify either as agreement or repetition errors. A sample of responses for each scoring category is reported in Appendix A.

*Design and data analysis.* The major statistical tests were performed using the numbers of agreement errors and the numbers of errors in the repetition of the head noun as the dependent variables.

Significant differences regarding: (1) the number of the head noun (singular vs plural), (2) the number (match vs mismatch) between the head and the local noun, (3) the

morphological marking of the head (marked, invariant, gender ambiguous) and (4) the distributivity of the head noun (single vs. multiple token) were tested using non-parametric tests. All effects that achieved significance were reliable at or beyond the .05 level. No analyses of variance were performed, given the unbalanced design.<sup>5</sup>

### Results

Application of the scoring criteria yielded 1638 (85.31%) correct responses, 74 (3.85%) agreement errors of which 70 were errors of number agreement, 3 were errors of gender agreement alone, 1 was an error of number and gender agreement. There were 132 (6.9%) repetition errors, of which 61 involved the number of the head noun and 4 errors of number agreement (0.21%) followed incorrect repetition of the preamble. There were 76 (3.96%) miscellaneous responses, including the 8 responses judged as ambiguous by all the three judges.

In general, the technique worked effectively in inducing number agreement errors that seemed to be influenced by all the experimental manipulations introduced. We found in fact more errors when the head and local nouns mismatched in number, when the preamble had a preferred multiple token reading and when the head noun was invariant. Unfortunately, only 4 gender agreement errors were generated. Therefore, the discussion will be limited to errors in the agreement of number alone.

*Distribution of agreement errors.* Errors of number, shown in Table 3, were generally more frequent when the head and the local noun mismatched for number (Wilcoxon test,  $z = 5.139$ ,  $p < .001$ ). Gender (agreement/disagreement) between the head and the local noun did not influence errors of number agreement: 33 occurred in the gender agreement condition and 38 in the gender disagreement condition.

The interpretation of the preamble will

<sup>4</sup> For example, given the preamble "I menu dei ristoranti" [The-M,P menu- $\emptyset$  of-the-M,P restaurants-M,P], in the participant's utterance the plural article "i" was not pronounced clearly, so that it was impossible to distinguish it from the singular form "il".

<sup>5</sup> In each list there were  $\frac{1}{2}$  marked,  $\frac{1}{4}$  invariant and  $\frac{1}{4}$  gender ambiguous head nouns.

TABLE 3  
EXPERIMENT 1: ERRORS OF NUMBER AGREEMENT

	Number of the head noun	
	Singular	Plural
	Number mismatch	
Gender agreement	15	13
Gender disagreement	12	16
	Number match	
Gender agreement	2	3
Gender disagreement	1	9
	30	41

depend on the words it contains, thus the effect of distributivity is necessarily confounded with items. That is to say, it is possible that the lexical items in the multiple token set may simply induce more errors. In order to ensure that the error rates are due to distributivity and not to lexical content, Table 4 shows number of errors when the lexical content is used in preambles that do not differ in distributivity, as well as where it does (singular head noun, plural local noun).

In the relevant singular head noun and plural local noun, condition errors for single token items were 6 whereas errors for multiple token items were 21. This difference was significant on the McNemar test ( $c^2 = 8.33, p < .005$ ). The difference is not significant in all the other number conditions.

Table 5 shows the distribution of errors in the agreement of number for the different morphological markers of the head noun.

TABLE 4  
EXPERIMENT 1: DISTRIBUTION OF THE NUMBER AGREEMENT ERRORS IN THE SINGLE AND MULTIPLE TOKEN CONDITIONS

	Distributivity	
	Single token	Multiple token
Sing. head N; sing. local N	1	2
Sing. head N; plur. local N	6	21
Plur. head N; plur. local N	8	4
Plur. head N; sing. local N	14	18

TABLE 5  
EXPERIMENT 1: EFFECTS OF MORPHOLOGICAL MARKING ON THE DISTRIBUTION OF THE NUMBER AGREEMENT ERRORS (IN PARENTHESES, ERRORS AS A PROPORTION OF ITEMS)

	Number of the head noun	
	Singular	Plural
	Number mismatch	
Marked ( $N = 480$ )	12 (.05)	9 (.04)
Invariant ( $N = 240$ )	6 (.05)	19 (.16)
Gender ambiguous ( $N = 240$ )	9 (.07)	4 (.03)
	Number match	
Marked ( $N = 480$ )	1 (.00)	3 (.01)
Invariant ( $N = 240$ )	2 (.02)	8 (.07)
Gender ambiguous ( $N = 240$ )	0 (.00)	1 (.00)
	30 (.03)	44 (.05)

The difference between the proportion of errors in the marked and unmarked condition was significantly different (.026 vs .072;  $z = 3.99, p < .001$ ) as well as the difference between invariant and gender ambiguous nouns (Wilcoxon test,  $z = 2.358, p = .018$ ) while the difference between the proportion of errors for marked and gender ambiguous nouns was not significantly different (.026 vs .029;  $z = .16, p = .84$ ). For invariant head noun, errors were more frequent with plural subjects than singular ones (McNemar test,  $c^2 = 7.25, p < .05$ ) while for the other categories of nouns there was the opposite tendency.

*Distribution of repetition errors.* Table 6 reports the distribution of errors in the repetition of the head noun along the same dimensions as agreement errors. There was an effect morphological marking of the head: the difference between the proportion of errors in the marked and unmarked head conditions was significantly different (.011 vs .092;  $z = 7.43; p < .001$ ) while the difference between marked and gender ambiguous nouns was not significant (.011 vs .012;  $z = -.095, p = .92$ ). Repetition errors were more common after invariant heads than gender ambiguous heads (Wilcoxon test,  $z = 4.321, p < .001$ ) and

TABLE 6  
EXPERIMENT 1: DISTRIBUTION OF  
REPETITION ERRORS

	Number of the head noun	
	Singular	Plural
(a)	Number mismatch	
Gender agreement	5	14
Gender disagreement	3	15
	Number match	
Gender agreement	3	14
Gender disagreement	1	6
Total	12	49
(b)		
Marked ( $N = 960$ )	4 (.01)	7 (.01)
Invariant ( $N = 480$ )	4 (.02)	40 (.16)
Gender Unmarked ( $N = 480$ )	4 (.02)	2 (.02)
Total	12 (.02)	49 (.05)

Note. In parentheses, errors as a proportion of items.

they were more frequent after a plural head than a singular one (McNemar test,  $c^2 = 15.38, p < .001$ ).

An important point to note is that where a repetition error was made, in the overwhelming proportion of cases (61/65) the verb agreed with the produced number and not with the target number.

### Discussion

The main results of this experiment may be summarized as follows: The overall error rate (3.85%) for Italian speakers was similar to that for English speakers obtained by Bock and Miller (1991), despite the far greater number of opportunities offered by the Italian inflectional system. As with the English subjects, errors of number agreement were more frequent when the head and the local noun were mismatched for number. In general the presence of an "attractor" in the immediate preverbal environment (Zandvoort, 1961) seemed to be the strongest determinant of agreement errors.

In contrast to Bock and Miller (1991), the distributivity of the subject NP significantly

affected error rate. Unpredicted by their account, the absence of morphological marking for number of the head noun also significantly affected errors.

Construction of subject-verb agreement appeared therefore to be sensitive to manipulation of semantic as well as morphological features of the sentential subject. However, the evidence of this first experiment is not conclusive: the magnitude of the distributivity effect was small and the morphological effect, related to invariant nouns, was not clear because of the unbalanced design that did not allow the assessment of an interaction between semantic and morphological factors.

The next experiment, therefore, aimed to replicate the effects of distributivity and morphological marking in a fully factorial design. Furthermore, an attempt was made to elicit more agreement errors using a new technique designed to magnify the "attraction" phenomenon.

### EXPERIMENT 2

In Italian, adjectives are inflected for number and gender, and they show agreement with the noun they modify. Examples of sentences in which the predicate shows agreement with the subject are given in (15) below.

- (15) a. Il disegno è colorato  
The-M,S picture-M,S is-3p,S colored-M,S  
b. I disegni sono colorati  
The-M,P pictures-M,P are-3p,P colored-M,P

Following Bock and Eberhard (1993) this experiment used visual presentation on a computer screen. An adjective (marked for singular or plural) was immediately followed by the sentence preamble. The subject's task was to complete the preamble using the adjective he/she has just seen. For instance, the subject saw "colorato" (colored) and then "il disegno sui quaderni" (the picture on the exercise books), and his/her task was to say "Il disegno sui quaderni

è/era colorato" (The picture on the exercise books is/was colored). 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 noncongruent case, subjects were required to change the form of the adjective. The experiment was divided into two parts: in Part One all the experimental sentence preambles had a singular head noun and a plural local noun; in Part Two all the experimental sentence preambles had a plural head noun and a singular local noun.

The same sentence preambles were used in Part One and in Part Two with singular head nouns in Part One and plurals in Part Two. It is important to note again that distributivity applies only to singular head noun and plural local noun preambles (Part One). For plural head nouns and singular local nouns (Part Two) the semantic interpretation is congruent with the syntactic number expressed by the head noun (plural nouns can only refer to a plurality of objects, apart from the well known *pluralia tantum*, such as *glasses*, *binoculars*, etc.). Thus, if distributivity influences subject-verb agreement errors, the effect will be found in Part One but not in Part Two.

We used visual instead of acoustical presentation to test the robustness of our findings. If there is any problem related to the modality of presentation, then the distribution of responses may be different from Experiment 1.

### Method

*Participants.* Forty undergraduate students from the University of Trieste participated in Part One and an additional 40 in Part Two.

*Materials.* The experimental variables were: (1) adjective (congruent vs incongruent), (2) distributivity of the preamble (sin-

gle token vs multiple token); (3) morphological marking of the head noun (marked vs invariant).

The preferred reading of the sentence preamble had been evaluated by 20 subjects required to indicate if the preamble referred to a singular or to a plural entity. Only those preambles unambiguously evaluated as single or multiple token items were included in the experiment.

All the experimental preambles had a prepositional phrase postmodifier after the head noun; all the head nouns used in Part One were singular while the local nouns were plural; all the head nouns used in Part Two were plural while the local nouns were singular. The gender of the head and the local noun was balanced.

Four 64-item lists were created, each of which was composed of 32 experimental items derived by the combination of the experimental variables and 32 fillers. There were 16 filler items with a prepositional phrase postmodifier and number match between the head and the local noun, 8 with a singular head noun and 8 with a plural head noun and 16 single plural (Part One) or singular (Part Two) head noun preambles. The distribution of experimental items and fillers in the lists was semirandom with the constraint that no more than three experimental items could occur consecutively.

Each sentence fragment was combined with a semantically plausible adjective (singular or plural) to be used in the sentence completion. Table 7 shows some examples of the experimental sentence preambles for Experiment 2.

*Procedure.* Each subject was run individually. On a VGA screen after a warning beep the adjective was presented for 900 ms and after a 600-ms interval the sentence preamble appeared for 900 ms. (The presentation time was chosen to be sufficient to read the adjective and the preamble and to perform at 95% correct level.) The subjects were instructed to read and complete the preamble using the adjective. Instruc-

TABLE 7  
EXPERIMENT 2: EXAMPLES OF ADJECTIVES TO BE USED WITH THEIR SENTENCE PREAMBLES

Single token	Multiple token
Adjective: <i>Pericolosale</i> (fem.sing/pl) (dangerous) <i>La strada verso i laghi</i> (the road to the lakes)	Adjective: <i>storta/e</i> (fem) (crooked) <i>L'etichetta sulle bottiglie</i> (the label on the bottles)
Adjective: <i>affettuosoli</i> (masc.sing/pl) (affectionate) <i>Il gorilla con i cuccioli</i> (the gorilla with the puppies)	Adjective: <i>complicatoli</i> (masc) (elaborate) <i>Il menu dei ristoranti</i> (the menu of the restaurants)

Note. The singular form of the adjective is "congruent" in these examples.

tions emphasized they had to repeat verbatim the sentence preamble. If, during a training session, the subject did not spontaneously correct the number of the adjective when this was incongruent with the subject of the preamble, for example trying to find a way of using the adjective in a different grammatical form or modifying the number of the subject, he/she was invited through modelling to change the adjective number.

The completed sentences were audio-recorded and then transcribed, using the same procedure as in Experiment 1.

*Scoring.* The scoring categories were the same used in the first experiment with the only exception that the miscellaneous responses included those cases in which the participant failed to grasp either the adjective or the preamble. Appendix B reports a sample of completions for each scoring category.

*Design and data analysis.* Parts 1 and 2 have been treated as two separate experiments as far as statistical analyses are concerned.

In each part, subjects received four items in each of the experimental conditions. Statistical tests were performed with agreement errors and errors in the repetition of the head noun as the dependent variables.

Two analyses of variance (both with subjects and items as random factors) were carried out, one on agreement errors and the second on repetition errors. The experimental factors were: (1) number of the ad-

jective (singular vs plural), (2) distributivity of the preamble (single token vs multiple token), and (3) morphological marker of the head noun (marked vs invariant).

### Results

Application of the scoring criteria yielded the following data. In Part One, there were 907 (70.8%) correct responses, 116 (9%) agreement errors, 190 (14.8%) repetition errors, of which 167 were errors in repetition of the head noun; 3 (.2%) agreement errors followed repetition errors and there were 64 (5%) miscellaneous responses. There were 11 agreement errors in the filler preambles. In Part Two we found 939 (73.4%) correct responses, 59 (4.6%) agreement errors, 189 (14.5%) repetition errors, of which 164 were errors on the head noun; 12 (0.9%) agreement errors followed a repetition error and there were 81 (6%) miscellaneous responses.

*Distribution of agreement errors.* Table 8 shows the distribution of agreement errors in the two parts of the experiment for the different conditions. It is evident they were quite different. First the error rate for singular head nouns (Part One) was significantly higher than for plural head nouns (Part Two) (8.89% vs 4.61%;  $t(39) = 3.78, p < .001$ ).

Agreement errors for both types of preambles were strongly influenced by the presence of an incongruent adjective (mismatching in number with the head noun). When the head noun was singular and the

TABLE 8  
EXPERIMENT 2: DISTRIBUTION OF NUMBER AGREEMENT ERRORS

	Morphological marker of the HN				
	Marked		Invariant		
	Sing adj.	Plur adj.	Sing adj.	Plur adj.	
(a) Part one: Singular head nouns and plural local nouns					
Single Token	2	6	4	15	27
Multiple token	6	36	5	43	90
Total	8	42	9	58	
(b) Part two: Plural head nouns and singular local nouns					
"Single token"	4	0	28	1	33
"Multiple token"	6	0	19	1	26
	10	0	47	2	

local noun plural, the distributivity of the head noun influenced the occurrence of agreement errors, especially when the adjective was plural while the morphology of the subject was not so important. When the head noun was plural and the local noun singular errors occurred mostly with morphologically unmarked nouns and with singular adjective while distributivity had no effects, as expected given that in this case semantic and syntactic number specifications are congruent. Finally note that neither in Part One nor in Part Two did distributivity and morphological marking interact.

The analysis of variance showed in Part One a significant main effect of the number of the adjective ( $F(1,39) = 52.07, p < .001; F(1,28) = 31.19; p < .001$ ), a main

effect of distributivity ( $F(1,39) = 43.63, p < .001; F(1,28) = 9.45, p = .005$ ), and a significant interaction between number of the adjective and distributivity ( $F(1,39) = 32.00, p < .001; F(1,28) = 12.46, p = .001$ ). The analysis of variance on agreement errors in Part Two showed a significant main effect of the number of the adjective ( $F(1,39) = 43.78, p < .001; F(1,28) = 26.81, p < .001$ ), a main effect of the morphological form of the head noun ( $F(1,39) = 36.19, p < .001; F(1,28) = 14.11, p = .001$ ), and a significant interaction between number of adjective and morphological form of the head ( $F(1,39) = 29.58, p < .001; F(1,28) = 10.15, p = .004$ ).

*Distribution of repetition errors.* Table 9 shows the distribution of repetition errors

TABLE 9  
EXPERIMENT 2: DISTRIBUTION OF REPETITION ERRORS

	Morphological Marker of the Head Noun				
	Marked		Invariant		
	Sing adj.	Plur adj.	Sing adj.	Plur adj.	
(a) Part one: Singular head nouns and plural local nouns					
Single token	0	13	16	53	82
Multiple token	3	15	5	62	85
Total	3	28	21	115	
(b) Part two: Plural head nouns and singular local nouns					
"Single token"	12	1	59	11	83
"Multiple token"	6	3	56	16	81
Total	18	4	115	27	



involving the head noun in the two parts of the experiment. The error rates were quite similar (13.04% vs 12.81%).

The distribution of agreement and repetition errors in Part One were very dissimilar: Agreement errors were influenced by distributivity while repetition errors were influenced by the morphological marking of the head noun. In Part Two the distributions were similar: Both agreement and repetition errors are influenced by the morphological expression of number. Furthermore while there were significantly more agreement errors for singular head and plural local noun preambles than for plural head and singular local noun fragments, the overall incidence of errors in the repetition of the head noun was almost identical in the two parts.

The analysis of variance performed on repetition errors in Part One showed a significant main effect of the number of the adjective ( $F(1,39) = 51.62, p < .001$ ;  $F(2,28) = 28.14, p < .001$ ), a main effect of the morphological form of the head noun ( $F(1,39) = 70.63, p < .001$ ;  $F(2,28) = 14.66, p = .001$ ) and a significant interaction between number of the adjective and the morphological form of the head ( $F(1,39) = 28.19, p < .001$ ;  $F(2,28) = 9.50, p = .005$ ). The same main effects and interactions were found in Part Two: a significant main effect of the number of the adjective ( $F(1,39) = 47.90, p < .001$ ;  $F(2,28) = 29.29, p < .001$ ), a significant main effect of the morphological marker of the head noun ( $F(1,39) = 64.29, p < .001$ ;  $F(2,28) = 17.40, p < .001$ ), and a significant interaction between number of the adjective and morphological marker ( $F(1,39) = 37.84, p < .001$ ;  $F(2,28) = 11.30, p = .002$ ).

The rates of agreement errors after a repetition error for Parts One and Two were lower than those of agreement errors following the correct repetition of the preamble.

### Discussion

The main results of Experiment 2 can be summarized as follows. For singular head

noun preambles, agreement errors were more likely when the subject had a preferred multiple token interpretation. The comparable manipulation for plurals, which of course did not affect distributivity, made no difference to the plural error rates. For plural head noun preambles, agreement errors were more likely when the subject noun lacked morphological marking of number. In neither Part One nor Part Two did these effects—distributivity and morphological marking—interact.

The presence of an adjective incongruent with the number of the subject noun (and hence, by design, with the same number of the local noun) increased the error rate in all conditions. Error rate was higher with singular head noun preambles than with plural head noun ones. Repetition errors rates were similar overall in the two parts of the experiment. Unlike agreement errors, repetition errors were not affected by distributivity.

The results of Experiment 2 thus confirm a role for semantics, at least distributivity, in the construction of Subject-Verb agreement. Italian and English speakers therefore seem to be differentially sensitive to the number of tokens referred to by the subject head noun. The results also indicate a role for the *form* of the subject noun. The lack of interaction between the two variables is compatible with two-stage models of language production such as Butterworth (1989) and Levelt (1989).

According to the Competition Model, the cost (the greater perceptual confusability) in the processing of invariant nouns may in part (or totally) account for the morphological effect; but since we found morphological effects in both repetition and agreement analyses, and for both auditory and visual presentation, there would appear to be more than perceptual confusability at issue here. From Experiments 1 and 2 it is unclear if the greater number of errors with invariant nouns is due to their lacking a cue with high validity (i.e., number marking) on the head noun, or to the total number of

cues marking number. In Experiments 1 and 2, when the head noun was marked, number was redundantly marked on the determiner and on the head noun, both in the subject and in the embedded NPs. In preambles with invariant nouns, number was marked only on the determiner in the subject NP while there were two markers for number in the embedded NP. In the next experiment we try to disentangle these factors.

### EXPERIMENT 3

In this experiment, we systematically manipulated the number cues on the head noun (N1) and local noun (N2) of the preambles. Of course, the determiners in these phrases remained unambiguously marked for number, and gender.

- (16) Number cues on both N1 and N2
- a. La melodia delle musiche  
The-F,S melody-F,S of-the-F,P  
musics-F,P
- b. La melodia della musica  
The-F,S melody-F,S of-the-F,S  
music-F,S
- (17) No number cues on either N1 or N2
- a. La radio sulle auto  
The-F,S radio-Ø on-the-F,P  
cars-Ø
- b. La radio sulla auto  
The-F,S radio-Ø on-the-F,S  
car-Ø
- (18) Number cue on N1 only
- a. La festa nelle tribù  
The-F,S feast-F,S in-the-F,P  
tribes-Ø
- b. La festa nella tribù  
The-F,S feast-F,S in-the-F,S  
tribe-Ø
- (19) Number cue on N2 only
- a. La città sulle colline  
The-F,S town-Ø on-the-F,P  
hills-F,P
- b. La città sulla collina  
The-F,S town-Ø on-the-F,S  
hill-F,S

In the number mismatch condition—examples 16a, 17a, 18a, 19a—subject-verb agreement errors would be higher than in the corresponding b. cases. The Competition Model predicts that if the local NP has more cues than the head NP, and if these cues are in conflict, then the error rate will be the highest of these examples. This case is shown in 19a, in which the singular head noun is unmarked and the local noun is marked plural.

On the other hand, if the critical issue is the morphological marking just on the head itself, then there need be no difference in error rates between 19a and 17a (which have no number marking on the head noun), but both should show more broken agreements than 16a and 18a.

### Method

*Participants.* Thirty-two subjects, all from the North of Italy, ranging from 25 to 40 years old and with an educational level of 8–13 years.

*Materials.* Examples of experimental sentence preambles are shown in Table 10.

The experimental variables were: (a) Morphological marking of the head noun (marked vs invariant), (b) morphological marking of the local noun (marked vs invariant), (c) number of the head noun (singular vs plural), and (d) number (mismatch vs match) between the head and local noun.

All the sentence preambles had a prepositional postmodifier after the head. Half of the head nouns were masculine and half were feminine; half of the local nouns were masculine and half feminine and the gender (agreement/disagreement) between the head and local noun was balanced.

Four 48-item lists were created by the combination of the experimental variables. Each list was composed of 16 experimental items and 32 fillers. In each list there were 4 items in which both the head and the local noun were unambiguously marked, 4 in which the head noun was invariant and the local noun marked, 4 in which the head noun was marked and the local noun invari-

TABLE 10  
EXPERIMENTS 3 AND 4: EXAMPLES OF SENTENCE PREAMBLES

Marked head nouns		Invariant head nouns
	Marked local noun	
La scoperta dello scienziato (the discovery of the scientist)		Il camion sulla strada (the lorry on the road)
La scoperta degli scienziati (the discovery of the scientists)		Il camion sulle strade (the lorry on the roads)
Le scoperte dello scienziato (the discoveries of the scientist)		I camion sulla strada (the lorries on the road)
Le scoperte degli scienziati (the discoveries of the scientists)		I camion sulle strade (the lorries on the roads)
	Unmarked local noun	
La trama del film (the plot of the film)		Il bar nella città (the bar in the town)
La trama dei film (the plot of the films)		Il bar nelle città (the bar in the towns)
Le trame del film (the plots of the film)		I bar nella città (the bars in the town)
La trama dei film (the plots of the films)		I bar nelle città (the bars in the towns)

ant and 4 in which both the head and the local noun were invariant. There were 8 items with a singular head noun (4 in which the head and the local noun mismatch in number and 4 in which they match in number) and 8 items with a plural head noun (4 in which the head and the local noun mismatched in number and 4 in which they matched in number). Fillers were the same used in Experiment 1. The arrangement of experimental items and fillers in the lists was semirandom.

*Procedure.* Same as in Experiment 1 except that each subject received all the four lists in two separate experimental sessions.

*Scoring.* Same as in the Experiment 1. A sample of completions for each scoring category is reported in Appendix C.

*Design and data analysis.* Each participant received four items in each condition. All statistical analyses were performed with the numbers of agreement errors and the numbers of repetition errors as the dependent variables. The experimental variables were orthogonally combined.

Two analyses of variance were carried out: one on agreement errors and the second on repetition errors with the experi-

mental factors described above (both with subjects and items as random factors).

### Results

Application of the scoring criteria yielded 1768 (86.30%) correct responses, 78 (3.81%) agreement errors, of which 76 were errors of number agreement and 2 were errors of gender agreement. There were 14 (0.68%) agreement errors after a repetition error, 148 (7.23%) repetition errors of which 83 were errors in the repetition of the head noun, and 40 (1.95%) miscellaneous responses.

*Distribution of agreement errors.* The results of the present experiment replicated both the effect of the morphological marking of the subject head noun and the effect of number mismatch between the head and the local noun. In addition, an asymmetry between singular and plural head nouns was found with more errors for singular than plural head nouns. No effect of the number marking of the local noun was found.

Table 11 shows the frequencies of number agreement errors. The analysis of variance showed a significant main effect of

TABLE 11  
EXPERIMENT 3: DISTRIBUTION OF NUMBER AGREEMENT ERRORS ACCORDING TO THE MARKING ON HEAD AND LOCAL NOUNS

Marking on local noun	Marking on the head noun				
	Marked		Invariant		
	Sing	Plural	Sing	Plural	
			Number mismatch		
Marked	7	5	10	6	28
Invariant	8	3	15	7	33
			Number match		
Marked	0	1	4	2	7
Invariant	2	1	3	2	8
Total	17	10	32	17	

number match/mismatch ( $F(1,31) = 11.04, p < .02$ ;  $F(1,14) = 24.90, p < .001$ ), a significant main effect, by subjects, of the number of the subject (singular/plural)  $F(1,31) = 5.66, p = .024$ ;  $F(1,14) = 4.07, p = .06$  and a significant main effect of the morphological marker of the head noun ( $F(1,31) = 6.07, p = .02$ ;  $F(1,14) = 6.32, p = .025$ ). No interactions were significant.

The difference between marked and invariant head nouns was significant on the Wilcoxon test ( $z = 2.15, p = .03$ ), while the difference between error frequencies with a marked and invariant local noun was not significant ( $z = 1.06, p = .29$ ).

*Distribution of repetition errors.* Table 12 shows the frequencies of errors in the repetition of the head nouns. Repetition errors

were most common with invariant nouns in the number mismatch condition. In contrast to the data on agreement errors, no asymmetry between singular and plural head nouns was found. Furthermore, although this effect did not reach a significant level in both subjects and items analyses, there was a conspicuous number of repetition errors when the head noun was invariant but the head and the local nouns matched in number. The analysis of variance showed a significant main effect of number match/mismatch ( $F(1,31) = 6.77, p = .01, F(1,14) = 7.10, p = .02$ ); a significant main effect of the morphological marking ( $F(1,31) = 31.16, p < .001, F(1,14) = 8.80, p = .01$ ) and an interaction between the number and the morpho-

TABLE 12  
EXPERIMENT 3: DISTRIBUTION OF REPETITION ERRORS ACCORDING TO THE MORPHOLOGICAL MARKING ON HEAD AND LOCAL NOUNS

Marking on local noun	Marking on the Head Noun				
	Marked		Invariant		
	Sing	Plural	Sing	Plural	
			Number mismatch		
Marked	2	8	19	5	34
Invariant	1	2	11	6	20
			Number match		
Marked	0	0	11	5	16
Invariant	0	0	10	3	13
Total	3	10	51	19	

logical marking of the head noun that was significant by subjects ( $F(1,31) = 17.87, p < .001$ ), but not by items ( $F(2(1,14) = 2.19, p = .14$ ).

The difference between marked and invariant head noun is significant on the Wilcoxon test ( $W = 2.03, p = .005$ ), and the difference between marked and invariant local nouns approaches significance (Wilcoxon test,  $z = 1.878, p = .06$ ).

### Discussion

There were three main results of Experiment 3. First, the morphological effect found in Experiments 1 and 2 has been replicated: Invariant head nouns yield higher error rates than marked head nouns. Second, the relative number of agreement markers in the subject and in the local NPs do not influence error rates. Agreement errors were equally likely in items such as 19a (one agreement marker in the subject NP versus two markers in the local NP), and items like 17a (one marker both in the subject and in the local NPs). Errors were also equal when there were two markers in the subject NP and one marker in the local NP, as in 18a, and two markers in both NPs, as in 16a. Finally, as in the previous experiment, the different distributions of agreement errors and repetition errors suggests that registration and repetition are processes separate from the generation of the completion (Table 13).

These results are not wholly explained by the Competition Model. As in the preceding experiments, heads with lower cue valid-

ity—i.e., with a cue just on the determiner—induced the most errors. However, this model meets a serious problem in that the morphological marking of the local noun did not affect error rates. If the difference between marked and invariant nouns has an explanation in terms of cue validity and cost, this should apply to the local noun as well, and fewer errors should be found when the head noun is marked and the local noun is invariant (16) than when the head and local nouns are both marked (14). In our data, errors were equally likely to occur after both types of preambles.

The present results are also incompatible with IPG, and other strictly hierarchical models of speech production, which do not allow feedback from morphophonology to earlier levels of processing.

### GENERAL DISCUSSION

#### Comparison with Previous Results

There were two main findings. First, the semantic number of the subject—in this case, experimentally manipulated distributivity—affects the rate of subject-verb agreement errors. This is in clear contrast to Bock's results for English (Bock & Miller, 1991). Second, the morphological marking of the head noun affects the rate of subject-verb agreement errors. This manipulation has not previously been explored in English or other languages, as far as we know.

In other respects, our results are broadly similar to previous findings. Overall subject-verb agreement error rates are low—just under 4% for sentence completions (without the required adjective in Experiment 2) despite the far greater opportunities for error in Italian as compared with English. There is clearly an effect of "attraction" in that mismatches between head and local nouns increase the error dramatically. Although not as strong as in English, there was a tendency to have more errors following singular than plural head nouns. As Bock and Eberhard (1993) showed for the

TABLE 13  
SUMMARY OF MAIN RESULTS OF EXPERIMENTS 3

	Agreement	Repetition
Number mismatch	✓ <sup>a</sup>	✓
Number of head noun	sing > plur	—
Marking of head noun	✓	✓
Marking of local noun	— <sup>b</sup>	✓
Number × marking of HN	—	✓

<sup>a</sup> ✓ An effect of this variable has been shown.

<sup>b</sup> —, No effect of this variable has been shown.

phonological realization of the local noun, we found that the morphology of the local noun had no effect on error rates.

*The Pattern of Results Is Not Due to Misrepresenting the Preamble*

If the pattern of agreement errors were due to misrepresenting the preamble, then we should find the same factors affecting the measures of how accurately the preamble had been represented (at least in the experimentally relevant respects). So to the extent that *repeating* the preamble correctly is a measure of correct representation, and repetition errors a measure of misrepresentation, then it is possible to assess whether the same factors affected repetition performance as agreement errors. Finally, the types of agreement that follow misrepetition can be used to assess whether it is the target or the actual representation of the preamble that determines the number on the verb.

*Repetition.* For each of the Experiments 1 to 3, the pattern of agreement errors and errors in repeating the preamble were analyzed. In Experiment 2, with a balanced design, it is clear that there is an effect of distributivity for agreement errors, but not for repetition errors (compare Tables 8 and 9). A comparison of Tables 11 and 12 show that the effects of morphological marking are different in agreement and repetition.

*Agreement errors after repetition errors.* As with correct repetition of the preambles, rates for agreement were low in the three generation experiments. Thus overwhelmingly, the speakers used the generated subject and not the target subject to determine verb agreement.

The greater processing cost involved in the reception of preambles containing invariant nouns in contrast to preambles containing marked nouns had also been addressed in an additional experiment in which we used the same preambles used in Experiment 3, and subjects were required to make an explicit speeded judgment about

the grammatical number of the head noun. In comparison with Experiment 3, the results for both reaction times and errors in this number judgment task are very different. There was a tendency for agreement errors to be more frequent when the head noun was singular, while for judgment errors they were reliably more frequent when the head noun was plural. Agreement errors were more frequent in the mismatch condition, while this manipulation had no effect on judgments. In comparison to repetition errors in Experiment 3, the number of judgments differed in that the number mismatch condition there increased the error rate, while this was not the case for the judgments results. Furthermore, repetition errors did not show any asymmetry for singular and plural head nouns. It should be noted that morphological invariance increases number judgment errors, repetition errors and agreement errors though it interacts differently with the other manipulated factors (namely, number marking on the head noun and number mismatch). Indeed, there is a cost in the processing of invariant nouns, but it appears that the greater perceptual confusability of invariant nouns per se cannot explain the pattern of agreement errors, and that the morphological effect is a genuine production effect.

These lines of evidence all indicate that it is not some misrepresentation of the input that leads to agreement errors following correct repetition. Different factors affect repetition errors and judgments, and it seems to be that what is generated in speech (even if this is premised on a misrepresentation) determines agreement.

*Implications for Psycholinguistic Models*

We now turn to the implications of the three most important factors in inducing broken agreements in our experiments: (1) number mismatching between the head and local noun, (2) distributivity, and (3) morphological form of the head noun and their implications for production models.

### *The "Number Mismatch" Effect*

As outlined in the introduction, IPG and the Competition Model provide very different accounts for the effect of a mismatching local noun in determining errors. Bock and Cutting (1993) demonstrated that clause boundaries blocked the attraction effect; thus an explanation in terms of feature-passing from the head (or, erroneously, the local) noun to the highest projection (NP<sub>x</sub>), seems preferable to an explanation in terms of local constraints (proximity, attraction) and/or in terms of processing cost.

In IPG, a copying mechanism diffuses agreement features from the controller. Thus for complex NPs like those used in these experiments, a feature like [sing] will be copied from NP<sub>1</sub> to NP<sub>x</sub>, and then to S (see Fig. 1). The presence of an attractor may increase error rates if its number feature [plur] is copied by mistake from NP<sub>2</sub> into NP<sub>x</sub> overwriting or competing with the [sing] feature of the head noun. Mismatching features clearly give an opportunity for error here. This proposal can also account for the relatively low error rates in English and Italian: Even if the wrong features are sometimes transmitted, the number of procedure calls from the subject NP to NP<sub>x</sub> is fewer than from the local NP to NP<sub>x</sub>, so that there is less chance of a local feature percolating through to NP<sub>x</sub>.

### *The Distributivity Effect*

Distributivity is a function of the interpretation of the subject noun phrase with respect to a discourse model. In distributed interpretations of singular head nouns, the quantifier of the singular noun falls within the scope of the plural quantifier of the other phrase, and the NP refers to more than one discourse entity, or token. For there to be the observed effect of distributivity, semantic information about the plurality of reference must sometimes override grammatical information about singularity. This means that the semantic information

must be available to the processes determining the agreement of the verb, independently of processes determining the number of the subject.

While our results clearly showed the effects of distributivity in both Experiment 1 and Experiment 2, Bock and Miller (1991) failed to find such an effect for English. It was suggested in the Introduction that there may be important differences between the two languages that would make Italian speakers more sensitive to semantic information when constructing the verb phrase. These were null subject sentences, postposed lexical subjects and rich verbal morphology. Speakers of Italian have to select verb conjugation specified uniquely for person, number, and sometimes gender, and they have frequently to do this before the subject NP has been expressed—either because it has been postposed or because there is no explicit subject in the sentence.

The use of discourse information directly in the determination of verb number does not appear to be allowable in Incremental Procedural Grammar, nor in any other theory that considers subject-verb agreement computation as a purely grammatical process, informationally encapsulated from reference to elements of the discourse model (Bock & Eberhard, 1993; Bock & Miller, 1991; Garrett, 1980; Kempen & Hoenkamp, 1987; Levelt, 1989).

However, IPG is designed to allow sentences to be built and expressed phrase-by-phrase, as semantic information becomes available from the Conceptualiser. Thus its fundamental design characteristics would seem to permit the independent retrieval of semantic information in the "verb-procedure" for constructing the main "verb segment." In recent developments of IPG, such as the Incremental Parallel Formulator (De Smedt, 1990) and in the model proposed by Kempen and Vosse (1989), the traditional feature-copying treatment of agreement has been replaced by a feature-sharing via a unification operation

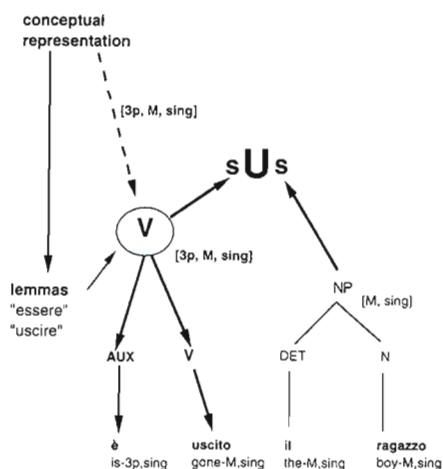


FIG. 2. Unification in IPG for the Italian VS sentence *È uscito il ragazzo* (The boy went out), showing how Person, Number and Gender features might be retrieved directly from the Conceptual Representation to determine the form of the auxiliary and verb. The unification of the features in the S node is denoted by the large U.

(see also Barlow, 1988). In these proposals, each constituent represented by a segment is incrementally attached to others through unification. According to this view, agreement will just be the result of combining the features carried by the NP and V constituents. This procedure is not directional in nature, but if one of the parts carries the most information (usually the NP in English), it might appear directional. According to our reading of the model, features like person, number (and gender if relevant) could be retrieved from the conceptual representation to specify the verb lemma, independently from the retrieval of the number and gender features for the head noun lemma.

In Fig. 2 we give the example of how agreement via Unification would work for an Italian VS sentence: *È uscito il ragazzo* (the boy went out).

An incremental grammatical encoder, with parallel processing of different constituents, and with agreement as a feature-sharing relation, may be able to account for the existence of these semantic effects. If,

moreover, the semantic effects are a function of *when* in the construction of a sentence the semantic information typically becomes available, we have a potential framework for explaining cross-linguistic variability based on properties like word-order and null-subjects. Italian speakers will frequently have to make reference to the discourse model in order to retrieve features necessary for verbal agreement *independently* of the retrieval of features to determine the subject NP, if present.

A further important point is that languages may differ in the extent to which they allow or require discourse/semantic number in different structures. Corbett (1983) proposed a hierarchical ordering of relations between the controller and the target. Following Comrie (1975), he postulated the agreement hierarchy: *attributive modifier* > *predicate* > *relative pronoun* > *anaphoric pronoun*. Moving from the left to the right of the hierarchy, the probability of purely syntactic agreement decreases. Corbett (1983) found that different Slavic languages differ one from another with regard to the agreement relation in which semantic influences are allowed. Relevant here is the finding by Bock, Eberhard and Cutting (1992) of a distributivity effect for pronoun agreement in a task requiring English subjects to complete single-token and multiple-token preambles with a tag question at the end. Italian and English therefore seem to occupy different positions in the Agreement Hierarchy.

No doubt information about the number of the referents will be available to English speakers. Pollard and Sag (1988) note that it is needed for constructing reflexives, as in (20).

- (20) a. The faculty voted themselves a raise  
b. The faculty voted itself a raise

#### *The Morphological Effect*

The morphological effect reported in Experiments 1–3 strongly points to interactiv-



ity between grammatical encoding and morphophonological encoding, since it implies an influence from the word form specification of the head noun to agreement construction. It is, therefore, problematic for every strictly hierarchical model of language production.

Interactive activation models generally allow feedback from morphological features to lexical-syntactic features; but detailed specification of how this might work will be needed to account for the complex pattern of results reported in Experiment 3. In particular, some mechanism for constructing agreement must be incorporated. For example, in Dell (1986) there is feedback but no agreement mechanism.

It is not at all clear how IPG could be modified to allow morphological effects. Kempen and Vosse's (1989) simulated annealing implementation for an IPG parser appears to be straightforwardly adaptable into a production model, but it would require major changes whose implications need to be worked out. For example, a single lexeme for the invariant *città* would need to feed back to two lemmas, one singular and one plural, such that occasionally the erroneous lemma will be the most activated, and will control agreement. However, the idea of one lemma, with diacritical features for number and gender, appears to us an intrinsic property of the model as it stands.

As pointed out in the discussion of Experiment 3, the Competition Model encour-

ters difficulties in explaining why the marking of the local noun does not influence error rates.

#### CONCLUSION

To sum up, agreement in English, Italian and many other languages, depends on three distinct sources of information: (i) grammatical features of the controller (e.g., number and gender of the noun), (ii) the syntactic relationship between controller and target (e.g., subject-(finite)verb, subject-participle, head-modifier etc.), and (iii) the referent(s) of the controller. We hypothesize that how a speaker deploys these sources of information will depend on what role they play in the speaker's language. Speakers of different languages may well deploy the same sources differently.

In order to account for the distributivity effect, a model of grammatical encoding requires features like number to be independently retrieved from the discourse model for the Subject and for the Verb, and then unified. During the unification operation, different languages will deploy the sources of information in different ways, depending, we believe, on language-specific properties like null-subjects and postponed subjects.

The model should also allow for feedback from the morphophonological encoding to the grammatical encoding to explain the effects of morphological marking. Exactly how this should be achieved is a matter for future research.

#### APPENDIX A

##### Sample of Responses for the Different Scoring Categories: Experiment 1

###### *Correct Responses*

Il	foulard con la	frangia è	elegante
The-M,S	scarf-Ø with the-F,S	fringe-F,S is-3p,S	elegant-Ø,S
Le	scatole con i	bottoni	sono piene
The-F,P	boxes-F,P with the-M,P	buttons-M,P	are-3p,P full-F,P
La	illustrazione sui	libri	descrive l'argomento
The-F,S	picture-Ø,S on-the-M,P	books-M,P	describes-3p,S the-M,S topic-M,S

I francobolli sulla busta sono molto rari  
The-M,P stamps-M,P on-the-F,S envelop-F,S are-3p,P very rare-M,P

*Agreement Errors*

La canzone dei gruppi sono troppo chiassose  
The-F,S song-Ø,S of-the-M,P bands-M,P are-3p,P too noisy-F,P  
I menu del ristorante è caro  
The-M,P menu-Ø of-the-M,P restaurants-M,P is-3p,S expensive-M,S  
Il disegno sui quaderni sono belli  
The-M,S drawing-M,S on-the-M,P exercise book-M,P are-3p,P beautiful-M,P  
I francobolli sulle buste è una tassa  
The-M,P stamps-M,P on-the-F,P envelopes-F,P is-3p,S a-F,S tax-F,S

*Repetition Errors*

Il (I) sofà nella camera è morbido  
The-M,S sofa-Ø in-the-F,S room-F,S is-3p,S cushy-M,S  
I gatti sui tetti si rincorrono  
The-M,P cats-M,P on-the-M,P roof-M,P CL chase-3p,P  
(The cats on the roof are chasing each other)  
I (II) wafer alle creme sono buonissimi  
The-M,P waffle-Ø with-the-F,P creams-F,P are-3p,P very good-M,P  
Le discussioni sulle proposte andarono avanti fino a notte avanzata  
The-F,P discussions-Ø,P on-the-F,P proposals-F,P went-3p,P on until night

*Repetition + Agreement Errors*

I (II) menu del ristorante è davvero interessante  
The-M,P menu-Ø of-the-M,S restaurant is-3p,S really interesting-Ø,S  
I wafer alle creme è delizioso  
The-M,P waffle-Ø with-the-F,P creams-F,P is-3p,S delicious-M,S  
Le pubblicità dei dentifrici è una noia  
The-F,P advertisements-Ø of-the-M,P toothpastes-M,P is-3p,S boring

*Miscellaneous Responses*

Il viaggio verso l'isola che non c'è  
The-M,S journey-M,S to the-F,S island-F,S that does not exist  
I gatti sui tetti con la gatta, cosa fanno?  
The-M,P cats-M,P on-the-M,P roof-M,P with the-F,S cat-F,S, what do they do?  
La scatola con il bottone da schiacciare  
The-F,S box-F,S with the-M,S button-M,S to press  
I foulard con la frangia, non lo so  
The-M,P scarf-Ø with the-F,S fringe-F,S, I don't know

APPENDIX B

Sample of Responses in the Different Scoring Categories: Experiment 2.

*Correct Responses*

MT S: *impegnato* [busy-M,S] Il viglie agli incroci  
R: Il viglie agli incroci era molto impegnato  
The-M,S cop-M,S at-the-M,P cross roads-M,P was-3p,S very busy-M,S

MT S: *Utili* [useful-Ø,P] La radio sulle macchine

R: La radio sulle macchine qualchevolta è utile  
The-F,S radio-Ø on-the-F,P cars-F,P sometimes is-3p,S useful-F,S

ST S: *fantastiche* [fantastic-F,P] La danza delle sirene

R: La danza delle sirene era fantastica  
The-F,S dance-F,S of-the-F,P sirens-F,P was-3p,S fantastic-F,S

ST S: *affettuoso* [affectionate-M,S] Il gorilla con i cuccioli

R: Il gorilla con i cuccioli è affettuoso  
The-M,S gorilla-Ø with the-M,P puppies-M,P is-3p,S affectionate

#### *Agreement Errors*

MT S: *colorati* [colored-M,P] Il disegno sui quaderni

R: Il disegno sui quaderni sono colorati  
The-M,S drawing-M,S on-the-M,P exercise books-M,P are-3p,P colored-M,P

MT S: *ricercate* [seeked-F,P] L'oasi nei deserti

R: L' oasi nei deserti sono ricercate  
The-F,S oasis-Ø in-the-M,P deserts-M,P are-3p,P sought-F,P

ST S: *fantastiche* [fantastic-F,P] La danza delle sirene

R: La danza delle sirene sono fantastiche  
The-F,S dance-F,S by-the-F,P sirens-F,P are-3p,P fantastic-F,P

ST S: *nascosti* [hidden-M,P] L'album con le fotografie

R: L' album con le fotografie sono stati nascosti da mia sorella  
The-M,S album-Ø with the-F,P pictures-F,P are-3p,P been-M,P hidden-M,P by my sister

(The album with the pictures have been hidden by my sister)

#### *Repetition Errors*

MT S: *visibili* [readable-Ø,P] Il numero sulle targhe

R: I numeri sulle targhe sono ben visibili  
The-M,P numbers-M,P on-the-F,P plates-F,P are-3p,P well readable-Ø,P

MT S: *complicati* [complex-M,P] Il menu dei ristoranti

R: I menu dei ristoranti sono complicati  
The-M,P menu-Ø of-the-M,P restaurants-M,P are-3p,P complex-M,P

ST S: *piene* [full-F,P] La scatola con i bottoni

R: Le scatole con i bottoni sono piene  
The-F,P boxes-F,P with the-M,P buttons-M,P are-3p,P full-F,P

ST S: *avvincenti* [intriguing-Ø,P] Il film sugli indiani

R: I film sugli indiani erano avvincenti  
The-M,P movie-Ø about-the-M,P indians-M,P were-3p,P intriguing

#### *Repetition + Agreement Errors*

ST S: *sbagliata* [wrong-F,S] La diagnosi dei dottori

R: Le diagnosi dei dottori è sbagliata  
The-F,P diagnosis-Ø by-the-M,P doctors-M,P is-3p,S wrong-F,S

ST S: *eterna* [endless-F,S] La crisi delle scuole

R: Le crisi della scuola è eterna  
The-F,P crisis-Ø of-the-F,S schools-F,S is-3p,S endless-F,S

MT S: *impegnati* [busy-M,P] Il vigile agli incroci

R: I vigili agli incroci è spesso impegnato  
 The-M,P cops-M,P at-the-M,P intersections-M,P is-3p,S often busy-M,S

*Miscellaneous Responses*

ST S: *famoso* [famous-M,S] Lo scrittore dei racconti

R: Lo scrittore dei racconti è noioso  
 The-M,S writer-M,S of-the-M,P novels-M,P is-3p,S boring-M,S

ST S: *sbiadito* [faded-M,S] Il foulard con le frange

R: Il foulard con le figure è sbiadito  
 The-M,S scarf-Ø with the-F,P pictures-F,P is-3p,S stink

ST S: *colorato* [colored-M,S] Il disegno sui quaderni

R: Quel disegno nel quaderno è colorato  
 That-M,S drawing-M,S in-the-M,S exercise book-M,S is-3p,S colored-M,S

MT S: *allegro* [happy-M,S] Il brindisi nelle feste

R: Il brindisi nelle foreste era allegro  
 The-M,S toast-Ø in-the-F,P forests-F,P (parties) was-3p,S happy-M,S

APPENDIX C

Sample of Responses in the Different Scoring Categories: Experiment 3

*Correct Responses*

I bar nelle città sono comodi

The-M,P bar-Ø in-the-F,P towns-Ø are-3p,P comfortable-M,P

La festa nelle tribu' è folcloristica

The-F,S festival-F,S in-the-F,P tribe-Ø is-3p,S traditional-F,S

Le scoperte dello scienziato servono all'umanità

The-F,P discoveries-F,P of-the-M,S scientist-M,S are useful to the humanity

Il computer nell' ufficio è molto utile

The-M,S computer-Ø in-the-M,S office-M,S is-3p,S very useful-Ø,S

*Agreement Errors*

Il camion sulle strade sfrecciano veloci

The-M,S truck-Ø on-the-F,P roads-F,P run-3p,P fast-Ø,P

La melodia delle musiche sono tristi

The-F,S melody-F,S of-the-F,P musics-F,P are-3p,P sad-Ø,P

La radio sull' auto fanno compagnia

The-F,S radio-Ø on-the-F,S car-F,S keep-3p,P company

La trama dei film sono belle o brutte

The-F,S plot-F,S of-the-M,P movies-Ø are-3p,P beautiful-F,P or horrible-F,P

*Repetition Errors*

I (II) camion sulla strada vanno troppo velocemente

The-M,P trucks-Ø on-the-F,S road-F,S run-3p,P too fast

Le melodie delle musiche sono belle

The-F,P melodies-F,P of-the-F,P musics-F,P are-3p,P beautiful-F,P

La crisi delle scuole è drammatica

The-F,S crisis-Ø of-the-F,P schools-F,P is-3p,S dramatic-F,S

*Repetition + Agreement Errors*

I (II) poster del gorilla è appeso alla parete  
 The-M,P posters-Ø of-the-M,S gorilla-Ø is-3p,S attached-M,S on the wall  
 La festa neele tribu' fanno divertire la gente  
 The-F,S festival-F,S in-the-F,P tribes-Ø make-3p,P people happy  
 La diagnosi dei medici non sempre sono buone  
 The-F,S diagnosis-Ø of-the-M,P doctors-M,P not always are-3p,P good  
 Le scoperte degli scienziati è stata clamorosa  
 The-F,P discoveries-F,P of-the-M,P scientists-M,P is-3p,S been-F,S remarkable-F,S

*Miscellaneous Responses*

Il pasto (poster) del gorilla è abbondante  
 The-M,S food-M,S (poster) of-the-M,S gorilla-Ø is-3p,S abundant-Ø,S  
 Il poster del gorilla King Kong  
 The-M,S poster-Ø of-the-M,S gorilla-Ø King Kong  
 I viaggi verso le isole Egadi  
 The-M,P journey-M,P to the-F,P islands-F,P Egadi  
 La melodia della musica di Brahms  
 The-F,S melody-F,S of-the-F,S music-F,S by Brahms

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