

## ORDER, DISTRIBUTIVITY AND ATTRACTION DURING AGREEMENT PRODUCTION<sup>1</sup>

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- **ABSTRACT:** Several studies have found that factors of different nature (semantic, morphological and syntactic) affect the computation of subject-verb agreement during sentence production (BOCK; MILLER, 1991; FRANCK; VIGLIOCCO; NICOL, 2002; HARTSUIKER et. al., 2003; HASKELL; MACDONALD, 2003; VIGLIOCCO; BUTTERWORTH; SEMENZA 1995) The aim of this paper are: a) to investigate the influence of the linear order of constituents, exploiting the relative flexibility of Spanish; b) inquire whether a semantic variable, such as distributive reading, and a morphological variable, such as manipulation of the number of local noun, are factors that affect the processing of the agreement. We designed an experiment using an image description task with preambles in which the order of the subject of the sentence (pre-verbal or post-verbal), the type of preamble (nominal phrases with distributive and non-distributive reading) and the number of the local noun (singular-plural) was manipulated. The results showed a main effect of the local noun number, the type of preamble and the linear order of the constituents: more subject-verb agreement errors occurred when the sentence presented an asymmetry in the number of nouns (N1 Singular- N2 Plural), the phrases had a distributive reading and the order was subject-verb. The results seem to indicate that syntactic, semantic and morphological factors interfere together in the agreement processing in Spanish and support the postulates of the interactive models of agreement production. In addition, they provide evidence to a general processing model in which the different factors work as keys to the retrieval of information in the agreement computation (BADECKER; KUMINIAK, 2007).
- **KEYWORDS:** Psycholinguistics. Sentence production. Agreement. Linear order. Distributivity. Spanish.

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## Introduction

The phenomenon of agreement has been studied from different views, both in Linguistics and Psycholinguistics. Among other issues, linguists have debated about how computation is implemented, its time course within the formulation process and the differences among languages. Since the beginning of the 1990 decade, Psycholinguistics has experimentally addressed some of the problems that theoretical linguistics had been discussing. With regard to language production, the initial interest was to investigate under what circumstances the speakers make errors of agreement and try to explain those errors in the framework of sentence processing models, following the pathway initiated by Fromkin (1973) and Garrett (1975) for other speech errors. Sentence production models are divided between those that support the idea that information flows exclusively forward and those that accept, to some extent, bidirectional flow. They emphasize different aspects of the available evidence. The former consider that the activation is spread from the message level to the phonological level, going through a grammatical level, in a serial and encapsulated way (BOCK; LEVELT, 1994). For these models agreement occurs at grammatical encoding level and is impervious to semantic and morphophonological influence. On the other hand, interactive models (BATES; MACWHINNEY, 1989; BADECKER; KUMINIAK, 2007; DELL, 1986; MACDONALD; PEARLMUTTER; SEIDENBERG, 1994; STEMBERGER, 1985; TANENHAUS et al., 1995) assume that, during the formulation of a sentence, information from different sources may play a role simultaneously. Thus, semantics, morphology and phonology could interact with syntax, even in the case of a process as agreement, eminently syntactic in nature.

## Attraction

The errors that have been specially exploited in the investigation of the subject-verb agreement are *attraction errors* (QUIRK et al., 1972). In these errors, the agreement is established between the main verb of the sentence and a local noun (N2), instead of being established between the verb and the head of the subject (N1), as in (1):

- (1) \*La etiqueta (N1) de las botellas (N2) son rojas. [The label (N1) of the bottles (N2) are red].

Experiments were designed to test if the processes of agreement at the syntactic level are influenced by the representations of the semantic and morphophonological levels. The scene continues to be conflictive. Some studies support the idea that agreement remains encapsulated and isolated from non-syntactic information (BOCK; EBERHARD, 1993; BOCK; EBERHARD; CUTTING, 2004; BOCK; MILLER, 1991; RODRIGUES 2006), while others found evidence indicating that semantic and

/ or morphophonological factors affect the processing of agreement (VIGLIOCCO; FRANCK, 1999; VIGLIOCCO; HARTSUIKER, 2002; VIGLIOCCO et al., 1996, among others). In the following sections we will present the most relevant background evidence of the role of syntactic, semantic and morphological factors during the production of agreement in different languages.

### **Semantic and morphological factors**

Experimental studies of the production of agreement have shown that factors of different nature strengthen the bias to make attraction errors, which suggests that these factors play a role during the computation of the agreement. In this sense, it has been investigated whether semantic factors, such as the conceptual representation of the number (or referent numerosity), could affect syntactic processing (BOCK et al., 2001). Specifically, it was studied whether the distributive reading of the noun phrases generates interference in the computation of the agreement, since there is the possibility of relating the head of the subject with a single instance of a referent (single token) or several (multiple token), depending on the semantic-pragmatic nature. Different studies have reported a consistent effect of distributivity in different languages (EBERHARD, 1999, for English, RODRIGUES, 2006, for Portuguese: VIGLIOCCO; BUTTERWORTH; GARRETT, 1996, for Spanish, French and Dutch, VIGLIOCCO; BUTTERWORTH; SEMENZA, 1995, for Italian, among others). Some authors attributed the distributive effect obtained in the Romance languages to the particular features of the languages: the morphological richness, the possibility of post-verbal subject and the null subject. The hypothesis is that in these languages grammatical information of subject number would not always be available quickly, so the verb number would be specified based on conceptual information, coming from the message level. After this, the agreement between the subject and the verb is specified. Thus, the semantic effect would be determined by an interference of the conceptual number coming from the level of the message. Thus, in languages with rich morphology this effect is caused by an inconsistency between the grammatical information of the subject number and the verb number information (VIGLIOCCO; BUTTERWORTH; SEMENZA, 1995; VIGLIOCCO; BUTTERWORTH; GARRETT, 1996). The explanation offered by the authors is that the verbal morphology would be highly informative, which is interpreted as an indication that the verb number information is defined directly from the message level.

The effect of distributivity was usually found together with an effect of singular-plural asymmetry of the nouns that appear within the determinant phrase. Here the incidence of the richness of the morphology in the size of the semantic effect plays a determining role; two hypotheses aim to explain this interaction. On the one hand, the maximalist hypothesis (VIGLIOCCO et al., 1996) argues that languages with rich morphology could be prone to the influence of conceptual number, thanks to

the penetration of meaning in the processing of agreement. The agreement errors, in this way, are possible due to the interaction between the different levels in the speech production system. On the other hand, the minimalist hypothesis (EBERHARD; CUTTING; BOCK, 2005) predicts that languages with rich inflectional morphology are less sensitive to the notional or semantic number, given that the inflectional morphemes would filter the effect of the meaning related to the number (ANTÓN-MÉNDEZ; HARTSUIKER, 2010; FOOTE; BOCK, 2011; LORIMOR et al., 2008; SÁNCHEZ; SEVILLA; JAICHENCO, 2013). This hypothesis holds that interference of semantic and / or morphophonological factors is set at levels before or after the calculation of the agreement. Therefore, the autonomy of the syntactic formulator in the matching process is preserved. In this sense, these hypotheses posit that the input that the encoder receives from the conceptual structure is restricted to the use at the message level. The solution found by minimalist hypotheses when locating semantic and morphophonological interference in an anterior or posterior stage, respectively, to the computation of agreement, does not seem to be compatible with translinguistic evidence. Different studies found, on the one hand, an extensive conceptual influence in the construction of the agreement of number and also of gender (BOCK; NICOL; CUTTING, 1999; EBERHARD, 1999; VIGLIOCCO; BUTTERWORTH; GARRETT, 1996; VIGLIOCCO et al., 1995; VIGLIOCCO; FRANCK, 1999; HARTSUIKER et al., 2003, among others), confirming that grammatical coding cannot remain isolated at least from conceptual structures.

## Syntactic factors

Syntactic theory has placed its interest in determining the syntactic aspects of the phenomenon of agreement, especially in theoretical frameworks such as those proposed by formal theory (CHOMSKY, 1995, 2001) that provide models of the structural conditions that govern agreement. Experimental studies generated a number of conclusions that are summarized below. First, syntactic encoding involves an abstract representation in which words are organized hierarchically before their linearization. Second, attraction is sensitive to structural proximity in the syntactic structure, that is, the place occupied by the local noun in the hierarchy influences the generation of attraction errors. Thus, the lower nouns in a tree structure generate less interference than the higher nouns (For example, *\*la correa de los perros del verdulero son azules* vs. *la correa del perro de los verduleros es azul* [*\*the belt of the greengrocer's dogs are blue* vs. *the green dog's belt is blue*]) The first condition give rise to more errors than the second, despite the linear proximity to the verb in the latter). Third, local nouns that are internal to the subject and internal to the predicate do not interfere in the same way, suggesting that the left and right ramifications may be involved differently in attraction (BOCK; MILLER, 1991; FRANCK; VIGLIOCCO; NICOL, 2002; FRANCK et al., 2006; FRANCK et al., 2010; RODRIGUES, 2006; SÁNCHEZ; SEVILLA, 2013; SÁNCHEZ; JAICHENCO;

SEVILLA, 2014; VIGLIOCCO; BUTTERWORTH; SEMENZA, 1995; VIGLIOCCO; NICOL, 1998). However, the proposed interpretation for the data is based on a very broad analysis of the syntactic structure, and a fine theoretical framework that fully accounts for the attraction is not established. Few studies have dealt with the role of the order of the constituents. Thus, in most of the studies that investigated the attraction in sentence production, the preambles or experimental items were constructed in the subject-verb order, where the whole determinant phrase (which includes the head noun and the local nouns) is always produced before the verb.

In order to separately evaluate the question of linear and syntactic distance, Vigliocco and Nicol (1998) requested participants to ask a question from the preamble they had heard, which led to producing the verb in the first place. In the preambles they manipulated the number of the head noun of the subject and of the local noun. Although they found an effect of number attraction, with more errors when the N1 appeared in singular and the N2 in plural, they did not verify an effect of the linear order of the head noun, which undermines the idea that the element closest to the verb interferes with the agreement. Following this line, Franck and collaborators (2006) discussed linear order, adopting a view that incorporates minimalist assumptions and a derivational approach to the formulation of a sentence. In an approach of this kind, when a sentence is computed, multiple intermediate representations reflect a cyclical derivation of the sentence. For the authors, these intermediate representations are presented in a tree format that specifies hierarchical relationships between the syntactic nodes (dominance) and also involve different linear orders (precedence). According to Franck et al. it is necessary to analyze the derivation of the sentence to verify if at any moment the local noun intervenes linearly between the subject and the verb. They reinterpreted the data of Vigliocco and Nicol (1998) presented previously, since they consider that in both interrogative and declarative sentences, there is a moment in which the plural noun would be between the subject and the node of the agreement. According to this analysis, the contrast between both types of sentences does not allow excluding an effect of linearity, understood in terms of linear precedence.

## Objectives

In this work, we will focus on a syntactic factor not studied in the literature: the linear order of the constituents of the sentence, and we will put it in relation to a semantic factor (distributive reading) and a morphological one (number of local noun). On the one hand, this work intends to investigate the influence of the linear order, exploiting the relative flexibility of our language, and on the other hand, to investigate whether a semantic variable, such as distributive reading, and a morphological variable, the number of local, are all factors that affect the agreement processing.

Our experimental design will try to contribute data to the discussion about the modularity in language production, since it was manipulated, at the same time,

information of different levels of processing, and in addition, we intend to give a unified answer to the evidence found from a general model of language processing.

## Overview of the experiment

We designed an experiment in which the pattern of subject-verb agreement errors and omissions in the sentences production of Spanish has been studied. We used an image description task with preambles in which the Number of the local noun (singular-plural), the Type of preamble (distributive and non-distributive) and the Linear order (pre verbal subject – post verbal subject).

## Method

### Participants

Fifteen native Spanish speakers participated in the experiment: 4 men and 11 women. The age of the participants ranged from 18 to 40 (with a mean of 26.93 years and standard deviation (SD) of 7.6). All participants had completed high school (Mean of scholarship; 15.53 years; SD: 1.72) and signed a written consent.

### Materials

The experimental items consisted of an image that represented a complex preamble consisting of noun phrase (N1), prepositional phrase (PP) with other noun (N2 or local noun). The images were in black and white and the object with which they should produce the image was colored (head noun of the subject or N1). The following variables were manipulated: Number of N2 (singular-plural), Type of preamble (distributive-non distributive) and Linear order (pre verbal subject-post verbal subject). Thus, 8 conditions were created, divided into 2 lists. Each subject was given a list containing 64 targets and 16 fillers. Examples of a sentence in the 8 experimental conditions are shown in Table 1.

In the lists, every two target items, filler appeared. The fillers were constructed in both experimental conditions of linear order, but the two nouns that appeared in the sentence (head noun and local noun) were always in plural (for example, *Los vestidos de las mujeres son amarillos* or *Son azules las polleras de la niñas*). In this way, subjects throughout the experiment were forced to produce plural sentences.

**Table 1** – Examples of experimental preambles

Condition	Preamble
N2Sing-D-SV	<i>El candado (N1) del armario(N2) es amarillo [The padlock of the locker is yellow]</i>
N2Pl-D-SV	<i>El candado de los armarios es amarillo</i>
N2Sing-ND-SV	<i>La luz de la mesa es violeta [The light on the table is violet]</i>
N2Pl-ND-SV	<i>La luz de las mesas es violeta</i>
N2Sing-D-VS	<i>Es amarillo el candado del armario</i>
N2Pl-D-VS	<i>Es amarillo el candado de los armarios</i>
N2Sing-ND-VS	<i>Es violeta la luz de la mesa</i>
N2Pl-ND-VS	<i>Es violeta la luz de las mesas</i>

N1: Head noun

N2: Local noun

Sing: Singular Number

Pl: Plural Number

D: Preamble distributive

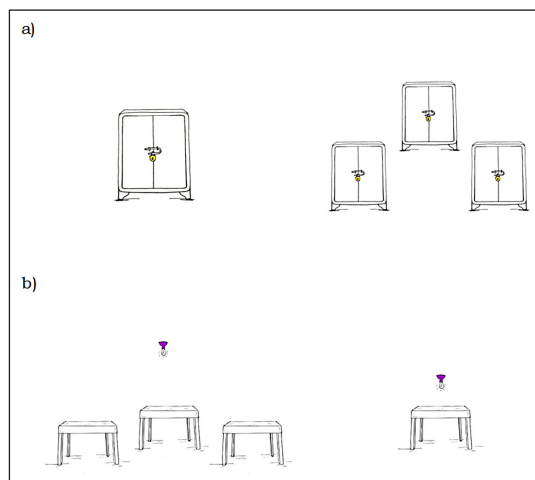
ND: Preamble non distributive

SV: subject-verb order (pre verbal subject)

VS: verb-subject order (post verbal subject)

**Source:** Author's elaboration.

**Figure 1** – Examples of experimental images. a) shows an example of distributive item in singular and plural : *El candado del (os) armario (s) es amarillo*. b) shows an example of non distributive item in singular and plural: *La luz de la (s) mesa (s) es violeta*.



**Source:** Author's elaboration.

## Procedure

Participants were tested individually while seated in front of a computer screen. A sentence production task was designed from a drawing presented in the centre of the screen. Each experimental item was composed of two drawings that appeared next to each other. On the first screen appeared a drawing with the complete sentence written above and the participants had to read it aloud. In the second screen appeared the drawing for 4 seconds and the participants had to produce the sentence beginning with the noun that was colored. This second drawing always belonged to a condition of number of N2 always different with respect to the first drawing. Every two target items, a filler item was inserted that was always plural.

For the key of the linear order, the instruction was that in the second screen they had to respect the sentence order presented in the first one. If in the first screen the order of the written sentence was SV, in the second screen they should begin with the subject of the sentence. On the other hand, if in the first screen the order was VS, in the second it was to begin to produce the verb in the first place.

Before the experimental items, the participants went through a training stage in which they saw the 48 black and white drawings (16 distributive, 16 non-distributive and 16 fillers) to familiarize with the type of sentences that they must produce. Then began the practice stage in which they saw four practice items, and received visual and orally indications of the task. Corrections were also made. Each participant was evaluated in an individual session of 15 minutes.

## Scoring criteria

We studied the pattern of subject - verb agreement errors and omissions pattern. Sentences were scored according to the following criteria:

- 1) Correct responses: when the participants correctly produced the sentence from the drawing and used the correct form of the verb.
- 2) Agreement errors: the verb was produced with an incorrect number feature.
- 3) Omission responses: when the participant did not produce any production from the drawing in the stipulated time.

## Data analysis

Analyses of variance by participant were performed using as dependent measure the transformation of the proportion of agreement errors and omission responses (JAEGER, 2008).

## Results

Analyses were performed over a total of 960 data points. There were 870 correct responses (90.62%), 49 subject-verb agreement errors (5.1%), and 41 omissions (4.27%). Table 2 displays mean (M) and standard deviation (SD) of agreement errors and omissions per experimental condition.



**Table 2** – Mean and standard deviation per experimental condition. Accuracy-error and accuracy-omission

<i>Condition</i>	Errors		Omissions	
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
N2Sing-D-SV	7.60	.299	7.09	.288
N2Pl-D-SV	4.09	.297	7.11	.327
N2Sing-ND-SV	7.60	.299	7.09	.288
N2Pl-ND-SV	6.63	.307	6.25	.297
N2Sing-D-VS	7.60	.303	6.71	.288
N2Pl-D-VS	5.88	.300	6.89	.305
N2Sing-ND-VS	7.60	.299	7.09	.288
N2Pl-ND-VS	7.33	.299	7.08	.290

M: Mean / SD: Standard deviation

N1: Head noun / N2: Local noun

Sing: Singular Number/ Pl: Plural Number

D: Preamble distributive / ND: Preamble non distributive

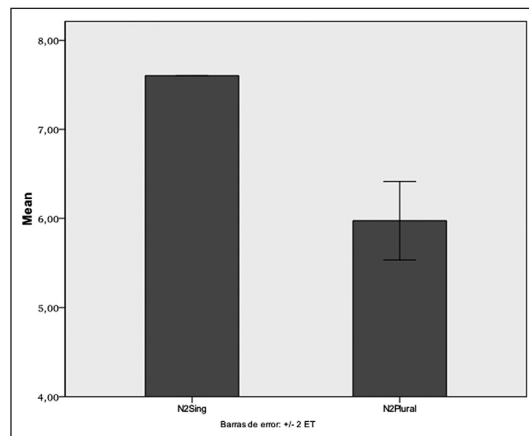
SV: subject-verb order / VS: verb-subject order

**Source:** Author's elaboration.

### Agreement errors

The ANOVA showed a main effect of the Number of N2 ( $F(1, 14) = 57.77, p = .000$ ) with more errors produced by the participants when the N2 was in plural (see Figure 2).

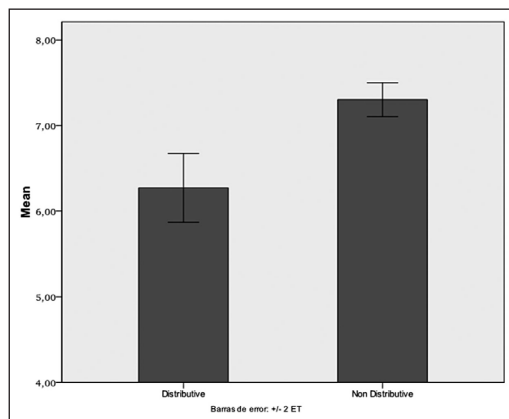
**Figure 2** – Accuracy mean to Number of local noun (Singular vs. Plural).



**Source:** Author's elaboration.

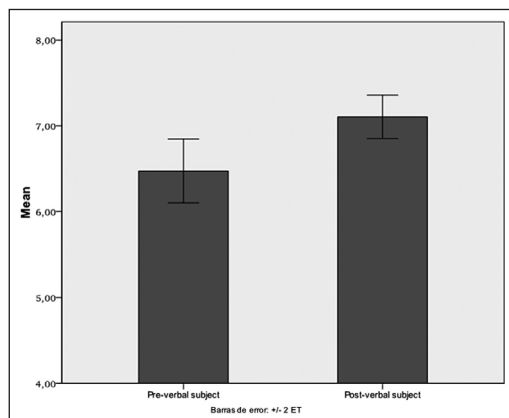
A main effect of the Type of preamble ( $F(1, 14) = 22.14, p = .000$ ) (see Figure 3) and Linear order ( $F(1, 14) = 8.62, p = .003$ ) (see Figure 4) were found. More agreement errors when the preamble was a reading distributive in Subject-Verb order.

**Figure 3** – Accuracy mean to Type of preamble (Distributive vs. Non distributive).



Source: Author's elaboration.

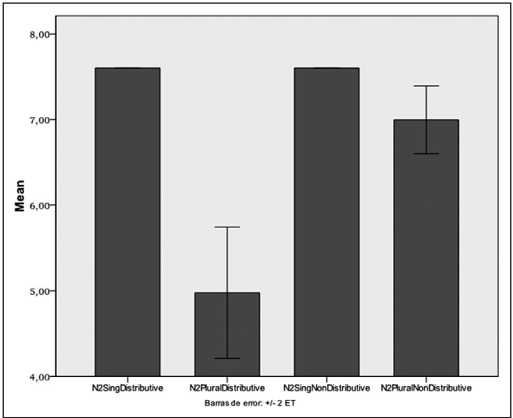
**Figure 4** – Accuracy mean to Linear order (pre-verbal subject vs. post-verbal subject).



Source: Author's elaboration.

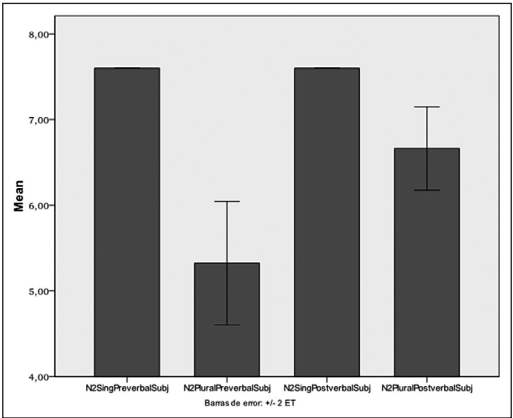
The following interaction was found: Number of N2 and Type of preamble ( $F(1, 14) = 22.14, p = .000$ ). The post-hoc analysis shows that the conditions with N2 plural and distributive preamble were significant different of the other conditions. In addition, an interaction between the Number of N2 (in favour of the plural) and the Linear order (Subject-Verb) was found:  $F(1, 14) = 8.62, p = .003$  (see Figures 5 y 6).

**Figure 5** – Accuracy mean to Type of preamble (Distributive vs. Non distributive) and Number of local noun (Singular vs. Plural).



Source: Author's elaboration.

**Figure 6** – Accuracy mean to Linear order (pre verbal subject vs. Post-verbal subject) and Number of local noun (Singular vs. Plural).



Source: Author's elaboration.

### Omissions

ANOVA showed no main effect or significant interaction between the variables manipulated. The omissions were homogeneously distributed among the different experimental conditions.

## Discussion

We have presented an experiment that aimed to elicit errors in number agreement in sentences with pre and post verbal subject, where the head of the subject was a noun that either could or could not admit a distributive reading. The data try to answer to two questions related to the factors that influence agreement processing during sentence production: the distributivity (semantic factor), the number of the local noun (morphological factor), and the subject's order (syntactic factor).

### Attraction and distributivity

The data from our experiment revealed a main effect of *Number of the local noun* or *N2*. That is, speakers made more agreement errors when N2 was plural (and N1 singular). We also found an effect of Type of preamble, with more errors when the preferred reading of the determinant phrase was distributive. It is interesting to point out that the interaction between these two factors was also significant. This is key to showing that the semantic effect is associated to a morphological effect. In this sense, the *minimalist hypothesis* and Eberhard, Cutting and Bock (2005)'s model of agreement production would not be able to explain why, in the conflict of conciliating the functional marking and the morphological marking, the conceptual number imposes itself and marks the whole noun phrase as plural – and consequently transmits this feature to the verb. The prominence of the conceptual number at the moment of phonological marking shows that the semantic level intervenes at the grammatical level, keeping the conceptual information active. As predicted by the *maximalist hypothesis* (VIGLIOCCO et al., 1996), Spanish, a morphologically rich language, is prone to be influenced by the conceptual number, which is part of the message level, at the stage in which agreement is computed. The results of the main effects and interaction obtained in our experiment suggest a certain penetration of information from previous (semantic) levels during the grammatical encoding and therefore contribute evidence in favour of interactive models of agreement production.

### Attraction and linear order

Being a language with relatively flexible order, Spanish makes possible the experimental study of whether there is an influence of the linear order of constituents in agreement production. Speakers produced more errors when the order was subject-verb than when it was the reverse (verb-subject). Moreover, we found an interaction between *Linear order* and *Number of the local noun* (more errors in sentences with subject-verb order and plural N2). This data suggest that a local plural noun or N2 perform a greater attraction when the constructions present the subject-verb order.

Franck and colleagues (2006) present data from an experiment in which they evaluated linear precedence and the double-checking of agreement features hypothesis. In one of their experiments they looked at the difference between structures with subject-verb (SV) and verb-subject (VS) order. In the VS structures, the subject remains internal to the verbal phrase; there is no raising movement of the subject, so it would not be possible to have an effect of linear intervention that would produce more errors. Besides, given the syntactic configuration of these sentences, agreement would be established by simple feature checking with the *Agree* operation. It is not the same in SV structures. In these, the derivation involves, first, subject movement to the position of specifier of the AgrS node (where agreement with the verb is established). In this movement there is a moment in which the subject's modifier (this is where the interfering noun is) intervenes in terms of linear precedence between the subject's head noun and AgrS, which affects agreement with the verb, leading to the production of more errors. Furthermore, in these constructions agreement is carried out in two moments: first, features are checked through the *Agree* operation; then, those features are checked again in the specifier-head configuration. This study found an effect of order, with more errors in the SV condition (as is derived from the previous explanation). This result is compatible with the idea that order, understood in terms of linear precedence (not in terms of superficial order), is a factor that plays a role in agreement processing.

The results from our experiment are aligned with this explanation, in which the structural aspects specific to the derivation of two different syntactic structures are related to the morphological features of the subject's head noun and of the intervening noun. In other words, following Franck et al. (2006), in the derivation of every sentence, agreement is established through the *Agree* operation between the subject agreement node (*AgrS*) and the unmoved verbal phrase-internal subject (CHOMSKY, 1995). In the sentences with post-verbal subject, such as *Es amarillo el candado* (N1) *de los armarios* (N2), the N2 does not intervene linearly nor hierarchically between AgrS and the subject's head noun or N1 (*candado*), because it is to the right of N1 as well as of the verb and performs no attraction (in this condition there were hardly any errors of the type of *\*Son amarillos el candado de los armarios*). The following example (2) shows the formal description of the derivation of these structures (VS), which illustrates the previous explanation:

Example (2) *Es amarillo el candado del armario*

- a) [AgrS] [[el candado del armario] es amarillo] AGREE
- b) [AgrS 3S [[el candado del armario] es amarillo] movement of V to AgrS
- c) [AgrS es amarillo] [[el candado del armario] t]

On the contrary, in preambles like *El candado de los armarios*, the movement of the subject to the position of specifier of the subject agreement node, *AgrS*, also drags the movement of the local noun and induces the consequent agreement check. In this

configuration, the local noun (*armarios*) intervenes linearly between the noun head and the *AgrS* node, and attraction is generated. The errors made in the production of this structure are of the type: \**El candado de los armarios son amarillos*.

To sum, the reported effects (linear order, distributivity and number of the local noun) indicate that factors of different nature play a role and can interfere with processing when agreement is computed in Spanish. This means that, as opposed to what is proposed by strictly modular models, in the production of language and, specifically, of agreement, there is interaction between the processing levels, in particular between the semantic and the syntactic levels (FRANCK et al., 2008; VIGLIOCCO; HARTSUIKER, 2002). The reported evidence allows us to discuss the discrete and encapsulated character of the components in the speech production system; however, given the characteristics of the design, it does not provide data for the discussion of the directionality of the information flow, in particular, whether there is feedback between the phonological and grammatical levels.

The ensemble of the data presented here can be interpreted within the framework of a general model of agreement in which syntactic, semantic and morphological factors function as cues for the retrieval of information (BADECKER; KUMINIAK, 2007).

### **Agreement and attraction in a processing modelling**

The theories that focus on the processing mechanisms can provide a unified framework to account for the phenomena we have just exposed. In this sense, a model like the *Working Memory Retrieval Model* (*WMRm*, BADECKER; KUMINIAK, 2007) could provide a unified explanation for the different effects found in our study. In general, the model works on the basis of a search for active elements in order to relate them and carry out production. For the model both the linear order of constituents and the morphological and semantic information of the subject's nouns play an active part in the search and function as guides during the computation of agreement.

The *WMRm* proposes that only a limited amount of information can be processed simultaneously (MCELREE; BEVER, 1989; LEWIS; VASISHTH; VAN DYKE, 2006). As language production is incremental, that is, as speakers planify a fragment of their message before starting to speak and continue the planning online, which guarantees speed and fluency in speech, only a small amount of information can be maintained active for a certain time. The elements processed later on in the sentence might need to retrieve information about the elements previously processed, which implies retrieving information that was held in working memory (WM). For example, to establish an agreement relation it is necessary to retrieve a controller, defined as the element that will transmit the necessary features, and put it in accordance with another element, the target. Once a noun phrase (or, more generally, some item marked with  $\Phi$  features) has been produced or retrieved, it is kept active in WM (or at least its associated features are). Then, once an item requiring the selection of a morphological agreement form (e.g.,

a verb or an adjective) is retrieved for production, a search for a relevant antecedent (the controller) begins in WM.

Following Lewis and Vasissth (2005), we assume that the level of activation of the features decreases with time or, equivalently in our proposal, with the amount of linguistic material of different types that has been produced or retrieved during a very short period of time. It is assumed that the parser, that has to work under time pressure and with strong working memory restrictions, needs a clear indication of the nature of the elements it has to connect through the *Agree* operation. In this sense, both the linear order of the constituents in the sentence and the morphological features function as cues for the retrieval and allows to choose the right noun. However, selecting a controller might not be a direct task if in the search space there is more than one candidate that was previously active. This means that, if a determinant phrase with two or more nouns is produced, the search and the retrieval can become more complicated. Thus, if an active interfering or local element is strong enough, agreement is more prone to error, since its morphosyntactic properties (and its semantic properties too, as we will see later) are strongly associated to a representation able of carrying out the agreement (BADECKER; KUMINIYAK, 2007). In other words, the system encounters the possibility of retrieving multiple candidates for controlling the agreement or the possibility of not retrieving any. In this way, the sentence becomes vulnerable to attraction and agreement errors appear (in this case, number agreement error).

As we have reported, there are no number agreement errors in sentences with post-verbal subject. Indeed, it seems that, in the linear order in which the subject is after the verb, the subject's nouns (head and local) are not in an active position and, therefore, according to this model, do not guide the search for the right controller during the computation of agreement. An important question for this kind of approach has to do with the definition of an active interfering element, since this would provide input for the reflection about what kind of information is stored in WM and consequently what kind of information is relevant for the parser to establish the agreement relation. Here, both marking (e.g. plural) and linear position could play a crucial role.

The greatest advantage of considering attraction within the framework of a WM model is that grammatical processing is implemented in the search for an agreement controller in an abstract structure possibly motivated by a more general mechanism, as might be similarity. Grammatical information only functions as an ensemble of cues driving the search. In this sense, the interference of semantic factors, such as the one reported in phrases with distributive reading, could also be explained in relation to similarity. The semantic or conceptual information of number could also function as a search cue. That is, if the subject's head noun is encoded as plural on the basis of its semantics and then a grammatically plural local noun appears, the similarity in the information of +plural features can lead the system to produce an agreement error. In general, it can be seen that the data are explained in accordance with a process that comes into play during agreement where the retrieval of an agreement controller is required within specific content in WM.

This model allows to explain the different effects found in the psycholinguistic studies of number (and also gender) agreement production, relating the semantic, syntactic and morphological factors with online measures of processing. Because of this, its value is not limited to the question of the interactivity between the levels in the formulation of a sentence; it has a much wider interpretative power.

## Conclusions

We have reported data about a syntactic factor affecting agreement that has been scarcely studied in Romance languages and never tested experimentally in Spanish. Results were explained using different language production and agreement processing theories as a framework but also taking into account more theoretically grounded theories of syntax. Taken together, results show that the plural feature of the local noun modulates the attraction at semantic and syntactic levels by directly interfering with the computation and processing of the agreement between the subject and the verb in Spanish. In addition, both the plural feature and the subject-verb linear order and the semantic information of the subject's nouns work as cues to trigger the search and establish agreement relationships.

SÁNCHEZ, M.; JAICHENCO, V.; SEVILLA, Y. Orden, distributividad y atracción en la producción de la concordancia. *Alfa*, São Paulo, v.61, n.3, p.565-584, 2017.

- *RESUMEN: Varios estudios han comprobado que factores de distinta naturaleza (semánticos, morfológicos y sintácticos) afectan el cómputo de la concordancia sujeto-verbo durante la producción de oraciones en numerosas lenguas, entre ellas el español (BOCK; MILLER, 1991; FRANCK; VIGLIOCCO; NICOL, 2002; HARTSUIKER et. al., 2003; HASKELL; MACDONALD, 2003; VIGLIOCCO; BUTTERWORTH; SEMENZA 1995; entre otros). Los objetivos de este trabajo fueron: a) investigar la influencia del orden lineal de constituyentes, explotando la relativa flexibilidad del español; b) indagar si una variable semántica, como es la lectura distributiva, y una variable morfológica, como es la manipulación del número de sustantivo interfiriente, son factores que afectan el procesamiento de la concordancia. Se diseñó un experimento utilizando una tarea de descripción de imágenes con preámbulos en los que se manipuló el orden del sujeto de la oración (preverbal o postverbal), el tipo de preámbulo (sintagmas nominales con lectura distributiva y no distributiva) y el número del sustantivo interfiriente (singular-plural). Los resultados mostraron un efecto principal del Número del sustantivo interfiriente, del Tipo de preámbulo y del Orden lineal de los constituyentes: se produjeron más errores de concordancia sujeto-verbo cuando la oración presentaba una asimetría en el número de los sustantivos (N1 Singular- N2 Plural), los sintagmas tenían una lectura distributiva y el orden era Sujeto-Verbo. Los resultados presentados parecen indicar que factores sintácticos, semánticos y morfológicos interfieren en conjunto en el procesamiento de*



*la concordancia en español y apoyan los postulados de los modelos interactivos de producción de la concordancia. Además, aportan evidencia a un modelo general de procesamiento en el que los distintos factores funcionan como claves para la recuperación de la información en el cómputo de la concordancia (Badecker & Kuminiak 2007).*

- **PALABRAS CLAVE:** *Psicolingüística. Producción de oraciones. Concordancia. Orden lineal. Distributividad. Español.*

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