Anchoring Agreement in Comprehension

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Abstract
Most linguistic theories of language offer analysis of agreement describing the rules and constraints involved in the computation and interpretation of this dependency. A good testing ground for theoretical accounts of agreement is mismatching patterns. In this article we focus on a mismatch available in the Spanish agreement system – Unagreement – in which there is a person mismatch in the realization of plural subject-verb agreement. Unagreement seems to challenge both purely syntactic and lexicalist analyses of agreement, as the realization of this pattern cannot be carried out either on a strictly formal basis or by simply postulating a lexically-driven asymmetry. We propose an approach that overcomes the limitations of existing analyses and that is able to successfully account for standard as well as non-standard agreement patterns.

1. The Mechanics of Agreement

As language comprehenders, we are constantly and unconsciously absorbed in the process of decoding language and its meaning, linking actors to their respective actions and also to real-world entities. Doing this requires careful unpacking of the linguistic input, in search of grammatical cues that give the reader/hearer fundamental coordinates concerning the participants in discourse: what is their role, their number, and whether they are animate or inanimate, female or masculine. This function is carried out by agreement features, morphological categories that signal the person, number and gender information associated with nouns, pronouns, verbs, articles and adjectives. Feature consistency between these different parts of speech is what gives rise to an agreement relation.

The realization of agreement entails displacing person, number and gender information from the controller (e.g. a subject argument) to the target (e.g. a verb) of the relation. Across languages, the amount and the type of controller-to-target information displacement can however vary, as shown in (1) below, where the agreement “richness” of Romance languages contrasts with the “poverty” of the system in English.

(1) Ipl.m linguisti3.pl.m scrivono3.pl articoli3.pl.m interessanti3.pl.m ITALIAN
Losm.pl linguísta3.pl.m escriben3.pl articulos3.pl.m interesantes3.pl.m SPANISH
Lesm.pl linguistes3.pl.m ecrivent3.pl des articles3.pl.m interessants3.pl.m FRENCH
Linguists3.pl.o write3.pl interesting3.pl.o articles3.pl.o ENGLISH

Formalizing the mechanics of agreement essentially amounts to describing the way features are structured and accessed by the system and how agreement information flows along the structure. Most theories of language offer their own account of agreement, describing the rules or constraints involved in the realization and interpretation of this relation. Broadly speaking, two main influential approaches to agreement can be
identified: a derivational one, which emphasizes the purely syntactic nature of agreement computation, and the lexicalist analysis proposed by constraint-based theories. A good testing ground for theoretical accounts of agreement is represented by mismatching patterns. In what follows, purely syntactic and lexicalist approaches will be reviewed and tested against a specific grammatical mismatch available in Spanish: Unagreement, an agreement pattern characterized by the presence of a person mismatch between subject and verb (Section 1). An alternative proposal – the Feature Interpretation Procedure – based on behavioral and electrophysiological data will be advanced (Sections 2 and 3) that more suitably accounts for the processing of legal mismatching patterns, and overcomes the limits of both the purely syntactic and the lexicalist approaches.

1.1. AGREEMENT: THE SYNTACTIC VIEW

Early derivational grammars defined agreement as an asymmetric relation in which the controller is the element from which grammatical information originates and the target the element that inherits such information. This controller-target asymmetry is a key aspect of feature-copying models of agreement such as that developed within the recent Minimalist Program (Chomsky 1995, 2000, 2001). Central to this approach is the assumption that features are expressed as a bundle on a single position in the syntactic tree (Tense, or T), and are uniformly dealt with by Agree, the operation that is responsible for checking and copying feature values from the controller to the target (see Figure 1). Chomsky (1995:308 ff) asserts that feature-type matching is a pre-requisite for the performance of Agree, and thus a mismatch would impede the copying of feature values from controller to target and therefore the correct realization of the dependency. The controller-to-target directionality of the copying is determined by the asymmetry in feature values existing between the specifications on the controller and those on the target: while controllers enter the process already endowed with feature values (e.g. 1st, 2nd or 3rd for person; singular or plural for number), targets do not, hence the need for the copying operation (see Figure 1). This asymmetry has interpretive consequences: not only is the controller the source from which the copying process originates, it is also the element that carries visible or interpretable information to the conceptual system responsible for assigning an interpretation to the dependency in a subsequent computational step. Conversely, agreement information is not interpretable on the target, which inherits the controllers’ information to fill its “empty” person and number specifications.

Agree operates within narrowly syntactic boundaries, as unvalued features need to receive a value before the syntactic representation is passed on for subsequent semantic-pragmatic analysis. This means that the computation of agreement relations takes place during the syntactic build-up of the sentence, independently of the thematic and semantic-pragmatic information of the arguments involved.

This approach is derivational in the sense that the creation (or derivation) of a well-formed linguistic expression goes through specific steps in which operations like Agree are applied. Crucially, purely syntactic computational steps precede semantic-pragmatic analysis.

1.1.1. Why a Purely Syntactic Analysis Cannot Work: Unagreement

There are exceptions to the systematic covariance characterizing agreement realization. Across languages, patterns are found in which controller and target do not systematically co-vary, but the well-formedness and the acceptability of the sentence are, however,
preserved. As an example, take the British English pattern in (2b), compared to (2a), probably one of the most frequently used examples of agreement mismatch.

(2) a. The faculty is meeting tomorrow
    b. The faculty are meeting tomorrow

The 3rd person singular subject faculty can be followed by a 3rd person plural verb, and any British English speaker would find this combination perfectly grammatical. Like other collective nouns, faculty is formally singular but its referent can be identified in a plurality of individuals: as such, it can trigger semantic agreement on the verb, as opposed to the purely syntactic agreement of (2a).

The Spanish agreement system presents an interesting mismatch that targets the realization of subject-verb agreement and on which we will rest our proposal. Beside standard patterns like the one in (3) below, a person mismatch between a plural subject and verb is allowed: example (4) below illustrates what is known as Unagreement (Hurtado 1985; Jaeggli 1986, among others). Here, the presence of a person mismatch between a 3rd person plural subject and a 1st person plural verb does not prevent the sentence from being grammatical, as opposed to the outright ungrammaticality of (5). In (4), grammaticality is ensured by superimposing the verbal person value onto the nominal one, thus shifting the interpretation of the subject from a 3rd person plural to a 1st person plural one.

(3) a. Los turistas visitaron un castillo muy bonito
    b. The tourists visited a very nice castle

(4) a. Los turistas visitamos un castillo muy bonito
    b. We tourists visited a very nice castle

(5) a. *El turista visitaste un castillo muy bonito
    b. *The tourist (you) visited a very nice castle

Fig 1. Agreement feature clustering under the T (Tense) head in minimalist analyses. T hosts uninterpretable (non-valued) person and number features, as opposed to the interpretable (valued) ones carried by the subject. Agree connects the two positions in a subject-to-verb direction.
Throughout the article, we will use the term “mismatch” to refer to a grammatical mismatch like Unagreement, while “anomaly” or “violation” will refer to an ungrammatical mismatch. Constructions in which full agreement between subject and verb is present will be referred to as standard or canonical agreement.

In his extensive description of agreement mismatches across languages, Corbett (2006:172) defines agreement patterns like Unagreement as “informative mismatches” that provide information not available elsewhere in the sentence, in this case information concerning the participants in the speech act. More precisely, in (4) it is verbal inflection that makes it clear that the speaker is part of the group of tourists. The type of mismatch illustrated in (4) is thus clearly different from the one in (2b): the verb superimposes its person feature on the subject and covertly shifts the interpretation of the nominal. Unagreement is thus yet another instance of how an exclusively syntactic analysis of agreement is unable to account for the variability of agreement realization across languages.

Unagreement poses relevant challenges to a standard Minimalist analysis in mainly two directions. Firstly, it seems to question the assumption that agreement is a uni-directional process taking place from the controller to the target: the 1st person plural specification of the verb clearly cannot result from a copying operation proceeding from the subject. Secondly, the 1st person plural interpretation assigned to the dependency is not compatible with the standard assumption that person is interpretable on the subject argument: in Unagreement it is the verb that provides the relevant person information to interpret the dependency. To rescue this analysis, one may possibly argue that in Spanish, plural lexical forms have a double person specification in the lexicon: one for 3rd person and one for 1st person. In Unagreement patterns, the latter, but not the former specification would be selected, thus allowing the performance of regular copying processes. Straightforward as it may sound, this explanation faces, however, two problems. First, the derivation should contain two lexical entries for los turistas, one specified for 3rd and one for 1st person, but this would add redundancy to the computation, something that any design wishes to avoid. Second, two lexical entries should be presupposed also for lexical forms in positions other than the subject, for example in object position. This appears not to be possible in Spanish, as 3rd person NPs in object position are never given a 1st person plural interpretation. This fact confirms that the shift in interpretation is not driven by an inherent property of Spanish NPs, but by the verb’s inflectional morphology, suggesting that Agree can operate in a reverse fashion here (we will come back to reverse Agree in Section 2).

A second limitation of the standard Minimalist analysis of agreement is to be found in the way features are represented in syntax. A feature bundle reduces computational load during feature checking, as it can be accessed uniformly by the system, but at the same time it obscures two important facts. Namely:

(i) The cross-linguistic variation of agreement realization: across languages agreement can manifest itself differently, depending, for example, on the position of the subject, a phenomenon known as partial agreement. A case in point is Arabic: preverbal subjects trigger full agreement on the verb, but postverbal ones only in gender, thus suggesting a differential access to features by the mechanisms driving agreement (Shlonsky 1989).

(ii) The inherent interpretive differences among person and number, which speak against a single-cluster representation of features, with recent psycholinguistic research also not supporting this view (see Section 3 below). While number features express the mere
numerosity of the subject argument (e.g. a single entity vs. a plurality), person features express the status of the subject with respect to the participants in the speech act. Thus, 1st person expresses identity with (or inclusion) of the speaker, 2nd person identity with (or inclusion) of the addressee, 3rd person exclusion of both speaker and addressee.

A partial solution to the second point raised here seems to be offered by Cartography (cf. Cinque and Rizzi 2008; Shlonsky 2010 for reviews), a research program recently developed within the Principle & Parameters (Chomsky 1981) framework. Cartography proposes a decomposition of the agreement field into a series of independent syntactic heads, according to the heuristic principle “one morphosyntactic property – one feature – one head” (Cinque and Rizzi 2008:50). This analysis attributes agreement features the key role of “atoms” of syntactic computations and can thus capture the underlying differences existing among them. Under this approach, the syntactic tree of Figure 1 is “unpacked” to obtain a much richer and articulated representation (see Figure 2), in which independent projections are responsible for person, number and gender agreement. In this case, the grammar accesses agreement features separately: person, number and gender agreement thereby results from the establishment of distinct Agree relations.

1.2. AGREEMENT: THE LEXICALIST VIEW

Semantic effects seem to find a more natural explanation within lexicalist views of agreement (Pollard and Sag 1994; Wechsler 2009, 2011; Wechsler and Zlaticˇ 2000, 2003). From a lexical perspective, features are assigned directly from semantics, which grants greater flexibility in the case of non-standard agreement. More specifically, the semantic content of nominals is endowed with referential indices, which contain the (person, number and gender) information necessary to identify the real-world referent of a linguistic object. Unlike in syntax-driven accounts, person, number and gender are therefore not regarded as specifications of grammatical categories such as nouns and verbs: agreement information rather belongs to the internal structure of indices. Indices can be thought of as abstract objects, whose function is to encode contextually relevant information concerning the entities being talked about, so that these can be identified by speakers (Pollard and Sag 1994:60). Reconciliation (or unification) of referential indices between sentence constituents leads to agreement.

Fig 2. Cartographic decomposition of the agreement field (based on Shlonsky 1989), in which each agreement feature has an independent representation in syntax: person is indicated by the Person Phrase (PersonP), number by the Number Phrase (NumberP) and gender by the Gender Phrase (GenderP).
Importantly, under a lexicalist account, agreement is not inherently directional, but it is rather the result of information symmetrically cumulating from both subject and verb. Formally, the realization of subject–verb agreement results from a unification process, which could be schematized as in (6) below:

\[
\left\{ \begin{array}{c}
\text{GENDER } \text{masc} \\
\text{NUMBER } \text{plur} \\
\text{PERSON } 3^{rd}
\end{array} \right\} \cup \left\{ \begin{array}{c}
\text{GENDER } \text{masc} \\
\text{NUMBER } \text{plur} \\
\text{PERSON } 3^{rd}
\end{array} \right\} = \left\{ \begin{array}{c}
\text{GENDER } \text{masc} \\
\text{NUMBER } \text{plur} \\
\text{PERSON } 3^{rd}
\end{array} \right\}
\]

When the verb \textit{llegaron}, with its feature structure (plural number, 3rd person) combines with the subject and its specifications, the relevant information undergoes unification, yielding a masculine 3rd person plural index. Under this view, the principles of agreement theory can be formulated as “a static set of identity conditions” between the indices of the elements involved in this relation (Pollard and Sag 1994:98).

1.2.1. Why a Lexicalist View Cannot Account for Unagreement

Unification handles canonical agreement well, but the referential indices characterizing unagreement and other grammatical mismatches may not be unified as easily as in (6) above, because of the mismatching person values of subject and verb. This can pose problems for the symmetrical nature of agreement. Lexicalist analyses of agreement try to accommodate the presence of grammatical mismatches and the asymmetry that these presuppose by invoking another type of asymmetry: that existing between controllers and target forms in terms of lexical specifications. For example, the range of gender values that a noun can take is definitely smaller compared to that an adjective can take: while the former has only one inherent gender (e.g. feminine), the latter has at least two options (feminine and masculine, but also neuter gender in languages allowing this third option).

Further sources of asymmetry are represented by underspecification and absence of controllers, which inevitably trigger a specific directionality of the agreement process, i.e. agreement information coming only from one “side” of the relation. Typical underspecified controllers are 1st and 2nd person pronouns, which lack a gender specification. In (7) below, the subject pronoun \textit{tu} has no gender specification, but the predicative adjective \textit{bella} that refers to it shows nevertheless feminine gender:

\[
\text{Tu} \text{2.sg } \text{eres} \text{2.sg } \text{bella} \text{sg.f.}
\]

You are beautiful

In the absence of explicit controllers, agreement information is entirely provided by the target, as happens in presence of null subjects:

\[
\text{Hablo} \text{1.sg } \text{espanol}
\]

(I) speak Spanish
According to Pollard and Sag, these facts are not sufficient to cast the principles of agreement theory in directional terms, as

the appearance of directionality in agreement processes is the result of lexical underspecification, that is, forms whose underspecified lexical entry allows them to be identified with the relevant properties of a larger class of forms. (Pollard and Sag 1994:98).

Controller underspecification may therefore be behind the existence of Unagreement patterns. Let us consider this hypothesis and assume that a 3rd person subject is underspecified for person, following the claim that 3rd person is absence of person (Benveniste 1966; Harley and Ritter 2002). Unification of the information provided by subject and verb would thus lead to the Unagreement pattern, as showed in (9) below:

(9) Los turistas_{3.pl,m} llegamos_{1.pl} al castillo
    We tourists arrived at the castle

In our opinion, this analysis encounters three problems: firstly, if 3rd person is underspecified for person, this should hold both for singular and plural forms, and Unagreement patterns should thus be available both in singular and plural. However, as shown in (5) above, 3rd person singular subjects can only agree with 3rd person singular verbs. Secondly, the person underspecification analysis should hold also for 3rd person pronominal forms, which should show Unagreement patterns exactly as their plural noun counterparts. Unfortunately, this is not possible in Spanish (and we are not aware of any such pattern in any language), as ellos (they) cannot precede a 1st person plural verb (*Ellos_{3.pl} visitamos_{1.pl} un castillo/*They (we-)visited a castle). Thirdly, the plural controller would be supposedly underspecified both in cases of standard agreement and Unagreement: this would imply that the two sentences are computationally equivalent, that is, (4) would represent no mismatching pattern. In processing terms, for sentences (3) and (4) no difference should be found in e.g. reading times, speed and accuracy in grammaticality judgment and in other finer measures such as electrophysiological responses. This prediction will turn out to be wrong, as we will show in Section 3.

Having reviewed the main properties of existing approaches of agreement (summarized in Table 1) and the problems that these face to account for agreement mismatches, we now turn to an alternative proposal under which Unagreement-like mismatches can be comfortably explained.

2. Finding the Place of Unagreement

Although evidently problematic for theories of agreement, mismatches cannot be simply and blindly labeled as “exceptions” to the normal functioning and realization of this dependency. Exactly because they challenge existing accounts, these patterns provide the
opportunity to explore the realms of agreement systems in depth, and therefore deserve special attention from a theoretical perspective.

Over the past few years, psycholinguistic research has made fruitful contributions to theoretical and typological research on agreement. The question of whether the realization of a specific linguistic phenomenon is syntactic rather than semantic in nature can be successfully addressed in a laboratory setting by making use of experimental techniques that can cast light on the cognitive resources involved in sentence comprehension. Critically, experimental research on s-v agreement has so far focused on core cases of person and number mismatches, contrasting them with correct sentences showing a full agreement pattern, in local relations as well as in configurations in which the subject is separated from the verb by a competing NP that generates agreement attraction (cf. Bock et al. 2001; Nicol et al. 1997; Pearlmutter et al. 1999; Wagers et al. 2009; among others). However, the processing of “legal” mismatches has been somehow neglected. A legitimate question, therefore, concerns the place that Unagreement occupies and how it should be dealt with by a theory of agreement computation. To our knowledge, an analysis of this linguistic phenomenon is still missing: our goal in this article is to fill this gap, showing that from the analysis of Unagreement, fundamental insights into the mechanics of agreement computation in general can be gained, and crucially, without either encapsulating agreement within narrowly syntactic boundaries, or by postulating the presence of a lexically-driven asymmetry. To this end, Unagreement will be theoretically and experimentally tested.

2.1. ON ANCHORS AND INTERPRETATION

Features can be conceived as the basic building blocks of an agreement relation. Assuming a tight connection between structure and interpretation, each feature is postulated to activate a link between its morphosyntactic expression (e.g. 1st, 2nd or 3rd person), which we will call $\varphi$-values, and the semantic-pragmatic information concerning the argument referent (e.g. a Speaker or an Addressee), or $\sigma$-values (see Table 2). A matching relation is established between these two types of values to drive feature interpretation (see D’Alessandro 2004; Sigurdsson 2004, 2006, 2009 for proposals along the same lines). Crucially, $\sigma$-values represent what we will call the “interpretive anchor” of a feature. By virtue of their different interpretive requirements, we will functionally and structurally dissociate person and number, identifying different $\sigma$-values and separate underlying

<table>
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<tr>
<th>FEATURES</th>
<th>DERIVATION-BASED ACCOUNTS</th>
<th>LEXICALIST ACCOUNTS</th>
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<tbody>
<tr>
<td>• Features are represented in bundles under a syntactic head.</td>
<td>• Agreement is inherently asymmetrical. Agreement is non-directional.</td>
<td></td>
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<tr>
<td>• Features are valued and interpretable on the controller, but unvalued and non-interpretable on the target</td>
<td>• Features are valued and interpretable on the controller, but unvalued and non-interpretable on the target</td>
<td></td>
</tr>
<tr>
<td>• Agreement is inherently asymmetrical</td>
<td>• Agreement is inherently symmetrical. Agreement is non-directional.</td>
<td></td>
</tr>
<tr>
<td>• Agreement is directional and flows from the controller to the target of the dependency</td>
<td>• Agreements are based on the lexical underspecification or the absence of controllers</td>
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Table 1. A comparison between derivation-based and lexicalist accounts of agreement.
matching operations. Let us deal with the two features separately. The \(\varphi\) - and \(\sigma\)-values for person and number features are illustrated in Tables 3 and 4.

**Person.** Person features express the status of an argument with respect to the participants in the speech act. Recent theoretical analyses have indeed emphasized the fact that this feature can be interpreted only in relation to the speech participants of the sentence (Bianchi 2006; Sigurdsson 2004, 2006, 2009; but see also Pollard and Sag 1994 and Wechsler 2009, 2011; Wechsler and Zlaticˇ 2000, 2003 for a similar claim under a lexicalist account): a matching relation must therefore be established between the morphosyntactic person values (1st, 2nd and 3rd person) and the speech participant values (Speaker, Addressee) encoded in the discourse representation of the sentence (see Figure 3a). As Table 3 shows, 1st person expresses identity with (or inclusion of) the Speaker, 2nd person expresses identity with (or inclusion of) the Addressee, 3rd person exclusion of both Speaker and Addressee (Benveniste 1966; Jakobson 1971; Sigurdsson 2004, 2006, 2009). Importantly, absence of a speech role for 3rd person does not imply absence of a matching between \(\varphi\) - and \(\sigma\)-values: a third person pronoun or a lexical item match speech participant features, albeit only negatively (e.g. \([-\text{SPEAKER}, -\text{ADDRESSEE}]\)).

**Number.** Number is a grammatical category that expresses the cardinality of discourse referents (a single entity vs. a plurality), indicated by either a pronominal or a nominal argument. Across languages, a considerable proportion of nouns vary between a singular and a plural number, hence between a \([+\text{ONE}, -\text{GROUP/MANY}]\) and a \([-\text{ONE}, +\text{GROUP/-\text{MANY}}]\) value (Table 4), although many languages have more complex systems (cf. Corbett 2000:20–42), including dual number (for two items), trial (for three items) and paucal

<table>
<thead>
<tr>
<th>Feature</th>
<th>(\varphi)-values</th>
<th>(\sigma)-values</th>
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<tbody>
<tr>
<td>Person</td>
<td>1st, 2nd, 3rd</td>
<td>SPEAKER, ADDRESSEE</td>
</tr>
<tr>
<td>Number</td>
<td>Singular, plural</td>
<td>ONE, GROUP-MANY</td>
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<tr>
<th>(\varphi)-values</th>
<th>(\sigma)-values</th>
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<tbody>
<tr>
<td>([+1, -2])</td>
<td>([+\text{SPEAKER}, -\text{ADDRESSEE}]) 1st person</td>
</tr>
<tr>
<td>([-1, +2])</td>
<td>([-\text{SPEAKER}, +\text{ADDRESSEE}]) 2nd person</td>
</tr>
<tr>
<td>([-1, -2])</td>
<td>([-\text{SPEAKER}, -\text{ADDRESSEE}]) 3rd person</td>
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<th>(\varphi)-values</th>
<th>(\sigma)-values</th>
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<tbody>
<tr>
<td>([+\text{sg}, -\text{pl}])</td>
<td>([+\text{ONE}, -\text{GROUP/MANY}]) singular</td>
</tr>
<tr>
<td>([-\text{sg}, +\text{pl}])</td>
<td>([-\text{ONE}, +\text{GROUP/MANY}]) plural</td>
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In light of the differences between person and number illustrated above, we formulate the following Feature Interpretation Procedure (Figure 3):

(10) **FEATURE INTERPRETATION PROCEDURE (FIP)**

A feature is interpreted in relation to its anchor:

a. Number anchor resides in the nominal argument of the dependency.

b. Person anchor resides in the speech act participant representation of the sentence.

In spite of their interpretive differences, person and number agreement processes have something in common: the grammar must make sure that the specifications on the subject and the verbal morphology are consistent. With current minimalist models, we will assume that an Agree relation connects the controller and the target’s morphology to ensure featural consistency, but the analogy in checking operations should not obscure the fact that anchoring points are different and that person and number will be targeted separately (similarly to what is postulated within Cartographic analyses).
Critical for the purposes of the present discussion is the way feature inconsistency can be managed by interpretive anchors. On the one hand, in the case of grammatical mismatches like Unagreement, the inspection of person anchor can provide a profitable solution to the mismatch, by “suggesting” the possibility of (covertly) superimposing verbal person onto the nominal one, a mechanism that we have dubbed Reverse Agree (RA). In languages specifically allowing this option, RA is a covert procedure that operates from verb to subject and that targets the σ-values of the arguments involved. In so doing, the heterogeneous [speaker + non-participant(s)] representation of the verb can be integrated with the [non-participants] group underlying the subject argument. On the other hand, in presence of a true violation, anchor inspection will lead to sanctioning of a syntax error.

Having laid down the core tenets of our analysis, the goal of the next section is to test the validity of this feature-anchoring approach against recent data on agreement comprehension.

3. Processing Agreement

The on-line processing of agreement has been fruitfully studied by measuring comprehenders’ reading and response times (cf. Carminati 2005) during the processing of correct and incorrect sentences. But perhaps the most influential and reliable evidence on agreement processing comes from methodologies with the finest temporal grain, like eye-tracking (Braze et al. 2002; Deutsch and Bentin 2001; Ni et al. 1998; Pearlmüller et al. 1999) and the event-related potentials (ERPs) technique, which enable taking “snapshots” of the comprehension process within different temporal frames. In eye-movement paradigms, sentences are subdivided into interest areas, and processing load can be locally measured in terms of the time spent on a specific region, the probability and number of regressions to earlier parts of the sentence, the number or re-fixations on that area, and so on. By fractionating the reading time and the reading space into distinct components, on-line measures of processing can be thus obtained without any secondary task (such as accuracy ratings or response times), to produce the dependent measure. The few eye-tracking studies on agreement processing (Deutsch and Bentin 2001; Pearlmüller et al. 1999; Sturt 2003) have reported an increase in gaze duration (i.e. the time spent on the critical word from first entering the region to first leaving it) and in total reading times (the total time spent on a word, including both forward and regressive movements) at anomalous word position.

ERPs are averages of brain electrical activity time-locked to some external or internal event, such as the reading of a word or sentence. They are classified according to their polarity (i.e. positive or negative deflections in the waveform), the time of their onset or peak occurrence in milliseconds, and their topographical distribution across the scalp. Variations in the nature (e.g. semantic–pragmatic vs. syntactic manipulations) and complexity (e.g. correct, incorrect or ambiguous material) of the linguistic information being processed can produce reliable modulations of brain electrical activity (i.e. ERP components) over time, revealing readers’ sensitivity to fine-grained aspects of language that behavioral techniques alone are less likely to capture.

Processing mechanisms can be best understood when the system is forced to deal with mistakes (Wagers et al. 2009). Cross-linguistically, agreement anomalies compared to correct sentences have been found to elicit a positive deflection starting about 600 ms post-stimulus onset (P600), often preceded by an increased anterior negativity lateralized to left hemisphere (LAN, left anterior negativity), between 300–500 ms post-stimulus (Italian:
De Vincenzi et al. 2003; Dutch: Hagoort and Brown 2000; Hagoort et al. 1993; German: Rossi et al. 2005; English: Osterhout and Mobley 1995; Spanish: Silva-Pereyra and Carreiras 2007). In general, LAN effects have been functionally interpreted as indexing the detection of a syntactic violation (Hagoort et al. 1999), while the presence of anomalies affecting the interpretation of the sentence has been found to produce a centro-posterior negativity with a slightly right scalp distribution that peaks about 400 ms post-stimulus onset. This effect, referred to as the N400, is commonly regarded as a marker of increased effort in lexical-semantic processing (Kutas and Federmeier 2007; Kutas and Hillyard 1980, 1983, 1984). P600 effects, in contrast, have been linked to reanalysis/repair operations (Friederici 2002; Hagoort et al. 1993) triggered in presence of an (apparent) anomaly, and the subsequent need to come up with a consistent meaning for the sentence, an operation which necessarily taps into metalinguistic factors. A slightly different functional interpretation instead associates P600 effects with integration processes that combine the incoming input with expectations generated by previous words (Carreiras et al. 2004; Kaan et al. 2000).

According to some authors (Barber and Carreiras 2005; Carreiras et al. 2004; Kaan and Swaab 2003; Molinaro et al. 2008, 2011a), the reanalysis processes underlying the P600 effect would be pursued in two consecutive stages. In the first stage (between about 500 and 800 ms), the information concerning the critical word and the information concerning the previous sentence fragment is integrated, in order to detect the source of the incongruence. In this stage, not only syntactic and semantic information would be handled by the parser, but also discourse-related information, as shown by Kaan and Swaab (2003), who reported frontally distributed P600 effects due to a greater number of referents to be integrated in the same discourse representation. Once the anomaly has been correctly diagnosed, in the late phase of the P600 effect (after 800 ms), repair of anomalous features is assumed to be performed (Barber and Carreiras 2005; Kaan and Swaab 2003; Molinaro et al. 2008; see Table 5).

3.1. THE ON-LINE DISSOCIATION OF PERSON AND NUMBER

Several ERP findings lend support to the idea that a quantitatively and qualitatively different amount of neurocognitive resources are employed in agreement processing, depending on the feature that is being manipulated (for a review, see Molinaro et al. 2011b).

While a considerable number of studies on agreement have dealt with number and gender (Barber and Carreiras 2003, 2005; Barber et al. 2004; Deutsch and Bentin 2001; Hagoort 2003; Hagoort et al. 1999; Molinaro et al. 2008; Osterhout and Mobley 1995; Wicha et al. 2004; among others), person has been given less attention and fewer studies can be found in the ERP literature on person agreement. Nevins et al. (2007) found that in Hindi, the P600 effect generated by a gender + person mismatch had

Table 5. Functional interpretation of event-related potential (ERP) components.

<table>
<thead>
<tr>
<th>LAN</th>
<th>N400</th>
<th>P600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing difficulties due to the detection of a morphosyntactic violation</td>
<td>Increased effort in lexico-semantic processing</td>
<td>Early phase: processes involved in constructing structural dependencies while interfacing with the available non-syntactic information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Late phase: repair of ill-formed sentences</td>
</tr>
</tbody>
</table>

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greater amplitude than the one elicited by single gender, single number and gender + number mismatches. According to these authors, this modulation in the P600 amplitude should be attributed to the special status of person violations compared to anomalies involving number and gender features, in line with language typology data (Greenberg 1963) that point to the presence of an implicational hierarchy among features, namely *Person > Number > Gender*. This hierarchy reads that if a language possesses gender, then it surely possess number and also person. If it has number, it surely has person, but not necessarily gender. Person occurs independently of the other two features, arguably because it serves the fundamental linguistic function of indexing individuals involved in a speech act.

Similar findings are reported for Spanish. Mancini et al. (2011a) found clear differences at the verb position in sentences containing person and number anomalies like those in (11a) and (11b), in early as well as in later processing stages.

(11)  

<table>
<thead>
<tr>
<th>(11a)</th>
<th>(11b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. *El cocinero$<em>3$$</em>{sg}$ cocinaste$<em>2$$</em>{sg}$ un pescado muy rico</td>
<td>b. *El cocinero$<em>3$$</em>{sg}$ cocinaron$<em>3$$</em>{pl}$ un pescado muy rico</td>
</tr>
<tr>
<td>The cook (yousg-)cooked a very tasty fish</td>
<td>*The cook (they-) cooked a very tasty fish</td>
</tr>
</tbody>
</table>

Both anomalies elicited a P600 effect, which was however preceded by qualitatively different negative effects. More precisely, while number violations showed an effect that was left-frontally distributed, the effect of person anomalies extended also to more posterior areas, where a significant difference was found between the two conditions. The authors labeled the former effect as a LAN and the latter as an N400, emphasizing the qualitative difference between the two effects. Nevertheless, it is worth noticing that the negative effect found for person violations may be the result of the superimposition of LAN and N400 effects, as the lack of differences between the two violations in frontal areas suggests (see Figures 4 and 5). Crucially for our analysis, this superimposition may be indicative of the fact that despite their functional dissociation, person and number agreement have a qualitatively similar process in common, arguably Agree and its parsing correlate. What significantly differentiates them is the information that has to be accessed for them to be licensed, i.e. the interpretive anchor. This implies that morphosyntactic checking and anchor inspection are independent operations that overlap in time and that yield an additive effect, a result that can be predicted within the feature-anchoring approach developed here.

Recently, the finding of N400 effects to case violations and case ambiguities (Bornkessel et al. 2004; Choudhary et al. 2009; Frisch and Schlesewsky 2001, 2005) has led to the interpretation of this effect as the result of the misapplication of interpretively relevant rules such as, for example, those engaged in the cross-level mapping between morphosyntactic and thematic information (Choudhary et al. 2009; Frisch and Schlesewsky 2001, 2005; but see Bornkessel and Schlesewsky (2006) for a review). Along similar lines, an agreement violation involving person may block the mapping between morphosyntactic and speech participant information, causing interpretation conflicts to arise. In contrast, cross-level mapping remains unaffected by number violations, since the thematic and speech roles of the argument referent can still be derived.

In sum, the data just reviewed show that there is more to s-v agreement than a simple link between two morphosyntactic feature sets: more complex underlying relations are certainly involved to make the morphosyntactic content of features readable to the conceptual system.
3.2. WHEN PERSONS DISAGREE: A COMPARISON OF TRUE PERSON MISMATCHES AND UNAGREEMENT

Unagreement introduces an important variation in the theme of agreement processes: it can help us to disentangle the neurophysiological processes involved in feature matching from those triggered by mere syntactic errors, but it can also open a window onto the extra-syntactic components involved in agreement processing, without overwhelmingly taxing the processor, as outright person anomalies do, or without “silencing” semantic-pragmatic factors, as happens in standard agreement sentences.

Mancini and colleagues have investigated the processing of Unagreement using different techniques, obtaining both behavioral and electrophysiological measures of the impact that this pattern has on comprehension compared to standard agreement and person-anomalous sentences, as shown in (4) to (6), here repeated from (12) to (14).

(12) Los turistas\textsubscript{3.pl} visitaron\textsubscript{3.pl} un castillo muy bonito
The tourists (they-) visited a very nice castle

(13) Los turistas\textsubscript{3.pl} visitamos\textsubscript{1.pl} un castillo muy bonito
\textit{We} tourists visited a very nice castle

Fig 4. Event-related potential (ERP) pattern and topographical maps for the Person Mismatch condition (dashed line) relative to the Control Condition (solid line) in Mancini et al. (2011a).
Fig 5. ERP pattern and topographical maps for Number Mismatch condition (dashed line) relative to the Control Condition (solid line) in Mancini et al. (2011a).

(14) *El turista_{3,sg} visitaste_{2,sg} un castillo muy bonito
The tourist (you_{1,sg}) visited a very nice castle

Because of its “apparent” person mismatch, the first important aspect to be studied to unveil the mechanisms behind Unagreement comprehension concerns speakers’ grammaticality judgments of this pattern, i.e. how easily its correctness is recognized compared to standard agreement sentences and true person anomalies. Off-line data (Mancini et al. 2011b) have shown that speakers judge Unagreement as equally grammatical as standard agreement sentences when they are asked to express their judgment without time pressure. However, when asked to provide an on-line grammaticality judgment, the apparent person mismatch characterizing Unagreement can mislead speakers to the effect that, on these sentences, they are significantly less accurate than on standard agreement and person-anomalous ones. Recent eye-movement data (Mancini et al. 2011b) confirm that at early stages of processing, Unagreement’s person inconsistency is perceived as no different from the mismatch found in a true person violation: equivalently longer gaze durations (i.e. the time spent on a segment before leaving it, during the reader’s first pass) have been found for Unagreement and person anomalies compared to standard agreement. The costly person shift necessary to interpret Unagreement is reflected in longer
total reading time effects (the duration of all the fixations in the verb area, including re-reading it) compared to standard agreement. The lack of regressions to the verb area and significant regression path effects (i.e. time from first fixating the verb to first moving forward, including re-reading earlier parts) indicates that the consequences of this shift are, however, more short-lived compared to the perturbation caused by a person mismatch.

Where and how exactly does Unagreement differ from standard agreement and person violations? This question has been addressed in an ERP study (Mancini et al. 2011c) in which different ERP responses were found for visitamos (we visited) compared to both visitaste (you sing visited) and visitaron (they visited) as Figures 6 and 7 show. Crucially, when reading the unagreeing verb relative to a 3rd person verb in the standard agreement condition, there was an N400-like effect that was followed by a central negative effect in the 500–800 ms interval, and no effect from 800–1000 ms, thus indicating that the shift in subject interpretation is performed before 800 ms. On the other hand, person violations elicited an N400 effect in the 300–500 ms interval, followed by a P600, replicating previous findings on person violations (Mancini et al. 2011a).

The topographically similar negativity elicited by Unagreement compared to person violations in the 300–500 ms interval suggests that this pattern is initially treated as a mismatch. In spite of this, the absence of P600 effects indicates that no reanalysis process is triggered (for a more detailed explanation of the absence of positive effects, see Mancini et al. 2011c:1369).

It is in the topographical similarity of person violations and Unagreement negativities that we can see the effect of person’s interpretive anchor. The fact that the two conditions
elicit similar negative effects between 300–500 ms indicates that these effects cannot be only the “symptom” of the detection of featural inconsistency, either apparent or real: if this were so, topographically similar positive effects would also have arisen in the following intervals, where instead two totally different scenarios are found for the two conditions. Rather, we take the similar negative effects to be evidence of the fact that the processor is dealing with similar information (person) and operations, i.e. $\varphi$–$\sigma$ feature matching, with the difference in effect size to be ascribed to the different grammaticality status of the two conditions. Crucially, the inspection of person $\sigma$-value in the speech act representation provides two different outcomes: in one case, a mismatch is found at the $\sigma$-level and the anchor sanctions an error (signaled by the N400), whereby repair/reanalysis operations are triggered and P600 effects elicited. In the case of Unagreement, subject and verb $\sigma$-values mismatch and the system is aware of this mismatch (cf. the posterior negative effect), but the anchor suggests solution: the performance of an alternative Agree operation through which subject interpretation can be shifted from 3rd to a 1st person plural.

4. Conclusions

4.1. AGREEMENT IS NEITHER PURELY SYNTACTIC NOR STRICTLY LEXICAL

The ERP and eye-movement data discussed above cannot be accounted for either under a strictly syntactic or a lexicalist analysis of agreement. In both cases, agreement features
are assumed to be bundled together, in syntactic heads or referential indices. Under a minimalist analysis, the system accesses the feature set without differentiating between person and number, while from a lexicalist perspective, the question of how feature content is accessed by the system is not addressed. Compared to the strictly syntactic view, the lexical one has the advantage of recognizing the need to anchor features to discourse entities to drive interpretive processes, but no different anchoring process is predicted for person and number. In neither account would a different response be predicted between person and number agreement violations. Instead, the FIP correctly predicts a distinction between features, by assuming the presence of different interpretive requirements for the two features. The ERP data reviewed here speak in favor of the FIP, showing a differential response from the system during the processing of person and number anomalies. In this respect, our results converge with a cartographic analysis of sentence structure (Cinque and Rizzi 2008; Shlonsky 2010), according to which each agreement feature is separately accessed by the grammar.

While this set of data cannot help us discriminate whether agreement is inherently directional or not, we can positively conclude that the person shift of Unagreement is not due to the underspecification of the controller. As hypothesized in Section 1, the underspecification analysis would predict absence of differences between standard agreement and Unagreement sentences, as the two patterns are expected to be computationally indistinguishable. This hypothesis is not borne out. Early eye-motion and ERP responses for Unagreement sentences pattern with the effects associated with person mismatch processing, and a significant decrease in accurate grammaticality ratings was found for Unagreement compared to Standard Agreement, thus suggesting sensitivity to a featural mismatch in the initial stages of processing. The FIP correctly predicts these findings, by postulating the performance of a checking between subject and verb’s \( \varphi \)-values, paired with \( \sigma \)-values checking to provide the system with potential solutions to the disagreement or to sanction an error. The fact that Unagreement and Standard Agreement eventually pattern together shows that anchor inspection has suggested the right answer to the system.

4.2. ANCHORING AGREEMENT IN COMPREHENSION

Overall, the ERP, grammaticality and eye-motion data support the hypothesis that in agreement comprehension two distinct stages can be identified: a feature-checking stage to check feature consistency, inspect anchors and sanction the presence of possible anomalies (cf. Molinaro et al. 2011b), and a subsequent stage, responsible for assigning an interpretation to the dependency and, when needed, for performing necessary repair and reanalysis operations.

Upon checking feature consistency between controller and target, the parser activates and inspects the interpretive anchor of each feature. If a match can be established between the \( \varphi \)- and the \( \sigma \)-values of the feature, as in standard agreement, the anchor remains “silent” and the resulting representation is passed on for further semantic elaboration. If a mismatch is found, the process takes different shapes depending on the nature of the disagreement, hence the emergence of different ERP responses. In the presence of Unagreement, inspection of the person anchor suggests the performance of an alternative Agree operation, while in the presence of outright person and number violation, the parser sanctions a syntax error that signals either the breaking of a cross-dimensional mapping (e.g. between discourse roles and morphosyntactic person values) or a more local conflict that can be solved by re-processing the inflectional information of the controller.
We have proposed a composite analysis of agreement that does not encapsulate this dependency within the boundaries of narrow syntax. Rather, we have decomposed feature bundles and tested person and number interpretive properties experimentally. What we see is that there is more to agreement than only a formal uni-directional feature-copying procedure targeting a set, or the covert filling of an underspecified argument. Features are accessed separately and their interpretation is driven by anchors that encode different semantic-pragmatic information concerning the role and number of the participants in the speech act. This anchoring between $\phi$- and $\sigma$- features holds for every agreement relation, in standard as well as in non-standard agreement patterns like Unagreement. We believe that the mechanism of anchor inspection proposed here captures an important aspect of non-standard agreement, namely that it is not to be treated as a different type of agreement, but as a different possibility that two elements have to be engaged in a dependency (cf. Corbett 2006:156).

Future work will be devoted to testing and refining feature anchoring against agreement configurations and mismatches that involve features other than person and number, such as gender, in domains other than the local subject-verb one explored here.

**Short Biographies**

Simona Mancini obtained her PhD in Cognitive Science from the University of Siena (Italy) and is currently a post-doctoral researcher at the Basque Center on Cognition, Brain and Language. Her research focuses both on the theoretical and experimental study of language, with a specific interest in morphosyntax and the processing of agreement.

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**Note**

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**Works Cited**


