Available online at www.sciencedirect.com
SCIENCE DIRECT®
COGNITION
Cognition 101 (2006) 173–216
www.elsevier.com/locate/COGNIT

Agreement and movement: A syntactic analysis of attraction

Julie Franck [a,*], Glenda Lassi [b], Ulrich H. Frauenfelder [a], Luigi Rizzi [a,b]

[a] *University of Geneva, Geneva, Switzerland*
[b] *University of Siena, Siena, Italy*

Received 28 June 2005; accepted 12 October 2005

Abstract

This paper links experimental psycholinguistics and theoretical syntax in the study of subject–verb agreement. Three experiments of elicited spoken production making use of specific characteristics of Italian and French are presented. They manipulate and examine its impact on the occurrence of 'attraction' errors (i.e. incorrect agreement with a word that is not the subject of the sentence). Experiment 1 (in Italian) shows that subject modifiers do not trigger attraction errors in free inverted VS (Verb Subject) structures, although attraction was found in VS interrogatives in English (Vigliocco, G., & Nicol, J. (1998). Separating hierarchical relations and word order in language production. Is proximity concord syntactic or linear? Cognition, 13–29) In Experiment 2 (in French), we report stronger attraction with preverbal clitic object pronouns than with subject modifiers. Experiment 3 (in French) shows that displaced direct objects in the cleft construction trigger attraction effects, in spite of the fact that the object does not intervene between the subject and the verb in the surface word order (OSV). Moreover, attraction is stronger in structures with subject–verb inversion (...). These observations are shown to be naturally interpretable through the tools of formal syntax, as elaborated within the Principles and Parameters/Minimalist tradition. Three important constructs are discussed: (1) the hierarchical representation of the sentence during syntactic construction, and the role of intermediate positions by which words transit when they move; (2) the role of specific hierarchical (c-command) but also linear (precedence) relations; and (3) the possibility that agreement involves two functionally distinct components. A gradient of computational

* Corresponding author. Address: Laboratoire de psycholinguistique expérimentale, Université de Genève, FAPSE, 40, Boulevard du Pont d'Arve, 1205 Genève, Switzerland.
E-mail address: julie.franck@pse.unige.ch (J. Franck).

0022-2860/$ - see front matter
doi:10.1016/j.cognition.2005.10.003

complexity in agreement is presented which relates empirical evidence to these theoretical constructs.

Keywords: Sentence production; Subject–verb agreement; Attraction; Movement; Experimental psycholinguistics; Formal syntax

1. Introduction

Psycholinguistics has shown strong interest in the production of subject–verb agreement for the last decade. A number of studies have been conducted based on the elicitation of agreement errors in experimentally controlled situations in laboratory. The major theoretical issue in this line of research is the object of a long-standing debate opposing advocates of a 'modular' view of sentence production, according to which syntactic construction proceeds in relative isolation from other components of language (semantics, phonology), and supporters of an 'interactive' view of syntactic production. Modularity in psycholinguistic models of sentence production has often been reduced to one of the properties modules are assumed to exhibit, their informational encapsulation. This refers to the relative insulation of processes at each level of sentence construction from other levels of representation (Fodor, 1983). In line with this approach, experiments on agreement were mostly designed to test whether agreement processes at the syntactic level are influenced by representations at the semantic and (morpho)phonological levels. A rather conflicting picture emerged from these studies; some of the results indicating encapsulation of agreement from non-syntactic information (e.g. Bock & Eberhard, 1997; Bock, Eberhard, & Cutting, 2004; Bock & Miller, 1991), others suggesting that conceptual and/or morphophonological variables actually do penetrate the process (e.g. Vigliocco & Franck, 1999; 2001; Vigliocco, Hartsuiker, Jarema, & Kolk, 1996).

However, in addition to informational encapsulation, modules are also assumed to exhibit another important property, which is their domain-specificity (Fodor, 1983). For syntactic production, domain-specificity means that the processes at this level operate on the basis of principles that are specifically syntactic in nature, i.e. that can only be explained by relying on factors from inside the syntactic domain. Answering the question of whether syntactic production operates on the basis of syntactic factors requires us to adopt a theoretical framework that identifies these factors. Such research on agreement is relatively rare in experimental psycholinguistics, although some studies have started to point to the involvement of syntactic factors like the hierarchical structuring of the words (Bock & Cutting, 1992; Franck, Cronel-Ohayon, Chillier, Frauenfelder, Hamann and Rizzi, 2004; Franck, Vigliocco, & Nicol, 2002; Vigliocco & Nicol, 1998, see Section 2).

In contrast to the rather limited interest for syntactic aspects of agreement in psycholinguistics, theoretical syntax has devoted much attention to the phenomenon, most notably in frameworks such as principles and parameters, and head driven phrase structure grammar (see e.g. Chung, 1998; Haegeman, 1994; Pollard & Sag, 1994). These approaches provide precise theoretical models of the structural conditions governing the agreement

process. Our research will be couched in the terms elaborated within the principles and parameters/minimalist tradition, and will crucially use aspects of the minimalist theory of agreement (Chomsky, 1995; 2000; 2001), as this approach has developed a very detailed analysis of the agreement process, and has begun to isolate the elementary computational components involved therein. A central aspect of minimalist syntax (and, in fact, of much of the generative tradition) is that sentences are derived through elementary formal operations applying stepwise to progressively assemble and structure constituents, and giving rise to abstract intermediate representations that lead to surface configurations. Such intermediate representations will play a critical role in our analysis.

The fundamental aim of this paper is to illustrate the relevance of combining the experimental approach of psycholinguistics and the refined analytic tools offered by formal syntax. The latter provides theoretical constructs that can be shown to be instrumental in capturing subtle gradients of computational complexity observed experimentally. On the other hand, experimental psycholinguistics goes beyond off-line observations (such as grammaticality judgments and cross-linguistic comparison) and thus provides novel types of evidence potentially bearing on the construction of formal syntactic models.

In the following section, we briefly present the research in psycholinguistics dealing with syntactic effects in agreement, and sketch how it is interpreted. Agreement as it is viewed in linguistic theory is then outlined in the following section.

2. Agreement and movement: Experimental reports and psycholinguistic theory

At the heart of much of the experimental work on agreement is the phenomenon of *attraction*[1] often observed in spontaneous speech, and illustrated in example (1): a noun (called *local noun*) situated in the vicinity of the subject–verb agreement relation, imposes its number on the verb. In the example, the verb *come* erroneously agrees with the local noun *neighbours*, which is proximal to it in the linear word chain.

(1) *The son of the neighbours always come back late

A first study that attempted to characterize more precisely the role of proximity involved in attraction was conducted by Bock & Cutting (1992). The authors hypothesized that attraction errors are caused by a general difficulty in dealing with elements that are structurally similar and that are part of the same unit of syntactic encoding (Bock, 1991). Under this assumption attraction would be delimited by the unit of encoding, i.e. a local noun would attract agreement if situated in the same unit as the subject head noun. In

[1] The term 'attraction' is used here (and more generally in psycholinguistics) differently from its meaning in linguistic theory in which it refers to a driving force to movement. The attraction effect in performance bears a certain family resemblance to grammatical principles of locality according to which certain kinds of interveners block local grammatical relations (in virtue of principles such as Relativized Minimality according to which a trace cannot be separated from its antecedent by another element of the same syntactic nature, see Rizzi, 1990; Chomsky, 1995). We leave open here whether this similarity can be captured in a precise way.

support of this hypothesis, Bock & Cutting (1992) found that a local noun (*books* in (2)) interferes more with the agreement process when situated in the same clause as the head noun (*editor*) as in (2a), than when situated in a separate clause as in (2b). This finding is in line with the common assumption that the basic unit of encoding at the syntactic level is the clause (e.g. Garrett, 1988).

(2a)*The editor of the history books were (…)
(2b)*The editor who rejected the books were (…)

Nicol (1995) further confirmed that nouns situated in a separate clause from the head (e.g. *realtors* in **The owner of the house who/which charmed the realtors are*…) interfere only weakly with the agreement process in English (less than 1% errors), bringing additional support for the hypothesis that attraction is bounded by the clause (see also Nicol, Jakubowicz, & Goldblum, 1996 for neuropsychological evidence).

Although clauses do certainly play a role in syntactic encoding, Franck, Vigliocco and Nicol (2002) suggested that the factor responsible for the low attraction rate with clausal subject modifiers was the syntactic depth of the local noun in such structures, rather than its separation from the head noun's encoding unit. Franck et al. (2002) introduced two local nouns in their materials (*program*(*s*) and *experiment*(*s*) in examples 3a and 3b). Since both nouns are situated in the same clause as the head noun (*computer* in the example), the authors predicted similar attraction in line with the clausal unit hypothesis.

(3a)*The computer with the programs of the experiment are broken
(3b)*The computer with the program of the experiments are broken

However, the authors reported a higher attraction rate by the local noun situated high in the tree structure, but far from the verb in the linear sequence (*programs* in (3a)) than by a local noun situated low in the tree structure, but linearly close to the verb (*experiments* in (3b)).

Crucially, the two local nouns are part of the same clause, and the more interfering noun is farther from the verb in the sentence's surface structure (almost no errors were produced with the local noun immediately preceding the verb a *experiments* in example 3b). Hence, the critical factor triggering attraction is not the position of the local noun with respect to the assumed units of encoding, nor its position in the final word string, but rather its position in the syntactic hierarchy, and more precisely the syntactic distance that separates it from the verb in the hierarchy. Along the same lines, Solomon and Pearlmutter (2004) reported different degrees of attraction depending on syntactic variations within the subject phrase (e.g. 'The drawing *of* the flowers' generated stronger attraction than 'The drawing *with* the flowers'), further attesting of the role of the hierarchical position of the local noun in attraction.

Independent evidence suggesting that attraction occurs on a hierarchical structure rather than on the final word order was produced by Vigliocco & Nicol (1998) who reported that the production of subject–verb agreement errors by English speakers was the same in interrogative sentences (4a) as in declarative sentences (4b).

(4a) *ARE the helicopter for the flights safe?
(4b) *The helicopter for the flights ARE safe

Such a finding is important since, as the authors argue, it shows that the final position of the local noun in the sentence is irrelevant to account for attraction. Rather, attraction errors occur in the grammatical encoding process before words are linearised in their left-to-right order, at a stage when words are organized hierarchically, and the declarative and interrogative structures are identical. The interrogative sentence is assumed to be formed late, after agreement has been realized, hence after attraction has taken place (see also Pearlmutter, 2000 for similar findings in sentence comprehension).

Attraction with words that are situated outside the subject constituent was also studied. A first study manipulating direct objects as local nouns was conducted in written French by Fayol, Largy, and Lemaire (1994). The authors reported large attraction effects with clitic object pronouns situated preverbally (as in (5), see also Chanquoy & Negro, 1996).

(5) *Il les promènent

(*He-S them-P walk-P; meaning: he walks them around)

In a study on Dutch, Hartsuiker, Anton-Mendez and Van Zee (2001) found that number features on the preverbal object (linearly intervening between the subject and the inflected verb in embedded clauses) also significantly interfered with subject–verb agreement. Attraction was reported both with full object NPs (6) and with weak object pronouns (7).

(6) *Karin zegt dat het meisje de kransen win

(*Karin says that the girl the garlands win; meaning: wins the garlands)

(7) *Ed ziet dat de kapitein hen aanvallen

(*Ed sees that the captain-S them-P attack-P; meaning: attacks them)

However, both these attracting features were found to disrupt agreement to a lesser extent than subject modifiers internal to the subject phrase. Hemforth & Konieczny (2003) reported similar attraction effects with direct objects in German SOV structures (see also Kaan, 2002 for ERP evidence of object attraction in German). Hartsuiker et al. (2001) concluded that the proximity of the local noun has to be defined with respect to the subject head noun rather than the verb, given the stronger attraction effect they reported when the local noun is close to the subject in the hierarchy (subject modifier), than when it is close to the verb (direct object).

All these studies generated a number of conclusions with regard to the role of syntactic factors in agreement that can be summarized as follows. First, syntactic encoding involves an abstract representation in which words are organised hierarchically before they are linearised. Second, attraction is sensitive to structural proximity in the syntactic structure: it is modulated by the syntactic depth of the local noun in this hierarchy; deeper (lower) nouns interfere less than higher nouns. Third, subject-internal and predicate-internal local

nouns do not interfere in the same way, suggesting that left and right branching may be involved differently in attraction. However, these studies pose the major question about the nature of the hierarchy. The proposed interpretation of the data is based on a very coarse approach to syntactic structure, which does not provide the fine-grained analytical framework required to account fully for attraction. This problem is particularly salient when one wants to interpret data involving direct objects, whether clitic or nominal, or more generally complex structures as we report in the following experiments here. So what is missing in psycholinguistic research in this area at this point is a framework that specifies how to represent the fine details of syntactic structure. As we will show now, linguistic theory not only provides a detailed description of the hierarchical configurations underlying sentence structure, it also proposes a dynamic view of syntactic construction which turns out to be crucial for interpreting some of the empirical evidence accumulated in psycholinguistic work on agreement.

2.1. Agreement in linguistic theory

The following characterisation is based on recent approaches to natural language syntax elaborated within the principles and parameters framework and the minimalist program (Chomsky, 1995 and much related work). This framework views the generation of syntactic structures as a succession of formal operations (MERGE, AGREE and MOVE). MERGE is the fundamental structure-building operation: it takes two elements A and B and strings them together to form a minimal phrase [A B]. Successive applications of MERGE assemble the thematic nucleus of the sentence (the verb and its arguments). Further applications of MERGE introduce the functional structure of the sentence (specifications of tense, aspect, mood, etc.), thus creating a configurational skeleton, which can be further modified by additional applications of MERGE and by MOVE, the option of displacing elements already introduced in the structure. So, rather than having a single hierarchical representation over which all syntactic operations are computed, as current psycholinguistic models tend to assume, several intermediate representations are postulated that reflect the cyclic derivation of the structure.

These intermediate representations have a tree-like format that specifies relationships between nodes. The basic building block of syntactic structures is the elementary tree in Fig. 1: a head is merged with a complement, and the head-complement constituent is merged with a specifier. For instance, the initial tree for any transitive clause is a particular instantiation of Fig. 1 with Specifier = Subject, Head = Verb, Complement = Object.

Each node in the tree, corresponding to a single word or to a larger phrase in the sentence, is always both in vertical, hierarchical relationships with the other nodes (*dominance*), and in horizontal relationships (*precedence*). A particularly important hierarchical dependency, built on the more elementary dominance relation is the relation of *c-command*. This structural relation, originally introduced by Reinhart (1976), can be defined as follows (see Chomsky, 2000):

(8) X c-commands Y iff Y is dominated by the sister node of X

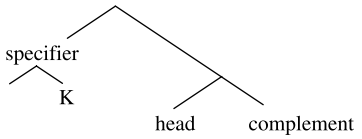


Fig. 1. The basic building blocks of syntactic structures: a head is merged with a complement, and the head-complement constituent is merged with a specifier.

So, a node c-commands all and only the material which is dominated by its sister node in a tree structure, as well as the sister node itself; in Fig. 1, the subject c-commands the verb and the object; an element K, dominated by the subject (e.g. a PP complement of the head noun) precedes the verb and the object, but does not c-command them. This relation has pervasive consequences on a variety of morphosyntactic and interpretive processes; in a nutshell, a node is "active" with respect to another node when it c-commands the other node. Being "active" encompasses a number of operations such as the binding of anaphors, the determination of quantifier scope and, as we will see, agreement, in which the relation of c-command between the specifier and its head plays an important role.

Dominance, c-command and precedence relations evolve throughout the construction of the sentence as new elements are merged and already built constituents move up the tree. This dynamic approach to the building up of a sentence has potentially crucial implications for psycholinguistics given that it naturally leads to a view of grammatical encoding as a complex process involving different stages, with each stage potentially expressing different structural relationships between elements. Under the assumption of a tight connection between grammar and processor (an assumption which is rarely made ever since the pioneering days of the derivational theory of complexity, but which seems to us to be the null hypothesis), the different derivational steps assumed in linguistics should be traceable in linguistic performance, and for our concerns here, in the way speakers err when producing agreement.

How does formal syntax view agreement realisation? Agreement is a process at the interface between syntax and morphology: it is morphological, as it affects the form of words, and syntactic, as it depends on syntactic properties like grammatical function, locality, etc. A classical assumption of principles and parameters models is that subject–verb agreement involves a special syntactic node in the functional structure of the clause, AgrS, expressing agreement morphology (Chomsky, 1995, ch. 2, and references quoted there).[2]

AgrS has a dual role: it provides the structural (syntactic) architecture for the subject-predicate articulation by hosting the subject in its specifier, and is responsible for the morphological agreement between the subject and the verb. The verb is assumed to move to this AgrS node (at least in some languages, see Pollock, 1989) in order to "pick up" the agreement affix expressing number and person; so, it is at the level of AgrS that the

[2] Whether there is an independent node expressing agreement, or the agreement features are attached to another node (Tense in the system of Chomsky, 1995, ch 4, 2000) is immaterial for our purposes. For concreteness, we assume an independent AgrS node, but nothing hinges on that decision.

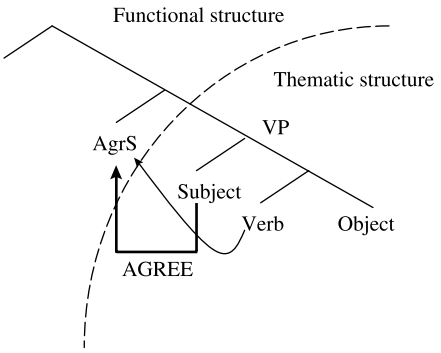


Fig. 2. Early stages of the derivation.

verb becomes inflected (or, in an alternative view, that the verbal affixes, attached to the verb in the lexicon, are "checked").

More specifically, the assembly of the elements directly involved in agreement proceeds as follows: the subject is first merged as the specifier of the lexical verb, the position in which the subject receives its theta role. At this initial stage of clausal assembly, the subject is situated within the verb phrase (VP), as illustrated in the lower part of Fig. 2 (this is the VP-internal Subject Hypothesis; see Sportiche (1988), Koopman and Sportiche (1991) for motivation and supporting evidence).

Then, the functional structure, including AgrS, is merged with the thematic structure (again, we omit functional heads not directly relevant in this context), and the functional node AgrS enters into an AGREE relation with the subject, still situated in its thematic position. Basically, the person and number features of AgrS need a value: since the subject is endowed with such features, they are copied onto AgrS. This process of searching for the subject and copying its features on AgrS, conducted under configurational conditions of c-command and locality, is the operation AGREE (represented by a thick line on the figure): AgrS, the *probe* of AGREE, looks for a *goal* with matching features within its local domain of c-command (Chomsky, 2000). Once AgrS is specified for these features, the verb (V) is assumed to move to this AgrS position to receive its morphological specification of number and person. In English and other languages with subject–verb (SV) order, the subject then moves out of the VP, to the canonical subject position which is the specifier (Spec) of AgrS. This movement leaves a trace of the subject in its thematic position (t_s, see Fig. 3).[3]

[3] In current versions of Minimalism, AGREE and MOVE are autonomous operations; they are.linked in the system of Chomsky (2000) in that MOVE presupposes AGREE; in this view, in the structure expressed in Fig. 3, the previous establishment of an AGREE relation between AgrS and the subject is a necessary prerequisite for the movement of the subject to Spec AgrS. But see Lidz and Williams (2002), Wurmbrand and Bobaljik (2004) for alternative views.

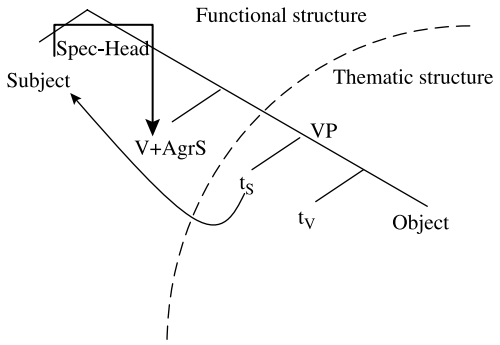


Fig. 3. Late stages of the derivation.

This movement creates a local Spec-head relationship between the moved subject (= Spec) and AgrS (=head); departing slightly from current minimalist assumptions (see discussion infra), we will assume that the proper sharing of featural values, already established by AGREE, is further checked in this local Spec-head configuration (represented by a thick line in Fig. 3).

While in ordinary SV sentences agreement is the morphological result of this sequence of operations, in special cases, agreement may be dissociated from movement of the subject, and may be determined solely by AGREE. Evidence supporting the separation between agreement resulting from AGREE and MOVE from agreement resulting solely from AGREE comes from cross-linguistic studies. Guasti & Rizzi (2002) observed that the morphological manifestation of agreement tends to be more stable when AGREE is associated with movement, and is more fragile otherwise, that is, more likely to manifest morphologically as the default feature on the verb in the presence of a marked subject (e.g. the singular for number agreement). For instance, in colloquial English, agreement is mandatory in configuration (9a) where the subject has moved to the Spec of AgrS (as attested by the leftmost...) position of the subject to the verb, but optional in configuration (9b) where the subject has not raised to Spec AgrS and this position is filled by the expletive element *there*. That is, whereas agreement has to be morphologically realized in the SV canonical construction involving movement, it is morphologically fragile in the VS expletive construction involving no movement.

(9a) Many books are/*is on the table
(9b) There are/‘s many books on the table

The same reduction of the constraint of morphological realization of agreement is found in the presentational *ce* construction in French (*C’est les filles*, *Ce sont les filles*, It is/are the girls). Along these lines, Guasti and Rizzi also give examples of some Italian dialects that do not mandatorily express agreement in VS structures (e.g. *Viene le ragazze* Comes the girls), while agreement is always manifested in SV structures where the subject has raised to Spec AgrS (**Le ragazze viene*, The girls comes). Similarly, Standard Arabic requires agreement in person and number only in SV sentences, not in VS structures. That

is, languages normally admitting VS order often show flexibility in the realisation of agreement in these structures as compared to the corresponding SV configurations. It is important to note that this instability does not manifest itself as a chance realization of the marked (plural) or unmarked (singular) features: in all the cases of VS disagreement, a singular verb precedes a plural subject, never the other way around (for a discussion of the psycholinguistic relevance of the notion of markedness see for example Eberhard, 1997 or Franck et al., 2004 for developmental arguments).

In sum, if a language has the agreement morphology, it does require the morphological manifestation of agreement when the subject is in a Spec-head relation to the AgrS node (i.e. when it has moved), whereas in VS configurations (i.e. when subject remains in the VP) the morphological realisation of agreement is more fragile: differences may be found even in close language varieties, agreement being obligatory in some, optional or even excluded in others.

We suggest here that the robustness of agreement in SV structures is linked to the fact that features are checked twice, in this case: (1) through AGREE, following the assumptions of Chomsky (1995), and (2) in the strictly local Spec-head configuration, after movement of the subject. On the other hand, in VS structures the feature checking is determined only once, through AGREE, with no additional Spec-head check since the subject does not occupy the position of Spec AgrS, whence its cross-linguistic instability (see Chomsky, 2001; Guasti & Rizzi, 2002 for the exploration of slightly different technical options). Here, we have departed slightly from standard minimalist assumptions, which generally include a single operation of feature checking (only in the Spec-head configuration in Chomsky (1995)), only through AGREE in more recent versions such as Chomsky (2000, 2001). Our "double check" innovation, motivated by the cross-linguistic generalisation discussed in Guasti & Rizzi (2002), will turn out to be instrumental to explain the observed patterns of agreement errors we report. We will come back in the general discussion to the question of what kind of formal operation "checking" is in the two configurations.

To summarize, the main relevant points of the view of agreement we have just outlined are the following:

(a) Sentences are derived by successive applications of computational operations (MERGE, AGREE, MOVE), giving rise to a series of intermediate representations on which other operations apply, until the final representation is reached;
(b) Agreement is a configurational phenomenon, computed on tree structures on the basis of hierarchical relations (c-command, locality);
(c) It involves the two separate components of AGREE and MOVE. Cross-linguistically, AGREE associated with MOVE gives rise to a more stable morphological manifestation of agreement than AGREE alone.[4]

[4] We assume that an AGREE relation is always established between AgrS and the subject, whether or not agreement is morphologically manifested. This is necessary to ensure the assignment of Nominative Case to the subject, a property determined by AgrS in the adopted framework.

2.2. Outline of the study

Three experiments making use of the attraction phenomenon were conducted to investigate the psycholinguistic relevance of some of the assumptions of syntactic theory outlined in the Section 2.1. These assumptions and the derived empirical predictions are summarized here, and described in more detail in the introduction to each experiment.

Experiments 1 and 2 investigate the structural conditions of intervention under which attraction occurs. In the most general case, we can say that an element B *intervenes*[5] between A and C when the following configuration holds:

(10) A > B > C

Where ">" is some relevant structural relation. We will focus here on precedence and c-command relations. B intervenes between A and C in terms of c-command precedence when A precedes B and B precedes C; B intervenes between A and C in terms of c-command when A c-commands B and B c-commands C.

Experiment 1, conducted in Italian, tests whether linear *precedence*, which is the most basic structural relation, triggers attraction. Moreover, we were interested to determine whether precedence constitutes a minimal intervention condition without which no attraction occurs. Attraction in structures involving a noun that intervenes in terms of precedence on the subject–verb agreement relation (a subject modifier in a declarative sentence) is compared to attraction in structures where the same noun does not intervene at all (the same subject modifier in a sentence with free inversion). If intervention in terms of precedence is necessary to observe interference in agreement, attraction is expected in structures involving precedence, but not in structures that do not involve it.

Experiment 2 (in French) was designed to test whether *c-command* intervention, which involves tighter links between the elements in the tree than precedence, increases attraction as compared to linear intervention. Attraction with an element which intervenes in terms of c-command on the subject–verb relation (a preverbal clitic direct object pronoun) is compared to attraction in structures with an element which intervenes in terms of simple precedence (a subject modifier). If intervention in terms of c-command is stronger than linear intervention, stronger attraction effects are expected in the former condition than in the latter.

Experiment 3, conducted in French, was designed to test the hypothesis that agreement comprises two separate components: the early AGREE between AgrS and the subject in its thematic position in VP, and Spec-head between the subject raised in its canonical position and AgrS. The additional checking involved in Spec-head is assumed to reinforce the morphological realization of agreement. In this final experiment, attraction in structures involving both AGREE and Spec-head (Object Subject Verb sentences with c-command intervention of the direct object) is compared with attraction in structures with the single AGREE checking (in which the subject does not raise: Object Verb Subject, also with c-command intervention of the direct object). If AGREE, not followed by the raising of the

[5] Here, we are using the term 'intervention' in a neutral way to express the configurational interposition without implying any effect.

Table 1
Design of the study: experimental conditions tested and factors involved

Experiment	Condition	Factors		
		Precedence	Precedence + C-command	Precedence + C-command + AGREE only
Experiment 1	VSM	−	−	−
	SMV	+	−	−
Experiment 2	SMV	+	−	−
	SO(clit)V	+	+	−
Experiment 3	OSV	+	+	−
	OVS	+	+	+

S, subject; V, verb; M, modifier; O, object; O(clit), clitic object pronoun. *Precedence* refers to intervention in linear terms between the subject and AgrS, *C-command* refers to hierarchical intervention in terms of c-command between the subject and AgrS, *AGREE only* refers to cases in which agreement relies on the single operation of AGREE.

subject, produces weaker morphological constraints on agreement than when augmented with Spec-head, stronger attraction is expected in the structure without subject movement.

The outline of the study is summarized in Table 1.

The table characterizes the six experimental conditions in terms of the three factors hypothesized to influence attraction: (1) precedence, (2) c-command, and (3) the operation of AGREE only (without Spec-head). Weaker effects are predicted in the upper condition of the table whereas the stronger effects are predicted in the bottom as factors of interference increase. In the general discussion, this theory-based gradient of attraction is compared with the experimental data reported.

3. Experiment 1: The role of precedence in attraction

Experiment 1, run in Italian, tests the hypothesis that intervention in terms of precedence is a minimal condition for interference to arise. We exploited a property typical of Romance Null Subject languages: the so-called "free inversion" construction. Interference with a subject modifier in declarative SV sentences (11a) was contrasted to interference with the same modifier in free inverted VS sentences (11b).

(11a) L'amica dei vicini telefonerà

(The friend of the neighbours will phone)

(11b) Telefonerà l'amica dei vicini

(Will phone the friend of the neighbours)

(11b) is a possible variant of (11a), normally used to focalise the subject (Belletti, 2001).

In Romance free inversion, the subject remains in the VP internal position (or possibly in a low focal position: Belletti, 2001); it is never raised to the position of specifier of the agreement node AgrS, as in Fig. 4(1). Hence, agreement is established by AGREE but crucially the plural modifier noun *vicini* does not intervene on this relation between AgrS and the head noun *amica*. But Italian, and SV languages in general, also has the option of continuing the derivation and raising the subject *l'amica dei vicini* to Spec AgrS, to yield the representation in Fig. 4(2). In this representation, the modifier noun *vicini* does intervene in terms of precedence between the head noun and AgrS when agreement is being checked in the Spec-head configuration.

If intervention is a minimal condition for interference to arise, no interference is expected in (11b) where no intervention occurs on the agreement relation. In contrast,

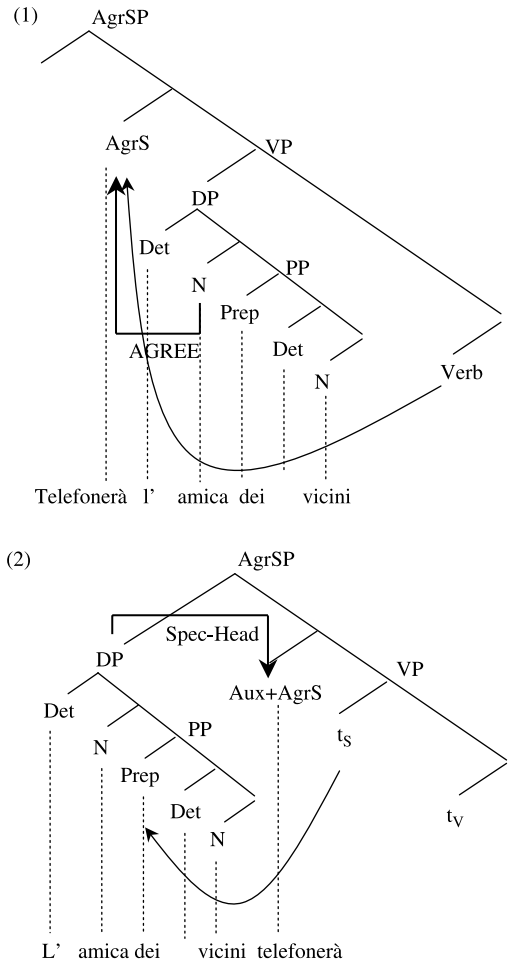


Fig. 4. Relevant aspects of the configuration of subject–verb agreement in sentences containing a complex subject with a prepositional phrase modifier and a verb in (1) a free inverted structure, (2) a declarative structure.

interference is expected in the corresponding condition (11a) in which the intervening noun intervenes in terms of precedence.

3.1. Method

3.1.1. Participants

Sixty students from the University of Siena took part in the experiment. They were aged between 18 and 28 and were all native speakers of Italian.

3.1.2. Materials

Materials consisted of 18 pairs of experimental sentence preambles. The variables manipulated were (1) the number of the head noun (singular vs. plural), and (2) the word order of the sentence to be produced (subject–verb vs. verb–subject). Local nouns were always of a different number from the head such that half of the items had a singular head noun and a plural local noun (SP condition) and the other half had a plural head noun and a singular local noun (PS condition). Both variables were manipulated within items. Whereas the number of the head noun was manipulated within participants, word order was a between-participant variable (each participant produced either only SV or only VS sentences). Examples of items are given in Table 2 and the complete list is presented in Appendix A.

Fifty-four filler sentences were added to the experimental items in order to introduce some variability in the syntactic structures. They consisted of 36 subject relative clauses and 18 complex prepositional phrases. Half of them had singular heads, the other half had plural heads, all with a number mismatching local noun. Two 90-items lists (18 experimental pairs and 54 filler items) were created that contained exactly the same items. However, whereas the 30 participants presented with List 1 were required to produce SV sentences, the 30 participants presented with List 2 had to produce VS sentences. Presentation order was random.

3.2. Procedure

The experiment was programmed with E-prime. Each sentence preamble was followed by a verb presented in the infinitive form. Participants were required to assemble the preamble and the verb in order to create a complete correct sentence. Participants were

Table 2
Examples of sentences in the different experimental conditions of Experiment 1 (Italian)

Word order	Number of the head noun and intervener	Preamble to be produced
SV	SP	Il vicino dei ragazzi viene
	PS	I vicini del ragazzo vengono
VS	SP	Viene il vicino dei ragazzi
	PS	Vengono i vicini del ragazzo

The first letter in the second column refers to the number of the head noun, the second refers to the number of the local noun.

run individually. They were divided into two groups: the first group was required to produce sentences with subject–verb order; the second group had to produce sentences with verb–subject order. Each preamble was presented for 1000 ms, directly followed by the verb which remained on the screen until the participant started to respond. Participants were asked to complete the sentence with the verb in order to produce a full correct sentence. Examples were given and the experimental session started with a series of warm-ups. The experimenter regulated herself the arrival of the next item after the response.

3.2.1. Scoring

Participants' responses were scored into one of four scoring categories. Correct responses were scored when the preamble was correctly repeated and the verb correctly inflected. Agreement errors were scored when the sentence produced met all the above criteria for correct responses but the verb failed to agree in number with the subject of the sentence. Repetition errors consisted of the incorrect repetition of the number of one or the two nouns involved in the sentence preamble. Miscellaneous responses were scored when incorrect words were produced, or in cases of mispronunciations, interruptions or rephrasing.

3.2.2. Design and data analysis

Balanced analyses of variance were carried out over the three categories of errors as dependent variables (agreement errors, repetition errors and miscellaneous responses), with participants (F1) and items (F2) as random factors. Word order was part of within-items but between-participants design, while the number of the head noun was part of a within-item and within-participants design.

3.3. Results

A total of 36 (3.3%) agreement errors, 114 (10.6%) repetition errors, and 129 (11.9%) miscellaneous responses were produced. The distribution of errors is illustrated in Table 3.

3.4. Agreement errors

Agreement errors were significantly more frequent in SV than in VS structures ($F1(1, 58) = 3.44$, $P = .06$; $F2(1,17) = 8.79$, $P < .01$). There were no more errors when the head noun was singular than when it was plural ($Fs < 1$). However, word order and the number of the head were found to significantly interact but in the item analysis only ($F1(1,58) = 2.1$, $P = .15$; $F2(1,17) = 6.54$, $P < .05$) suggesting that the main effect of word order mostly appears when the head noun is plural (PS condition).

3.4.1. Repetition errors

Word order and number of the head noun did not have main effects on repetition errors ($Fs < 1$). However, a significant interaction was found showing that, the head noun did not affect repetition errors participants produced significantly more errors in VS sentences as compared to SV sentences ($F1(1,58) = 9.45$, $P < .005$; $F2(1,17) = 8.87$, $P < .01$), in opposition to what was reported for agreement errors.

Table 3
Experiment 1 (Italian): raw data and percentages per cell (between parentheses) for agreement, repetition and miscellaneous errors in the different experimental conditions

	Agreement errors		
	SV	VS	Total
SP	11 (4.1)	9 (3.3)	20 (3.7)
PS	14 (5.2)	2 (.1)	16 (3)
Total	25 (4.6)	11 (2)	36 (3.3)
	Repetition errors		
	SV	VS	Total
SP	29 (10.7)	20 (7.4)	49 (9.1)
PS	18 (6.7)	47 (17.4)	65 (12)
Total	47 (8.7)	67 (12.4)	114 (10.6)
	Miscellaneous responses		
	SV	VS	Total
SP	17 (6.3)	38 (14.1)	55 (10.2)
PS	29 (10.7)	45 (16.7)	74 (13.7)
Total	46 (8.5)	83 (15.4)	129 (11.9)

3.4.2. Miscellaneous responses

A significant effect of word order was found, though marginal in the item analysis ($F1(1,58)=6.1$, $P<.05$; $F2(1,17)=4.13$, $P=.06$), attesting more such miscellaneous responses in VS sentences than in SV sentences. No main effect of the number of the head was found ($F1(1,58)=2.25$, $P=.12$; $F2(1,17)=2.57$, $P=.13$). There is no interaction between the two factors ($Fs<1$).

3.5. Discussion

The main result of this first experiment in Italian is the finding that whereas a subject modifier significantly attracts verb agreement in SV sentences, it does significantly less so in the corresponding VS sentences.[6] The finding that subject modifiers do not attract agreement in free inverted VS sentences supports the hypothesis that intervention is a necessary condition for interference, and that linear precedence, which is the most basic structural relation, triggers attraction.[7]

Under the theory of agreement we have assumed, agreement is established via AGREE between AgrS and the unmoved VP-internal subject in all structures. At this stage of the derivation, the subject modifier does not intervene between AgrS and the head noun either linearly or hierarchically: it is situated to the right of both the subject head noun and

[6] The analysis of the filler items consisting of subject relative clauses shows the same distribution with significantly more errors produced in SV than in VS sentences.

[7] A reviewer drew our attention to the possibility that the temporal order of the presentation of the preamble and the verb could have influenced the results, under the assumption that the matching of the presentation order and the sequencing of the sentence might play a role in the production process. If this were the case, this factor should have contributed to increase the error rate in the VS condition as compared to the SV given that the preamble was presented before the verb.

of the verb (which has moved into AgrS). Since this configuration is assumed to be the final step in the derivation of free inverted sentences, the absence of attraction observed in these structures supports the hypothesis that the mere proximity of a potential attractor to the head noun is not sufficient to trigger attraction. Hence, some kind of structural intervention is necessary for attraction to occur. In contrast, the SV structure involves movement of the subject to Spec AgrS, crucially bringing along the subject modifier, and the follow-up local check of agreement. In this configuration, the subject modifier intervenes linearly between the head noun and AgrS (see Fig. 4(2)).

Unexpectedly, repetition errors and miscellaneous responses showed sensitivity to word order as well. Crucially, whereas VS inversion yielded fewer subject–verb agreement errors (11) than did the SV order (25), the production of VS structures generated more repetition and miscellaneous errors (67 and 83, respectively) than SV structures (47 and 46, respectively). Since the presence of these other errors (repetition and miscellaneous) is classically assumed to reflect some kind of complexity in dealing with the materials, it is interesting to note that attraction errors were more numerous in SV than in VS structures, in spite of an apparently higher global level of complexity related to VS structures as attested by the increased amount of repetition and miscellaneous errors produced. This latter finding reinforces the assumption that it is the agreement operation itself, and not some related processing that is prone to error in SV configurations.

Our finding in Italian contrasts with the result of Vigliocco & Nicol (1998) who found the same error rate in interrogatives (with VS word order as in 12b) as in declaratives (with SV order as in 12a) in English (examples repeated here for clarity).

(12a) *The helicopter for the flights are safe
(12b) *Are the helicopter for the flights safe?

This fact was interpreted by the authors as showing that agreement is determined on the basis of a hierarchical representation, identical in both sentences. Crucially, what counts in this view is the respective hierarchical position of the head and local nouns, which is the same in the interrogative and declarative sentences, so that similar behavioural data are expected. However, under the view that the same syntactic hierarchy underlies different surface orders, interference would have been expected in free inverted sentences as well.

In the model of syntax we adopted, the VS order can arise in very different ways across languages, involving very different derivations. In English, the declarative SV order corresponds to a representation similar to the Italian SV in Fig. 4(2). In order to form the interrogative, the inflected auxiliary verb has to further move to the left of the tree (to the Complementizer). This final movement occurs after agreement has been computed, hence does not modify the configuration of intervention observed in the declarative. Hence, whereas in the interrogative the subject modifier noun intervenes between the head noun and the AgrS node at the level of the Spec-head checking (exactly as it does in the configuration of the declarative), it never intervenes between AgrS and the head noun in the free inverted VS sentence. Such an approach that assumes intermediate derivational steps and, more particularly here, derivational differences between the interrogative and free inverted VS order accounts for the different data reported for these two structures. The role of intermediate representations is further addressed in Experiment 3.

Interestingly, we did not report any asymmetry between singular and plural modifiers in the SV condition. Asymmetrical error patterns have often been reported in subject–verb agreement studies, plural modifiers creating more attraction than singular ones. It has been suggested that plural nouns are better attractors because they are 'marked' for number, as compared to the unmarked or default singular value (e.g. Bock & Eberhard, 1993; Eberhard, 1997). Nevertheless, Franck et al. (2002) also reported an absence of asymmetry in their experiment in French, and even reviewed a number of other studies with similar observations. Whereas asymmetry is clearly reported throughout the English experiments, this is much less clear for French and Italian. In our previous work, we suggested that this cross-linguistic variation reflects the involvement of two factors: (1) the markedness of the local noun, which causes the system to produce erroneous plural verbs in all languages, and (2) the morphological complexity of the verb, which also causes the system to produce erroneous plural verbs in English (given the higher complexity of singular verbs), but erroneous singular verbs in French (given the higher complexity of plural verbs), and possibly no effect in Italian given the equal complexity of singular and plural verb forms. Hence, whereas both factors would point in the same direction in English, where asymmetry is indeed strongest, they would point in opposite directions in French. In Italian, only markedness would be at play, which explains the absence of asymmetry we report here (see Franck et al., 2002).

4. Experiment 2: The role of c-command in attraction

In line with previous research on interference by a modifier noun, the data of Experiment 1 show that precedence is sufficient to trigger such effects. As illustrated in Fig. 4(2), the modifier intervenes in terms of precedence between the head noun and the inflected verb in the derivation of the declarative structure, but not in terms of c-command (the modifier, embedded within the subject phrase, does not c-command the agreement node AgrS). Experiment 2 tries to determine if c-command creates additional interference as compared to precedence, which is a weaker structural relation.

We compared attraction effects with an object clitic intervening between the subject and the inflected verb (as in 13a) to attraction with a subject modifier (as in 13b).

(13a) Le professeur les lit/*lisent

(The professor them reads/*read)

(13b) Le professeur des élèves lit/*lisent

(The professor of the students reads/*read)

In our two experimental conditions, the surface order is the same: the subject and the inflected verb are separated by an intervener. But as illustrated in Fig. 5, the two cases differ in that the clitic (13a) intervenes in terms of c-command (the subject c-commands the clitic, which in turn c-commands the inflected verb), whereas the subject modifier (13b) only intervenes in terms of precedence (it does not c-command the inflected verb). If

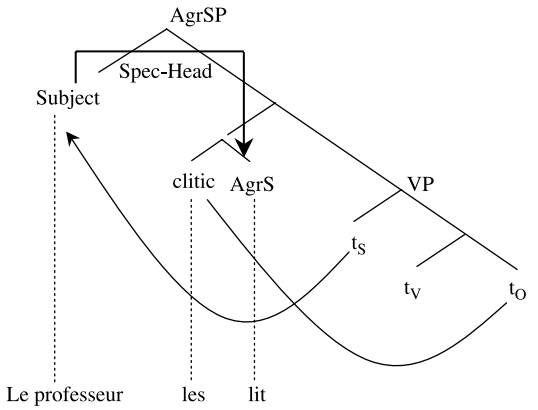


Fig. 5. Relevant aspects of the configuration of subject-verb agreement in a sentence with a preverbal clitic object (details about the object agreement position omitted for simplicity but see Fig. 6).

hierarchical intervention increases interference, we expect stronger interference in (14a), where the intervening word intervenes in terms of c-command and precedence, than in (14b), where it only intervenes in terms of precedence.

4.1. Method

4.1.1. Participants

Forty subjects aged between 18 and 25 from the Université catholique de Louvain in Belgium took part in the research. All were native French speakers. They were paid 4 euros for their collaboration.

4.1.2. Materials

Thirty-two items were constructed. The variables manipulated were: (1) the number of the head noun (singular vs. plural), (2) the number of the intervening word (singular vs. plural), (3) the syntactic status of the intervening word (subject modifier vs. clitic pronoun) . In order to be able to combine the same head noun with a modifier and a clitic pronoun attractor, only verbs that allowed for both an intransitive and a transitive use were selected: in the modifier condition, the verb was used in an intransitive context while it was used in a transitive context in the clitic condition. All verbs were marked for number in the spoken modality (they were all of the ending classes -IR or -RE). Examples of items are given in Table 4 and the complete list is presented in Appendix B.

The 32 items were distributed over eight experimental conditions. Each item appeared in eight different versions depending on the number of the head noun, the number of the local noun and the syntactic status of the attractor (see Table 4). Such a design allowed for within-item comparisons between the experimental conditions. Eight experimental lists were created so that only one version of each item appeared in each list, and participants were assigned to one of the lists at random.

Table 4
Examples of sentences in the different experimental conditions of Experiment 2 (French)

Type of intervener	Number of the head noun and intervener	Preamble to be produced
Subject modifier	SS	Le professeur de l'élève lit
	SP	Le professeur des élèves lit
	PS	Les professeurs de l'élève lisent
	PP	Les professeurs des élèves lisent
Clitic object pronoun	SS	Le professeur le lit
	SP	Le professeur les lit
	PS	Les professeurs le lisent
	PP	Les professeurs les lisent

The first letter in the second column refers to the number of the head noun, the second refers to the number of the local noun.

Thirty filler items were created. All of them had verbs that were unmarked for number in spoken speech. Syntactic structures were varied: one third of the fillers consisted of single head nouns, one third consisted in a head noun followed by a prepositional phrase, one third consisted of a head noun followed by a double prepositional phrase. Number on the head and on the local noun was balanced. The order of experimental and filler items was randomised in the lists.

4.1.3. Procedure

Participants were tested individually. Materials were presented on a computer screen using the Superlab experimental software for Apple Macintosh. Like in Experiment 1, participants were asked to create full correct sentences on the basis of the preamble and verb presented. Preambles were presented for 3000 ms and verbs for 800 ms, separated by a blank screen of 500 ms. The experimenter regulated herself the appearance of the preamble on the screen as soon as the subject had finished to complete the previous one. Each session started with an example and 10 exercises. Instructions insisted on the importance of articulation speed. Answers were tape-recorded.

4.1.4. Scoring

Same as Experiment 1.

4.1.5. Design and data analysis

The three independent variables manipulated (syntactic status of the attractor, number of the subject, number of the object) were all part of a within-participant and within-item design. The three dependent variables (agreement errors, repetition errors and miscellaneous responses) were submitted to analyses of variance taking both the participants (F1) and the items (F2) as random factors.

4.2. Results

A total of 83 (6.5%) agreement errors, 106 (8.3%) repetition errors, and 13 (1%) miscellaneous responses were produced. The distribution of errors is shown in Table 5.

Table 5
Experiment 2 (French): raw data and percentages per cell (between parentheses) for agreement, repetition and miscellaneous errors in the different experimental conditions

	Agreement errors		
	Modifier	Clitic pronoun	Total
SS	0	1 (.1)	1 (0)
SP	10 (6.3)	18 (11.3)	28 (8.8)
PS	8 (5)	19 (11.9)	27 (8.4)
PP	4 (2.5)	23 (14.4)	27 (8.4)
Total	22 (3.4)	61 (9.5)	83 (6.5)
	Repetition errors		
	Modifier	Clitic pronoun	Total
SS	5 (3.1)	4 (2.5)	9 (2.8)
SP	11 (6.9)	15 (9.4)	26 (8.1)
PS	16 (10)	17 (10.6)	33 (10.3)
PP	30 (18.8)	8 (5)	38 (11.9)
Total	62 (9.7)	44 (6.9)	106 (8.3)
	Miscellaneous responses		
	Modifier	Clitic pronoun	Total
SS	1 (.1)	1 (.1)	2 (.6)
SP	0	2 (1.3)	2 (.6)
PS	4 (2.5)	2 (1.3)	6 (1.9)
PP	2 (1.3)	1 (.1)	3 (.9)
Total	7 (1.1)	6 (.9)	13 (1)

4.3. Agreement errors

Participants produced significantly more errors (62) with object clitic pronoun interveners than with subject modifiers (44) ($F1(1,39)=15.6$, $P<.001$; $F2(1,31)=18.1$, $P<.001$). Number mismatches between the head noun and the intervener generated more errors (55) than number matches (28) ($F1(1,39)=6.9$, $P<.01$; $F2(1,31)=7.8$, $P<.01$). Plural head nouns generated more errors (54) than singular head nouns (29) ($F1(1,39)=5.1$, $P<.05$; $F2(1,31)=5.7$, $P<.05$), and so did plural intervening elements (55) as compared to singular ones (28) ($F1(1,39)=10.1$, $P<.01$; $F2(1,31)=6.2$, $P<.01$). The effect of syntactic status interacted significantly with the number of the head noun ($F1(1,39)=6.5$, $P<.01$; $F2(1,31)=7.2$, $P<.01$) and marginally with the number of the intervener ($F1(1,39)=4.6$, $P<.05$; $F2(1,31)=3.1$, $P<.09$), indicating that the syntactic status of the intervening element plays a stronger role with plural subject head nouns, and, to a lesser extent, a stronger role with plural interveners. Note that these interactions mostly reflect the stronger power of the tests with plurals given the greater number of errors in these conditions. No other interactions were observed ($Fs<1$).

4.3.1. Repetition errors

More repetition errors (71) were produced with singular head nouns than with plural heads (35) ($F1(1,39)=8.9$, $P<.01$; $F2(1,31)=7.2$, $P<.01$). Similarly, slightly more errors occurred with plural interveners (62) than with singular ones (42) but this difference

did not reach significance level ($F1(1,39)=3.2$, $P=.08$; $F2(1,31)=2.8$, $P=.12$). The syntactic status of the intervener interacted with the number of the head noun ($F1(1,39)=5.6$, $P<.05$; $F2(1,31)=4.1$, $P<.05$), a finding which is entirely due to the high error rate in the PP condition. It did not interact significantly with the number of the intervener ($F1(1,39)=2.9$, $P=.09$; $F2(1,31)=2.5$, $P=.15$). The three way interaction is significant ($F1(1,39)=7.8$, $P<.01$; $F2(1,31)=7.1$, $P<.01$), again because the syntactic status effect lies entirely in the match PP condition. There were no more errors in the mismatch condition than in the match condition ($Fs<1$).

4.3.2. Miscellaneous responses

No effects or interactions were found ($Fs<1$).

4.4. Discussion

The main finding of Experiment 2 is that clitic object pronouns not only generate significant attraction in subject–verb agreement, but that their attraction power is significantly greater than that triggered by subject modifiers. Whereas both the modifier and the clitic pronoun intervene between the head noun and AgrS in terms of precedence, the clitic pronoun also intervenes in the hierarchical terms of c-command (the subject c-commands the clitic, which in turn c-commands AgrS). Attraction in subject–verb agreement therefore appears significantly stronger when the intervening constituent is in a c-command relationship with AgrS than when it is in a simple precedence relation to it.

With regard to the effect of the head noun's number, both conditions showed significantly stronger attraction in the condition of a singular head and a plural intervener (SP), as compared to the SS control condition, along the lines of what has often been reported in the literature (see Section 3.4). However, the pattern of results with plural heads is less clear. Although PS tends to generate more errors than its control condition PP in the modifier condition, preambles with clitic interveners triggered a particularly high rate of agreement errors in the PP condition. We have no explanation for this. Interestingly, some of the studies manipulating direct objects as interveners reported a similar finding (in French: Fayol et al., 1994; in German: Hemforth & Konieczny, 2003). Similarly, we previously reported a large number of errors in the spoken production of complex sentences involving two interveners when these, as well as the head, were plural (Franck et al., 2002). We suggested that the production of plural markers may introduce some additional complexity, which is only observable in complex structures, but this hypothesis requires external validation.

Finally, the PP condition also generated many repetition errors. However, in contrast to agreement errors, which mostly occurred in the clitic pronoun condition with double plurals, repetition errors mostly occurred in the subject modifier condition with double plurals. The finding of a reverse pattern for agreement and repetition errors suggests that these two types of errors have different causes, and that therefore the difficulty in keeping track of the number of the noun (as indexed by repetition errors) does not account for the structural effect found in agreement errors.

5. Experiment 3: The role of the Spec-head checking in attraction

Experiment 3 further tests the relevance of intermediate representations for the production of agreement sketched in Section 3.5, and explores the view that agreement is comprised of two separate components, AGREE and Spec-head. To do so, we investigated clefting which involves focusing on a clausal constituent by moving it to the left periphery of the sentence like in (14a) and (14b) where the direct object is moved to the front of the sentence.[8] Importantly, clefting is among the constructions which license Stylistic Inversion, i.e. the VS order, by the preposing of a clause-internal constituent (French, unlike Italian, does not allow free inversion but permits this kind of triggered inversion). Here, the movement of the object allows the VS inversion observed in (15b).

(14) a. C'est les négociations que le ministre suspend

(It's the negotiations that the minister stop)

(14) b. C'est les négociations que suspend le ministre

(It's the negotiations that stop the minister)

Here, we aim to discover whether object preposing determines an attraction effect on subject–verb agreement. In the resulting object–subject–verb (OSV) or OVS word order, the object does not intervene (linearly or hierarchically) between the subject and the inflected verb. So if surface intervention is critical for attraction, no effect should be expected here. Hence, an attraction effect would point to the existence of an intermediate representation in which the object intervenes in the subject–verb agreement relation.

Current syntactic analyses of object movement to the left periphery in cleft sentences and related constructions postulate a stepwise movement, with an intermediate position (AgrO) to the immediate left periphery of the VP (see Fig. 6).[9]

In the classical analysis of Kayne (1989) (later extended and generalized also to clauses not involving participial forms by Chomsky (1995, ch. 1, 2001), the object first moves to the specifier of this object agreement head (AgrO), triggering participial agreement, and then continues on to the complementizer system. Hence, the AGREE relation between AgrS and the subject crosses over this AgrO position and its specifier. As a result, Spec AgrO intervenes both linearly and hierarchically on AGREE. If intermediate representations (AgrO in the present case) are able to trigger attraction in the same way as surface representations do, we expect an attraction effect in *both* OSV and OVS sentences, in spite of the fact that they show no linear or structural intervention of the object between the subject and the verb in the surface word order.

---

[8] C'est (c'est les négociations) is a presentative, fixed singular form in spoken French, which does not necessarily agree with the following noun. The finding of symmetrical effects for singular and plural objects (see Experiment 3) suggests that speakers were not disturbed by the singular 'c'est' preceding the plural object.

[9] This intermediate position is assumed to ensure agreement in gender and number of the past participle with the direct object in languages like French. Importantly, agreement with the direct object is observed in French only when the direct object has moved, i.e. when it has crossed the intermediate AgrO position, and not when it remains in its initial, postverbal position in the VP (in which case the past participle is singular, masculine by default).

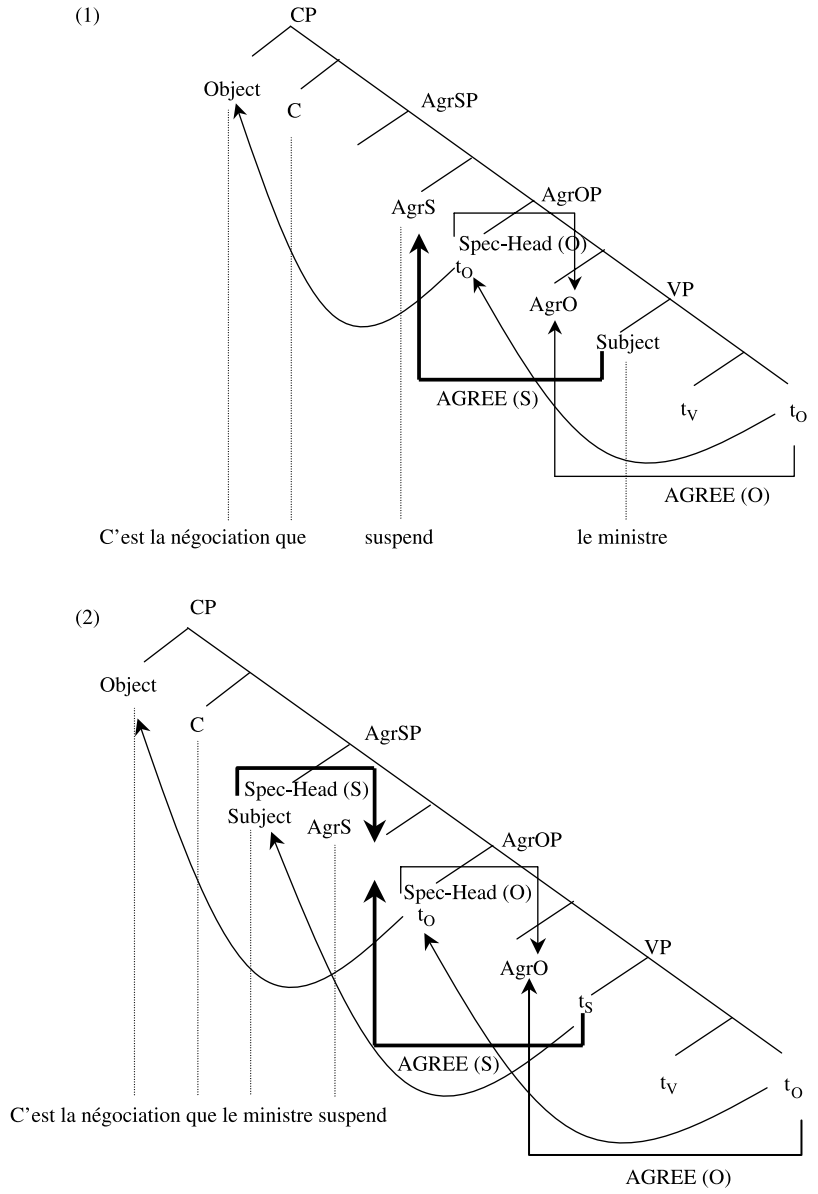


Fig. 6. Relevant aspects of the configuration of subject–verb agreement in a cleft sentence with the object in initial position and (1) verb–subject order, (2) subject–verb.

Contrasting these two structures also makes it possible to test our hypothesis of the fragility of agreement based on AGREE only, without the follow-up Spec-head checking. We have seen that subject–verb agreement is cross-linguistically stable in SV structures whose derivation involves both AGREE and Spec-head checking, while it is more fragile in VS,

where agreement is established uniquely under AGREE and where there is no local checking in Spec-head. We predict that the fragility of agreement in VS is observable in terms of a greater number of attraction errors in the OVS construction than in the OSV construction.

Verb–subject inversion in OVS structures is similar to the free inversion in VS structures examined in Experiment 1 (at least under certain formal analyses like in Friedemann, 1997, but see Kayne & Pollock, 1978, for a different view): in both structures the subject is assumed to remain in its initial position in the thematic structure, without moving to Spec AgrS. However, the crucial difference between the VS structure manipulated in Experiment 1 and the OVS structure of Experiment 3 is that whereas the modifier does not intervene at all on the subject–verb relationship in the former, the moved object intervenes both linearly and hierarchically in the latter. Hence, while no attraction was expected in the VS sentences of Experiment 1 (which is what we reported), we predict here strong attraction in OVS structures. Moreover, attraction is expected to be stronger than in the corresponding OSV construction, since OVS combines both the c-command position of the intervener over AGREE and the morphological fragility of the VS configuration.

5.1. Method

5.1.1. Participants

The same forty subjects who took part in Experiment 2 participated in this experiment. The two experiments were administered within the same experimental session with a 10 min break in between the two.

5.1.2. Materials

Thirty-two items were constructed. The three variables manipulated experimentally were: (1) the number of the head noun (singular vs. plural), (2) the number of the object (singular vs. plural), (3) word order (OSV vs. OVS). All verbs were marked for number in the spoken modality (they were all of the ending classes -IR or -RE). Examples of items are given in Table 6 and the complete list is presented in Appendix C.

Each of the 32 items appeared in eight different versions, depending on the experimental condition (see Table 6), which allowed for highly controlled within-item comparisons between the different conditions. Eight lists were created so that only one version of each of the 32 items only appeared once in a session. Lists were assigned at random to the 40 participants.

In addition to the 32 experimental items, each list contained 18 filler items. All fillers contained verbs that were unmarked for number orally in order to distract the speaker from number agreement processing. Syntactic structures of the fillers were varied such that there were six single head nouns, six head nouns followed by a preposition phrase and six head nouns followed by a double prepositional phrase. Number on the head and on the local noun was balanced. Experimental and filler items were arranged at random in the lists.

5.1.3. Procedure, design and data analysis

The same procedure as Experiment 2 was used, except that in the condition where participants had to produce an OVS sentence the preamble was presented with a line at the position of the verb (e.g. C'est les négociations que___le ministre).

Table 6
Examples of sentences in the different experimental conditions of Experiment 3 (French)

Word order	Number of the head noun and intervener	Preamble to be produced
OSV	SS	C'est la négociation que le ministre suspend
	SP	C'est les négociations que le ministre suspend
	PS	C'est la négociation que les ministres suspendent
	PP	C'est les négociations que les ministres suspendent
OVS	SS	C'est la négociation que suspend le ministre
	SP	C'est les négociations que suspend le ministre
	PS	C'est la négociation que suspendent les ministres
	PP	C'est les négociations que suspendent les ministres

The first letter in the second column refers to the number of the head noun, the second refers to the number of the local noun. The order of the letters is opposite to the linear order of the head and local nouns in the sentence.

5.1.4. Scoring

Same as Experiment 1.

5.2. Results

A total of 144 (11.3%) agreement errors, 152 (11.9%) repetition errors, and 83 (6.5%) miscellaneous responses were produced. The distribution of errors is shown in Table 7.

5.3. Agreement errors

Significant attraction effects were observed in both OSV and OVS conditions, as attested by the higher error rate in the conditions of number mismatch as compared to the conditions of number match (135 vs. 9), a difference that is highly significant statistically as attested by the interaction between the number of the subject and the number of the object ($F1(1,39)=129.9$, $P<.001$; $F2(1,31)=83.6$, $P<.001$). Agreement errors were more frequent in the OVS word order (102) as compared to OSV (42) ($F1(1,39)=27$, $P<.001$; $F2(1,31)=25$, $P<.001$). Finally, the three-way interaction between word order, number of the subject and number of the object was found significant ($F1(1,39)=11.9$, $P<.001$; $F2(1,31)=9.2$, $P<.01$), illustrating the fact that the effect of word order is mostly observable in conditions of number mismatch. No other effects or interaction were found ($Fs<1$).

5.3.1. Repetition errors

More repetition errors occurred when there was a number mismatch between the number of the subject and the number of the object (113) as compared to the match

Table 7
Experiment 3 (French): raw data and percentages per cell (between parentheses) for agreement, repetition and miscellaneous errors in the different experimental conditions

	Agreement errors		
	OSV	OVS	Total
SS	0	4 (2.5)	4 (1.3)
SP	24 (15)	51 (31.9)	75 (23.4)
PS	18 (11.25)	42 (26.2)	60 (18.8)
PP	0	5 (3.1)	5 (1.6)
Total	42 (6.7)	102 (15.9)	144 (11.3)
	Repetition errors		
	OSV	OVS	Total
SS	6 (3.8)	7 (4.4)	13 (4.1)
SP	25 (15.6)	37 (23.1)	62 (19.4)
PS	29 (18.1)	22 (13.8)	51 (15.9)
PP	13 (1.0)	13 (1.0)	26 (8.1)
Total	73 (11.4)	79 (12.3)	152 (11.9)
	Miscellaneous responses		
	OSV	OVS	Total
SS	6 (3.8)	17 (10.6)	23 (7.2)
SP	9 (5.6)	15 (9.4)	24 (7.5)
PS	6 (3.8)	9 (5.6)	15 (4.7)
PP	6 (3.8)	15 (9.4)	21 (6.6)
Total	27 (4.1)	56 (8.8)	83 (6.5)

conditions (39), as the significant interaction between these two factors shows ($F1(1,39) = 31.2$, $P < .001$; $F2(1,31) = 22.6$, $P < .001$). OVS word order generated slightly more errors than OSV but only with singular subjects, as suggested by the interaction between word order and the number of the subject in the participants analysis ($F1(1,39) = 4.3$, $P < .05$), however, this interaction did not reach significance level in the item analysis ($F2(1,31) = 2.9$, $P = .10$). No other effects or interactions were found ($Fs < 1$).

5.3.2. Miscellaneous responses

Speakers produced more miscellaneous responses in OVS sentences (56) as compared to OSV sentences (27) ($F1(1,39) = 20.5$, $P < .001$; $F2(1,31) = 12.8$, $P < .01$). No other effects or interactions appeared in the analysis of variance ($Fs < 1$).

5.4. Discussion

The first important finding that emerges from this experiment is that an object preposed to the left periphery of the clause in a cleft construction gives rise to interference on subject–verb agreement. This would not be expected on the basis of the surface order, since the object in its final position does not intervene between the subject and the verb. However, it is expected if one takes into account the derivational steps that the sentence undergoes and the intermediate representation that is generated (see Fig. 6). Indeed, the

object moving stepwise to the left periphery first stops in the intermediate position of Spec AgrO, the agreement node ensuring participial agreement, a position which crucially intervenes on the AGREE relation between AgrS and the subject in its VP-internal position. Hence, the data further support the existence of intermediate representations in agreement production which already were instrumental in accounting for the difference between our results on free inversion reported in Experiment 1 and the results on interrogative inversion reported by Vigliocco & Nicol (1998) (see Section 3.5).

A second important finding that emerges from the data is that, keeping the syntactic position of the object intervener constant, stronger attraction occurred in inverted VS sentences (OVS) as compared to canonical SV (OSV) sentences. This result supports our hypothesis, based on the cross-linguistic analyses of Guasti & Rizzi (2002), that two components underlie agreement: AGREE and MOVE (or, more precisely, the follow-up Spec-head checking subsequent to subject movement). Subject–verb agreement in OVS sentences is assumed to rely solely on the AGREE operation that relates the subject in its VP-internal position to AgrS. In contrast, agreement in OSV is further checked by the local Spec-head relation established as the subject moves higher in the structure to occupy the position of specifier of AgrS. Our data suggest that this additional checking reinforces the agreement relation between the head noun and AgrS, therefore reducing the risk of interference.[10]

It is important to note that the finding of a difference in interference between the two structures cannot be explained under the hypothesis that a single hierarchical representation underlies OSV and OVS, as is often assumed in psycholinguistics.

One could argue that OVS sentences are in some sense more complex than their OSV counterparts. Some studies indeed found significantly more comprehension errors in OVS sentences as compared to OSV in French (e.g. Holmes & O'Regan, 1981; Rigalleau, personal communication). Along these lines, our participants produced significantly more miscellaneous responses in the OVS condition than in the OSV one. But other studies failed to find such a difference; for example, in a reading task, Schelstraete & Degand (1998) reported faster reaction times at the verb in OVS than in OSV sentences in French.

The existence of contradictory results illustrates the necessity to clearly define 'complexity' before using it as an explanatory factor for the data. The concept most probably involves a multiplicity of factors that remain to be identified.[11] Still, what is of interest here is whether the word order effect reported in agreement errors can be explained by factors unrelated to agreement computation. The major argument suggesting that the locus of agreement errors is the syntactic operation of agreement per se is the finding that

[10] A reviewer suggested, as a possible alternative approach, that the more error-prone character of OVS relative to OSV may be due to the fact that the Spec-head relation is more local than the AGREE relation. This alternative would require a way of relating locality to robustness of morphological manifestation. That locality may correlate with robustness is intuitively plausible, and we find the alternative worth exploring. Nevertheless, at the moment we do not know of any formal way of expressing the correlation, so for the purposes of this paper we will stick to the more elementary idea that double checking determines a more robust morphological manifestation than simple checking.

[11] For example, it was pointed out to us that Schelstraete & Degand (1998) used complex subject phrases with modifiers which may have contributed to facilitate comprehension in OVS sentences by shortening the distance between the verb and the receptor of the agent role, along the lines of what was suggested by Gibson (1998).

most of these errors are attraction errors, i.e. errors that occurred in the number mismatch conditions (SP and PS); that is, agreement errors arise precisely when the system deals with number specification, which is itself closely linked to agreement processes. In contrast, the word order effect reported in miscellaneous responses is equally distributed over the number match and mismatch conditions, indicating that, contrary to agreement errors, these non-target responses are not sensitive to number processing. A close look at the large number of repetition errors produced shows that these are mostly located in the mismatch conditions SP and PS. This suggests that the difficulty in dealing with two different number features is not limited to the agreement computation. However, and importantly, word order did not influence the occurrence of repetition errors; they occurred similarly in OVS and OSV structures.

It could still be argued that participants were confused about which noun phrase is the subject in the OVS condition. Such confusion may indeed occur in the process of understanding these sentences, whose order of noun phrases is reversed with regard to the canonical order in French (SVO). However, if such errors occurred in the production of these sentences, the overall structure produced would be affected: for instance, we would expect the production of the complementizer *qui* instead of *que*, as *qui* normally signals relativization of the subject in French. For example, if the observed error **C'est les négociations que suspendent le ministre* arose because the speaker actually assumed that the negotiation is the subject of the verb, then he would have produced *C'est les négociations QUI suspendent le ministre* (which, then, is correct). We did not observe any change of *que* into *qui*, which suggests that speakers produced the cleft structure with object extraction as expected.

To sum up, the combined effects of both word order and number mismatch on agreement errors, together with the precise predictions from syntactic theory, argue for the relevance of these errors as an index of agreement computation. The first prediction from the theoretical framework was that the intermediate trace of the object intervening on AGREE would trigger interference errors. As expected, interference was found in OSV and OVS sentences which both involved the intervention of the object's intermediate trace. The second prediction was that stronger attraction effects would occur in OVS than in OSV sentences, a prediction which is also validated by the data. The fact that the theory proposes a detailed explanation for this word order effect brings elements to refine the notion of complexity: agreement realization is more difficult when the subject does not rise to the specifier of AgrS, and therefore does not allow for the supplementary local checking to take place. However, word order and number mismatch also affect components of sentence production which do not appear to be directly linked to agreement computation. These components, which remain to be identified, are indexed by miscellaneous and repetition errors showing, respectively, sensitivity to word order and number mismatch, but crucially not to the two factors simultaneously.

6. General discussion

Three studies were presented, based on the experimental elicitation of subject–verb agreement errors. The theory of agreement proposed by formal syntax models within

the principles and parameters/minimalism tradition was taken as the starting point for constructing the relevant experimental situations, and the results obtained are now used to propose some refinements of the theory. This discussion will illustrate very concretely those bi-directional links between psycholinguistic experimentation and linguistic theory.

Two important ingredients for the understanding of agreement were put forth in the paper. First, the assumption of the theory that agreement processing depends on abstract, hierarchical syntactic representations, not on the final surface word order is necessary to explain attraction. More specifically, it is necessary to appeal to the assumption that *intermediate representations* mediate between the initial configuration of the sentence and the final word order produced. The first argument comes from the difference between the lack of attraction found in verb–subject, free inverted sentences in Experiment 1 and the significant attraction previously reported in verb–subject, interrogative sentences by Vigliocco & Nicol (1998). The two structures have the same initial syntactic configuration and the same final surface structure; hence, they must differ at another level of representation. Syntactic theory assumes that the interrogative generates an intermediate representation in which the modifier intervenes on the agreement relation, triggering attraction, while no such representation underlies free inversion. The second argument for the role of intermediate representations is the attraction found with the intermediate trace of the object in Experiment 3. In the two cleft structures with object extraction we manipulated (OSV and OVS) the object does not intervene on agreement either in the initial configuration or in the surface configuration. Syntactic theory assumes the existence of an intermediate representation between these two configurations, in which the object passes via a position that intervenes on AGREE. The finding that this intermediate position of the object triggered attraction is, to our knowledge, the first piece of experimental evidence for the role of intermediate representations in language production (for related evidence in language comprehension see Gibson & Warren, 2004).

Second, empirical results help refine linguistic theory by shedding light more specifically on *the nature of agreement*, which we develop in the following sections. We first briefly discuss a possible mechanism underlying attraction errors, and then review the new pieces of empirical evidence provided in the paper as to the syntactic factors found to modulate attraction. These factors are: (1) the role of precedence in attraction, (2) the role of c-command in attraction, and (3) the role of a one (AGREE) vs. two-steps (AGREE and Spec-head) agreement computation. We then sketch a gradient in the difficulty of agreement realization, integrating linguistic theory and experimental data.

6.1. How does attraction come about?

The focus of our work was not on the mechanism of attraction itself but on the configurational conditions that favour or disfavour it. We have assumed a two-step agreement process, which we referred to as ‘checking’, without taking a position on the role and nature of AGREE and Spec-head. Here, we propose some hypotheses about the

functional status of these two components, and sketch how agreement errors could arise in this framework.

AGREE is responsible for specifying the subject's features of AgrS when the subject is still in its base position in the VP. Hence, AGREE imports a number feature onto the unspecified AgrS, and can therefore be understood as an operation of feature copying.

The second step, Spec-head, takes place after the subject has moved to the position of specifier of AgrS (in canonical SV structures). So when Spec-head comes into play, AgrS has already been given a value via AGREE. Despite the configurational difference between AGREE and Spec-head, empirical data show that interference can arise in both components: when Spec-head is established (Experiments 1 and 2, but see the alternative explanation in the following section on c-command), and when AGREE is established (Experiment 3). In all these cases, interference comes about because a mismatching element intervenes in the relationship between the head noun and the agreement node.

As mentioned before, Spec-head is realized at a stage of the derivation where AgrS has already been attributed a value via AGREE. Spec-head could then be understood as a follow-up procedure responsible for verifying that both the subject (in Spec of AgrS) and the verb (in AgrS) carry the same value. In this view, AGREE ensures copy and Spec-head ensures verification where verification is not rewriting, but a comparison of the two specifications. To validate this scenario, we need evidence that attraction can arise on a verification procedure, where no copy is involved. A possible case of verification identified in linguistics is feature matching between antecedent and anaphor (or bound pronoun), where the binder and the bindee must have matching features, but there is presumably no copying procedure involved. Bock, Nicol, and Cutting (1999) reported attraction effects in such structures (15), similar in size to attraction in verb agreement (16).

(15)*The actor in the soap operas watched themselves.

(16)*The actor in the soap operas were popular.

The finding that intervention on antecedent-anaphor relations generates attraction shows that attraction is not limited to a copying procedure, because in these cases no copying is involved, each nominal is presumably born with its own intrinsic featural constitution. It is therefore possible that the function of Spec-Head is to verify that the number value assigned to AgrS via AGREE is the same as the value of Spec AgrS.

Additional evidence in favour of this approach can be found in Experiment 3. We reported increased attraction in the OVS condition (15b) as compared to OSV (15a). Given that the intervention configuration is the same in both structures (the object intervenes on the subject–verb relation during AGREE), the difference in attraction cannot be explained by this factor. What distinguishes these two structures is that whereas in OSV the subject moves in Spec AgrS, which creates the condition for Spec-head to take place; this procedure does not apply in OVS where the subject does not

raise. If the role of Spec-head is to verify the matching between features on the subject and on the verb, we suggest that the data actually attest of a decrease in attraction in OSV, rather than an increase in OVS. The object would trigger similar errors at the level of AGREE in both structures, but the Spec-head configuration in OSV would correct a number of these errors by verifying (through the assumed mechanism) the feature match between Spec AgrS and AgrS.[12] Such a procedure could be likened to the monitoring procedure assumed in a number of psycholinguistic models of sentence production (e.g. Levelt, 1989).

6.2. Precedence and attraction

In the first experiment in Italian, we showed that while significant attraction was found in subject–verb order structures (13a), the number feature on a subject modifier does not attract agreement in free inverted, verb-subject order sentences (13b). This contrast between SV and VS structures shows the crucial role of precedence in attraction: in the SV order, the subject modifier intervenes in terms of precedence between the head noun and AgrS. When the subject raises to derive the canonical SV structure, the modifier is moved to a position in which it intervenes in terms of precedence between the head noun and the inflected verb. This configuration does not occur if the subject remains in its initial VP-internal position when a free inverted sentence is being produced. This indicates that word order, as defined by precedence (or 'horizontal') relationships, does actually play a role in attraction.

This result stands in a nice contrast to the previous finding by Vigliocco & Nicol (1998) that VS inversion in English interrogatives does trigger attraction, in a similar way to the corresponding SV declarative structures. In sum, empirical work shows that (1) two structures with different surface orders (interrogative VS and declarative SV in English) generate similar linguistic behaviour with regard to agreement, and conversely (2) two structures with a similar VS surface order (interrogative in English and free inversion in Italian) generate different behaviours. This 'double dissociation' between surface order and agreement computation strongly suggests that the processor uses abstract, intermediate representations of the grammar, not just the output sequence of words. The relevant configuration to consider is the one over which the agreement process takes place. The Spec-head component of agreement operates *after* the subject has risen to the subject position in Spec AgrS but *before* the verb raise to C in the construction of interrogative sentences (as attested by the similar effects found for declarative and interrogative sentences in English). In other words, in English interrogatives the canonical SV configuration where Spec-head takes place is an intermediate representation that is elaborated after the initial thematic configuration, but before the final configuration is

[12] As for the implications for the formal linguistic literature, it is worth noting that our approach combines and reconciles recent minimalist approaches to agreement, such as the one in Chomsky (2001), with Kayne's (1989) classical analysis, the seminal source of much syntactic work on agreement thereafter, which looked on agreement as feature matching in a Spec-head configuration. It is also worth observing that the parallel we were led to draw between agreement and anaphor binding was already noted much earlier in Fauconnier's (1974) approach to these phenomena.

derived to form the interrogative through movement of the inflected V to C. Intermediate representations are necessary to account for the data.[13]

6.3. C-command and attraction

Experiment 2 points to the need for further refinements of the structural conditions of intervention in attraction. We reported that a clitic object pronoun situated in preverbal position (14a) creates more interference than a preverbal subject modifier (14b), in French. This result replicates what Fayol et al. (1994) previously reported in the written production of French. Whereas both the clitic pronoun and the modifier linearly precede AgrS, the clitic pronoun also c-commands it, which is not the case of the modifier. This finding suggests that the structural relation of c-command plays a special role in agreement, as compared to a simple precedence relation. This result is in line with much work in formal syntax. As noted earlier, a node is 'active' with respect to another node for various formal and interpretive processes when c-command holds. In particular, the c-command relation is crucially involved in the agreement process so that it is to be expected that when an intervening element c-commands the agreement node, it will determine stronger interference than a non c-commanding element.[14]

It is interesting to note that movement of the object clitic into the preverbal position actually also involves passing through the Spec AgrO position identified in Experiment 3 (as attested by the manifestation of past participle agreement with the object clitic in such structures). It could then be that the interference effect reported with clitics in Experiment 2 is actually triggered by the Spec AgrO position (represented on Fig. 6), rather than by the clitic itself. This conclusion is potentially supported by Anton-Mendez (1996) who failed to find attraction with object clitics in Spanish: Spanish differs from French (and other Romance languages) in that it lacks participial agreement, and therefore the AgrO head. So, if Spec AgrO is the position responsible for interference and Spanish lacks this position, then the observed absence of interference in this language would be expected.

Hence, rather than generating attraction by intervening during the Spec-head component of agreement, the clitic may have triggered attraction when situated in its AgrO position through its intervention on AGREE, exactly like what happened in the two conditions of Experiment 3. In either case, both hypotheses imply interference effects in c-command relations (either on AgrS when Spec-head takes place or on the subject in the VP when AGREE takes place).

---

[13] Under trace theory, and in particular the conception of traces as complete but unpronounced copies of the moved element, surface representations recapitulate all the information expressed by the various derivational steps. So, the evidence discussed is compatible with both views that the processor accesses intermediate derivational steps, or the final derived representations recapitulating derivational steps through traces. For concreteness, we have expressed our analysis in terms of access to intermediate derivational steps. Whatever view is chosen, the substantive fact remains that the processor must access fine and abstract properties of syntactic structures.

[14] We referred to the strength of the structural relation of c-command in terms of a node being 'active' with respect to another node to open the possibility that the classical notion of 'activation level' in psycholinguistics be defined structurally. The ultimate goal is to link the level of formal explanation developed in linguistic theory to the level of processing explanation developed in psycholinguistics.

6.4. The role of a one vs. two-step agreement computation

The last experiment shows that not only clitic direct objects, but also full nominal direct objects displaced to the left periphery in the cleft construction trigger attraction on subject–verb agreement. Surprisingly, the displaced direct object appears in a surface position that does not intervene, either linearly or hierarchically, between the subject and the inflected verb, in either OSV or OVS. How can a non-intervening object lead to attraction? Again, it appears necessary to refer to intermediate derivational steps.

Consider OSV first. Current syntactic analyses of object movement to the left periphery in cleft sentences and related constructions involve an intermediate step to the immediate periphery of the VP, as illustrated in Fig. 6. On the basis of the observation of participial agreement with the preverbal direct object, Kayne (1989) suggested that the object first moves to the specifier of an object agreement head (Spec AgrO) before it reaches the complementizer system where it occupies the focus position in the final word order. As a result, when AGREE takes place between the subject and AgrS, the direct object in its intermediate Spec AgrO position crosses the agreement relation. Hence, Spec AgrO intervenes both linearly and hierarchically on the AGREE relation.

The invisible, intermediate position of the object postulated in syntactic theory on independent grounds appears again crucial to account for the interference effect reported in Experiment 3. In a sense, this effect offers complementary evidence to that provided in Vigliocco and Nicol's (1998) experiment. Both involve configurations in which the final word order does not manifest the intervention configuration (11), whereas a critical intermediate representation does. The two cases are complementary in that, in the English Subject-Aux inversion construction, the critical intermediate configuration is modified by further movement of the element bearing AgrS (the verb), while in the French cleft construction the critical configuration is modified by further movement of the intervener (the object). The movements that further modify the critical configuration of intervention are different, but in both cases the interpretation of the data leads us to assume the existence of abstract intermediate representations in which the critical intervention configuration holds. Thus, these findings also provide evidence for syntactic models involving intermediate, abstract derivational steps (or, equivalently, representations enriched with traces as copies), as in many versions of principles and parameters or minimalist models, and evidence against models only involving concrete representations of the output word sequence.

We have seen that the manifestation of subject–verb agreement is cross-linguistically more fragile in VS structures whose derivation does not involve subject movement to Spec of AgrS (see Rizzi & Guasti, 2002). On this basis, we suggested in the introduction that agreement involves two steps: AGREE and Spec-head. The robustness of agreement in SV structures would be due to the fact that, in these configurations, agreement is checked twice: through AGREE first, and then through the follow-up Spec-head verification after movement of the subject. In contrast, in VS structures agreement is established uniquely through AGREE, as the local checking in the Spec-head configuration is not available. The derivation of OVS structures is similar to the one of OSV structures except that movement of the subject to Spec AgrS does not take place, and subject agreement is therefore established uniquely by AGREE (at least in an analysis of French stylistic

inversion which makes it akin to Italian free inversion in the relevant respects, Friedemann, 1997[15]). The higher error rate reported in OVS as compared to OSV structures brings empirical support for our hypothesis of a double checking involved in agreement computation.

6.5. The gradient

In Table 1, we hierarchized the experimental conditions we manipulated according to three linguistic factors identified as potentially playing a role in attraction: precedence, c-command and AGREE only. Fig. 7 summarizes the attraction effects reported in this paper as a function of these factors (average percent errors in the mismatch conditions SP and PS).

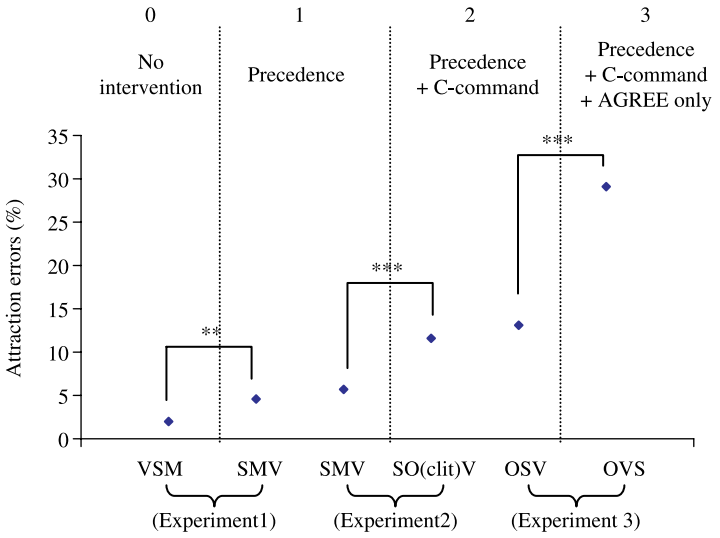
Four statistically different levels of attraction emerge from the plotting of the experimental data points (from 0 to 3). Attraction in free inversion (VSM) represents the lowest level, or degree 0. It is significantly different from the condition involving an intervening subject modifier (SMV), as reported in Experiment 1. The next level, degree 1, is represented by the modifier condition (SMV), which appears to produce similar attraction in both Italian and French (Experiments 1 and 2, respectively; note that here no statistical comparison is possible). Degree 2 of attraction is represented by object interference in SV sentences: either with the clitic (SO(clit)V, Experiment 2) or with a full DP (OSV, Experiment 3). Statistical tests were run to compare the size of the attraction effect in these two conditions (an analysis which was possible given that Experiments 2 and 3 were conducted on the same participants, using the same procedure). As expected, these two conditions do not differ statistically ($t(49) = .56$, $P = .58$). Degree 3 of attraction is represented by object interference in VS sentences (OVS), which generated significantly more errors than SOV (as reported in Experiment 3).

To account for this gradient of attraction, let us now examine the theoretical factors discussed in the previous sections. What distinguishes degree 0 from all the others is that it involves no intervention, either linear or hierarchical: subject agreement is established through AGREE, and the subject modifier does not intervene in any sense between AgrS and the head noun.

What distinguishes degree 1 from the remaining cases is that here, the attractor noun intervenes linearly (in terms of precedence), but not hierarchically (in terms of c-command). The subject modifier is preceded by the head noun and precedes the inflected verb, but being embedded within the subject noun phrase, it does not intervene in terms of c-command.

From degree 2 on, intervention is not linear but hierarchical, in terms of c-command. In Experiment 2, the clitic c-commands AgrS at the moment of the Spec-head

[15] Under the analysis of stylistic inversion by Kayne & Pollock (1978), the VS order in OVS is obtained by a movement of the subject after it has reached the Spec AgrS position, followed by a leftward movement of the clausal remnant. The assumption of an additional movement in OVS as compared to OSV structures potentially accounts for the complexity effects reported in sentence comprehension (see Section 5.4). However, since in this analysis the structural difference between OVS and OSV lies in stages of the derivation that follow agreement checking, it predicts no difference in attraction between these two types of sentences, unlike what we found.



Note: ** = p<.01, *** = p<.001

Fig. 7. Gradient of attraction errors as a function of the syntactic structure in the six experimental conditions tested. Each configuration is characterized by a weight (from 0 to 3) depending on its sensitivity to error.

checking. Similarly, in both conditions of Experiment 3, the direct object moves to the intermediate position of specifier of AgrO from which it the subject in the VP. Hence, when AGREE takes place, the object intervenes in terms of c-command on the relation between AgrS and the subject. As degrees 2 and 3 both involve hierarchical intervention, the dividing line between 1 and 2 can be understood in this way.

Interestingly, no difference was found between the clitic interveners of Experiment 2 and the object interveners in the OSV condition of Experiment 3. This result was expected from Table 1 since both configurations involve precedence and c-command, but not the third factor of AGREE only. Note that according to the interpretation of an attraction effect related to the intervention on AGREE of the clitic in the Spec of AgrO (see Section 6.5), the very same cause would be responsible for attraction effects in SO(clit)V and OSV, which again would predict no difference in error rates.

Finally, what distinguishes degree 3 from all the other cases is that in 3 we have a case of (hierarchical) intervention in a VS structure, that is, in a structure in which agreement is ensured by AGREE only, without the additional local Spec-head checking. The stronger attraction effect here can thus be understood as a consequence of the inherent fragility of agreement in this configuration, along the lines discussed previously.

Let us now briefly consider other findings reported in the literature in the light of our conclusions. First, intervening elements situated low in the tree structure of the subject phrase hardly disrupt agreement. This was found to be the case for nouns situated in subject relative clauses (Bock & Cutting, 1992; Nicol, 1995), as well as for nouns

modifying the subject modifier (Franck et al., 2002). These studies reveal the role of linear intervention on the Spec-head configuration, and suggest that this factor is sensitive to the syntactic embedding of the attractor: it has an impact only when not too far down the subject's arborescence.

Concerning attraction with elements that are not part of the subject, Hartsuiker et al. (2001) found smaller attraction effects with direct objects (both weak pronouns and nouns) than with subject modifiers in Dutch. Similarly, Hemforth & Konieczny (2003) found very small attraction effects with objects in SOV German structures. If we attempt to integrate these findings within our gradient, the direct object in Dutch/German SOV determines a detectable attraction effect weaker than 1, the subject modifier case, and then a fortiori weaker than our French constructions SO(clit)V, OSV and OVS. This raises the question of why OV structures give rise to very different degrees of attraction in Germanic and in French. While an adequate analysis of this cross-linguistic difference would require detailed assumptions on the nature of OV in Germanic languages, which cannot be developed and justified here, we can observe that according to many current analyses, the object may remain in a relatively low position in Germanic SOV structures, from which it would not intervene in terms of c-command between the subject and AgrS. If this were the case, the object would intervene only in terms of precedence, hence in a configuration in which the strength of interference depends on the degree of syntactic embedding of the intervener, as mentioned in connection with the various cases of modifiers. Pending a more refined analysis of these word order phenomena, we leave this discussion at that.

7. Conclusion

This paper illustrates how interactions between psycholinguistic experimentation and linguistic theory can lead to a better understanding of language phenomena. Experimentally controlled observations of interference effects in agreement were presented and interpreted in light of theoretical assumptions about agreement proposed by the model of generative syntax. The model provides specific theoretical constructs that were crucial to account for our experimental findings of agreement. Moreover, these findings were used to further refine the theoretical assumptions about agreement in the framework of formal syntax. Three conclusions emerged from our work, with different degrees of theoretical specificity: (1) the hierarchical nature of syntactic encoding and the role of intermediate representations, (2) the existence of relations of different strengths between syntactic positions in this hierarchy, and (3) the existence of specific components involved in agreement.

The first conclusion which the data support is that syntactic encoding has to be represented hierarchically, and crucially, that it does not involve a single hierarchical representation (as usually assumed in psycholinguistics) but a series of intermediate representations between the thematic structure and the final word order. Intermediate representations are instrumental to explain interference in agreement. In particular, the

report of interference effects with the object when it does not intervene between the subject and the verb in the surface structure nor in the thematic structure, suggests that it transits via an intermediate position (AgrO) which, in contrast, is precisely assumed to intervene on the subject–verb relation. It is, to our knowledge, an entirely new illustration of a behavioural reflex of intermediate representations.

The second conclusion that the data led us to is that syntactic representations involve specific relations between the words (hierarchical but also linear) which determine syntactic operations like agreement. As is expected under current theoretical assumptions, our experimental reports of attraction show that hierarchical c-command intervention creates stronger interference than linear precedence intervention.

The third conclusion supported by the data is that agreement can be finely decomposed along the lines we suggested. Two functionally distinct components appear to be involved in agreement: the first one (AGREE) is obligatory, realized early and before constituents move; the second one (Spec-head) is active only when the subject has raised to its canonical preverbal position. The prediction that agreement would be more vulnerable with respect to interference when realized only via AGREE as compared to when it is checked twice by both components was experimentally validated.

The kind of two-way interaction between experimental psycholinguistics and theoretical syntax illustrated in this paper is perhaps atypical in the current state of the study of language as a cognitive capacity. We believe it should not be: we hope that we have shown that a more intense dialogue between psycholinguists and syntacticians has a great potential for advancing research in both disciplines.

Acknowledgements

The work reported here was supported by grant number 1114-068250.02 of the Fonds National de la Recherche Suisse to Uli Frauenfelder and Julie Franck. Glenda Lassi's research was supported in part by the Progetto di rilevante interesse nazionale "La Cartografia Strutturale delle Configurazioni Sintattiche", Italian Ministery of University and Research, 1999. Some of the experiments were conducted as the first author was at the University College London; many thanks to Brian Butterworth for his support and advising. We are grateful to Odile Bagou, Celia Jakubowicz, Alissa Melinger, François Rigalleau, Ur Shlonsky and three anonymous reviewers for valuable comments and discussions.

Appendix A

Italian materials used in Experiment 1.

Plural–singular	Singular–plural	Verb
Gli amici della sorella	L'amico delle sorelle	PARTIRE
The friends of the sister	The friend of the sisters	TO LEAVE

Plural–singular	Singular–plural	Verb
I capi dell'operaio	Il capo degli operai	LAVORARE
The bosses of the worker	The boss of the workers	TO WORK
I vicini del ragazzo	Il vicino dei ragazzi	PARLARE
The neighbours of the boy	The neighbour of the boys	TO TALK
I compagni del bimbo	Il compagno dei bimbi	GIOCARE
The companions of the kid	The companion of the kids	TO PLAY
I soldati del tenente	Il soldato dei tenenti	MARCIARE
The soldiers of the lieutenant	The soldier of the lieutenants	TO MARCH
I soci del direttore	Il socio dei direttori	LEGGERE
The partners of the director	The partner of the directors	TO READ
Le nipoti del nonno	La nipote dei nonni	DORMIRE
The granddaughters of the grandfather	The granddaughter of the grandparents	TO SLEEP
I medici della cugina	Il medico delle cugine	PENSARE
The doctors of the cousin	The doctor of the cousins	TO THINK
I camerieri del conte	Il cameriere dei conti	GUIDARE
The waiters of the count	The waiter of the counts	TO DRIVE
I fattori della signora	Il fattore delle signore	ARRIVARE
The farmers of the lady	The farmer of the ladies	TO ARRIVE
Le maestre del ragazzo	La maestra dei ragazzi	URLARE
The teachers of the boy	The teacher of the boys	TO SHOUT
Le figlie del genitore	La figlia dei genitori	SALUTARE
The daughters of the parent	The daughter of the parents	TO GREET
Le spie del rapinatore	La spia dei rapinatori	GUARDARE
The spies of the rubber	The spy of the rubbers	TO LOOK
I padroni del gatto	Il padrone dei gatti	MANGIARE
The owners of the cat	The owner of the cats	TO EAT
I fantini del cavallo	Il fantino dei cavalli	CORRERE
The jockeys of the horse	The jockey of the horses	RUN
I truccatori del divo	Il truccatore dei divi	CANTARE
The make-up artists of the star	The make-up artist of the stars	TO SING
I pianisti del tenore	Il pianista dei tenori	SUONARE
The pianists of the tenor	The pianist of the tenors	TO PLAY
Le sarte della ragazza	La sarta delle ragazze	CUCIRE
The dressmakers of the girl	The dressmaker of the girls	TO SEW

Appendix B

French materials used in Experiment 2 (only items in the mismatch SP condition are presented).

Subject modifier (SPV)	Clitic object (SO(clit)V)	Verb
Le massage des kinés	Le massage les	DETENDRE
The massage of the physiotherapist	The massage them	TO RELAX
Le chauffeur des ministres	Le chauffeur les	CONDUIRE
The driver of the ministers	The driver them	TO DRIVE

(*continued on next page*)

Subject modifier (SPV)	Clitic object (SO(clit)V)	Verb
	La pollution les	VIEILLIR
La pollution des usines		
The pollution of the factories	The pollution them	TO AGE
Le trafiquant des peintures	Le trafiquant les	VENDRE
The trafficker of the paintings	The trafficker them	TO SELL
Le syndicat des ouvriers	Le syndicat les	DECEVOIR
The trade-union of the workers	The trade-union	TO DISAPPOINT
Le courant d'air des fenêtres	Le courant d'air les	RAFRAICHIR
The draught of the windows	The draught them	TO REFRESH
La performance des acteurs	La performance les	SURPRENDRE
The performance of the actors	The performance of the actors	TO SURPRISE
La fumée des drogues	La fumée les	JAUNIR
The smoke of the drugs	The smoke them	TO TURN YELLOW
Le professeur des élèves	Le professeur les	LIRE
The teacher of the students	The teacher them	TO READ
Le sourire des hostesses	Le sourire les	SEDUIRE
The smile of the hostesses	The smile them	TO SEDUCE
Le commentaire des journaux	Le commentaire les	CONVAINCRE
The comment of the newspapers	The comment them	TO CONVINCE
L'avocat des criminals	L'avocat les	ECRIRE
The lawyer of the criminals	The lawyer them	TO WRITE
La visite des châteaux	La visite les	ENRICHIR
The visit of the castles	The visit them	TO ENRICH
Le calmant des médecins	Le calmant les	AFFAIBLIR
The sedative of the doctors	The sedative them	TO WEAKEN
La matraque des gendarmes	La matraque les	MEURTRIR
The bludgeon of the policemen	The bludgeon them	TO HURT
Le représentant des immigrés	Le représentant les	FUIR
The representative of the immigrants	The representative them	TO ESCAPE
Le singe des clowns	Le singe les	APPLAUDIR
The monkey of the clowns	The monkey them	TO APPLAUD
La ponceuse des charpentiers	La ponceuse les	POLIR
The sander of the carpenters	The sander them	TO POLISH
Le cochon des fermiers	Le cochon les	BOIRE
The pig of the farmers	The pig them	TO DRINK
La responsable des décors	La responsable les	COUDRE
The responsible of the decorations	The responsible them	TO SEW
Le producteur des debutants	Le producteur les	ATTENDRE
The producer of the beginners	The producer them	TO WAIT
Le curé des paroisses	Le curé les	BENIR
The bishop of the churches	The bishop them	TO BLESS
La secrétaire des agencies	La secrétaire les	ATTENDRE
The secretary of the agencies	The secretary them	TO WAIT
La victime des bombardements	La victime les	EMOUVOIR
The victim of the bombings	The victim them	TO MOVE
Le gardien des prisonniers	Le gardien les	SORTIR
The guardian of the prisoners	The guardian them	TO THROW OUT
La lame des canifs	La lame les	SERVIR
The blade of the knives	The blade them	TO SERVE
Le jumelage des villes	Le jumelage les	UNIR
The twinning of the towns	The twinning them	TO UNITE

(*continued on next page*)

Subject modifier (SPV)	Clitic object (SO(clit)V)	Verb
Le régime des diététiciennes	Le régime les	MINCIR
The diet of the dietician	The diet them	TO SLIM
Le spectacle des rues	Le spectacle les	DIVERTIR
The show of the streets	The show them	TO ENTERTAIN
Le propriétaire des camionnettes	Le propriétaire les	SUIVRE
The owner of the vans	The owner them	TO FOLLOW
Le cauchemar des enseignants	Le cauchemar les	REPRENDRE
The nightmare of the teachers	The nightmare them	TO START AGAIN
L'explication des experts	L'explication les	ENDORMIR
The explanation of the experts	The explanation them	TO PUT TO SLEEP

Appendix C

French materials used in Experiment 3 (only items in the mismatch PS condition are presented)

Object subject verb (OSV)	Object verb subject (OVS)	Verb
C'est la négociation que les ministres	C'est la négociation que_les ministres	SUSPENDRE
It's the negotiation that the ministers	It's the negotiation that_the ministers	TO SUSPEND
C'est l'adolescente que les boxeurs	C'est l'adolescente que_les boxeurs	SEDUIRE
It's the adolescent that the boxers	It's the adolescent that_the boxers	TO SEDUCE
C'est le casseur que les surveillants	C'est le casseur que_les surveillants	SORTIR
It's the breaker that the supervisors	It's the breaker that_the supervisors	TO THROW OUT
C'est le psychotique que les policiers	C'est le psychotique que_les policiers	POURSUIVRE
It's the psychotic that the policemen	It's the psychotic that_the policemen	TO PURSUE
C'est le chien que les vaches	C'est le chien que_les vaches	SUIVRE
It's the dog that the cows	It's the dog that_the cows	TO FOLLOW
C'est le mouton que les bergers	C'est le mouton que_les bergers	TONDRE
It's the sheep that the shepherds	It's the sheep that_the shepherds	TO SHEAR
C'est le roman que les enseignants	C'est le roman que_les enseignants	DECRIRE
It's the novel that the teachers	It's the novel that_the teachers	TO DESCRIBE
C'est le bénéfice que les privatisations	C'est le bénéfice que_les privatisations	ACCROITRE
It's the benefit that privatisations	It's the benefit that_privatisations	TO INCREASE
C'est l'escalier que les presidents	C'est l'escalier que_les présidents	DESCENDRE
It's the stairway that the presidents	It's the stairway that_the presidents	TO WALK DOWN
C'est l'auteur que les préfaces	C'est l'auteur que_les préfaces	INTRODUIRE
It's the author that the prefaces	It's the author that_the prefaces	TO INTRODUCE
C'est le gréviste que les manifestants	C'est le gréviste que_les manifestants	REJOINDRE
It's the strike man that the demonstrators	It's the strike man that_the demonstrators	TO JOIN
C'est le champion que les amateurs	C'est le champion que_les amateurs	BATTRE
It's the champion that the amateurs	It's the champion that_the amateurs	TO BEAT
C'est le mollet que les exercices	C'est le mollet que_les exercices	RAIDIR
It's the carve that exercises	It's the carve that_exercises	TO TIGHTEN
C'est l'ennemi que les gardes	C'est l'ennemi que_les gardes	ENVAHIR

(*continued on next page*)

Object subject verb (OSV)	Object verb subject (OVS)	Verb
It's the enemy that the guards	It's the enemy that_the guards	TO INVADE
C'est le député que les sénateurs	C'est le député que_les sénateurs	RECEVOIR
It's the deputy that the senators	It's the deputy that_the senators	TO WELCOME
C'est le gendarme que les lois	C'est le gendarme que_les lois	PUNIR
It's the policeman that the laws	It's the policeman that_the laws	TO PUNISH
C'est la commission que les directeurs	C'est la commission que_les directeurs	REUNIR
It's the commission that the directors	It's the commission that_the directors	TO MEET
C'est la fraude que les juges	C'est la fraude que_les juges	COMBATTRE
It's the fraud that the judges	It's the fraud that_the judges	TO FIGHT
C'est l'agneau que les barbecues	C'est l'agneau que_les barbecues	ROTIR
It's the lamb that the barbecues	It's the lamb that_the barbecues	TO ROAST
C'est le capitalisme que les banques	C'est le capitalisme que_les banques	SERVIR
It's capitalism that the banks	It's capitalism that_the banks	TO SERVE
C'est le monstre que les images	C'est le monstre que_les images	SAISIR
It's the monster that the images	It's the monster that_the images	TO CAPTURE
C'est la prostituée que le film	C'est la prostituée que_le film	SALIR
It's the prostitute that the film	It's the prostitute that_the film	TO SULLY
C'est l'impôt que les décisions	C'est l'impôt que_les décisions	RESTREINDRE
It's the tax that the decisions	It's the tax that_the decisions	TO DIMINISH
C'est le milliardaire que les mendiants	C'est le milliardaire que_les mendiants	PLAINDRE
It's the millionaire that the beggars	It's the millionaire that the beggars	TO PITY
C'est la novice que les maîtres	C'est la novice que_les maîtres	PEINDRE
It's the beginner that the masters	It's the beginner that_the masters	TO PAINT
C'est le propriétaire que les locataires	C'est le propriétaire que_les locataires	REJOINDRE
It's the owner that the tenants	It's the owner that_the tenants	TO JOIN
C'est l'héroïne que les événements	C'est l'héroïne que_les événements	TERNIR
It's the heroin that the events	It's the heroin that_the events	TO TARNISH
C'est le dépressif que les plantes	C'est le dépressif que_les plantes	GUERIR
It's the depressed (person) that the plants	It's the depressed (person) that_the plants	TO CURE
C'est l'évacuation que les accords	C'est l'évacuation que_les accords	GARANTIR
It's the evacuation that the agreements	It's the evacuation that_the agreements	TO GUARANTEE
C'est la fourmi que les cloportes	C'est la fourmi que_les cloportes	CRAINDRE
It's the ant that the woodlouses	It's the ant that_the woodlouses	TO FEAR

References

Anton-Mendez, I. (1996). Clitics and attraction errors: an experimental study on language production. Unpublished Master thesis, Department of Cognitive Science, University of Arizona.

Belletti, A. (2001). Inversion as focalisation. In A. Hulk, & J. Y. Pollock (Eds.), *Subject inversion in romance and the theory of universal grammar* (pp. 60–90). Oxford: Oxford University Press.

Bock, J. K. (1991). A Sketchbook of production problems. *Journal of Psycholinguistic Research*, *20*, 141–160.

Bock, J. K., & Cutting, J. C. (1992). Regulating mental energy: Performance units in language production. *Journal of Memory and Language*, *31*, 99–127.

Bock, J. K., & Eberhard, K. M. (1993). Meaning, sound and syntax in English number agreement. *Language and Cognitive Processes*, *8*, 57–99.

Bock, J. K., & Miller, C. A. (1991). Broken agreement. *Cognitive Psychology*, *23*, 35–43.

Bock, J. K., Nicol, J., & Cutting, J. C. (1999). The ties that bind: Creating number agreement in speech. *Journal of Memory and Language*, *40*, 330–346.

Bock, K., Eberhard, K. M., & Cutting, J. C. (2004). Producing pronoun number. *Journal of Memory and Language*, *51*, 159–323.

Chanquoy, L., & Negro, I. (1996). Subject-verb agreement errors in written productions: A study of French children and adults. *Journal of Psycholinguistic Research*, *25*, 553–570.

Chomsky, N. (1995). *The minimalist program*. Cambridge, MA: MIT Press.

Chomsky, N. (2000). Minimalist inquiries: The framework. In R. Martin, D. Michaels, & J. Uriagereka (Eds.), *Step by step—essays in minimalist syntax in honor of Howard Lasnik*. Cambridge, MA: MIT Press.

Chomsky, N. (2001). Derivation by phase. In M. Kenstowicz (Ed.), *Ken Hale: A life in language*. Cambridge, MA: MIT Press.

Chung, S. (1998). *The design of agreement*. Chicago, IL: The University of Chicago Press.

Eberhard, K. M. (1997). The marked effect of number on subject-verb agreement. *Journal of Memory and Language*, *36*, 147–164.

Fauconnier, G. (1974). *La coréférence: Syntaxe ou sémantique?* Paris: Editions du Seuil.

Fayol, M., Largy, P., & Lemaire, P. (1994). When cognitive overload enhances subject-verb agreement errors. A study in French written language. *Quarterly Journal of Experimental Psychology*, *47*(2), 437–464.

Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: MIT Press.

Franck, J., Cronel-Ohayon, S., Chillier, L., Frauenfelder, U., Hamann, C., Rizzi, L., et al. (2004). Normal and pathological development of subject-verb agreement in speech production: A study on French children. *Journal of Neurolinguistics*, *17*, 147–180.

Franck, J., Vigliocco, G., & Nicol, J. L. (2002). Subject-verb agreement errors in French and English: The role of syntactic hierarchy. *Journal of Language and Cognitive Processes*, *17*(4), 371–404.

Friedemann, M.-A. (1997). *Sujets syntaxiques: Positions, inversions, et pro*. Bern: Peter Lang.

Garrett, M. F. (1988). Processes in language production. In F. J. Nieuwmeyer, *Linguistics: The Cambridge survey*. *Biological and psychological aspects of language* (Vol. III) (pp. 69–96). Cambridge, MA: Harvard University Press.

Gibson, E. (1998). Linguistic complexity. Locality of syntactic dependencies. *Cognition*, *68*, 1–76.

Gibson, E., & Warren, T. (2004). Reading time evidence for intermediate linguistic structure in long-distance dependencies. *Syntax*, *7*(1), 55–78.

Guasti, M. T., & Rizzi, L. (2002). Agreement and tense as distinct syntactic positions. Evidence from acquisition. In G. Cinque, *The structure of DP and IP—the cartography of syntactic structures* (Vol. 1). New York: Oxford University Press.

Haegeman, L. (1994). *Introduction to government and binding theory*. Oxford: Blackwell.

Hartsuiker, R. J., Anton-Mendez, I., & Van Zee, M. (2001). Object attraction in subject-verb agreement construction. *Journal of Memory and Language*, *45*, 546–572.

Hemforth, B., & Konieczny, L. (2003). *Proximity in agreement errors Proceedings of the conference of the cognitive science society, Boston*.

Holmes, V., & O'Regan, J. K. (1981). Effects of syntactic structure on eye fixations during reading. *Journal of Verbal Learning and Verbal Behaviour*, *20*, 417–430.

Kaan, E. (2002). Investigating the effects of distance and number interference in processing subject-verb dependencies: An ERP study. *Journal of Psycholinguistic Research*, *31*, 165–193.

Kayne, R. (1989). Romance clitics, verb movement and PRO. *Linguistic Inquiry*, *22*, 647–686.

Kayne, R., & Pollock, J.-Y. (1978). Stylistic inversion, successive cyclicity and move NP in French. *Linguistic Inquiry*, *9*, 595–621.

Koopman, H., & Sportiche, D. (1991). The position of subjects. *Lingua*, *85*, 211–258.

Levelt, W.J.M. (1989). Speaking: From intention to articulation. Mass., MIT Press.

Nicol, J. (1995). Effects of clausal structure on subject-verb agreement errors. *Journal of Psycholinguistic Research*, *24*, 507–516.

Nicol, J., Jakubowicz, C., & Goldblum, H. (1996). Sensitivity to grammatical marking in English-speaking and French speaking non-fluent aphasics. *Aphasiology*, *10*, 593–622.

Pearlmutter, N. J. (2000). Linear versus hierarchical agreement feature processing in comprehension. *Journal of Psycholinguistic Research*, *29*, 89–98.

Pollard, C., & Sag, I. A. (1994). *Head-driven phrase structure grammar Centre for the Study of Language and Information*. Chicago, IL: Stanford and University of Chicago Press.

Pollock, J.-Y. (1989). Verb Movement, Universal Grammar and the Structure of IP. *Linguistic Inquiry*, *20*(3), 365–424.

Reinhart, T. (1976). The syntactic domain of anaphora, PhD dissertation, Cambridge, MA: MIT.

Rizzi, L. (1990). *Relativized minimality*. Cambridge, MA: MIT Press.

Schelstraete, M. A., & Degand, L. (1998). Assignment of grammatical functions in French relative clauses. *Language Sciences*, *20*(2), 163–188.

Solomon, E. S., & Pearlmutter, N. J. (2004). Semantic integration and syntactic planning in language production, Cognitive Psychology, 49, 1–46.

Sportiche, D. (1988). A theory of floating quantifiers and its corollaries for constituent structure. *Linguistic Inquiry*, *19*, 425–449.

Vigliocco, G., & Franck, J. (1999). When sex and syntax go hand in hand: Gender agreement in language production. *Journal of Memory and Language*, *40*, 455–478.

Vigliocco, G., & Franck, J. (2001). When sex affects syntax: Context influences in sentence production. *Journal of Memory and Language*, *45*, 368–390.

Vigliocco, G., Hartsuiker, R. J., Jarema, G., & Kolk, H. H. J. (1996). How many labels on the bottles? Notional concord in Dutch and French. *Journal of Language and Cognitive Processes*, *11*, 407–421.

Vigliocco, G., & Nicol, J. (1998). Separating hierarchical relations and word order in language production. Is proximity concord syntactic or linear? *Cognition*, *68*(1), 13–29.