THE NATURE OF SYNTACTIC GENDER PROCESSING IN SPANISH:

AN ERP STUDY

by

Polly Lee O’Rourke

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As members of the Dissertation Committee, we certify that we have read the dissertation prepared by Polly Lee O'Rourke entitled the Nature of Syntactic Gender Processing in Spanish: An ERP Study and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy.

_________________________________________________________Date: 6/16/08
Janet Nicol

_________________________________________________________Date: 6/16/08
Cyma van Petten

_________________________________________________________Date: 6/16/08
LouAnn Gerken

Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copies of the dissertation to the Graduate College. I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

_________________________________________________________Date: 6/16/08
Dissertation Director: Janet Nicol
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SIGNED: Polly Lee O’Rourke
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DEDICATION

To Mom and Eduardo
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ABSTRACT

The Nature of Syntactic Gender Processing in Spanish: An ERP Study

Syntactic gender as a lexical feature has been studied via picture-word interference paradigms in many languages. While effects have been found for noun phrase production in many languages, no effects have been found in Spanish, despite the fact that articles, nouns, and adjectives have a syntactic gender. Cubelli et al. (2005) found inhibitory effects in bare noun production in Italian which led to the hypothesis that such effects could be found for Spanish. Experiments 1 and 2 represented attempts to replicate Cubelli et al.'s findings (Experiment 1 used an auditory distractor word and Experiment 2 a visual distractor), however no gender congruency effects were found. Experiment 3 attempted to generate congruency effects by requiring subjects to utilize gender-marked demonstratives and adjectives but still no effects were found. The lack of effects gave rise to the proposal that gender is not accessed during noun phrase production in Spanish and that the extreme regularity of the gender-marking system makes an article-plus-noun phrase more akin to a single lexical unit that can be accessed without an explicit synthetic process. Experiment 4 contrasted simple noun phrases that might be directly retrieved to constructions with long-distance dependencies, for which access to abstract gender features is relevant to parsing hierarchical sentence structure and aimed to distinguish these distinct cognitive processes via event-related potentials. The hypothesis was that a local gender violation in a sentence like “la piano” (the-fem piano-masc) would elicit a LAN as compared to the correct alternative, while a long-distance violation like “el piano que compré ayer es antigua” (the-masc piano-masc that I
bought yesterday is antique-fem) would elicit a P600. All violations elicited a LAN and all violations involving adjacent segments elicited a P600; critically, the long-distance violation did not elicit a P600. It was concluded that the P600 reflects a repair process which occurs when such repair is not costly to the parser. Experiment 5 was a behavioral study using the stimuli from Experiment 4 with an error detection task which confirmed that subjects were sensitive to all error types.
Chapter 1 – Introduction

INTRODUCTION

Grammatical gender is a feature which is pervasive in Indo-European languages and many other language families. In such languages, all nouns are classified by gender. Spanish, Italian and French, for example, have two genders (masculine and feminine) so all nouns in these languages will be either masculine or feminine. Croatian, German and Dutch, on the other hand, have three genders, while Yimas (a Lower Sepik language) has eleven genders (Corbett 1991). In most instances, this gender is a purely grammatical feature. In Spanish, for example, there is a small group of nouns, all animate, which in addition to their syntactic gender also bear a natural gender feature. The nouns mujer, chica and profesora (woman, girl and female professor, respectively) bear feminine syntactic gender and represent feminine things in the world. Not all words which bear natural gender also bear the corresponding syntactic gender. In German, the noun mädchen (young girl) is not feminine but neuter in terms of its grammatical gender. Most nouns are inanimate and do not represent things in the world which are associated with a natural gender and there is, therefore, no correspondence between their syntactic gender and any real-world notions of masculinity or femininity. Gender is, for the most part, merely a way in which nouns are categorized in these languages.

While syntactic gender does provide a means by which to classify the nouns in a given language, the way in which gender is overtly manifest in languages is through agreement. Steele (1978) defines agreement as follows:
The term agreement commonly refers to some systematic covariance between a semantic or formal property of one element and a formal property of another. For example, adjectives may take some formal indication of the number and gender of the noun they modify.

Steele (1978, p. 610)

The following are examples of gender agreement in Spanish and German, respectively.

1. Las casas nuevas están limpias.
   The fem,pl house fem,pl new fem,pl are clean fem,pl.
   The new houses are clean.

2. Das neue Haus ist sauber.
   The neu,sg new neu,sg house neu,sg is clean.
   The new house is clean.

The example above from Spanish illustrates how all segments within the noun phrase (the determiner and any adjectives) must agree in gender (and number) with the head noun. In addition, it shows that any adjectives outside of the noun phrase which modify that head noun (limpias, in this example) must also agree in gender. This agreement with the noun is manifest in determiner selection and the selection of agreement morphemes which produce gender inflection in the adjective. This is typical of the Romance languages. The example from German shows that all segments (determiners and adjectives) within the noun phrase which modify the head noun must agree in gender. In other languages such as Hindi conjugated verbs must also agree in gender (and number) with their subject.
Although that crazy musician will sing a song, the listeners won’t boost his morale.

(adapted from Nevins, et al. 2007, p. 91)

While this example contains an animate subject (sangiitkaar) which bears a natural gender, the gender agreement between the subject and verb is obligatory for animate and inanimate nouns alike. While the precise mechanisms will vary, gender will be realized in agreement structures in some form in all languages that have syntactic gender (Corbett 1991). Morphological agreement between a noun and elements associated with it assists in the identification of constituents during parsing, and gender is one feature that participates in agreement processes.

**OVERVIEW OF DISSERTATION**

One of the primary types of research on gender processing explores the activation of gender features during lexical access. Of course, lexical access occurs during production, as a speaker/writer puts his or her thoughts into words, and during comprehension, as another individual interprets what is heard or read. In Chapter 2, I will discuss the word-level production studies. In Chapter 3, I present three experiments on the production of gendered nouns in Spanish for which reaction time is the measure of interest. Because the results were distinct from those previously published with other languages, I propose that, although many languages include gender as a lexical feature, the way in which speakers “find” the gender feature may be determined by language-
specific factors. In Chapter 4, I introduce a methodology of recording brain electrical activity (event-related potentials) and review its application to the study of sentence processing, typically in comprehension paradigms without production demands. Chapter 5 then presents an experiment which studies how native Spanish speakers process different types of agreement structures in sentences. Chapter 6 briefly summarizes the new behavioral and event-related potential experiments and attempts to integrate their findings.
Chapter 2

LEXICAL ACCESS AND PRODUCTION OF GENDER AGREEMENT

Syntactic gender has been examined extensively via the Picture-Word Interference paradigm which utilizes a picture naming task. The focus of this research is to examine syntactic gender as a lexical feature, determine how it is represented in the lexicon, and how agreement morphemes are selected during production. The following is a review of the literature relating to the access of syntactic gender features conducted with the Picture-Word Interference paradigm. The picture that will emerge from this literature is that in Spanish, unlike all other languages studied, the manipulation of gender features seems to have no effect on noun phrase production. This conclusion gives rise to the speculation that in Spanish, the gender agreement which exists between a determiner and noun is processed differently than that which exists between a noun and non-adjacent elements.

Much of the psycholinguistic research on gender effects in lexical access has been done with the Picture-Word Interference Paradigm. In this paradigm, subjects are shown a picture and asked to name it while, at the same time, they are presented with a distractor item (either visually or auditorily). The features of the target word and distractor word can be manipulated in order to gain insight into the process of lexical access and the representation of lexical items. In this paradigm, robust semantic relatedness effects which are inhibitory in nature have been found (Glaser and Düngelhoff 1984) as well as effects of phonological similarity which are, in contrast, facilitatory (Jeschniak and
Schriefers 2001). This indicates that features of the lemma and lexeme of the distractor word are activated (See Figures 1 and 2).
Figure 1 – The structure of a lexical item (adapted from Levelt, Roelofs & Meyer 1999)
Figure 1 illustrates the independence of the word form (lexeme) from the underlying representation of the word (lemma). The lemma is generally considered to be the part of the lexical entry in which syntactic and semantic features are stored, while the lexeme represents the phonological or output form. As Figure 1 illustrates, in this model the lemma is broken down into two parts (the conceptual and syntactic levels) and gender is stored as part of the syntactic portion of the lemma. This is not uncontroversial. In fact, one of the critical questions addressed in this literature is where exactly gender features are stored (adjoined to the lemma (Levelt 1989, Roelofs 1992, Levelt, Roelofs & Meyer 1999) or to the lexeme (Caramazza 1997)).

**Models of Word Production**

The following is a description of two prominent models of lexical access: the WEAVER ++ model (Roelofs 1992 and Levelt, Roelofs and Meyer 1999) and the Independent Network model (Caramazza 1997).

**WEAVER++**

Roelofs (1992) posits four stages of processing in the naming of a perceptually presented object: (1) “object identification based on perceptual input” (113), (2) lemma retrieval (the retrieval of the bundle(s) of abstract semantic and syntactic features that comprise a lexical item), (3) word-form (phonological) encoding and (4) articulation (see Figure 2). Roelofs assumes that there is bidirectional communication between the conceptual identification level and the lemma retrieval level. When a written word is presented, the lemma retrieval and word-form encoding levels will be activated independently (so, from the word-form encoding stage the process will proceed to
articulation and, therefore, visually presented distractor words will be encoded even though the subject will not produce them). Research indicates (Glaser and Glaser 1989, La Heij, et al. 1990, Glaser & Düngelhoff 1984) that the word-form can be accessed directly from a written representation of a word in a production task.
Figure 2: Picture-Word Interference Paradigm in the WEAVER++ Model. (adapted from Roelofs 1992, 114)
With regard to the structure of the lexical network there are three strata (see Figure 3).
Figure 3: The lexical network involved in the picture-word interference paradigm in the WEAVER++ Model. (adapted from Roelofs 1992, 116) The lemma is composed of two levels: The Conceptual Stratum and the Syntactic Stratum (see above).
First there is the conceptual stratum (containing conceptual nodes) in which semantic features are specified. Roelofs posits numerous ‘relation’ nodes (can, has, is-a, etc.) which link the representations at the conceptual stratum to their semantic features and hypernyms. This stratum has the visually presented object as its input and sense (the conceptual specifications for the lemma) as its output. Second, there is the syntactic stratum (containing lemma nodes) in which syntactic features such as syntactic category and gender are specified. Please note that, because the example in Figure 3 is in English, there are no gender nodes specified. The nodes marked “syntactic features” represent the location of gender features in this model. This stratum has inflex (orthographically presented input lexeme) as its input and outflex (output lexeme which links the syntactic and word-form strata) as its output. In addition, it provides feed-back to the conceptual stratum in the form of the two-way sense link. Lastly, the third level is the word-form stratum where morphological, phonological and prosodic features are specified. This stratum has also inflex as its input in addition to outflex (the output of the syntactic stratum).

Roelofs’ spreading activation model characterizes lemma retrieval as “a very simple process” in which “[t]he activation level of the node of the to-be-verbalized concept is enhanced, followed by the spread of the activation from the conceptual stratum towards the syntactic stratum, and a selection of the highest activated lemma node” (Roelofs, p. 117). Roelofs indicates that “[t]he activation level of the target lemma node must also exceed that of the other nodes in the response set by some critical amount”
Roelofs, p. 118). In the picture-word interference paradigm, the “retrieval system must select the lemma activated by the picture, and prevent selection of the lemma activated by the distractor word” (Roelofs, p. 117). He accounts for the semantic inhibition effect observed in previous experiments (e.g. Glaser and Dunkelhoff 1984) by positing that when the object and distractor word are semantically related, each activates the other’s lemma node. For example, in Figure 3, the object in the picture is a fish and the distractor word is dog so the lemmas of both are activated. The target is FISH. When the path from the distractor word to the target lemma node (dog - DOG (X) – ANIMAL (X) - FISH (X) - fish) is longer than from the picture to distractor lemma node (FISH (X) - ANIMAL (X) - DOG (X) - dog), there is semantic inhibition. Because the path from the picture to the target distractor lemma is shorter than the path from the distractor word to the target lemma, the picture will prime the distractor word lemma more than the distractor word will prime the target lemma for the picture. The related distractor word, therefore, receives higher activation from the target than the target from the distractor. This is the cause of the semantic inhibition in that the increased activation of the distractor word delays the production of the target word (i.e. it takes longer for the target word to reach a level of activation sufficiently greater than the distractor). Nevertheless, the fact that the target gets activation from the picture and the distractor means that it receives higher total activation than the distractor. In the unrelated condition, the two lemmas which are active do not activate each other and there is no conflict.

Roelofs’ model provides an adequate framework for lexical access within the context of the picture-word interference paradigm. The only condition he examines,
however, is semantic relatedness. Levelt, Roelofs and Meyer (1999) advance the model by providing a more in depth analysis of its properties relating to syntactic, morphological, phonological and phonetic selection. The key insight for the current analysis is that the syntactic features of a lemma may only become available after the lemma is selected for production, not by mere activation (Levelt, Roelofs & Meyer, p. 4). There is no spreading activation from active but not-selected lemmas. While activation from the conceptual stratum may spread to various lemmas, this lemma-level activation will spread to the syntactic nodes, and the word-form level, only when the lemma with the highest activation is selected. Another important point made by Levelt, Roelofs and Meyer (1999) is that they assume that "recognizing a word, whether spoken or written, involves accessing its syntactic potential, that is, the perceptual equivalent of the lemma [and, therefore,] activation of the corresponding lemma-level node" (Levelt, Roelofs & Meyer, p. 7). In other words, word recognition (lexical access) always involves the access of that word’s syntactic features (i.e. potential). The implication is that “distractor words will have direct access to the lemma stratum” (Levelt, Roelofs & Meyer, p. 11) and according to the assumption cited above, they should access syntactic features.

This model claims that the “gender congruency effect should only be obtained when agreement has to be computed” (Levelt, Roelofs & Meyer.1999, p. 14) because only then would the gender features be selected. The WEAVER++ model does make a distinction between lemma activation and lemma selection. Gender nodes may be activated when a lemma is selected but they will not be selected unless they are necessary for use. The priming of a gender node will only affect lexical access when the gender
node has to be selected for use in an agreement structure. While all lemma nodes of nouns point to their corresponding gender node (eg., all feminine nouns are linked to a feminine gender node which is used to generate gender agreement), these connections are one-way. Activating the gender node of one lemma will not influence the level of activation of another lemma, unless those gender nodes are selected. This model, therefore, predicts gender congruency effects in the picture-word interface paradigm when subjects are required to produce noun phrases but not when they produce bare nouns.

**Independent Network Model**

Caramazza’s (1997) model of lexical production addresses more directly the issue of the representation of syntactic features and provides valuable insights into the nature of grammatical gender. Caramazza maintains that it is critical to distinguish between a lexical-semantic level and the word-form level but disputes Roelofs (1992)’s assertion of the existence of the lemma as an obligatory intervening step between the lexical-semantic and word-form levels. He argues that this intervening lemma level, in which, as per Roelofs, syntactic information is specified, is superfluous. He proposes the Independent Network (IN) model in which the representation of syntactic information is autonomous from that of semantic and phonological information (see Figure 4). In the IN model, there is a lexical-semantic network representing “word meanings as sets of semantic properties, features or predicates” (Caramazza, p. 194) and a lexical syntactic network representing “features such as grammatical category, gender, auxiliary type, tense,” (Caramazza, p. 194) etc. In the lexical-syntactic network, there are subnetworks for
different grammatical features (grammatical category, gender, etc.). “Nodes within a subnetwork have inhibitory links since they are in competition” (Caramazza, p. 194). His IN model contains no modality independent lexeme representations but rather distinct lexeme representations for the oral and orthographic modalities (P-lexemes and O-lexemes, respectively).
Figure 4: The lexical access network in the Independent Network Model (adapted from Caramazza 1997, 196). In this model, the output form selected is either orthographic or phonological.
Word production, then, involves the following. The activation of a lexical-semantic representation spreads to the lexical-syntactic network and to either a P-lexeme or an O-lexeme network. Caramazza states that “[n]ot all syntactic features can be activated by the semantic network” (Caramazza, p. 194), and a prime example of this is grammatical gender. Even though some grammatical features, like grammatical category, are activated by the semantic network, the level of activation is not sufficient for the feature to reach threshold and be selected. The syntactic network itself must be activated by the selection of the modal-appropriate lexeme. Syntactic features are selected prior to the selection of the specific phonological/orthographic form of the word. Thus, in a TOT state, it is possible to retrieve the first phoneme without the syntactic gender information as “the selection of the lexeme does not guarantee the selection of the full set of its associated syntactic features” (Caramazza 1997, 197). In cases in which anomic subjects can retrieve the gender of the target noun but not any form information (Miozzo & Caramazza 1997), the Independent Model posits a “a deficit in accessing the phonological content of the correctly selected lexeme representations” (Caramazza 1997, 198). The spread of activation from the lexical-semantic representation to the lexical-syntactic and lexeme levels is independent and simultaneous.

This model makes clear predictions for gender congruency effects in the picture-word interference paradigm. Gender as a syntactic feature is not accessed until the output form is selected so activation of a gender feature would not be a prerequisite for the selection of a bare noun for production (as opposed to semantic features). With regard to noun phrases, which do require the access of gender information for production, it is
possible that, as Caramazza and Miozzo (1997) propose, gender congruency effects in the production of NPs is due to competition in the selection of determiners. If two different gender marked determiners are activated equally by the distractor word and target word, then they will compete. Gender congruent picture-word pairs will not be subject to competition and so response latencies will be faster. The IN model, therefore, predicts a null effect in bare noun production and a facilitatory effect in NP production. Next, the results of the picture-word interference experiments are discussed. As will become clear, different effects are seen in different experiments.

**Picture-Word Interference Experiments in Dutch**

The first relevant study was by Schriefers (1992) and examined gender congruency effects in Dutch. For all practical purposes, Dutch nouns are grouped into one of two genders; neuter and common. Historically, Dutch had three genders (neuter, masculine and feminine) but in modern Dutch, masculine and feminine have been collapsed in the common gender (Donaldson 1997). There is no overt morphology corresponding to gender-marking on nouns (Donaldson 1997). Schriefers used the picture-word interference paradigm: subjects were asked to name a pictured object with a specified type of noun phrase. The noun phrase consisted of either a determiner, adjective and noun or just an adjective and noun. In Dutch, the determiner and adjective, when no determiner is present, must agree in gender with the noun. Please see the noun phrases (NPs) in (1) for examples.
4. a. het rode bed
   the(neuter) red bed(neuter)
b. de rode stoel
   the(non-neuter) red chair(non-neuter)
c. rood bed
   red(neuter) bed(neuter)
d. rode stoel
   red(non-neuter) chair(non-neuter)  (La Heij, et al. 1998, p. 209)

The gender of the visually presented distractor word was either congruent or incongruent with the gender of the target word. Schriefers found that subjects’ naming latencies were longer when the gender of the distractor word and target word were incongruent.

Assuming that lexical representations in Dutch include links to “gender nodes”, he attributed this slowdown to competition among the two different gender nodes which were activated when the distractor and target words were accessed. Subsequently, Schiller and Caramazza (2003) found that the effect was only elicited when subjects produced NPs with singular determiners (which are gender specific) as opposed to plural determiners, which while they specify a gender bearing noun, are themselves ambiguous with respect to gender-marking in Dutch. In addition, Schiller and Caramazza found that there was no effect of gender congruency in the production of NPs consisting of gender-marked adjectives and nouns. La Heij, Mak, Sander and Willeboordse (1998) sought to expand upon Schriefers’ (1992) results. They also used the picture-word interference paradigm with a visually presented distractor word. They asked their Dutch speaking subjects to produce an NP consisting of a determiner and a noun and replicated Schriefers’ results for noun phrase production. They also, however, included a condition in which subjects were required to produce bare nouns as labels for the pictures. In this
bare noun condition no gender congruency effect was found. The general conclusion from the Dutch data is that gender features are accessed when they are needed for the selection of appropriate agreement morphemes. The selection of a noun’s syntactic gender node is an automatic non-competitive process; competition exists only in determiner selection.

**Picture-Word Interference Experiments in German**

German, a language which bears many similarities to Dutch, behaves similarly in this paradigm. German has a three gender system (masculine, feminine and neuter) and, like Dutch, no overt (i.e. morphological) gender marking. There are derivational morphemes that are correlated with specific genders (famously the diminutive suffix -

\[\text{chen},\] which renders a young girl (\text{mädchen}) neuter). Schriefers and Teruel (2000) used the picture-word interference paradigm with auditorily presented distractor words, and asked subjects to produce NPs (either determiner+noun or determiner+adjective+noun) as labels for the pictures. The researchers found facilitatory gender congruency effect for both types of NPs.\(^1\) Schriefers and Teruel interpret this result as indicating competition between activated gender-related nodes. Schiller and Caramazza (2003) found that in German, as well as Dutch, gender congruency effects are only elicited in the production of NPs with singular definite articles (and not the morphologically ambiguous plural forms, nor the gender-marked adjectives). The results for German, therefore, confirm the hypothesis that gender congruency effects are driven by competition during the selection of the determiner. Schiller and Costa (2006) obtained a gender congruency effect in the

\[^1\quad\text{This effect was limited to later SOAs (+75, +150)}\]
production of NPs with definite determiners but not in the production of NPs with gender marked adjectives. This suggests that the gender congruency effect is grounded in competition for the selection of determiners rather than in activation levels of gender nodes.

**Picture-Word Interference Experiments in Croatian**

Costa, Covacic, Fedorenko and Caramazza (2003) examined gender-congruency effects in Croatian, a Slavic language, using the picture-word interference paradigm. Croatian, like German, has a three gender system (masculine, feminine and neuter) and like German and Dutch, nouns do not bear overt gender-marking morphemes. Croatian does not, however, have articles, so gender congruency effects were assessed with gender-inflected possessive adjectives and gender-marked pronouns. The gender-marked pronouns are free-standing morphemes while the gender-marking morphemes on the possessive articles are bound. In the pronoun conditions, subjects would be shown a picture (together with a distractor word) and asked to produce a simple sentence. The pronoun (*ga* or *je*) agrees in gender with the target noun. In the possessive adjective condition, subjects were asked to produce NPs.

5. a. vidim ga
   See$_{1S}$ it$_{masc}$
   I see it.

   b. vidim je
   see$_{1S}$ it$_{fem}$
   I see it.
6. a. moj klarinet
   my\textsubscript{masc} clarinet\textsubscript{masc}

   b. moja tuba
   my\textsubscript{fem} tuba\textsubscript{fem}

Costa et al. found facilitatory gender-congruency effects when subjects produced a gender-marked pronoun (which had the picture as the referent). No effects were found for the production of inflectional suffixes on possessive adjectives. Thus, the proposal that gender congruency effects are result from competition between gender marked lexical items (rather than inflectional morphemes) is supported by this data.

**Picture-Word Interference Experiments in French**

French, which has a two gender system (masculine and feminine), has also been studied in this paradigm (Alario & Caramazza 2002). As in Italian, the selection of the determiner (le or l’ for masculine nouns, la or l’ for feminine nouns) is influenced by the phonological form of the noun. If a masculine noun begins with a consonant, le is used. If a feminine noun begins with a consonant, la is used. If a noun begins with a vowel, l’ is used. Unlike Italian, French does not have overt gender-marking morphology (although, like German, some derivational morphemes are highly correlated with specific genders). Alario and Caramazza found no gender congruency effects for the production of NPs (det+noun) and concluded that the determiner only becomes available late in the process due to the dependency on the availability of the lexeme. The production of bare nouns was not investigated.
**Picture-Word Interference Experiments in Italian**

In addition to Germanic and to a much lesser extent Slavic languages, the Romance languages have received much attention in this area of research. While Alario and Caramazza (2002) conducted their study on French, French is different from many other Romance languages like Spanish and Italian in terms of its gender marking. Research on gender congruency in Romance languages like Spanish and Italian shows a different pattern of results from the Germanic and Slavic languages. We should note at this juncture that the gender systems in these Romance languages are different in important ways from the Germanic systems. First, they are binary (masculine and feminine) and overt morphological gender marking on nouns is prevalent. In Italian and Spanish, for example, most masculine words end in -o while most feminine words end in -a. Another important distinction is that for some Romance languages it is necessary to know the phonological form, in addition to the gender specification, of the noun prior to selecting the appropriate definite determiner. The following are examples involving masculine nouns in Italian.

7. a. l’amore
   The\textsubscript{masc} love\textsubscript{masc}

   b. lo spirito
   The\textsubscript{masc} spirit\textsubscript{masc}

   c. il vino
   The\textsubscript{masc} wine\textsubscript{masc}

All of the nouns in (7a-b) are singular and masculine but select different articles based on their phonological form. The gender system of Italian differs from Dutch and German in
that in order to select the appropriate definite article, it is necessary to know the phonological form (i.e. have access to the lexeme) of the corresponding noun. The masculine article can either be *lo*, *il* or *l’* and a feminine article can be *la* or *l’* depending on the first phoneme of the noun. If a masculine noun starts with *z*, *gn*, *ps* or *s+consonant* the definite article will be *lo*. If it begins with any other consonant or cluster of consonants, the article will be *il*. In addition, if a noun of any gender begins with a vowel, the article will be contracted to *l’*.

Miozzo and Caramazza (1999) conducted a study in Italian using the picture-word interference paradigm. The researchers found no gender congruency effects in the production of NPs (determiner + noun). The researchers propose that because the selection of the article must be delayed until the phonological form of the noun is retrieved, any gender congruency effects that might have occurred earlier in the process would have disappeared. They make a distinction between “early selection” languages (like Dutch and German) in which the gender of the noun is the only criterion for determiner selection and “late selection” languages (like Italian). In early selection languages, the gender-specific determiner receives higher activation when in the congruent conditions. In late selection languages, no one determiner can receive heightened activation as gender alone is not sufficient to ascertain which determiner will be selected.

Cubelli, Lotto, Paolieri, Girelli and Job (2005) looked at the question of the production of bare nouns in Italian. They indeed found an inhibitory effect in Italian (naming latencies were longer when in the gender congruent condition) which is evidence
gender congruency effects are not necessarily limited to the selection of determiners or other free standing morphemes. As was predicted, based on the earlier study, the effect disappeared when subjects were asked to produce NPs. Cubelli et al. proposed their “Double Selection” Model in which, due to the overt gender-marking that exists on most nouns of Italian, there is competition, not only for the selection of semantic representations but also for abstract syntactic representations. The result of this competitive selection process is the selection of the proper gender-marking morphemes on the noun.

The Double Selection Model

Cubelli et al.’s (2005) finding of inhibition (or interference) with congruent gender defied the predictions of the two models of lexical access during language production discussed thus far. In order to account for these data, Cubelli et al. developed the Double Selection model. As Cubelli et al. note,

Our findings, [. . .], allow us to propose that in contrast to what is assumed by the WEAVER++ model, the selection of a noun’s grammatical gender, at least in Italian, is mandatory (i.e., it occurs also when the noun has to be produced outside a sentential context), and that, in contrast with what is assumed by the IN model, it is not automatic (i.e., it reflects a competitive process). (p. 52)

Cubelli et al. suggest that both lexical-semantic and lexical-syntactic information must be selected before the phonological form of a word is accessed. The two feature types (semantic and syntactic) are selected independently of each other and both are competitive selection processes. Only after the competition at both levels has been resolved can the phonological form of the word be accessed. Competition at the semantic or conceptual stratum is assumed in both of the models of lexical access (WEAVER++
and IN). When representations at this semantic level are similar, they are both highly activated and compete for selection. Cubelli et al. propose that the same competitive selection process occurs with syntactically similar lemma representations (i.e., representations which share the same gender). See Figure 5. “[C]ompetition at the lemma level produces the selection of the abstract, full description, either semantic or syntactic, of a given noun” (Cubelli et al. p. 53) not a semantic category or gender node. In other words, the semantic and syntactic features of a lexical item are contained in two independent, abstract representations (rather than in a feature network).
Figure 5: Base noun production in Italian (a) and Dutch (b) in the Double Selection model. (adapted from Cubelli, et al. 2005, 54)
Figure 5 (Cubelli et al. 54) provides a graphic representation of the production of bare nouns in Italian (A) and Dutch (B) in Cubelli et al.’s Double Selection model. The left hand box shows the semantic representations while the right hand box shows the syntactic representations. The arrows connecting the representations within a box indicate activation while the arrows connecting the lemma to lexeme indicate selection. Cubelli et al. assumes that the selection of the grammatical gender feature is only required in languages like Italian in which almost all nouns have a complex morphological structure related to gender, as opposed to Dutch which has no such structure. Cubelli et al. describe the process of accessing the correct form for the target in Italian as follows:

At the lemma level, the semantic competition occurs first. Then, if the target and distractor nouns have the same grammatical gender, their syntactic representations compete for selection, thus slowing the access to the correct vowel ending. Therefore, the gender interference effect originates at the level of representation that precedes the level specifying the morpho-phonological form. (p. 54)

In Dutch, no inflectional information needs to be selected in the production of bare nouns so the selection of semantic information is sufficient in order to access the phonological form of a noun. The selection of grammatical gender is, therefore, irrelevant outside of a sentential context in Dutch and, so, there is no gender congruency effect in the production of bare nouns. This account is consistent with the WEAVER++ model in that it posits that grammatical information must be selected before accessing word form, however, in contrast to the WEAVER++ model, Cubelli et al. also proposes a direct link between semantic representations and phonology.
In accordance with the current data and that of Miozzo and Caramazza (1997), the model predicts that the gender congruency effects will disappear when subjects produce an NP (see Figure 6).
Figure 6: Noun phrase production in Italian (a) and Dutch (b) in the Double Selection model. (adapted from Cobelli, et al. 2005, 54)
In Italian (Figure 6a), when the distractor word and target are gender congruent, they do send activation to the same set of determiners but, ultimately, the selection of the determiner is postponed until the phonological form of the noun is available (indicated by the dashed arrow), so that any effects based on the congruency between the two nouns have dissipated. In Dutch (Figure 6b), the selection of the determiner can be made prior to the selection of the phonological form as there is no relationship between the two. The increased activation of the definite article gives rise to the facilitatory effects observed in previous research (Schriefers 1992, La Heij et al. 1998).

**Picture-Word Interference Experiments in Spanish**

Spanish, like Italian, has a two gender system (masculine and feminine). Put simply, there are nouns which are transparently gender-marked which end in -o or -a, for masculine and feminine respectively (ojo, eye-masc, casa, house-fem), as well as opaquely marked nouns which end -e and can be either masculine or feminine (coche, car-masc, parte, part-fem). There are also derivational morphemes which are associated with specific genders (-ción tends to be feminine while -dor tends to be masculine, for example) and word final consonants form phonologically opaque nouns (-z, -s, -l, etc.) for which gender cannot be determined by the word final phoneme or morpheme. There are also irregular forms which bear a word-final sound that is typically associated with one gender but are actually the other gender For example, in *la radio* (radio), the word final vowel typically indicates a masculine noun but the word is feminine. Likewise with, *el mapa* (map), the word final –a typically indicates a feminine noun but the word is...
masculine. Also like Italian, but unlike Dutch and German, Spanish has overt gender marking in the morphology of nouns; nouns that end in –o are masculine (el carro (car), el libro (book)) and nouns that end in –a are feminine (la taza (cup), la tienda (store/tent)). The gender of a noun, therefore, is relevant to the realization of its form and, therefore, to the production of nouns both within and outside of a syntactic context (the NP and bare noun conditions, respectively). It can be proposed, as per Cubelli et al., that grammatical gender is available in Spanish, as in Italian, at the level of selection of open class words.

Costa et al. (1999) conducted a series of experiments on Spanish and Catalan in order to provide clarification on the issue of gender congruency effects in languages which require knowing the phonological form of the noun prior to the selection of the determiner. Catalan is similar to Italian and French in that it is necessary to know the phonological form of the noun in order to select the appropriate article. The articles el (masculine) and la (feminine) are used with nouns beginning in a consonant while l’ is used for nouns beginning in a vowel. Spanish, in contrast, is more similar to Dutch and German in that, for the most part, phonological information is not needed to select the article. (There is, however a small number of feminine nouns (less than 0.5% of nouns) in Spanish which, due to their phonological form, do not select the standard feminine article².) In all of the experiments, subjects were required to produce an NP (determiner + noun). Again, no gender congruency effects were observed for either language. Costa et al. adopt Miozzo and Caramazza’s (1999) explanation of the Italian data: selection and

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² If a feminine noun begins with an /a/ which has primary stress, the article will be el. In all other cases, the feminine article is la. Therefore, it is el agua and el águila but la adolescencia and la aspirina.
retrieval of the phonological form of a word renders invisible any gender congruency effects that may have occurred during early lexical selection processes.

Conclusions

The predictions of the WEAVER++ and Independent Network models—that congruency effects will arise in the production of NPs but not bare nouns—hold for Dutch and German but not Italian, Catalan and Spanish. With regard to NP production, several factors can be examined in an attempt to account for this data. First, as has been previously noted, Italian, Catalan and Spanish require phonological form information in order to select between gender appropriate determiners whereas Dutch and German do not. This distinction between early and late selection languages could explain the contrasting data (Miozzo and Caramazza 1997, Costa et al. 1999). The group of possible determiners would be activated but not selected until the phonological form of the noun is specified. It is doubtful, however, if Spanish can be included in the late selection group because phonological form information is relevant to determiner choice for a tiny minority of nouns. Schriefers and Teruel (2000) observe that gender congruency effects are found in languages in which there is a one-to-one relationship between the gender node of the noun and its determiner (as opposed to the one-to-many relationship in the Romance languages). It appears that the nature of the mapping from gender node to determiner establishes whether or not a gender congruency effect will be obtained. Again, such an explanation appears plausible for Italian and Catalan but it remains uncertain that Spanish belongs in the one-to-many category.
The conflict between the Dutch and Italian data for bare noun production is very important as it establishes that not all languages will pattern like Dutch. The Double Selection model provides an account for Cubelli et al.’s (2005) findings based on the morphological differences between Italian and Dutch. The critical question is, will the predictions of the Double Selection model for bare noun production hold for other Romance languages, specifically Spanish?

**General Conclusions**

The research described above indicates that gender congruency effects vary cross-linguistically and are indicative of the properties of language-specific gender systems. The differing results serve to inform our models of the structure of the lexicon and lexical access. The goal of the experiments detailed in Chapter 3 is to determine if bare noun production in Spanish will pattern like Italian or Dutch in order to clarify the process of lexical access in Spanish.
Chapter 3 - Behavioral Experiments

In order to examine further how syntactic gender features are utilized during production, I conducted three experiments using the Picture-Word Interference paradigm with Spanish speakers. The results of Cubelli, et al. (2005) for bare noun production in Italian lead us to ask whether such a result could be obtained in other Romance languages. Spanish, the object of the current study, provides an excellent opportunity to address this question. The gender system of the Spanish language is similar to that of Italian but it has some important differences. After discussing the relevant features of the Spanish language, the previous research on Spanish will be assessed and the parameters for the current study will be set forth. Experiment 1 sought to determine if Cubelli’s findings for bare noun production in Italian could be replicated in Spanish. In addition to the gender conditions (see below) a semantic relatedness condition was also included.

EXPERIMENT 1

Method

Subjects

Data were collected from a total of 16 subjects. All of the subjects were Spanish/English bilinguals for whom Spanish was the dominant language. A total of 25 subjects were tested in the experiment. Two had to be excluded due to the fact that they were English dominant and seven more had to be excluded due to problems with the recording equipment. The ages of the participants ranged from 18 to 45 (average age was 31.3). Participants were recruited via flyers and word of mouth in the general university community.
Stimuli

Fifty-five pictures (line drawings) were selected from Lotto, Dell’Acqua and Job’s (2001) database (thirty for the gender conditions, fifteen for the semantic conditions and ten for the training phase). This database was also the source of Cubelli et al.’s picture stimuli. All of the targets (picture names) for the gender condition ended in either –a or –o (for feminine and masculine, respectively) while some of the nouns in the semantic conditions ended in –ón (masculine). Of the thirty pictures selected for the gender conditions fifteen names were masculine and fifteen were feminine. The words in each of the two lists (masculine and feminine) were matched for frequency and word length (Feminine targets: Avg. Frequency = 301.1 (per 6,750,000), Avg. Length = 4.3; Masculine targets: Avg. Frequency = 307.6, Avg. Length = 4.4). Frequency information was obtained from Davies’ (2005) Corpus del Español. Fifteen pictures were chosen for the semantic conditions (Targets: Average Frequency = 398, Avg. Length = 6.00). Eight additional pictures were selected for the training phase (Avg. Frequency = 4197, Avg. Length = 6.4). 106 distractor words were chosen. For the gender conditions, sixty canonically gender marked nouns (all bearing the –a or –o morpheme), all the matched for frequency and length, were chosen as the distractor words Feminine distractors: Avg. Frequency = 837.3, Avg. Length = 4.4; Masculine distractors: Avg. Frequency =836.7, Avg. Length = 4.4). Thirty distractor words, 15 related and 15 unrelated to the targets, were chosen for the semantic conditions (Related distractors: Avg. Frequency = 1140, Avg. Length = 5.47, Unrelated distractors: Avg. Frequency = 1070, Avg. Length = 4.7). Sixteen additional distractors were chosen for the training phase (Avg. Frequency = 2643,
Avg. Length = 4.6). As the distractor words were to be presented auditorily, recordings were made of a native Spanish speaker pronouncing all of the distractor words. In addition, a non-word speech sound ([m:]\textsuperscript{3}) was recorded in order to have a baseline. Six conditions, differing as to the relationship between the target and distractor, were employed in this experiment. They are as follows:

\begin{itemize}
\item 
\item 
\item 
\item 
\item 
\item 
\end{itemize}

\textsuperscript{3} This sound in informal transcription is “ummmm”.

Table 1 – Sample Stimuli from Experiment 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Target (example)</th>
<th>Distractor (example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender congruent</td>
<td>bota (boot-feminine)</td>
<td>seda (silk-feminine)</td>
</tr>
<tr>
<td>Gender incongruent</td>
<td>bota (boot-feminine)</td>
<td>queso (cheese-masculine)</td>
</tr>
<tr>
<td>Gender baseline</td>
<td>bota (boot-feminine)</td>
<td>[m:::] (baseline)</td>
</tr>
<tr>
<td>Semantically related</td>
<td>piña (pineapple)</td>
<td>frutas (fruit)</td>
</tr>
<tr>
<td>Semantically unrelated</td>
<td>piña (pineapple)</td>
<td>lobo (wolf)</td>
</tr>
<tr>
<td>Semantic baseline</td>
<td>piña (pineapple)</td>
<td>[m:::] (baseline)</td>
</tr>
</tbody>
</table>
Within each session, each of the 30 pictures in the gender conditions were presented three times, once in each condition/distractor type (congruent, incongruent and baseline). In the gender congruent condition, the target and distractor were of the same gender. In the incongruent condition they were of different genders. Lastly, in the baseline condition, the picture was accompanied by the non-word speech sound ([m:]). Similarly, in the semantic conditions each of the 15 pictures were presented with a semantically related distractor (7 of the 15 pictures had gender congruent distractors and 8 had incongruent distractors), an unrelated distractor or the neutral non-word speech sound. The remaining ten pictures were incorporated into a training phase which mimicked the arrangement of the experimental items. Subjects participated in two sessions. In one session, they were asked to produce a bare noun in the picture-naming task and in the other they were asked to produce a noun phrase (definite article + noun). The picture-word pairs were the same in both sessions but the order of presentation was in a different random order in each session. There were, therefore, a total of 135 trials per session (30 in each of the three gender conditions and 15 in each of the three semantic conditions).

**Procedures**

After the subject filled out a consent form and language history questionnaire, the experimenter showed the subject hard copies of all of the pictures that would appear in the experiment and asked him/her to name the objects depicted. This warm-up activity (lasting between 5 and 10 minutes) was conducted exclusively in Spanish. Next, the subject performed the experimental tasks in a sound attenuated booth. In each trial,
subjects saw an orienting cross prior to being presented (simultaneously) with the picture and distractor word. Subjects were instructed to name the object shown in the picture as quickly and accurately as possible. Naming latencies were measured from the onset of the distractor word. Display of stimuli, recording of naming latencies and the creation of Digital Audio (*.wav) files of subjects’ responses was achieved with the DMDX software package developed at the University of Arizona by J.C. Forster (Forster & Forster, 2003). Each session lasted about fifteen minutes. The order of the sessions (Bare noun/NP, NP/bare noun) was balanced across subjects. All sessions were recorded on cassette tape (as a back-up to the digital *.wav files).

Results

In bare noun production, 7.2% (155) of responses was excluded from the analysis, 25.2% (39) of which were naming errors. In NP production, 7.6% (164) of responses was excluded from the analysis, 33.5% (55) of which were naming errors. The mean correct response times (RTs) are plotted in Table 2.
Table 2: Reaction Times for Bare Noun and NP Production in All Conditions

(Experiment 1) (* indicates p < .05)

<table>
<thead>
<tr>
<th>Bare Noun Production</th>
<th>Condition</th>
<th>RT</th>
<th>Condition</th>
<th>RT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gender Congruent</td>
<td>845</td>
<td>Semantic Related</td>
<td>898</td>
</tr>
<tr>
<td></td>
<td>Gender Incongruent</td>
<td>846</td>
<td>Semantic Unrelated</td>
<td>853</td>
</tr>
<tr>
<td></td>
<td>Gender Baseline</td>
<td>786</td>
<td>Semantic Baseline</td>
<td>755</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>(-1)</td>
<td></td>
<td><strong>Difference</strong></td>
<td>(45*)</td>
</tr>
<tr>
<td>(Congruent –Incongruent)</td>
<td></td>
<td></td>
<td>(Related –Unrelated)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Noun Phrase Production</th>
<th>Condition</th>
<th>RT</th>
<th>Condition</th>
<th>RT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gender Congruent</td>
<td>829</td>
<td>Semantic Related</td>
<td>847</td>
</tr>
<tr>
<td></td>
<td>Gender Incongruent</td>
<td>827</td>
<td>Semantic Unrelated</td>
<td>836</td>
</tr>
<tr>
<td></td>
<td>Gender Baseline</td>
<td>769</td>
<td>Semantic Baseline</td>
<td>768</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>(2)</td>
<td></td>
<td><strong>Difference</strong></td>
<td>11</td>
</tr>
<tr>
<td>(Congruent –Incongruent)</td>
<td></td>
<td></td>
<td>(Related –Unrelated)</td>
<td></td>
</tr>
</tbody>
</table>
An analysis of variance (ANOVA) was performed on these data and the only significant finding is the semantic inhibition effect in bare noun production \((F(1,15) = 5.87, p < .05)\). such that reaction times were longer when the distractor words were related to the targets. The 11 ms inhibitory effect between the related and unrelated conditions in the noun phrase production task does not approach significance \((F <1)\). The differences in reaction times in the gender conditions (congruent – incongruent) were were not significant in bare noun or NP production (all \(Fs <1\)). In both bare noun and NP production tasks, there was a main effect of condition reflecting shorter reaction times in the baseline condition relative to the conditions with distractor words (Bare nouns: \(F(2,30) = 11.851, \varepsilon = .814, p < .005\), NPs: \(F(2,30) = 10.637, \varepsilon = .883, p < .005\)). Simple comparisons show that each gender condition (congruent and incongruent) differed significantly from the baseline (Bare nouns: congruent \(F(1,15) = 11.961, p < .005\), incongruent \(F(1,15) = 16.801, p < .005\), NPs: congruent \(F(1,15) = 11.610, p < .005\), incongruent \(F(1,15) = 27.559, p < .001\)). Overall naming latencies in bare noun production were longer than in noun phrase production but this did not approach significance (for all items with distractor words: difference = 23, \(F <1\); overall including the baseline items: difference =16, \(F <1\)). Though the gender conditions differed from the baseline, there was no difference between the congruent and incongruent conditions. There were, therefore, no gender congruency effects in this experiment. However, the significant effect of semantic relatedness in bare noun production replicates past findings with this method and demonstrates sensitivity to this relationship in this population.
EXPERIMENT 2

In order to address the possibility that the difference in results between Experiment 1 and Cubelli et al. (2005) was due to the difference in modality of the distractor word, an additional experiment was performed with materials identical to those of Experiment 1, except that instead of an auditory distractor word, the distractor word was visually presented.

Method

Subjects

Data were collected from a total of 14 subjects. All of the subjects were Spanish/English bilinguals for whom Spanish was the dominant language. A total of 23 subjects were tested in the experiment but nine had to be excluded due to the fact that they were English dominant. The ages of the participants ranged from 18 to 38 (average age was 25.14). Participants were recruited via flyers and word of mouth in the general university community.

Stimuli

The stimuli were exactly the same as in Experiment 1, except instead of being presented auditorily, the distractor word appeared below the picture in white letters. The baseline was five “X”s.

Procedures

The procedure was identical to Experiment 1.

Results

Please see Table 3 for the reaction time data.
### Table 3: Reaction Times for Bare Noun and NP Production in All Conditions (Experiment 2)

<table>
<thead>
<tr>
<th>Bare Noun Production</th>
<th>Condition</th>
<th>RT</th>
<th>Condition</th>
<th>RT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gender Congruent</td>
<td>861</td>
<td>Semantic Related</td>
<td>822</td>
</tr>
<tr>
<td></td>
<td>Gender Incongruent</td>
<td>848</td>
<td>Semantic Unrelated</td>
<td>809</td>
</tr>
<tr>
<td></td>
<td>Gender Baseline</td>
<td>829</td>
<td>Semantic Baseline</td>
<td>821</td>
</tr>
<tr>
<td></td>
<td><strong>Difference</strong></td>
<td><strong>13</strong></td>
<td><strong>Difference</strong></td>
<td><strong>13</strong></td>
</tr>
<tr>
<td></td>
<td><em>(Congruent –Incongruent)</em></td>
<td></td>
<td><em>(Related –Unrelated)</em></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Noun Phrase Production</th>
<th>Condition</th>
<th>RT</th>
<th>Condition</th>
<th>RT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gender Congruent</td>
<td>793</td>
<td>Semantic Related</td>
<td>804</td>
</tr>
<tr>
<td></td>
<td>Gender Incongruent</td>
<td>792</td>
<td>Semantic Unrelated</td>
<td>801</td>
</tr>
<tr>
<td></td>
<td>Gender Baseline</td>
<td>791</td>
<td>Semantic Baseline</td>
<td>772</td>
</tr>
<tr>
<td></td>
<td><strong>Difference</strong></td>
<td><strong>1</strong></td>
<td><strong>Difference</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td></td>
<td><em>(Congruent –Incongruent)</em></td>
<td></td>
<td><em>(Related –Unrelated)</em></td>
<td></td>
</tr>
</tbody>
</table>
There was a main effect of task (bare noun vs. NP production) \( (F(1,13) = 9.18, p < .05) \) such that reaction times were longer for the production of bare nouns than noun phrases (832 ms and 793, respectively). There were no other significant main effects or interactions on the entire data set. Separate analyses of the data for bare noun and NP production were performed and no effect of gender congruence was found for either bare nouns \( (F < 1) \) or NPs \( (F < 1) \), nor were there any significant effects of semantic relatedness in the production of bare nouns \( (F < 1) \) or noun phrases \( (F < 1) \). There was also no main effect of gender. In bare noun production, the difference between the congruent condition and the baseline was significant \( (F(1,13) = 6.728, p = .022) \) but no other conditions differed significantly from the baseline. It is unclear why there was no effect of semantic relatedness.

**DISCUSSION OF EXPERIMENTS 1 AND 2**

As predicted, there were no gender congruency effects in noun phrase production and, thus, the findings of Cubelli, et al. (2005), Costa, et al. (1999) and Miozzo and Caramazza (1999) were successfully replicated. This reinforces the notion that Spanish can be included in the same category with respect to determiner selection as Italian and Catalan, in spite of the fact that the form dependency in Spanish is nowhere near as pervasive.

The critical prediction of the study was not supported: There were no gender congruency effects of any kind found in bare noun production. From this result, it must be concluded that in Spanish, as in Dutch, syntactic gender is not accessed in bare noun production. This finding is in direct contrast to that of Cubelli et al. findings for Italian—
recall, they found gender congruency inhibition effects with bare nouns—and leads us to
wonder if there is some critical, previously overlooked, difference between Spanish and
Italian that could affect the access of gender information in lexical access. As has been
previously stated, phonological form dependency in determiner selection is less pervasive
in Spanish than in Italian but this should not have any bearing on the bare noun
production condition. One difference between the two languages that could have some
bearing on issues relating to gender access is that, almost without exception, Italian nouns
end with a vowel. Italian, therefore has a limited number of segments that can appear
word-finally in nouns (-a, -o, -e, -i, -à, -i, -è, -ò, -ù) (Altiere Biagi 1973). Naturally, the
–a and –o endings represent transparent gender marking while the –e and –i endings are
ambiguous with respect to gender. Cubelli et al. takes the –e (which is far more common
than the –i) to be “opaque inflection” (51) but a gender marked inflectional ending all the
same, albeit phonologically opaque. Adopting Cubelli et al.’s view, we will consider
these unaccented noun-final vowels to represent inflectional morphemes. The remaining
noun-final vowels, which bear primary accent, are typically either derivational
morphemes themselves or the nucleus of a derivational morpheme. While the gender of
derived nouns is often predictable, the word-final morpheme designates the word class,
not the gender (it is not gender inflection).

Spanish has a similar system in that there are word-final vowels which can be
construed as gender inflection (-a, -o and the ambiguous –e), but Spanish allows coda
consonants in word final position. This is critical because, while in Italian, if a word-
final morpheme ends in a consonant, a gender marked inflectional morpheme (a vowel) must also be selected, in Spanish, this does not occur.

8. Spanish: a. la opin-ión d. la actr-iz g. el vende-dor
       Italian: b. l’opin-ion-e e. l’attr-ie-e h. il vendi-tor-e
       English: c. opinion f. actress i. vendor

In Cubelli et al.’s Double Selection model, the Italian syntactic representation of *opinione* would compete with other activated feminine representations for selection. The result of this competitive process would be the selection of the correct vowel ending. As the Spanish *opinión* does not require any gender inflection (i.e. no word final vowel), would not participate in such a process. That is to say, any competition that may occur among syntactic representations would have no effect on the production outcome.

We can then conclude that Spanish, by virtue of permitting coda consonants word finally, has fewer nouns than Italian that will carry gender inflection and, therefore, Spanish has more nouns than Italian for which gender information is not necessary to access the phonological form. In this respect, Spanish seems to be more like Dutch and German. It follows from these observations that Spanish would pattern like Dutch and German in bare noun production. In terms of Cubelli et al.’s Double Selection model, it seems as though the gender marked syntactic representations of Spanish nouns are not in competition but rather, as Cubelli et al. sets forth for Dutch, “the selection of semantic representation is sufficient to access the whole lexical form of a given noun” (54).

The data from Spanish fits nicely in the existing models (WEAVER++ and the IN model), indeed it conforms exactly to their predictions. It is Cubelli et al.’s Italian data that did not fit these models. The findings of the current study do not confirm or detract
from the Double Selection model as an account of Cubelli et al.’s findings, but they do show that the predictions of the model do not hold for Spanish and, therefore, further research will be necessary to validate the proposed processes in the access of syntactic features.

The goal of these experiments was to determine if a gender congruency effect would be observed in Spanish. No effect was predicted for NP production, pursuant to the previous findings of Costa et al. (1999) but there was sufficient reason to believe, due to Cubelli et al.’s (2005) findings, that an effect would be seen in Spanish in the bare noun production. The fact that no effect was found in bare noun production necessitated a closer examination of the gender systems of Spanish and Italian in order to account for the divergent findings. This analysis gave rise to the conclusion that, with regards to gender marking morphology, Spanish nouns are not unlike Italian and indeed bear some similarity to Dutch. The lack of gender congruency effects in NP production reaffirms the inclusion of Spanish in the “late selection” class of languages, together with Italian and Catalan, even though Spanish is not identical to either language with regard to the need for phonological form information in determiner selection. Lastly, the speculation that because only (a small proportion of) the feminine nouns in Spanish are affected by form dependence in determiner selection, there would be some difference in naming latencies between masculine and feminine nouns in the NP production task was not borne out. In conclusion, this research has (1) showed that the mere fact that Spanish and Italian are both Romance languages does not guarantee that the access of syntactic gender
during lexical access is identical for the two, and (2) confirmed the predictions of the WEAVER++ and IN models.

If indeed the lack of gender congruency effects in the picture-word interference paradigm for Spanish is due to the dependency on phonological form for determiner selection and the lack of a competitive selection process for the gender marking morphemes –both of which are relatively late occurring processes and are possibly artifacts of the production task - then it might be speculated that a gender congruency effect would emerge with a different task which does not involve production and, perhaps, addresses syntactic gender more directly. One means of forcing subjects to attend directly to gender is by using the gender decision task (see Radeau & van Berkum 1996). Gender decision has been shown to be sensitive to word frequency (Navarrette, Basagni, Alario & Costa 2006, Jescheniak & Levelt 1994). Navarrette et al. found that, in Spanish, response latencies in a gender decision task were shorter for high frequency words. Jescheniak and Levelt found the same for Dutch. Starreveld and La Heij (2004) conducted an experiment in Dutch in which they used both picture naming and the gender decision task in a picture-word interference experiment in order to determine if gender is represented at the level of the lemma (Roelofs 1992) or the lexeme (Caramazza 1997). Their gender decision task involved the production of the appropriate definite article, given the gender of the noun which was represented by the picture. The relationship between the distractor word and picture name varied on the bases of phonology (related or unrelated) and gender (congruent or incongruent). Analysis of the reaction time data showed a facilitatory effect of both phonology and gender congruency. Subjects were
quicker to respond if the distractor and picture name were similar phonologically and they were faster to respond if the two words were of the same syntactic gender. These findings support Caramazza’s (1997) Independent Network model’s tenet that syntactic gender features are attached to the lexeme, not lemma. In this account, increased activation of the lexeme (induced by the phonologically similar distractor word) led to faster selection of the target lexeme and faster access of the gender features.

If the lack of effect in Experiments 1 and 2 is an artifact of the production task or due to the fact that subjects were not attending directly to gender, then it is possible that gender congruency effects would emerge in a gender decision task. In order to determine if this is the case, an additional experiment was performed with materials very similar to those from the first two but a gender decision task was employed instead of picture naming.

**EXPERIMENT 3**

In order to determine whether congruency effects in Spanish were observable under any conditions at all, the picture-word interference experiment was conducted using a gender decision task. In one phase of the experiment, subjects were asked to select the appropriate gender-marked demonstrative adjective (either *este*, this\textsubscript{masc}, or *esta*, this\textsubscript{fem}), and in the other, subjects were asked to select the correct gender marked adjective (either *lindo*, pretty\textsubscript{masc}, or *linda*, pretty\textsubscript{fem}). As both demonstratives and adjectives require overt gender inflection, it was predicted that the gender of the distractor would interfere with this selection process as gender must be utilized to select the gender-marking morpheme. The critical difference between the demonstrative and
attributive adjectives is that the demonstrative precedes that noun while the attributive adjective typically appears after the noun.

**Method**

**Subjects**

Data were collected from a total of 12 subjects. All of the subjects were Spanish/English bilinguals for whom Spanish was the dominant language. A total of 14 subjects were tested in the experiment. Two were excluded due to technical problems. The ages of the participants ranged from 27 to 34 (average age was 29.8). Participants were recruited via flyers and word of mouth in the general university community.

**Stimuli**

Sixty-one pictures (line drawings) were selected from Lotto, Dell’Acqua and Job’s (2001) database (28 for targets with opaque morphology, 28 for targets with overt gender-marking and 6 for the training phase). Both types of gender-marking were utilized in order to allow for the distinction between nouns in which gender is predictable based on the noun’s morphemes and nouns in which abstract gender features must be accessed in order to select agreement morphemes. Of the twenty-eight pictures selected for each group, fourteen had masculine target names and fourteen had feminine target names. Five additional drawings were used to create a practice run. The target words in the experimental conditions were balanced for length and frequency. Frequency information was obtained from Davies’ (2005) Corpus del Español. The 28 targets with opaque gender marking were were matched for frequency and word length within each
gender (Feminine targets: Avg. Frequency = 506 (per 6,750,000), Avg. Length = 5.1; Masculine targets: Avg. Frequency = 687.9, Avg. Length = 5.1). The 28 targets with transparent gender marking were matched for frequency and word length within each gender (Feminine targets: Avg. Frequency = 301.1 (per 6,750,000), Avg. Length = 4.3; Masculine targets: Avg. Frequency = 307.6, Avg. Length = 4.4). Sixty-four distractor words were chosen. For the opaque conditions, twenty-eight words which do not bear any gender-marking morphology were selected (Feminine: Avg. Frequency = 1885.6, Avg. Length = 4.7, Masculine: Avg. Frequency = 1891.6, Avg. Length = 5) and for the transparent conditions, twenty-eight canonically gender marked nouns (all bearing the –a or –o morpheme) were chosen as the distractor words (Feminine distractors: Avg. Frequency = 837.3, Avg. Length = 4.4; Masculine distractors: Avg. Frequency = 836.7, Avg. Length = 4.4). In addition, eight words were selected for the practice run. The experiment had three factors: type of gender marking and congruency and phrase type. With respect to gender marking, nouns were either transparently (overtly) marked for gender or opaquely marked (no overt marking). The congruency factor represents the relationship between the target word and the distractor (either they had the same gender or different genders). Lastly, subjects were either asked to produce one of two phrase types: a bare noun (a noun with no determiner) or a noun phrase consisting of a definite article and noun.

Each picture appeared twice per session as each target was matched with two different distractors. In the gender congruent condition, the target and distractor were of the same gender. In the incongruent condition they were of different genders. Subjects
participated in two sessions. In one session of the experiment, subjects were asked to select the appropriate gender-marked demonstrative adjective (either *este*, *this*$_{\text{masc}}$, or *esta*, *this*$_{\text{fem}}$), and in the other, subjects were asked to select the correct gender marked adjective (either *lindo*, *pretty*$_{\text{masc}}$, or *linda*, *pretty*$_{\text{fem}}$). In both sessions, subjects were instructed to use specific keys on a computer keyboard to indicate the correct demonstrative or adjective. The order of the sessions was balanced across subjects. The picture-word pairs were the same in both sessions but the order of presentation was in a different random order in each one.

**Procedure**

Upon arriving in the lab, subjects filled out a consent form and language history questionnaire. The experimenter then showed the subject hard copies of all of the pictures that would appear in the experiment and asked him/her to name the objects depicted. This warm-up activity (lasting between 5 and 10 minutes) was conducted exclusively in Spanish. After completing the warm-up activity, the subject performed the experimental tasks in a sound attenuated booth. Before beginning the session, subjects were told that they would be deciding if *este* or *esta* went with the noun depicted in the picture in the demonstrative session. In the adjective session, they were told to decide if *lindo* or *linda* was appropriate for the noun depicted in the picture. In each trial, subjects saw an orienting cross prior to being presented (simultaneously) with the picture and distractor word. Subjects were instructed to indicate the correct demonstrative or attributive adjective (depending on which session) by pressing a key on the computer keyboard. The demonstratives and adjectives were not displayed on the screen but
subjects were instructed, depending on the session, that they should indicate the correct
demonstrative or adjective by pressing the keys on the computer keyboard indicated by
the experimenter. Reaction times were measured from the onset of the distractor word.
Display of stimuli and recording of reaction times was achieved with the DMDX
software package developed at the University of Arizona by J.C. Forster (Forster &
Forster, 2003). Each session lasted about fifteen minutes, rendering the total time of
participation approximately 40 minutes. The order of the sessions
(demonstrative/adjective, adjective/demonstrative) was balanced across subjects.
Table 4: Mean Reaction Times (Experiment 3)

<table>
<thead>
<tr>
<th>Condition</th>
<th>RT</th>
<th>Condition</th>
<th>RT</th>
<th>Condition</th>
<th>RT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Congruent</td>
<td></td>
<td>Gender Congruent</td>
<td></td>
<td>Gender Congruent</td>
<td></td>
</tr>
<tr>
<td>(Overall)</td>
<td>875</td>
<td>(Opaque)</td>
<td>874</td>
<td>(Transparent)</td>
<td>876</td>
</tr>
<tr>
<td>Gender Incongruent</td>
<td></td>
<td>Gender Incongruent</td>
<td></td>
<td>Gender Incongruent</td>
<td></td>
</tr>
<tr>
<td>(Overall)</td>
<td>898</td>
<td>(Opaque)</td>
<td>892</td>
<td>(Transparent)</td>
<td>903</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>Difference</td>
<td></td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>(Congruent –</td>
<td>-23</td>
<td>(Congruent –</td>
<td>-18</td>
<td>(Congruent –</td>
<td>-27</td>
</tr>
<tr>
<td>Incongruent)</td>
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<td>Incongruent)</td>
<td></td>
<td>Incongruent)</td>
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</tr>
<tr>
<td>Adjective Condition</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>RT</td>
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<td>RT</td>
<td>Condition</td>
<td>RT</td>
</tr>
<tr>
<td>Gender Congruent</td>
<td></td>
<td>Gender Congruent</td>
<td></td>
<td>Gender Congruent</td>
<td></td>
</tr>
<tr>
<td>(Overall)</td>
<td>922</td>
<td>(Opaque)</td>
<td>948</td>
<td>(Transparent)</td>
<td>897</td>
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<tr>
<td>Gender Incongruent</td>
<td></td>
<td>Gender Incongruent</td>
<td></td>
<td>Gender Incongruent</td>
<td></td>
</tr>
<tr>
<td>(Overall)</td>
<td>925</td>
<td>(Opaque)</td>
<td>934</td>
<td>(Transparent)</td>
<td>917</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>Difference</td>
<td></td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>(Congruent –</td>
<td>-3</td>
<td>(Congruent –</td>
<td>14</td>
<td>(Congruent –</td>
<td>-20</td>
</tr>
<tr>
<td>Incongruent)</td>
<td></td>
<td>Incongruent)</td>
<td></td>
<td>Incongruent)</td>
<td></td>
</tr>
</tbody>
</table>
There was no main effect of phrase type (demonstrative vs. adjective) \( (F < 1) \). There was a significant interaction of phrase type (demonstrative or adjective) and morphology of the target noun \( (F(1,11) = 4.95, p < .05) \) such that reaction times were longer in the adjective condition for target nouns that were opaque with respect to gender marking (see Figure 7). Simple comparisons showed that the RTs for opaque nouns in the adjective condition were significantly longer than transparent nouns in that same condition \( (F(1,11) = 4.50, p < .05) \). Separate analyses of the data for each phrase type were performed and no effect of gender congruence was found in either the bare noun condition \( (F < 1) \) or the NP condition \( (F < 1) \).
Figure 7: Chart of Reaction Times (Experiment 3)
DISCUSSION OF BEHAVIORAL EXPERIMENTS

While it is possible to assimilate the results of Experiments 1 and 2 into the greater body of gender congruency research, the lack of findings in Experiment 3 are somewhat vexing because subjects were being asked to attend to gender specifically and no gender congruency effects emerged.

While all languages studied (with the possible exception of French) exhibit some form of gender congruency effect, Spanish remains impervious. The congruency between the distractor word’s gender and the target word’s gender has no impact, whatsoever, on the behavioral response of participants in a picture-naming task in Spanish. While the lack of effect in Spanish can be accounted for within the operative models of lexical access, the complete lack of effect in Spanish leads us to ask the question: Is gender accessed in NP production in Spanish?

Direct Retrieval Hypothesis

One possibility is that the extreme regularity of the gender-marking system in Spanish makes an article-plus-noun more akin to a single lexical unit. In other words, the semantic concept of piano leads to production of el piano without the need for a compositional process of linking masculine-article to masculine-noun. Direct retrieval of determiner+noun would be viable in Spanish production because a very large majority of nouns have overt and reliable gender marking. As noted above, in Spanish, 78% of all nouns end in either –a or –o (Moreno-Sandoval & Goñi-Mendooyo 2000). 96.3% of the nouns which end in –a are feminine and 99.9% of the nouns which end in –o are masculine (Teschner & Russell 1984). Italian is similar to Spanish in that 80% of all
nouns are regularly marked for gender (Franck, Vigliocco, Antón-Méndez, Collina & Frauenfelder 2008). This is in stark contrast to other languages in which, while there may be some derivational morphemes that pattern with a specific gender, there is no morphological marking specifically dedicated to gender (e.g., In German, *Messer* (knife-neuter), *Butter* (butter-feminine), *Finger* (finger-masculine)).

My *direct retrieval* hypothesis posits that simple, frequency-based associations between determiners and nouns afford Spanish speakers a shortcut during production that is less viable in other languages which have syntactic gender. The proposal regarding production is that the determiner+noun noun phrase would be retrieved as one lexical item. This would explain why there are effects in German and Dutch, for example, but none in Spanish. Explaining the difference between Spanish and Italian is more difficult as their two gender systems are similar with respect to the regularity of gender marking. The current proposal is, therefore, limited to Spanish for the time being.

The notion of processing gender marking morphemes without accessing gender features can also be applied to sentence parsing. I propose that abstract gender features are not accessed in the parsing of a simple determiner+noun NP because this agreement relationship can be assessed on the basis of the high correlation between the gender-marked determiner and the word final gender-marking morpheme. This association would exist at the level of the lexeme at which morphemes are represented (Roelofs 1992, Levelt 1989) and would thus be morphophonologically based. Given *el*, it is highly likely that the next word (i.e. accessed lexeme) will end with the gender-marking morpheme –*o*. The correlation would be between the two morphemes, rather being
purely phonologically based (i.e. the correlation exists at the level of the morpheme not phoneme). Abstract gender features (located on the lemma), however, would necessarily continue to serve a critical role in sentence comprehension as gender agreement relations can exist between non-adjacent segments. For instance, in sentences (9) and (10) below, the gender marking on the adjective *delicado* indicates which noun it modifies. The relationship between a noun and adjective is not as rigid as that which exists between a article and noun in Spanish (the adjective is optional and could be one of thousands while the article is essentially mandatory and belongs to a very small closed class of determiners) and therefore is more likely to be based on abstract features.

The dress made of delicate silk is beautiful.

The delicate dress made of silk is beautiful.

This hypothesis was tested in an ERP study. By contrasting ERPs to different types of agreement violations in Spanish, I hoped to show a distinction between hierarchical and non-hierarchical processing.

**The Current ERP Study**

The goal of the next experiment is to test the hypothesis that the gender features are not accessed in local agreement relations that are both high frequency and highly correlated with morphological features (such as the association that exists between the determiner and noun). These associations may be frequency-based and not require the use of syntactic gender features. When the determiner *el* is introduced, the probability
that a segment ending in \(-o\) will follow is very high. The parsing of a noun phrase consisting of a determiner and noun (as in 9a), therefore, would not recruit abstract gender features in order to establish agreement. On the other hand, agreement relations that represent lower frequency pairings (noun+adjective as in 9b, for example) and/or involve long distance dependencies (agreement relations between non-adjacent segments) (11c and 11d), will require the access of abstract gender features.

Consider the following examples:

11. a. El \textit{piano} está aquí.
The\textit{masc} piano\textit{masc} is here.
The piano is here.

b. El \textit{piano antiguo} está aquí.
The\textit{masc} piano\textit{masc} antique\textit{masc} is here.
The antique piano is here.

c. El \textit{piano} es \textit{antiguo}.
The\textit{masc} piano\textit{masc} is antique\textit{masc}
The piano is antique.

d. El \textit{piano} que compramos ayer \textit{es antiguo}.
The\textit{masc} piano\textit{masc} that bought-1P yesterday is antique\textit{masc}
The piano that we bought yesterday is antique.

I propose that the simple noun phrases (e.g. \textit{el piano} in 11a) might processed based on morphophonological features alone and transitional probabilities among same. The critical association is between gender-marking morphemes (\textit{el} and \textit{–o} in the noun phrase \textit{el piano}) between which there is a high degree of transitional probability because of the high frequency of cocurrence. As previously stated, this association would exist at the level of the lexeme at which morphemes are represented (Roelofs 1992, Levelt 1989) and
would thus be morphophonologically based. Other structures involving long-distance dependencies (11c and 11d) would require the access of abstract gender features and the construction of hierarchical sentence structure. In order to assess the agreement relation between two nonadjacent segments, the gender features of the noun, in a sentence like 11d, would have to be accessed and utilized in order to determine agreement relationship (established by the hierarchical structure of the sentence) between the noun and adjective is correct. The distance between the segments makes a frequency based approach for nonadjacent segments unviable as the second segment can't effectively be predicted. In the case of 11b, while the pairing of nouns and adjectives is common, the relationship is not as intimate and obligatory as that which exists between the determiner and noun (the adjective is optional and can be any one of thousands in the lexicon, while the determiner is necessary more often than not and belongs to a tiny closed class). Because of this, it is proposed that abstract gender features are accessed and utilized in the computation of gender agreement between the noun and adjective. The occurrence of the adjective would trigger the access of gender features of the previous noun in order to assess the acceptability of the adjective's gender inflection. I propose to distinguish between these distinct cognitive processes via noninvasive recordings of brain electrical activity, event-related potentials (ERP).
Chapter 4 ERP (General, Gender Processing)

The question of whether or not gender is accessed in the processing of det+noun NPs can be examined using ERP. The ERP technique has been used to examine brain activity in language processing research extensively during the last three decades. The basis of ERP data is the electroencephalogram (EEG). While in a resting state, all neurons bear an electrical charge (resting membrane potential). When they become active (and action potentials are generated), this charge fluctuates. Using electrodes placed on the scalp, the voltage changes associated with neural activity in different populations of neurons in the cerebral cortex can be recorded. This data is the EEG, and the fluctuations in voltage are called potentials. In ERP research, the EEG is time locked to specific experimental events (the presentation of a stimulus, for example). When the ERPs are categorized by experimental condition and averaged, patterns in brain activity emerge showing that certain potentials are associated with certain cognitive events. Potentials are described according to their polarity (negative or positive) and latency relative to the critical event (measured in milliseconds).

LANGUAGE-RELATED POTENTIALS

Semantic/Lexical Processing: The N400

Several potentials have been identified as associated with specific aspects of language processing. The first, and possibly the most robust, is the N400 (a negative going wave, peaking between 300 and 500 ms after stimulus onset). This potential, which is typically associated with lexical access and semantic processing, was first noted
by Kutas and Hillyard (1980a, 1980b). In Kutas and Hillyard (1980a), sentences like the following were contrasted:

12a. He took a sip from the glass.  
12b. He took a sip from the transmitter.  (Kutas & Hillyard 1980a, p. 203)

Glass clearly is semantically consistent with the larger sentence context and highly predictable. Transmitter on the other hand, while being grammatically legitimate, is incongruent with the meaning of the rest of the sentence. The ERPs were time-locked to the presentation of the critical sentence final word. The results showed that the semantically deviant words (the transmitter condition), when compared with the semantically consistent words, elicited an increased negativity which began at about 250 ms and peaked at about 400 ms after stimulus onset (an N400). The N400 effect in response to semantically deviant stimuli has been replicated countless times. This potential is generally sensitive to semantic context and constitutes a very reliable effect in ERP research. The N400 is also sensitive to lexical factors like word frequency (greater amplitude for low frequency versus high) (Holcomb & Neville 1990), word class (greater amplitude for open class words versus closed class) (Kutas & Hillyard 1983), concreteness (greater amplitude for concrete versus abstract) (Paller, McIssac & Kutas 1987) and lexical status (greater amplitude for pronounceable nonwords than words) (Chwilla, Brown & Hagoort 1995).

**Syntactic Processing: The LAN and P600**

While the N400 is the primary effect relating to semantic processing, there are two potentials associated with syntactic processing: left anterior negativity (LAN) and the
P600. Both are elicited by syntactic violations but, as will be seen, there are some differences in the types of violations that elicited each one as well as the reliability of each effect.

The LAN was first observed by Kutas and Hillyard (1983). This study included subject verb agreement discrepancies and other verb form errors (“to stayed”, “are consider”) (Kutas & Hillyard, cited in Kutas, Van Petten and Kluender (2006)). These morphosyntactic violations elicited a negativity with a frontocentral focus, emerging between 300 and 400 ms after the onset of the second word. This anterior negativity is usually left-lateralized or bilateral and is associated with morphosyntactic errors of various kinds (Kutas, Van Petten & Kluender 2006). The anterior distribution of this component distinguishes it from the N400. This potential does not exhibit a clear peak and it usually emerges 300 to 500 ms after stimulus onset. Sometimes this negativity has a shorter latency of onset (100-300 ms) which has prompted some researchers to consider this earlier left anterior negativity (ELAN) to be functionally distinct from the LAN (Kutas, Van Petten & Kluender). For the purposes of this analysis, the two will not be considered as distinct from one another. The LAN has been elicited by many types of morphosyntactic errors, including errors in subject-verb agreement (Osterhout & Mobley 1995, De Vincenzi, Job, Di Matteo, Angrilli, Penolazzi, Ciccarelli & Vespignani 2002, Rossi, Gugler, Hahne & Friederici 2005), verb form (Friederici, Pfeifer & Hahne 1993, Osterhout & Nicol 1999) and gender agreement (Barber & Carreiras 2005, Barber, Salillas & Carreiras 2004, Gunter, Friederici & Schriefers 2000). There are two basic theories on the function of the LAN. One view posits that the LAN (and ELAN) are
involved in monitoring initial structure building and theta role assignment. Another proposes that the LAN serves as a “look forward” and “look back” mechanism allowing the parser to check previous segments or anticipate subsequent segments when a segment requiring an antecedent or licenser is encountered in the sentence string (Kutas, Van Petten & Kluender 2006).

The second potential associated with syntactic processing is the P600. This is a positive component which has no clear peak but manifests as a positive shift which emerges 500 to 800 ms after stimulus onset and has its maximum amplitude around 600 ms. The P600 is typically largest over centroparietal sites. While the P600 can be elicited by morphosyntactic violations of all types, it is also elicited by errors involving long distance dependencies and other higher level syntactic violations. Osterhout and Mobley (1995) and Schmitt, Lamers and Münte 2002) both found a P600 for sentences which contained violations of long distance dependencies (agreement violations) between an anaphora and its antecedent. The P600 is not limited to syntactic violations. It is also sensitive to syntactic complexity and to preferred structure such that the P600 is elicited by sentences which are syntactically complex (Kaan, Harris, Gibson & Holcomb 2000) and by sentences which require reanalysis (garden path sentences) (Osterhout, Holcomb & Swinney 1994). As with the LAN, there are two views of the purpose of the P600. One posits that the P600 is a general response to low probability targets, in other words a member of the P300 family. The P300, another positive component peaking around 300 ms post stimulus, is a domain general response to low probability stimuli (Coulson, King & Kutas 1998a, Coulson, King & Kutas 1998b). Another proposes that the P600 is
specific to language and represents difficulty in parsing due to syntactic violations, need for reanalysis or inability to assign preferred structure (Hagoort, Brown & Groothusen 1993, Münte, Heinze, Matzke, Wieringa & Johannes 1998, Friederici, Hahne & Mecklinger 1996, Kaan, Harris, Gibson & Holcomb 2000, Osterhout & Hagoort 1999, Osterhout, McKinnon, Bersick & Corey 1996, see also Kutas, Van Petten & Kluender 2006). Regardless of the true source of the P600, it is a potential that is observed as a response to various types of syntactic errors, particularly those involving long distance dependencies and other violations of “higher level” syntactic structure, as well as complex syntactic structure and non-preferred structures.

**The N400 and Syntactic Processing**

While the N400 is considered to be an index of lexical or semantic integration and the P600 is associated only with syntax, there seems to be some overlap between the two suggesting that each has a more complex relationship to language processing than was previously imagined. Kuperberg, Sitnikova, Caplan, and Holcomb (2003) conducted an experiment in which two types of semantic manipulations were included: semantic and thematic congruency.

13a. For breakfast, the boys would only eat toast and jam.

13b. For breakfast, the eggs would only eat toast and jam.

(adapted from Kuperberg, et al. 2003, p. 118)
The ERPs were time-locked to the critical verb (*eat* or *bury* in the examples above) in all conditions. While the N400 is predicted for both semantic violation types, only the semantically incongruent items (13c) evoked an N400. The thematic violations (13b) elicited no N400, but rather a P600. Other researchers have seen similar results with sentences containing errors involving the theta criteria of a verb (Kim & Osterhout 2005, Kolk, van Herten, Chwilla & Oor 2003, Hoeks, Stowe & Doedens 2004). Kuperberg (2007) proposes that the P600 indexes the mediation of conflicting output from the different systems (semantic and combinatorial) that collaborate in language processing.

While each of the three potentials just discussed (LAN, P600 and N400) are correlated with different aspects of language processing, it is not possible to specify definitively the precise source of each. As will be seen in the following section, all three come into play in some aspect of gender agreement processing but the primary players are the LAN and P600.

**ERP STUDIES ON GENDER PROCESSING**

Most of the ERP studies that have made gender or gender agreement an experimental factor do not have syntactic gender as the primary object of research, but rather a representative syntactic process to compare to semantic processing. While the precise mechanics of gender agreement in the various syntactic contexts in which it can be manifest have not been examined, much can be learned from the existing research with respect to the primary question of the current study.

One thing which is worth noting is that while many different languages may have gender (and, therefore, gender agreement structures), the extent to which different types
of morphological information is used in sentence comprehension is language specific.

MacWhinney, Bates and Kliegl (1984) conducted an off-line behavioral experiment in order to determine the degree to which of various types of cues influence sentence processing (specifically, the determination of which NP is the agent) in English, German and Italian. The cues which were examined were word order patterns, inflectional morphology on verbs, sentence-level prosodic stress, and animacy. There is a very salient contrast between English and Italian in terms of verbal agreement morphology (English being highly impoverished whereas Italian is rich) as well as word order conventions (English has fairly rigid word order rules as where word order in Italian is much freer). Simple sentences consisting of a subject, transitive verb and object were created in each of the three languages which varied along four factors (1) word order (NVN, VNN and NNV), (2) animacy (both nouns animate, only first noun animate, only second noun animate), (3) stress (neutral stress, first noun stressed or second noun stressed) and (4) agreement (ambiguous number agreement in which the verb agrees with both arguments, verb agrees with first noun only, verb agrees with second noun only).

Sentence like the following were constructed in English, German and Italian. Please note that prosodic stress features are not included in the samples as that experimental factor is not relevant to the current analysis.

14a. The eraser the pig chases.
    (inanimate first noun, animate second noun, NNV order, ambiguous verb agreement)
14b. Licks the cow the goats.

(both nouns animate, VNN order, verb agrees with first noun)

14c. The dog grab the pencils.

(animate first noun, inanimate second noun, NVN order, verb agrees with second noun)

(adapted from MacWhinney, Bates & Kliegl 1984, p. 139)

The goal of this experiment was to determine which cues were relied upon most and if there were cross-linguistic differences in “parsing” strategies. Subjects were presented with the sentences and asked to indicate which noun phrase (NP) was the subject. The pertinent finding was that English speakers relied most on word order (they tended to identify the first NP as the subject, regardless of other cues) while Italian speakers used verbal inflectional morphology as the best clue to identify the subject of the sentence (they tended to identify the NP which agreed with the verb’s inflection as the subject regardless of other cues). These data indicate that in languages with rich inflectional morphology, like Italian, these agreement features are utilized to facilitate parsing.

**Semantic Context and Activation of Gender Features**

There have been several studies which examine how semantic context affects the activation of gender features. To be more specific, if the semantic context of a sentence predicts a specific noun (“I needed to mail some letters so I went to the post-office to buy . . .”); *stamps* would be highly predictable), are that noun’s syntactic features (specifically gender) part of that prediction?
Van Berkum, Brown, Zwitserlood, Kooijman and Hagoort (2005) conducted a study to determine if anticipation of a noun, given the semantic context of the sentence, would also lead to anticipation of the syntactic gender of that noun (i.e. when a specific lexical item is activated, are syntactic gender features activated and utilized in parsing?). In their experiment which was conducted with Dutch speakers, they used gender-marked adjectives (preceding the expected noun) as a means of testing gender expectation. After a context sentence such as (15), subjects would be presented with a sentence which contained a noun phrase in which the noun was either consistent with context-based expectations (16a) or inconsistent (16b). The level of predictability of the noun at the end of each “mini-story” was based on cloze probability. In addition, subjects in Experiment 1 were asked to complete a cloze probability pretest in which they were given all of the mini-stories, without the critical sentence final noun, and asked to complete the final sentence. Thus, the experimenters were assured that the consistent targets were predictable based on the discourse and inconsistent targets were not. In all cases, the consistent nouns were of the neuter gender and inconsistent nouns were of the common gender. The difference between the inflections of the adjectives (groot and groote in 16a and 16b, respectively) is the first indication of whether or not the expectation is being fulfilled.

15. De inbreker had geen enkele moeite de gemeime familiekluis te vinden. The burglar had no trouble locating the secret family safe.

16a. Deze bevond zich natuurlijk achter een groot maar onopvallend schilderij. It was situated of course behind a big but unobtrusive painting.
An increase in negativity during the 300-400 ms time window was elicited by the unanticipated nouns relative to the anticipated nouns. This negativity peaked between 350-400 ms and was maximal at CZ but present at all electrode sites and was classified as an N400. ERPs time-locked to the gender inflection of the critical adjective showed a positive deflection, on all but a few left posterior electrodes, starting at 50ms and persisting until about 250ms after the onset of inflection. Whether or not this potential relates to the contextually based expectation is uncertain. Given that all consistent nouns were of the neuter gender and all inconsistent nouns were common, the observed ERP could have been caused not but the preceding context but by some unintended acoustic difference between the two. In order to address this potential confound, the researchers performed a second experiment using the same stimuli as Experiment 1 except they excluded the context sentences. If the effect persisted it must be attributed to an acoustic difference but if it did not occur without the context sentences then it could indeed be considered an effect of anticipation of a specific noun, and its full array of syntactic features. In Experiment 2, there were no effects time-locked to the onset of the inflection of the critical adjective, nor was there an N400 associated with the onset of the critical noun, due to the lack of discourse to generate an expectation for any specific noun. The authors conclude that these results indicate that people do indeed create predictions for upcoming words during sentence comprehension and these predictions, while semantically based, facilitate parsing of syntactic information.
Wicha, Moreno and Kutas (2003) also examined gender processing in sentences in which a specific noun (of a specific gender, naturally) is highly predictable, based on the semantic context. Spanish speaking participants were presented with sentences in which, at a certain point in the sentence, a specific noun was predicted. At this point, subjects would be presented with a picture of an object (either the object represented by the predicted noun or something else). In the following examples, the bolded noun in all caps is that which was presented as a picture.

**Semantically Congruous – Gender Match**

17a. El príncipe soñaba con tener el trono de su padre. El sabía que cuando su padre muriera podría al fin ponerse la CORONA por el resto de su vida.

The prince dreamt of having the throne of his father. He knew that when his father died, he could finally wear the [fem] CROWN[fem] for the rest of his life.

**Semantically Incongruous – Gender Match**

17b. El príncipe soñaba con tener el trono de su padre. El sabía que cuando su padre muriera podría al fin ponerse la CANASTA por el resto de su vida.

The prince dreamt of having the throne of his father. He knew that when his father died, he could finally wear the [fem] BASKET[fem] for the rest of his life.

**Semantically Congruous – Gender Mismatch**

17c. El príncipe soñaba con tener el trono de su padre. El sabía que cuando su padre muriera podría al fin ponerse el CORONA por el resto de su vida.

The prince dreamt of having the throne of his father. He knew that when his father died, he could finally wear the [masc] CROWN[fem] for the rest of his life.
Semantically Incongruous – Gender Mismatch

17d. El príncipe soñaba con tener el trono de su padre. El sabía que cuando su padre muriera podría al fin ponerse el CANASTA por el resto de su vida.

The prince dreamt of having the throne of his father. He knew that when his father died, he could finally wear the BASKET for the rest of his life.

(adapted from Wicha, Moreno & Kutas 2003, p. 486)

The comparison of the ERPs to the semantically congruous and incongruous sentences resulted in an N400 effect. As for gender congruity, there was no effect within the 200-500ms window but in the 500-700ms window the gender mismatch items elicited a significant increase in negativity. In this later time frame there was a significant interaction between electrode and gender congruency indicating that the negativity was greater over medial frontal sites over the left hemisphere. There was no interaction between semantic congruity and gender agreement during either of the two time frames. ERPs between 300-600ms after the article were also analyzed and there was a main effect of gender expectancy such that an article which did not agree in gender with the noun predicted by the context elicited an N400.

In order to address the possibility that the late negativity elicited by the gender mismatching pictures was specific to picture stimuli, Wicha, Moreno and Kutas (2004) ran another ERP experiment using the same stimuli as Wicha et al. (2003) except that the pictures were replaced with words. An analysis of the ERPs to the target noun showed that there was a semantic congruity effect in the form of an N400. The gender mismatch items elicited an increased positivity in the 500-900 ms time window which was most pronounced over posterior sites (P600). An analysis of the preceding articles showed that
those of the unexpected gender elicited a P600 but no significant effects during the 300-500 ms time window.

In another experiment integrating picture stimuli into sentence processing, Wicha, Bates, Moreno and Kutas (2003) used stimuli very similar to that of Wicha, Moreno and Kutas (2003) except auditory presentation of stimuli was used (except, of course, for the picture). They wanted to test whether, when context gives rise to the expectation of a particular noun, was there also an expectation the gender-marked determiner associated with that noun. If so, when the preceding article does not conform to the gender of the expected noun, the article should elicit an N400. They found that the semantically incongruous pictures elicited an N400 (increased negativity between 300-500ms after presentation of the picture which was more prominent over frontal and central sites on the right hemisphere), while the pictures in the gender mismatch conditions elicited a late negativity (between 500 and 700 ms) but this did not reach significance as a main effect. As predicted, the unexpected articles elicited a negativity between 300 and 500 ms which was greater over central medial sites, relative to expected articles.

Van Berkum et al. (2005) and Wicha, Moreno and Kutas (2004) are really the most relevant studies from this group as they use word stimuli rather than pictures. It is interesting that the violation of a long distance agreement violation in van Berkum et al. (2005) elicits the N400 only (no LAN or P600). Wicha, Moreno and Kutas’ finding of a P600 to a gender violation in a sentence is unexceptional as the P600 is associated with syntactic errors. Given that the experiment involved semantic expectancy, even in the gender agreement conditions, it is interesting to note that is consistent with Kuperberg,
Caplan, Sitnikova, Eddy and Holcomb (2006) (in which a P600 was found to violations of theta criteria in sentences) it is difficult to attribute this P600 to the gender violation alone. It is interesting, especially in Wicha, Moreno and Kutas that there was no LAN effect in response to the agreement violation (which, due to the overt gender-marking in Spanish, is a true morphophonological error in that the morphemes are realized phonologically) but, again as will be seen this is not entirely surprising. It is also possible that the strong expectation for the target noun, and the resulting N400 effect, rendered invisible any effects that may have arisen from the gender mismatch.

**Gender Processing in Dutch**

Hagoort and Brown (1999) investigated ERPs elicited by gender agreement violations in Dutch. As was mentioned previously, Dutch has a two gender system (common and neuter). In this experiment, agreement violations were realized via lack of agreement between the definite article and noun with an adjective intervening (see 18a, 18b, 19a and 19b). The authors controlled for the position of the critical NP in the sentence. Subjects were asked merely to read the sentences while their EEG was recorded. The authors predicted a P600 for the violation conditions but not a LAN effect because there is no overt gender-marking morphology on nouns in Dutch, so the violation does not involve the phonological realization of grammatical morphemes (i.e. it is not morphophonological in nature). The violation would not be manifested by a lack of correspondence between gender-marking morphemes but rather a discord between the noun’s abstract gender features and the determiner and is, therefore, a syntactic rather than morphophonological issue.
18a. De kapotte paraplu staat in de garage.
The\textsubscript{com} broken umbrella\textsubscript{com} is in the garage.

18b. *Het kapotte paraplu staat in de garage.
The\textsubscript{neu} broken umbrella\textsubscript{com} is in the garage.

19a. Cindy sliep slecht vanwege de griezelige droom.
Cindy slept badly due to the\textsubscript{com} scary dream\textsubscript{com}.

19b. *Cindy sliep slecht vanwege het griezelige droom,
Cindy slept badly due to the\textsubscript{neu} scary dream\textsubscript{com}.
(adapted from Hagoort & Brown 1999, p. 718-719)

The agreement violation conditions elicited an increased negativity, maximal over central and posterior sites and peaking around 400 ms post stimulus. This increased N400 for sentences with gender agreement violations relative to the grammatical sentences only emerged in sentences that had the agreement violation in word final position (19b).

Though the authors don’t mention this, these sentence final noun phrases have an increased amount of semantic context relative to sentence medial noun phrases. The N400, therefore, could be an effect similar to that of van Berkum et al. (2005) which was elicited by a gender agreement violation in a noun phrase that was highly predicted by the preceding semantic context. The authors do suggest that the sentence final N400 could be due to sentence wrap-up effects, coupled with the syntactic violation. This account is pursued more seriously in Hagoort (2003) (see below). A positive deflection, starting around 500 ms, which was largest over posterior sites, (P600) was found as a main effect of agreement regardless of sentence position, without a significant interaction of position of the critical noun (mid-sentence as in 18a & 18b, or sentence final as in 19a & 19b).
Hagoort (2003) conducted an experiment very similar to Hagoort and Brown (1999) in which they examined how semantic and syntactic information interact during sentence processing. They used sentences similar to 20a, 20b, 21a and 21b, as well as sentences like the following with semantic anomalies:

    The <em>com</em> honest <em>paraplu</em><sub>com</sub> is in the garage.

    The <em>neu</em> honest <em>paraplu</em><sub>com</sub> is in the garage.

    Cindy slept badly due to the <em>com</em> sniffing <em>droom</em><sub>com</sub>

    Cindy slept badly due to the <em>neu</em> sniffing <em>droom</em><sub>com</sub>

(adapted from Hagoort 2003, p. 886)

Again, no LAN was predicted based on the lack of overt gender-marking. They found that the syntactic violations elicited an N400 followed by P600. The N400, which peaked around 400 ms and seemed to be maximal over central sites, was significant only for target nouns in sentence final position (not for sentence medial targets). The semantic violations elicited an N400 (in all positions). This effect was maximal at CZ but for sentence internal anomalies, the N400 had a somewhat more anterior distribution than for sentence final semantic anomalies. In the combined condition (19b), the N400, which seemed to be maximal over central and posterior sites (no statistics were offered), was enhanced relative to that which was elicited by the semantic anomaly condition. The P600, on the other hand, was unaffected by the addition of the semantic anomaly in the combined condition. This effect was most pronounced over central and posterior sites, though the authors don’t indicate whether there are any significant topographical effects.
The authors attribute the N400 to syntactic violations as sentence wrap-up effects (characterized by an N400 effect for the sentence-final word (Hagoort et al. 1993, Osterhout and Holcomb, 1992, 1993, Osterhout and Nicol 1999)) rather than the result of the sentence final syntactic violation due to the fact that there was a significant N400 effect following sentence final words in sentences with sentence internal violations. The researchers’ prediction that no LAN would be found due to the lack of overt gender marking morphology on the nouns was confirmed.

Given that, as Hagoort (2003) proposes, the N400 may be the result of sentence wrap-up effects, it is not possible to definitively attribute the N400 observed in Hagoort and Brown (1999) to the gender agreement violation. The P600 effect was, however, more pervasive in that it emerged in response to the agreement violation regardless of sentence position. This later potential is, therefore, the only significant indicator of a gender agreement violation in Dutch, thus far. In this experiment, the disagreeing segments are not adjacent but separated by an adjective. This is interesting to note because the distance between agreeing segments will be a critical question in this analysis.

While there has been little ERP research in gender processing in Dutch, the two studies which examine gender agreement violations, as stated previously, both render a robust P600. The finding of a P600 in response to a syntactic violation in a sentential context is not shocking but it is also not the only possible outcome as will be seen in the following section which reviews gender processing research in German, a language which is very similar in terms of its lack of gender marking morphology to Dutch.
Gender Processing in German

As has been discussed previously, German has a three gender system (masculine, feminine, neuter) and, like Dutch, has no gender-marking morphology. It is also similar to Dutch in that there have been very few ERP studies looking at syntactic gender processing in German. The following is a summary of the relevant studies.

Münte and Heinze (1994) looked at the processing of gender violations (among other types of syntactic errors) in word pairs in German. While the processing of word pairs may certainly invoke the creation of syntactic structure, it is likely to be very different from the processing of complete structured sentences. In the experiment, various types of errors were included (subject-verb agreement, word class errors and gender agreement). Subjects were presented with word pairs and asked to perform a grammatical judgment.

22a. Ich verteidige
     I₁S defend₁S

22b. *Er bevundere (subject-verb agreement)
     he₃S admire₁S

22c. Der Wurm
     themasc wormmasc

22d. *Der Haus (gender agreement)
     themasc houseₙeu

22e. *Du Parlament (word class)
     you₂s Parliament

22f. *Der verteile (word class)
     the distribute₁S

(adapted from Münte & Heinze 1994, p. 223)
All error types elicited a negativity beginning approximately 300ms post-stimulus presentation. There was a main effect of error type (correct vs. agreement vs. word class) but the authors don’t pursue comparisons among the types of errors. The authors note that this negativity, while distributed over the entire scalp, is maximal over frontal sites and is, therefore, a LAN. It is worth noting, however that the negativity is evident at all sites but T3 and T4. The authors don’t offer any statistics to support their statement regarding the anterior distribution of this deflection. No late positivity was found.

The finding of a LAN for these violations between local segments would be interesting in light of the fact that German does not have overt gender-marking morphology and the LAN is typically associated with morphosyntactic violations. As has been mentioned previously, the fact that these word pairs appeared outside of a sentential context makes it difficult to compare the data to that which is elicited by reading sentences. An experiment which looked at gender agreement violations between adjacent segments within a sentence was performed by Gunter, Friederici and Schriefers (2000).

The goal of Gunter, Friederici and Schriefers’ experiment was to examine the interaction of semantic and gender expectancy. In order to do so, they created sentences with target nouns which were either highly predictable given the semantic context or relatively unexpected, based on cloze probability. Naturally, the expectation of a specific noun also creates the expectation of a specific gender. In order to assess the role of gender expectancy, they included gender agreement violation conditions in which the determiner of the target noun was of the wrong gender. In the examples below, the noun
phrase *das land* (the land) is more likely to appear after the verb *bereisen* (to travel) than it is after *befahren* (to drive).

23a. Sie bereist das Land auf einem kraftigen Kamel.
    She travels the neu land neu on a strong camel.

23b. *Sie bereist den Land auf einem kraftigen Kamel.
    She travels the masc land neu on a strong camel.

24a. Sie befährt das Land auf einem kraftigen Kamel.
    She drives the neu land neu on a strong camel.

24b. *Sie befährt den Land auf einem kraftigen Kamel.
    She drives the masc land neu on a strong camel.            (Gunter et al., p. 559)

They predicted the manipulation of semantic expectancy would elicit an N400 effect which would be impervious to the syntactic violation. Likewise, they predicted that the LAN, though elicited in the agreement violation conditions, would not be modulated by semantic expectancy. They predicted that the P600 (evoked by syntactic violations) would be affected by semantic expectancy. These predictions were all confirmed. An N400, maximal over central and posterior sites, was elicited by low cloze nouns while a LAN, restricted to left anterior sites, was elicited by nouns which did not agree with the preceding article. There was also a P600, emerging 550 ms post stimulus, over posterior electrode sites as a main effect of gender agreement. With respect to the P600, the cloze probability (high or low) of the critical nouns affected the latency of the P600 such that it occurred earlier (starting at 450ms) for high cloze nouns in an agreement violation and slightly later (starting at 700ms) for low cloze nouns.

It is interesting that Gunter and colleagues found a LAN in German but Hagoort and Brown (1999) and Hagoort (2003) found no such effect in very similar sentences in
Dutch as neither language has overt gender-marking on nouns. Perhaps the fact that German has a robust case-marking system, a syntactic feature which no longer exists in Dutch (Donaldson 1997), contributes to the elicitation of the LAN because the determiner in the gender agreement conditions is gender specific but it also marked for case.

While the first two studies discussed in this section deal with agreement violations between adjacent segments, Hammer, Jansma, Lamers and Münte (2005) conducted a study on long distance gender agreement in German. In their sentences (please see below), the critical agreement relation was between the matrix subject (a person or thing) and the subject of a subordinate clause (a pronoun). In their first experiment, the pronoun had only one possible antecedent.

25a. Die Frau ist beliebt, weil sie schön ist.
    thefem womanfem is beloved because she pretty is.
The woman is beloved because she is pretty.

    thefem womanfem is beloved because he pretty is.

26a. Die Jacke ist warm, weil sie gefüttert ist.
    thefem jacketfem is warm because she lined is.
The jacket is warm because it is lined.

26b. *Die Jacke ist warm, weil er gefüttert ist.
    thefem jacketfem is warm because he lined is.

(adapted from Hammer et al. 2005, p. 229)

In the 300-400 ms time window following presentation of the word following the pronoun (schön and gefüttert in the examples above), there was a main effect of pronoun type (congruent v. incongruent) such that incongruent pronouns were more negative. This negativity appears to be largest over posterior sites. Simple comparisons showed that this effect was limited to thing antecedents. They characterize this negativity as an
N400. In a later time window (400-700) there was also a congruency effect but it was a positive deflection (a P600) which was greater for person antecedents than things (there was a significant interaction of pronoun type and antecedent type). This positivity was widely distributed and the authors say it is maximal over posterior sites, though they don’t provide supporting statistics. Hammer and colleagues performed a second experiment in which a context sentence was provided. There were two distinct sets of sentences. In the “Context Person” sentences, the critical adjective (*friert*, frozen, in the examples below) selects a person as experiencer and so the pronoun preceding this adjective must have a person as its antecedent. Likewise, in the “Context Thing” sentences, the critical adjective (*gefüttert*, lined, in the examples below) selects things and, therefore, the pronoun preceding this adjective must have a thing as its antecedent.
### Context Person

**Ambiguous**

26a. Die Frau steht im kalten Schnee.
   *the*<sub>fem</sub> *woman*<sub>fem</sub> stands in cold snow.
The woman stands in cold snow.

Die Jacke ist warm, weil sie friert ist.
*the*<sub>fem</sub> *jacket*<sub>fem</sub> is warm because *she* frozen is.
The jacket is warm because she is freezing.

**Congruent**

26b. Der Mann steht im kalten Schnee.
   *the*<sub>masc</sub> *man*<sub>masc</sub> stands in cold snow.
The man stands in cold snow.

Die Jacke ist warm, weil er friert ist.
*the*<sub>fem</sub> *jacket*<sub>fem</sub> is warm because *he* frozen is.
The jacket is warm because he is freezing.

**Incongruent**

26c. Der Mann steht im kalten Schnee.
   *the*<sub>masc</sub> *man*<sub>masc</sub> stands in cold snow.
The man stands in cold snow.

*Die Jacke ist warm, weil sie friert ist.
*the*<sub>fem</sub> *jacket*<sub>fem</sub> is warm because *she* frozen is.
The jacket is warm because she is freezing.

### Context Thing

**Ambiguous**

27a. Die Frau steht im kalten Schnee.
   *the*<sub>fem</sub> *woman*<sub>fem</sub> stands in cold snow.
The woman stands in cold snow.

Die Jacke ist warm, weil sie gefüttert ist.
*the*<sub>fem</sub> *jacket*<sub>fem</sub> is warm because *she* lined is.
The jacket is warm because it is lined.
**Congruent**

27b. Der Mann steht im kalten Schnee.
the\textsubscript{masc} man\textsubscript{masc} stands in cold snow.
The man stands in cold snow.

Die Jacke ist warm, weil sie gefüttert ist.
the\textsubscript{fem} jacket\textsubscript{fem} is warm because \textbf{she} lined is.
The jacket is warm because it is lined.

**Incongruent**

27c. Der Mann steht im kalten Schnee.
the\textsubscript{masc} man\textsubscript{masc} stands in cold snow.
The man stands in cold snow.

*Die Jacke ist warm, weil er gefüttert ist.
the\textsubscript{fem} jacket\textsubscript{fem} is warm because \textbf{he} lined is.
The jacket is warm because he is lined.

(adapted from Hammer et al. 2005, p. 233)

The incongruent sentences are ungrammatical due to the fact that jackets can’t freeze and a man can’t be lined. In other words, the selectional properties of the adjectives are violated. In each case, the critical pronoun has two possible antecedents. In sentences 26a and 27a, at the point of encountering the pronoun \textit{sie}, the antecedent is ambiguous. In 26b, there is no ambiguity because \textit{der Mann} is the only possible antecedent for ER, given the adjective \textit{friert}. Likewise in 27b, \textit{die Jacke} is the only antecedent which matches gender features with \textit{sie}. In 26c, at the point of encountering the pronoun \textit{sie}, \textit{die jacke} becomes the only matching antecedent but the subsequent adjective \textit{friert} indicates that the pronoun should agree with \textit{der Mann}. Likewise, in 27c, at the point of encountering the pronoun \textit{er, der Mann} becomes the only matching antecedent but the subsequent participle \textit{gefüttert} (lined) indicates that the pronoun should agree with \textit{die}
Jacke. Given that, in the violation condition, there are possible antecedents of each
gender and the violation is not detected until encountering the adjectives, it is not
surprising that the researchers found no significant differences in ERPs time-locked to the
pronoun. There was, however, an N400 elicited by the participle in the violation
condition (26c and 27c). This negative deflection started around 400ms after
presentation of the adjective and persisted for about 300 ms. This potential was only
significant over parietal sites.

While all of the findings of Hammer et al. are relevant to the discussion, the most
important is that of Experiment 1, in which the gender mismatch between the pronoun
and its only possible antecedent, a long distance dependency, elicited an N400 (followed
by a P600). Schmitt, Lamers and Münte (2002) also examined the interaction between
natural and syntactic gender in German and got similar results.

In Schmitt, Lamers and Münte (2002), the stimuli included words which bear
natural gender which is either consistent or inconsistent with the syntactic gender. They
were able to do this by exploiting the fact that diminutive suffix –chen makes any noun it
is affixed to neuter. Hence, we have the much cited example of das Mädchen (the
young girl_neuter) which is a neuter noun, representing a feminine person. The researchers
created sentences which contained words with natural gender as subjects and,
subsequently in the sentence, a coreferent pronoun. The pronoun was any of the three
genders. For the subjects with the same natural and syntactic gender (der Bub below) the
pronoun is either consistent with both or inconsistent with both. For subjects like das
Bübchen the pronoun was either inconsistent with the grammatical gender, the natural
gender or both.

28a. **Der Bub** will schlafen und darum schaltet *er* eine Lampe aus
The\_masc boy\_masc wants to sleep and so turns 3SNom\_masc the lamp out.
The boy wants to sleep and so he turns the lamp off.

28b.  *Der Bub* will schlafen und darum schaltet *es* eine Lampe aus
The\_masc boy\_masc wants to sleep and so turns 3SNom\_neu the lamp out.
The boy wants to sleep and so it turns the lamp off.

28c.  *Der Bub* will schlafen und darum schaltet *sie* eine Lampe aus
The\_masc boy\_masc wants to sleep and so turns 3SNom\_fem the lamp out.
The boy wants to sleep and so she turns the lamp off.

Pronoun is consistent with grammatical but not natural gender

29a.  **Das Bübchen** will schlafen und darum schaltet *es* eine Lampe aus
The\_neu little boy\_neu wants to sleep and so turns 3SNom\_neu the lamp out.
The little boy wants to sleep and so he turns the lamp off.

Pronoun is consistent with natural but not grammatical gender

29b.  *Das Bübchen* will schlafen und darum schaltet *er* eine Lampe aus
The\_neu little boy\_neu wants to sleep and so turns 3SNom\_masc the lamp out.
The little boy wants to sleep and so he turns the lamp off.

Pronoun is inconsistent with both natural and grammatical gender

29c.  *Das Bübchen* will schlafen und darum schaltet *sie* eine Lampe aus
The\_neu little boy\_neu wants to sleep and so turns 3SNom\_fem the lamp out.
The little boy wants to sleep and so she turns the lamp off.

(adapted from Schmitt et al., p. 335)

Subjects were presented with these sentences and asked to read them. They were told
that from time to time they’d have to answer comprehension questions regarding the
sentences. The results showed that there was an N400 (starting around 300 ms and
maximal over posterior sites) in response to agreement violations in sentences like 28a-
28c (in which the natural and syntactic gender of the subject coincided). No such effect
was found for sentences like 29a-29c (in which the natural and syntactic gender of the
subject were at odds). There was, however, a main effect of agreement violation in all sentence types which consisted of a positive deflection, maximal around 600 ms in central and parietal sites (P600).

Both Hammer et al (2005) and Schmitt et al. (2002) found a N400, followed by a P600 for violations of gender agreement between segments that are involved in long distance dependencies. This is interesting given that Gunter, Friederici and Schriefers (2000) found a LAN for agreement violations between adjacent segments (determiner and noun) in a sentence. The divergent findings suggest that agreement is processed differently based on the distance (be it linear or syntactic) between the segments. There were also differences in the grammatical category of the elements in the agreement relationship (determiner+noun versus noun . . . pronoun). The following section discusses a study that is unique not only because it was conducted with Hindi speakers but also because it examines gender-marking on inflected verbs.

**Gender Processing in Hindi**

Nevins, Dillon, Malhotra and Phillips (2007) investigated gender and number agreement errors in Hindi. Hindi has two syntactic genders (masculine and feminine) however, unlike all of the languages discussed thus far, inflected verbs must agree not only in person and number but also in syntactic gender with the subject NP. While this example from Nevins et al. contains an animate subject (*sangitkaar*) which bears a natural gender, the gender agreement between the subject and verb is obligatory for animate and inanimate nouns alike. Nevins et al. utilized this property of Hindi’s verbal
system to contrast the ERPs to different types of violations. The critical inflected verb is bolded in the example below.


   although that crazy**masc** musician**masc** song **sing-fut.3rd.sg.masc** but listeners morale NEG enhance

   Although that crazy musician will sing a song, the listeners won’t boost his morale.

(adapted from Nevins, et al., p. 91)

In this example, the critical inflected verb (**gaayegaa**) agrees in person, number and gender features with the noun **sangiitkaar**. In the ungrammatical conditions, the critical verb contained agreement violations.

   **Gender Violation**
   31a. gaayegii
       **sing-fut.3rd.sg.fem**

   **Number Violation**
   31b. gaayengee
       **sing-fut.3rd.pl.masc**

   **Gender and Number Violation**
   31c. gaayengii
       **sing-fut.3rd.pl.fem**

   **Person and Gender Violation**
   31d. gaauungi
       **sing-fut.1st.pl.fem**

(adapted from Nevins, et al., p. 91)

Participants listened to sentences and were asked to make a grammaticality judgment. A P600, peaking around 600 ms with a central-posterior distribution, was elicited by all violation conditions. There was no difference between the number, gender and combined
number/gender conditions. The person/number condition elicited a significantly larger
P600 than the other violations. It is interesting that no LAN was elicited by the
agreement violations but it is in keeping with the Dutch findings in which no LAN was
found for agreement violations between nonadjacent segments (Hagoort & Brown 1999,
Hagoort 2003). A LAN was indeed found in German for agreement violations, but these
violations were between adjacent segments. The relationship between distance and ERP
patterns will be more thoroughly explored in the following section which details the
relevant studies in Spanish.

**Gender Processing in Spanish**

Prior to discussing the experiments relating to gender agreement processing in
Spanish, it is necessary to mention a study in which the agreement relation was between
subjects and conjugated verbs in Spanish. Subject verb agreement is similar to gender
agreement in that it is also manifested in overt morphology (the inflectional morphology
on the verb matches it with the person and number features of the subject). Silva-Pereyra
and Carrieras (2007) examined the processing of subject-verb agreement in Spanish.
Subjects were asked to read sentences in which the agreement between nominative
pronouns and conjugated verbs was manipulated (see below for examples) and make a
grammaticality judgment, while ERPs were recorded. The agreement errors were the
result of the verb being improperly inflected for number (32b), person (32c) or both
(31d).

32a. Yo entiendo la idea.
    I1stPerSg understand1stPerSg the idea.
32b. *Nosotros entiendo la idea.
   we[1stPerPl] understand[1stPerSg] the idea.

32c. *Tú entiendo la idea.
   You[2ndPerSg] understand[1stPerSg] the idea.

32d. *Ustedes entiendo la idea.
   You[3rdPerPl] understand[1stPerSg] the idea.

(adapted from Silva-Pereyra & Carreiras 2007, p. 207)

The double violation condition elicited an anterior negativity between 300 and 450 ms over right and middle anterior sites. Neither single violation condition elicited an early negativity. Similarly, a P600 between 500 and 700 ms over central and posterior sites was found for the double violation. No effects were found in this time window for single violations. In the 700-900 time window, both double and single violation conditions elicited positivities over central and posterior sites. From this experiment we can conclude that the double violations are more salient than the single violations.

This experiment is interesting because it tests the effect of an agreement violation between two adjacent segments. In all of these examples the two segments in the agreement relationship were adjacent and there was overt inflectional morphology reflecting the agreement. The double violation elicits an early negativity, which was clearly not an N400, followed by a later positivity. As will be seen in the subsequent review, this pattern is typical for gender agreement violations in Spanish as well.

Word-Pair Experiments

The first few experiments that will be discussed in this section (Barber & Carreiras 2003, 2005) used word pairs as stimuli in order to examine the integration of gender (and number) features during lexical processing. In Barber and Carreiras (2003),
subjects were presented with word pairs (noun-adjective) in which the adjective either agreed with the noun, disagreed in gender, number or both.

33a. faro alto
lighthouse\textsubscript{masc, sg} tall\textsubscript{masc sg}

33b. faro alta
lighthouse\textsubscript{masc, sg} tall\textsubscript{fem sg}

33c. faro altos
lighthouse\textsubscript{masc, sg} tall\textsubscript{masc pl}

33d. faro altas
lighthouse\textsubscript{masc, sg} tall\textsubscript{fem pl}

(adapted from Barber & Carrieras 2003, p. 470)

They were asked to perform a grammaticality judgment, with respect to agreement, on the two words. All disagreement conditions elicited an increased negativity which the authors characterize as an N400. This negativity, which peaked around 350-400 ms after the presentation of the critical adjective, appeared to be maximal over central posterior sites but the statistical analysis showed no effect of electrode site or hemisphere.

Following the N400, there was a slight positive deflection in some posterior electrodes. When only the posterior electrodes were included in the analysis, there was a significant effect of agreement. The authors characterize this positivity as a P3 but, given that it begins to emerge around 500 ms post stimulus onset and basically persists until the end of the epoch (1000 ms), it is unclear how it is distinguished from an ordinary P600. This positive deflection had a shorter peak latency in the double violation condition as compared to the single violation conditions. Furthermore, the positivity elicited in the
gender disagreement condition had a significantly longer latency than in the number disagreement condition. This potential, previously associated with preparation for a response (Bentin et al. 1985, Bonchin & Coles 1988), could merely reflect the rapidity of the grammatical decision (faster with more grave violations). The authors justify the classification of the positivity as a P3 rather than a P600 based on the fact that the stimuli were word pairs rather than sentences and the P600 is restricted to “syntactic transgression and anomalies” (Barber & Carreiras 2003). The finding of an N400 for a violation between two adjacent segments is interesting given Hammer et al.’s findings, and the lack and N400 for a mismatch between adjacent segments in German, both in word pairs (Münte & Heinze 1994) and in sentences (Gunter, Friederici & Schriefers 2000).

Barber and Carreiras (2005) sought to expand upon their initial experiment on gender and number agreement. In the first of their two experiments aimed at contrasting agreement violations of number and gender, Barber and Carreiras looked at agreement errors in NPs consisting of determiner-noun and noun-adjective in Spanish.

34a. El piano
   The_{masc, sg} piano_{masc, sg}

34b. La piano
   The_{fem, sg} piano_{masc, sg}

34c. Los piano
   The_{masc, pl} piano_{masc, sg}

35a. faro alto
   lighthouse_{masc, sg} tall_{masc, sg}

35b. faro alta
   lighthouse_{masc, sg} tall_{fem, sg}
Subjects were presented with the word pairs and asked to make a grammatical judgment (indicating if the agreement relation between the two was correct). In experiment 1, they predicted that the LAN would be greater for determiner-nouns than noun-adjective as the former “can be considered a noun phrase” (Barber & Carreiras 2005, p. 140). The P600 effect was also predicted. Violations generally elicited greater negativity which peaked around 400ms and was broadly distributed. This negativity for determiner-noun pairs was distributed over the entire scalp but maximal at anterior sites. For noun-adjective pairs it was more restricted to central and posterior sites and was not significant at left anterior and central sites. A comparison of the ERPs to the two NP types showed that the distribution for determiner-noun pairs was significantly more anterior than that of the noun-adjective pairs. While the authors characterize both effects as N400s, this topographical difference suggests that there are two distinct effects (a LAN for the determiner-noun pairs and an N400 for the noun-adjective pairs). It is interesting to note that the negativity associated with gender agreement violations in determiner-noun pairs was greater and more left-lateralized than that of noun-adjective pairs, which suggests that there is some difference in the way agreement is processed in the two structures. There was no significant difference of violation type. The authors propose that the increased anterior negativity reflects the failure to construct a viable syntactic unit with
two items that should form one and conclude that the creation of syntactic structure
would definitely be initiated by the determiner-noun sequence, and perhaps not by the
noun-adjective sequence.

This finding of this experiment, in addition to being consistent with the findings
of Münte and Heinze (1994) for determiner-noun NPs in German, are interesting because
it supports my proposal that the type of relationship between a determiner and noun is
distinct from that which exists between a noun and an adjective, even though both
involve agreement. While it is possible to have NPs without determiners in Spanish, in
the standard NP, the noun is preceded immediately by a determiner. Furthermore, most
nouns in Spanish bear regular gender marking and so the presentation of a determiner
would predict that the following segment ends with a specific morpheme. There is,
therefore, a fairly regular correspondence between a determiner and a subsequent specific
phonological form. On the other hand, not all nouns are modified by adjectives and,
therefore, though the adjective bears gender marking which is predicted by the preceding
noun, the correspondence between the gender marked noun and adjective is not as regular
as that of the determiner and noun. Naturally, it is difficult to draw firm conclusions
about sentence processing from data from word pairs. The following experiments all
examine the processing of gender agreement violations during sentence processing in
Spanish and, while there is variation in the findings across experiments, a pattern with
respect to the early negativities begins to emerge.
Gender Processing at the Sentence Level

In their second experiment, Barber and Carreiras looked at agreement errors but in a sentential context.

36a. El piano estaba viejo y desafinado.
*La piano estaba viejo y desafinado.

36b. Los piano estaba viejo y desafinado.
*El piano estaba viejos y desafinado.

(adapted from Barber & Carreiras 2005, p. 151)

The offending segment was either at the beginning (the determiner) or in the middle (the first adjective). Subjects were presented with the sentences and asked to perform a grammaticality judgment. The P600 and LAN were predicted for both types of violations but the LAN is predicted to be greater for number violations. The proposal is that gender and number are represented differently in parsing and that a number violation (by virtue of being a syntactic head and therefore accessible at all moments in the derivation as per Ritter (1988)) would have a greater effect in the initial parsing, hence a greater LAN.

Both violation types elicited a LAN (a negativity peaking around 400 ms, and maximal over left anterior sites) but there were no significant differences between the types of agreement violations in the LAN time window. Both violation types also elicited a P600 but the amplitude was greater for gender violations than number. Effects were also
greater for violations in the middle of the sentence than at the beginning. From these two experiments, we see that there are differences in the ERPs to agreement errors involving a determiner and noun, and those involving noun-adjective agreement.

**Syntactic versus Semantic Incongruencies**

Martín-Loeches, Nigbur, Casado, Hohlfeld and Sommer (2006), contrasted syntactic violations (of number and gender agreement) with semantic incongruencies. In the syntactic error conditions (37a-37c below) there were violations of gender and/or number agreement while in the semantic conditions (38a-38c below) the adjective didn’t make sense conceptually.

37a. El sentimiento profundo emociona.
    The feeling\textsubscript{masc, sg} profound\textsubscript{masc, sg} moves.
    The profound feeling is moving.

37b. *El sentimiento profunda emociona
    The feeling\textsubscript{masc, sg} profound\textsubscript{fem, sg} moves.

37c. *El sentimiento profundos emociona
    The feeling\textsubscript{masc, sg} profound\textsubscript{masc, pl} moves.

38a. El sentimiento peludo emociona.
    The feeling\textsubscript{masc, sg} hairy\textsubscript{masc, sg} moves.
    The profound feeling is moving.

38b. *El sentimiento peluda emociona
    The feeling\textsubscript{masc, sg} hairy\textsubscript{fem, sg} moves.

38c. *El sentimiento peludos emociona
    The feeling\textsubscript{masc, sg} hairy\textsubscript{masc, pl} moves.

(adapted from Martin-Loeches, et al. 2006, p. 182)

Subjects were presented with the sentences and asked to perform a grammatical judgment. The results showed that syntactic violations elicited a small LAN, peaking around 470ms after stimulus onset with a left-frontal distribution but this did not reach
significance as a main effect. A P600 followed which was largest over parietal areas and peaked around 800 ms post stimulus onset. This effect did reach significance (there was a main effect of grammaticality). The semantic violation elicited an N400 which was distributed all over the scalp but maximal at central sites and peaked around 470ms. The combined violations elicited both the P600 (similar in latency and distribution to that of the syntactic violations) and the N400 (similar in latency and distribution to that of the semantic violations). Within the LAN/N400 window, there was a main effect of semantic violation but not of syntax. There was no significant interaction of electrode and semantics. The P600 was larger in the syntactic condition than in the semantic or combined condition. According to the authors, these findings suggest a predominance of semantics over syntax in that the P600 was reduced in combined violations, relative to single-syntactic violations. Syntactic reanalysis is curtailed when the errant lexical item is a bad semantic fit.

Barber, Salillas and Carreiras (2004) conducted a similar ERP experiment in order to determine if gender agreement processes were different for nouns bearing semantic gender, as opposed to the majority of nouns in which gender is arbitrarily assigned and not related to any notions of natural gender. They examined sentences like the following:

The$_{masc}$ lighthouse$_{masc}$ is bright$_{masc}$ and tall
The lighthouse is bright and tall.

The$_{masc}$ lighthouse$_{masc}$ is bright$_{fem}$ and tall

40a. El abuelo estaba delgado y débil
The$_{masc}$ grandfather$_{masc}$ was thin$_{masc}$ and weak
The grandfather was thin and weak.
40b. *El abuelo estaba delgada y débil  
The\textsubscript{masc} grandfather\textsubscript{masc} was slim\textsubscript{fem} and weak  
(adapted from Barber, Salillas & Carreiras, p. 315)

Subjects were presented with these sentences and asked to perform a grammatical judgment. The electrophysiological data showed a LAN effect in the disagreement conditions (without regard to type of gender) and a P600 effect in which there was an effect of type of gender (the positivity was more pronounced in anterior sights in the semantic disagreement condition).

**Long Distance Agreement Structures**

Demestre and colleagues (Demestre, Meltzer, García-Albea & Vigil 1999, Demestre & García-Albea 2007a, see also Demestre & García-Albea 2007b) conducted two experiments aimed at determining when the non-lexical subject of an infinitive (PRO) (Chomsky 1986) in a control structure retrieved its referent. A control structure consists of a verb that takes an infinitival complement and requires that the subject of the infinitive is coreferent with one of the arguments of the matrix verb. For example, in 39a and 39b the matrix verb *prometer* (to promise) is a subject- control verb which requires that the subject of the subordinate infinitival clause agree with the matrix subject (i.e. Pedro is the one who will be strict, not María). In 41a and 41b, the verb *aconsejar* (to advise) is an object-control verb in that the subject of the infinitival clause will be coindexed with the direct object of the verb (so María is advised to be polite, not Pedro). Of course, PRO is a non-lexical entity (merely an indicator that the infinitive assigns a theta-role to a subject). In order to study these referential relationships, the researchers
used the phenomenon of overtly marked gender agreement. As can be seen in the sentences below, the adjective modifies the subject of the infinitival clause.

41a. Pedro\textsubscript{i} ha prometido a María\textsubscript{j} PRO\textsubscript{i} ser estricto con los alumnos.
Pedro\textsubscript{i} has promised María\textsubscript{j} PRO\textsubscript{i} to be strict\textsubscript{masc} with the students.

41b. *María\textsubscript{i} ha prometido a Pedro\textsubscript{j} PRO\textsubscript{j} ser estricto con los alumnos.
María\textsubscript{i} has promised Pedro PRO\textsubscript{i} to be strict\textsubscript{masc} with the students.

42a. Pedro\textsubscript{i} ha aconsejado a María\textsubscript{j} PRO\textsubscript{j} ser educada con la gente.
Pedro\textsubscript{i} has advised María\textsubscript{j} PRO\textsubscript{j} to be polite\textsubscript{fem} with people

42b. *María\textsubscript{i} ha aconsejado a Pedro\textsubscript{j} PRO\textsubscript{j} ser educada con la gente.
María\textsubscript{i} has promised Pedro PRO\textsubscript{i} to be polite\textsubscript{fem} with people.

(De mestre, et al. 2007a, p. 346)

By comparing grammatical sentences (41a and 42a) with sentences in which the adjective contains a gender agreement violation (41b and 42b), the researchers hoped to gain insights into how fast these coreferential relationships were established. Naturally, the binding of PRO is not relevant to the current study but the fact that these sentences contain long-distance gender agreement relations is of interest.

In their first experiment (De mestre, Meltzer, García-Albea & Vigil 1999), subjects were presented with sentences containing a subject control verb and only one possible antecedent for PRO (43a & 43b) and sentences containing an object control and two possible antecedents (42a & 42b). The sentences were either grammatical (41a & 42a) or contained a violation of gender agreement (42b & 43b) on the adjective. As the critical adjective depends on the identity of the PRO for its gender specification, this manipulation allowed researchers to assess how quickly reference is assigned to PRO.

43a. Pedro\textsubscript{i} quiere PRO\textsubscript{i} ser rico en un futuro próximo.
Pedro\textsubscript{i} wants PRO\textsubscript{i} to be rich in the near future.
EEG was recorded while subjects listened to the sentences. The ERPs were time-locked to the onset of the final syllable of the adjective (i.e. the gender-marking). The manipulation of gender-agreement resulted in an increased early negativity (peaking around 150-250ms) followed by a positive deflection for the ungrammatical sentences. With respect to the early negativity, though the authors do not provide statistics in favor or against a hemispheric effect, visual inspection of the data indicates that the effect is not left lateralized, nor is it limited to frontal sites. The agreement effect was significant in all regions (anterior, central and posterior). There was a main effect of region but the authors did not do simple comparisons among regions. As the effect is significant in anterior, central and posterior regions, it seems more to an N400. The authors do not indicate if there was an effect of sentence type in this time window. The negative deflection was followed by a positivity which began around 200 ms after the onset of the critical syllable and was distributed all over the scalp but maximal over posterior and central sites, indicative of a syntactic violation. There was a significant interaction of grammaticality and hemisphere indicating that the effect of grammaticality was larger on the left side. There was also a significant main effect of sentence type such that the effect was larger for the object-control sentences with two possible antecedents.

In the second experiment (Demestre & García-Albea 2007a) subjects were presented with sentences containing control verbs together with more than one possible antecedent for PRO (like 40a, 40b, 41a & 41b). ERPs were time-locked to the onset of
the adjective. Both types of verbs elicited a clear P600 effect and there was no main effect of verb type. The positivity emerged around 500 ms and persisted until 900 ms. Statistical analysis showed that, though this positivity was widely distributed, it was not significant over anterior sites and was maximal over posterior sites.

From this collection of experiments, several interesting trends emerge. First and foremost, all agreement violations in a sentential context elicited a P600. With respect to the early negativities (the LAN and N400) there is a higher degree of variability. Upon reviewing the findings of the six studies detailed above, it seems that the character (as defined by topographical distribution) of the early negativities is related to the distance between the two segments which are involved in the agreement violation. If the violation is between two segments which are adjacent or separated by only one word, if any negativity is found, it will be the LAN (Barber & Carreiras 2005, Barber, Salillas & Carreiras 2004). If the violations involve two segments which are farther away from each other, if any negativity is found, it will be the N400 (Demestre, et al. 1999). These findings are consistent with the data from German (Münte & Heinze 1994, Hammer et al. 2005, Schmitt et al. 2002), though not for the Dutch studies in which an N400 was found when the critical words (a determiner and a noun) were separated by an adjective (Hagoort & Brown 1999, Hagoort 2003). Given the variability in gender processing evidenced in the behavioral research, it is not surprising that there is cross-linguistic variation in the ERP data. Nevertheless, the results from the studies looking at Spanish, the language in question in the current study, do show this pattern in which different
distances between segments involved in agreement violations elicited distinct
negativities.

**Conclusions**

I have proposed, based on the production of noun phrases in Spanish (specifically, the lack of effects in noun phrase and bare noun production in the picture-word interference paradigm), that simple noun phrases consisting of a determiner and noun might be directly retrieved as one lexical unit whereas other structures involving long-distance dependencies would require the access of abstract gender features and the construction of a hierarchical sentence structure. In sentence parsing, I propose that a similar distinction exists such that the agreement between a determiner and noun is processed on the basis of their morphophonological features (the extremely regular correspondence between the gender marked determiner and the word-final gender marking), whereas the processing of agreement structures between non-adjacent segments during sentence parsing would invoke the utilization of abstract gender features and true syntactic structure. I propose to distinguish these distinct cognitive processes via noninvasive recordings of brain electrical activity, event-related potentials (ERP).

Specifically, I hope to show evidence that different potentials will be elicited by the different processing types. As was previously discussed, the two potentials typically elicited by syntactic violations are the LAN and P600. A closer look at the types of violations that generally elicit the LAN shows that this potential is usually associated with violations involving adjacent (or near adjacent segments) and specifically when the agreement relationship is overtly marked with inflectional morphemes. The LAN can,
therefore, be construed as an index of violations of transitional probabilities between segments. When there is a strong correlation (based on frequency of occurrence) between two segments, the presentation of the first predicts the second and, thus, there is a high transitional probability between the two. For the determiner+noun noun phrase, the association would be between the gender specific determiner and the word-final gender-marking morpheme. This proposal is supported by the studies which have found a LAN when there is a violation between adjacent (or near adjacent) segments involving some form of overt morphological marking. The P600, on the other hand, has been shown to be sensitive to many different violations and anomalies in a sentence and, while may be elicited by violations of long distance dependencies, it is not specific to any particular violation type. It seems to appear whenever there is a syntactic violation in a sentential context. I would argue that the P600 is not sensitive to transitional probabilities between morphemes but rather it is indicative of a violation involving hierarchical sentence structure. For example, Barber and Carreiras (2005) found a LAN but no P600 for agreement violations in word pairs consisting of a determiner and noun, but, in a subsequent experiment in which such noun phrases formed part of a sentence, they found a LAN and P600. So, in word pairs no positivity was found (no hierarchical phrase structure was formed) but in sentences there was a P600.
LAN versus P600 in Agreement Structures

While the generalizations I have made about the LAN and P600 are based on the research on gender agreement, these patterns can also be observed in other types of agreement structures. The following are a few examples of how this distinction plays out in other types of agreement.

Osterhout and Mobley (1995) looked at adjacent versus long distance agreement structures like the following:

44a. The elected official hopes to succeed.
44b. *The elected official hope to succeed.
45a. The hungry guests helped themselves to the food.
45b. *The hungry guests helped himself to the food.
46a. The successful woman congratulated herself on the promotion.
46b. *The successful woman congratulated himself on the promotion.

(adapted from Osterhout & Mobley 1995, p. 742)

In sentence 44a, the subject and verb are adjacent and there is overt morphology indicating the relationship between the two (the subject is singular and receives no /s/ and, thus, the verb is marked as singular with a /s/). The latter two sentence types involve long distance agreement relationships which must be hierarchically mediated. Violations of subject-verb agreement (44b) elicited a LAN followed by a P600, while violations of long distance dependencies (45b and 46b) elicited only a P600.

Kaan (2002) also looked at subject-verb agreement. In an experiment with Dutch speakers, Kaan used sentences in which the subject and verb were either separated by one
word or separated by three or four words. The sentences were either grammatical or had number agreement violations between the subject and verb (both bear overt number-marking morphemes).

47a. **Short distance, grammatical**
Hoewel volgens het gerucht de keizer de dissident zal gaan verbannen is er veel tegenstand. 
Although according to the rumor the emperor will the dissident go ban is there a lot of opposition.

47b. **Long distance, grammatical**
Hoewel de keizer volgens het gerucht de dissident zal gaan verbannen is er veel tegenstand. 
Although the emperor according to the rumor the dissident will go ban is there a lot of opposition.

47c. **Short distance, ungrammatical**
*Hoewel volgens het gerucht de keizer de dissident zullen gaan verbannen is er veel tegenstand. 
Although according to the rumor the emperor the dissident will go ban is there a lot of opposition.

47d. **Long distance, ungrammatical**
*Hoewel de keizer volgens het gerucht de dissident zullen gaan verbannen is er veel tegenstand. 
Although the emperor according to the rumor the dissident will go ban is there a lot of opposition.

(Kaan 2002, 173)

Subjects were asked to read the sentences and perform grammaticality judgments on sentences while ERPs were recorded. Kaan found no effect of distance but she did find a P600 as a main effect of violation. This is consistent with the current proposal as all of the sentences had non-adjacent dependencies.
Kaan (2000) looked at subject-verb agreement errors in complex sentences containing subordinate clauses with two types of indirect questions (who vs. whether).

48a. Emily wondered who the performer in the concert had imitated for the audience’s amusement.

48b. Emily wondered whether the performer in the concert had imitated a pop star for the audience’s amusement.

The “who” type of indirect question is more complex in that “who” must be identified as the patient of the verb *imitated* in order to satisfy the theta criteria of the verb, and the two segments are distant from one another. No such relationship needs to be resolved in the “whether” condition. The goal of her experiment was to assess the role of syntactic complexity and determine if an interaction between complexity and violation would be evidenced by differences in the P600 time window. Her stimuli, however, are suited to the present discussion as in all sentences the subject of the relative clause and the relevant verb were separated by several words. She found a P600 as a main effect of violation but no LAN.

While these are only a few examples, there seems to be a basis for the generalization that the LAN can be construed as an index of violations of transitional probabilities between segments, while the P600 monitors syntactic processing from the perspective of the hierarchical structure.

**Distance and Processing of Agreement**

One issue that is important to this discussion of the findings from the experiments looking at gender agreement in Spanish is the effect of distance on the processing of agreement. As has been stated previously, agreement errors between segments which are
adjacent or near adjacent tend to evoke a LAN while violations between segments that are farther away will evoke an N400. This generalization was based on many studies which did not directly examine the effects of distance. While there have been some studies that include distance as a factor, it remains an area which has not been thoroughly explored and the findings that exist are contradictory. The following is a brief review of studies that look at distance as a factor in parsing agreement structures.

Pearlmutter (2000) which represents the continuation of the research in production first published in Franck, Vigliocco and Nicol (2002) used preambles that included two intervening noun phrases (rather than one as in the Bock and Miller studies). Pearlmutter recorded reading times for the following sentence types.

56a. The lamp near the painting of the house was damaged in the flood.
56b. The lamp near the painting of the houses was damaged in the flood.
57a. The lamp near the paintings of the house was damaged in the flood.
57b. The lamp near the paintings of the houses was damaged in the flood.

(Pearlmutter 2000, p. 92)

They found no difference in reading times for these different sentence types. Given the robust attraction effects found in agreement tasks when the local noun is plural, the lack of effect is surprising. In a subsequent experiment, they used plural head nouns.

58a. The lamps near the painting of the house were damaged in the flood.
58b. The lamps near the painting of the houses were damaged in the flood.
59a. The lamps near the paintings of the house were damaged in the flood.
59b. The lamps near the paintings of the houses were damaged in the flood.
They found that reading times were longer when the second noun was singular. Singular second nouns caused interference (longer RTs). They indicate that this supports the hierarchical model because in the phrase structure “painting” is closer to the verb than “house”. Again, this finding is interesting in light of the verb agreement production literature because there is generally less of an effect with singular local nouns. It seems that the segment closest to the subject causes interference. In this respect, these findings are somewhat consistent with those of Bock and Miller (1992) (more errors were found in the postmodifier types in which the local noun is closer to the head noun).

Deutsch (1998) examined how looking times (measured with an eye-tracker) were influenced by subject-verb agreement errors in Hebrew. They, therefore, contrasted correct sentences with sentences that had number agreement violations between the subject and verb. Number inflection is overtly marked on both the noun phrase and the verb in Hebrew with number-marking morphemes. They also included distance as a factor, so in the short condition, subjects and verbs were adjacent, while in the long condition the two were separated by a five word intervening phrase. They found that looking times were longer for violations than for correct sentences in the short condition only. This experiment is very interesting because it provides an example of a distinction between the processing of agreement structures involving adjacent, highly morphologically marked segments, and those involving segments which are at a distance from one another. The agreement errors involving adjacent segments seem to be more
salient, perhaps because they contain violations relating to both local transitional probabilities and hierarchical phrase structure.

As described above, Kaan (2002) looked at the effect of distance on the processing of subject-verb agreement in an ERP study. In an experiment with Dutch speakers, Kaan used sentences in which the subject and verb were either near adjacent (separated by one word) or separated by three or four words. The sentences were either grammatical or had number agreement violations between the subject and verb (both bear overt number-marking morphemes). Subjects were asked to read the sentences and perform grammaticality judgments while ERPs were recorded. While the behavioral data showed that accuracy in the grammatical judgment task was reduced in the long condition relative to the short, the ERP data showed no distinction between the two.

Lastly, Philips, Kazanina and Abada (2005) looked at the effect of distance on processing wh-dependencies in English. While this study does not relate to agreement, the inclusion of distance as a factor makes it relevant to the current discussion. Philips and colleagues used sentences like the following in which the dependency involves the object of an object relative and the transitive verb which selected it (*accomplice* and *recognize* below).

60a. The detective hoped that the lieutenant knew which *accomplice* the shrewd witness would *recognize* in the lineup.

60b. The lieutenant knew which *accomplice* the detective hoped that the shrewd witness would *recognize* in the lineup.

(Philips, Kazanina & Abada 2005, p. 410)
The wh-dependency is a long distance dependency but in the “long” condition, the distance is enlarged with another relative clause. Subjects were asked to read the sentences and respond to comprehension questions while ERPs, time locked to the critical verb (recognize in the examples above) were recorded. The ERP data showed that there was no effect of distance. This finding is interesting in that both the long and short condition involve long distance dependencies, which necessarily require the use of hierarchical syntactic structure. Also, the relationship between the object and the verb that selects it (accomplice and recognize, respectively) is not distinguished by any kind of overt inflectional morphology.

Given the diversity of languages and experiment methodologies it is difficult to draw any strong conclusions about this body of research. It suffices to say that no clear and consistent effects of distance have been found. None of these studies examined how parsing agreement structures would be affected by progressively increasing the distance (i.e. making distance a factor with more than two levels) which is a potential issue that will be examined in the current study.
Chapter 5 – Experiments 4 and 5

EXPERIMENT 4

In order to test the theory that, in Spanish, gender agreement between a determiner and noun is processed differently than other types of gender agreement, I conducted an ERP experiment in which various types of gender agreement violations were compared. The central proposal is that the parsing of determiner+noun agreement is not mediated by syntax (i.e. hierarchical structure) but rather is processed on the basis of transitional probabilities between the gender-marking morphemes. This type of processing may also apply to noun+adjective sequences as both are overtly marked and adjacent but the co-occurrence of the noun and adjective is nowhere near as frequent as that which exists between the determiner and noun. In most cases, the determiner is obligatory, the determiner belongs to a small closed class, whereas the adjective is optional and can be any one of thousands. I hoped to distinguish between hierarchical and non-hierarchical processing of gender agreement relations by using the ERP technique. Specifically, I predicted that the LAN will be elicited by the non-hierarchical processing (frequency-based associations between elements) while the P600 will be associated with hierarchical processing (characterized by the use of abstract syntactic features to select segments be they phrases or morphemes). In order to fully contrast the determiner-noun noun phrase with noun-adjective agreement, an array of agreement structures involving nouns and adjectives will be included in the stimuli. These structures will vary in distance (adjacent, separated by one word, separated by many words) and, though the distance manipulation was introduced in order to have conditions...
in which agreement must be computed using hierarchical phrase structure, it will have the
added benefit of allowing us to assess the role of distance in the processing of gender
agreement.

METHODS

Subjects

Data were collected from a total of 27 subjects (13 females). All of the subjects
were Spanish/English bilinguals for whom Spanish was the native and dominant
language. Dominance was established by subjects’ language history. Subjects on
average were first exposed to English at age 11. Six subjects had begun to learn English
in school before age 11, but none of these subjects experienced an immersion setting until
after age 11. All subjects were neurologically normal with normal or corrected-to-normal
vision. The ages of the participants ranged from 18 to 37 (average age was 26.4).
Twenty-one of the subjects were right handed. Two of the left handed subjects had
sinistral relatives. Subjects were paid for participation. Data from three subjects were
eliminated from analysis due to excessive blink artifacts.

Stimuli

The following are the four sentence types (each with a grammatical and
ungrammatical version) which were designed to address the question of the nature of
access of syntactic gender in native speakers of Spanish as evidenced by differences in
ERP effects. In conditions 1 and 2, the critical structure is a determiner+noun noun
phrase. In conditions 3 and 4, the noun+adjective agreement structure is examined. In
conditions 5 and 6, the target structure is the agreement between a noun and adjective
separated by a copular verb, and in 7 and 8, the same structure is targeted but with additional distance between the two segments. The downward pointing arrow indicates the word to which the ERPs will be time-locked.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Sample Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Det+Noun</td>
<td>Acabo de llegar y creo que <strong>el piano</strong> está aquí.</td>
</tr>
<tr>
<td>(Grammatical)</td>
<td>I’ve just arrived and I think that <strong>the piano</strong> is here.</td>
</tr>
<tr>
<td>2 – Det+Noun</td>
<td>Acabo de llegar y creo que <strong>la piano</strong> está aquí.</td>
</tr>
<tr>
<td>(Ungrammatical)</td>
<td>I’ve just arrived and I think that <strong>the piano</strong> is here.</td>
</tr>
<tr>
<td>3 – N+Adj</td>
<td>Llegamos hace poco y vimos <strong>el piano roto</strong> en la sala.</td>
</tr>
<tr>
<td>(Grammatical)</td>
<td>We arrived not long ago and saw <strong>the broken piano</strong> in the room.</td>
</tr>
<tr>
<td>4 – N+Adj</td>
<td>Llegamos hace poco y vimos <strong>el piano rota</strong> en la sala.</td>
</tr>
<tr>
<td>(Ungrammatical)</td>
<td>We arrived not long ago and saw <strong>the broken piano</strong> in the room.</td>
</tr>
<tr>
<td>5 – N+Cop+A</td>
<td>Me han dicho que <strong>el piano</strong> está <strong>roto</strong> y ya no funciona.</td>
</tr>
<tr>
<td>(Grammatical)</td>
<td>They’ve told me that <strong>the piano</strong> is <strong>broken</strong> and no longer works.</td>
</tr>
<tr>
<td>6 – N+Cop+A</td>
<td>Me han dicho que <strong>el piano</strong> está <strong>rota</strong> y ya no funciona.</td>
</tr>
<tr>
<td>(Ungrammatical)</td>
<td>They’ve told me that <strong>the piano</strong> is <strong>broken</strong> and no longer works.</td>
</tr>
<tr>
<td>7 – N...A</td>
<td><strong>El piano</strong> que compramos ayer está <strong>roto</strong> y no funciona.</td>
</tr>
<tr>
<td>(Grammatical)</td>
<td><strong>The piano</strong> we bought yesterday is <strong>broken</strong> and doesn’t work.</td>
</tr>
<tr>
<td>8 – N...A</td>
<td><strong>El piano</strong> que compramos ayer está <strong>rota</strong> y no funciona.</td>
</tr>
<tr>
<td>(Ungrammatical)</td>
<td><strong>The piano</strong> we bought yesterday is <strong>broken</strong> and doesn’t work.</td>
</tr>
</tbody>
</table>
In these conditions, which constitute the main experiment, there are two factors: Grammaticality (2) x Sentence type (4). Given this design, there were eight lists and each sentence (i.e. each noun-adjective pairing) was realized in each of the eight conditions across eight lists so that each subject will see each sentence once. All nouns were canonically marked for gender. Half of the target nouns were masculine and half were feminine. The critical words (nouns and adjectives, depending on condition) were balanced for frequency, length and position (in the sentence) across the eight chunks. All critical nouns had 10 letters or less (average length: 6.2 letters) and all critical adjectives had 11 letters or less (average length: 7.3). There were 40 sentences in each of the eight conditions, and, thus, each list had 320 sentences in the gender agreement conditions. In the sentences with copular verbs, both copular-type of the verbs of Spanish (ser and estar) were used. There were no other NPs intervening between the noun and the critical adjective (in conditions 3-8) in order to avoid any superfluous gender access. Also, there was never anything intervening between the determiner and noun in conditions 1 and 2. The critical word (either a noun or adjective depending on the condition) was never be sentence initial or sentence final and the position of these words in the sentences was balanced across conditions.

In the experimental conditions above, we would like to compare the effects of the violation of gender agreement on a noun (the determiner+noun sentence type) with the rest of the violation types which involve a non-agreeing adjective. In order to address the possibility that any differences in effects could be attributed to the different word classes, we will add in (in lieu of filler sentences) two new sentence types in which both nouns
and adjectives will be the site of number agreement violations in hopes of demonstrating that the word class doesn’t influence the effects. As for comparing number and gender agreement violations, Barber and Carreiras (2005), found that the only difference between the two, on nouns and adjectives, was that the later component of the P600 was greater for gender violations than number. There is, therefore, reason to believe that the effects of number and gender violations are similar enough to be compared in this manner.
Table 6 – Stimuli for Number Agreement Conditions (Experiment 4)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>D+N (# Ag)</td>
<td><strong>Una casa</strong> nueva fue destruida en el huracán.</td>
</tr>
<tr>
<td></td>
<td>(Grammatical)</td>
<td>A new house was destroyed in the hurricane.</td>
</tr>
<tr>
<td>10</td>
<td>D+N (# Ag)</td>
<td><strong>Una casas</strong> nueva fue destruida en el huracán.</td>
</tr>
<tr>
<td></td>
<td>(Ungrammatical)</td>
<td>A new houses was destroyed in the hurricane.</td>
</tr>
<tr>
<td>11</td>
<td>D+N (# Ag)</td>
<td><strong>Hay casas nuevas</strong> en el barrio donde vivo yo.</td>
</tr>
<tr>
<td></td>
<td>(Grammatical)</td>
<td>There are new houses in the neighborhood where I live.</td>
</tr>
<tr>
<td>12</td>
<td>D+N (# Ag)</td>
<td><strong>Hay casas nueva</strong> en el barrio donde vivo yo.</td>
</tr>
<tr>
<td></td>
<td>(Ungrammatical)</td>
<td>There are new houses in the neighborhood where I live.</td>
</tr>
</tbody>
</table>
The syntactic errors in these sentences are such that they cannot be resolved by additional sentence input. There is no way that “Una casas” can lead to a grammatical sentence, nor can “Hay casas nueva” lead to an acceptable parse. This portion of the experiment had two factors with two levels each (Target type (2) x Grammaticality (2)). Quartets were formed so that each noun-adjective pair will appear in each condition once. Each subject saw each noun-adjective pair once. There were 30 sentences in each quartet, 120 in all. The near initial position of the critical words will serve to add a little variety in terms of the location of the violation and perhaps prevent the subjects from getting into a routine or developing strategies. The critical words in will be balanced for frequency, length and position and across conditions and lists. Half of the nouns were masculine and half were feminine. All nouns and adjectives were cannonically marked for gender. There were 30 sentences in each quartet, 120 in all.

Lastly, as a control (in order to be able to compare any LAN effects to a proper N400), semantic conditions were included which will differ by the semantic fit of the critical noun.
<table>
<thead>
<tr>
<th></th>
<th>Stimuli for Semantic Conditions (Experiment 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Me gusta pasar las vacaciones en la playa\downarrow durante el verano.</td>
</tr>
<tr>
<td></td>
<td>I like to spend vacations at the beach \downarrow in the summertime.</td>
</tr>
<tr>
<td>14</td>
<td>Me gusta pasar las vacaciones en la escoba\downarrow durante el verano.</td>
</tr>
<tr>
<td></td>
<td>I like to spend vacations at the broom \downarrow in the summertime.</td>
</tr>
</tbody>
</table>
There will be sixty sentences in all (30 congruent and 30 incongruent). The critical nouns in each chunk will be balanced for frequency, length and position across conditions and lists. Half were masculine and half were feminine.

All in all, eight lists were prepared containing sentences from all 14 above referenced conditions.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Conditions</td>
<td>8 * 40 = 320</td>
</tr>
<tr>
<td>Number</td>
<td>4 * 30 = 120</td>
</tr>
<tr>
<td>Semantic</td>
<td>2 * 30 = 60</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>500</td>
</tr>
</tbody>
</table>

Each list had a total of 500 sentences. Due to the large number of sentences, data were collected over two sessions. 250 sentences were presented during each session.

In addition to the sentences, comprehension questions were prepared for 20% of the sentences in each list (100 questions per list). These comprehension questions were simple yes/no questions regarding the immediately previous sentence. The following are some examples of sentence-question pairs.

61a. Dicen que recuerdan la compañía que usamos pero yo lo olvidé.

They say that they remember the company that we used but I forgot about it.

61b. ¿Se han olvidado de la compañía?

Have they forgotten the company?

62a. Ahora es evidente que el requisito fue impuesto por el presidente de la universidad.

Now it is evident that the requirement was imposed by the president of the university.
¿Fue el presidente el que impuso ese requisito?

Was the president the one who imposed the requirement?

Acabo de notar que el carro está dañado y no podemos usarlo.

I just noticed that the car is damaged and we can't use it.

¿Se puede usar el carro?

Can the car be used?

Questions were prepared for all conditions except 14 (the semantically incongruent condition). The lists were balanced for number of questions per condition and number of “yes” responses per condition. As each list was split into two sessions, there were fifty questions per session and, again, the questions were evenly distributed across conditions and there were the same number of “yes” and “no” responses in each session.

**Procedure**

Sentences appeared word by word in a rectangular box in the center of a high resolution computer screen. The rectangular box appeared continuously on the monitor. Each word was presented for 200 ms, followed by a blank of 300 ms. The final word of the sentence was presented with a period sign and was followed by a 5.5 second rest period. 20% of the sentences were followed by questions. The questions were presented in their entirety above the rectangular frame for 2500 ms, followed by a rest period of 3500 ms. Key presses with the right and left index fingers were used for yes and no responses to the target words, with the mapping between response and right or left hand counterbalanced between the two sessions. Participants participated in two experimental
sessions, each lasting approximately two hours. Within each session, the stimuli were broken into 10 runs of approximately 5 minutes each.

Upon arrival at the lab, participants signed a consent form and filled out a language history questionnaire. Participants were then tested individually in a sound attenuated booth. They were seated in a comfortable chair with button boxes on either armrest. They were instructed to read the sentences and that they would occasionally have to answer comprehension questions regarding the sentences. Subjects were instructed to sit still and not to blink or move their eyes during the presentation of the sentences. Each session, including electrode application and removal, took approximately two hours.

**EEG Recording**

ERPs were recorded from the scalp using twenty-five tin electrodes mounted in an elastic cap. The electrode sites used in this experiment were FPZ, FP1/2, FZ, F3/4, F7/8, FCZ, FT7/8, CZ, C3/4, T3/4, CPZ, CP3/4, TP7/8, PZ, P3/4, T5/6 and 0Z, as defined by the 10-20 system (Jasper 1958). ERPs were recorded using the left mastoid as a reference and then re-referenced offline to an average of the left and right mastoids. Vertical eye movements and blinks were monitored with an electrode placed below the right eye referred to the left mastoid. Horizontal eye movements were monitored with a bipolar montage using two electrodes placed on the right and left canthus. Amplifier band pass was 0.01 to 100 Hz; sampling rate was 250 Hz, and gain was 50,000. Trials containing blinks, eye movement, or amplifier saturation artifacts were rejected prior to averaging the trials into ERPs for each condition.
RESULTS

Participants responded correctly to 88% of the comprehension questions on average. The lowest accuracy rate was 79%, so that all participants were deemed to show adequate attention to, and comprehension of the stimuli. Accuracy on the comprehension questions was not affected by experimental condition (i.e. the agreement relationship in the preceding sentence) or the grammaticality of the preceding sentence. Reaction times did show a main effect of sentence type \( (F(3,69) = 3.912, \epsilon = .873, p < .05) \) such that the reaction times for questions following the Noun-Copular Verb-Adjective sentences were longer than the others. There was no main effect of violation but there was a significant interaction of violation and sentence type \( (F(3,69) = 3.445, \epsilon = .781, p < .05) \) such that reaction times were longer for questions following ungrammatical sentences in the Noun-Copular Verb-Noun conditions. The ERP results will be presented in three main sections describing the impact of violating gender agreement, number agreement, and semantic congruity, respectively. These are followed by a fourth section comparing the gender violation and semantic incongruity manipulations.

Gender Agreement

Figure 8 shows ERPs collapsed across the four sentence types in the gender conditions. Visual inspection of these plots reveals two effects of violating gender agreement: an early negativity that is most prominent over left frontocentral sites, and a later positive deflection that is largest at parietal sites and not strongly lateralized. These are the expected LAN and P600 effects. Figure 9 illustrates the left anterior focus of the violation effect in an early latency window of 200 to 500 after the onset of the critical
words, and the parietal focus of the violation effect in a later latency window of 500 to 800 ms after stimulus onset. These two latency windows were selected for analysis, and are generally consistent with prior studies (see Kutas, Van Petten, & Kluender, 2006 for review). Figures 10 through 13 are plots of the individual sentence types comprising the gender conditions, and for the most part show effects similar to those in Figure 8. Figures 10 and 11 (the determiner+noun and noun+adjective conditions, respectively) both show an early anterior negativity followed by a late posterior positivity. While it is somewhat less prominent in the noun+copular verb+adjective condition, an anterior negative deflection can also be seen in Figure 12. This negativity is followed by a late positivity as in the other conditions. Figure 13 shows that the long distance condition in which the noun and adjective are separated by several words differs from the rest in that, although there seem to be some early negativities, there is no late positivity to speak of.
Grammatical Gender Agreement

*Gender Agreement Violation*

**Figure 8.** Grand average ERPs from 24 subjects for nouns and adjectives preceded by other sentence words that agree in gender (e.g., el PIANO, piano ROTO), or disagree in gender (violations, la PIANO, piano ROTA). Arrows indicate the two influences of violations on the ERPs: larger negative potential at left anterior sites (LAN), and larger positive potential most evident at parietal sites (P600), both as compared to the gender agreement conditions.
Figure 9. Topographic maps of the spatial distribution of the difference between gender violations and gender agreement in two latency windows. Waveforms are shown for a left frontal (F3) and midline parietal (Pz) site where the two effects are largest.
Figure 10 - Grand average ERPs from 24 subjects for nouns immediately preceded by determiners that agreed (grammatical) or disagreed (violations) in gender.
**NOUN-ADJECTIVE GENDER CONDITIONS**

- **Grammatical** (piano ROTO)
- **Ungrammatical** (piano ROTA)

**Figure 11** - Grand average ERPs from 24 subjects for adjectives immediately preceded by nouns that agreed (grammatical) or disagreed (violations) in gender.
Figure 12 - Grand average ERPs from 24 subjects for adjectives immediately preceded by a noun (and copular verb) that agreed (grammatical) or disagreed (violations) in gender.
LONG DISTANCE GENDER CONDITIONS

Grammatical (el piano que compramos ayer está ROTO)
Ungrammatical (el piano que compramos ayer está ROTA)

Figure 13 - Grand average ERPs from 24 subjects for adjectives separated from the preceding noun which they modify by a copular verb and relative clause that agreed (grammatical) or disagreed (violations) in gender with that noun.
Mean amplitudes of the ERPs in the 200-500 and 500-800 ms latency windows were measured with respect to a 100 ms baseline preceding the critical words. For each latency window, these values were first subjected to ANOVAs taking sentence type (determiner+noun, noun+adjective, noun+copula+adjective, and noun+other+adjective), violation (grammatical versus violation), and scalp location of the electrodes as repeated measures. Three such ANOVAs were performed for each latency window: 1) on the midline electrode sites of Fpz, Fz, Fcz, Cz, Cpz, Pz, and Oz with anterior-to-posterior (AP) as the sole location factor; 2) on lateral electrode sites located close to the midline (dorsal sites Fp1, Fp2, F3, F4, C3, C4, Cp3, Cp4, P3, P4) taking both AP and laterality (left versus right) as factors; and 3) on the lateral sites farther from the midline (ventral sites F7, F8, Ft7, Ft8, T3, T4, Tp7, Tp8, T5, T6), also taking AP and laterality as repeated spatial factors. These initial ANOVAs are followed by analyses on amplitudes from selected electrode sites where the LAN (200-500 ms) and P600 (500-800 ms) are largest, including pairwise comparisons between grammatical and ungrammatical versions of each sentence type. F-ratios with more than one degree of freedom in the numerator were subjected to the Huynh-Feldt correction for nonsphericity of variance; reported are the original degrees of freedom, the epsilon ($\varepsilon$) correction factor, and the corrected probability level.

**Early Negativities (200-500ms)**

**Midline electrodes.** ERPs elicited by violations of gender agreement were reliably more negative than those elicited by their grammatical versions (main effect of violation, $F(1, 23) = 4.82, p < .05$). The anterior distribution of the enhanced negativity
resulted in a significant interaction of AP and violation \((F(6, 138) = 3.31, \varepsilon = .28, p < .05)\). The interaction between sentence type and violation was not significant \((F < 1)\), suggesting that the LAN effect was equivalent across the four sentence types.

**Dorsal electrodes.** Analysis of the dorsal electrode sites similarly returned a main effect of violation \((F(1, 23) = 4.48, p < .05)\), and a significant interaction of violation and anterior-posterior electrode location \((F(4, 92) = 17.3, \varepsilon = .32, p < .0005)\). This analysis also confirmed that the enhanced negativity elicited by gender agreement violations was larger over the left than right side (violation by laterality, \(F(1, 23) = 9.60, p < .05\), see Figure 9. Finally, the restricted scalp distribution of the LAN effect also resulted in a three way interaction of violation, AP and laterality \((F(4, 92) = 5.31, \varepsilon = .81, p < .005)\). There were no significant interactions between violation and sentence type.

**Ventral electrodes.** Analysis of the ventral sites revealed no significant effect of violation or interactions involving violation.

**Left anterior region of interest.** Given the interactions between violation and scalp location above, the LAN data were also evaluated via follow-up analyses on a small region of interest in which the effect was largest: midline and left frontal and frontocentral sites Fz, Fcz, F3, C3. An ANOVA with sentence type and violation as factors revealed a main effect of violation \((F(1, 23) = 10.18, p < .005)\), such that violations were more negative, and no other significant effects. There was not a significant interaction of sentence type and violation, but given that the type of gender agreement violation is relevant to the motivation of the experiment, simple comparisons were performed for each sentence type. None of the simple comparisons revealed main
effects of violation ($F_s < 3.4$). These null results are surprising given the robust violation effect in analyses with all four sentence types, and suggest that the small amplitude of the LAN effect requires a large number of trials before it becomes reliably distinguishable from noise. The results are, however, consistent with the conclusion that the LAN effects are homogeneous across sentence type.

**P600 (500-800ms)**

**Midline electrodes.** The gender violations elicited more positive ERPs than their grammatical controls (main effect of violation ($F(1, 23) = 5.82, p < .05$). A significant interaction of violation and the anterior-posterior factor reflected the posterior maximum of the violation effect ($F(6, 138) = 6.54, \epsilon = .36, p < .005$; see Figures 8 and 9). There were no significant interactions between sentence type and violation.

**Dorsal electrodes.** An ANOVA on dorsal sites revealed a significant main effect of violation ($F(1, 23) = 5.5, p < .05$), such that there was an increased positivity associated with violations. There was also a significant interaction of violation and laterality ($F(4, 92) = 7.28, \epsilon = .49, p < .005$) which reflects the slight rightward distribution of the effect, as seen in Figures 8 and 9.

**Ventral electrodes.** An ANOVA on ventral sites revealed a main effect of violation ($F(1, 23) = 6.35, p < .05$) such that violations were more positive. There was a marginal interaction of laterality and violation ($F(1,23) = 3.76, p = .065$) indicating the rightward distribution of positivity (see Figures 8 and 9). There were no other interactions involving the factor violation.
Posterior region of interest. In order to further examine the P600 effect, ANOVAs were performed on a group of electrodes consisting of Pz, P3, P4, Tp7, Tp8, as these represent sites where the enhanced positivity for agreement violations was most prominent. The ANOVA with all four sentence types returned the expected main effect of violation ($F(1, 23) = 24.99, p < .0005$). More critically, a significant interaction of sentence type and violation ($F(3, 69) = 4.05, p < .05$) indicated that the four gender agreement violations did not elicit equivalent P600s. As noted above, comparison of Figures 10-13 suggest that the sentence type with the longest distance between (dis)agreeing elements elicited little to no P600 effect. The interaction was pursued by follow-up analyses for each sentence type. Analyses of the determiner+noun, noun+adjective, and noun+copula+adjective sentence types all led to main effects of violation ($Fs(1, 23) = 19.75, 6.36, 14.95$ respectively, all $ps < .05$). In contrast, there was no main effect of violation in the long distance violation condition in which the noun and adjective were separated by a copular verb and subordinate clause, ($F < 1$).

Number Agreement

The combined results for the two sentence types with number agreement or violations of number agreement can be seen in Figure 14. There seems to be some evidence of the left anterior negativity in response to agreement violation, but it is a smaller effect. Likewise while there is some positivity at parietal sites, the effect of number violation is greatly reduced relative to gender violation. Data analyses paralleled those of the gender conditions, taking sentence type (those with singular versus plural
nouns), violation (number disagreement versus grammatical), and electrode location as repeated factors.
Grammatical Number agreement (una CASA, casas VIEJAS)
Number Agreement Violations (una CASAS, casas VIEJA)

Figure 14 - Grand average ERPs from 24 subjects for critical nouns and adjectives in sentences which contained a phrase in which the noun and determiner or noun and adjective agreed in number and for critical adjectives that did not agree in gender with the noun.
Early Negativities (200-500ms)

**Midline electrodes.** An ANOVA on amplitudes from the midline electrodes showed no main effect of violation ($F < 1$). There was an interaction of violation and anterior-posterior ($F(6, 138) = 2.87, \varepsilon = .48, p < .05$, which reflects the small anterior negative deflections seen in Figure 14.

**Dorsal electrodes.** An ANOVA on dorsal sites was performed and, once again, there was no main effect of violation ($F < 1$), nor were there any interactions involving the violation factor.

**Ventral electrodes.** An ANOVA on ventral sites revealed no main effect of violation ($F < 1$), nor were there any interactions involving the violation factor.

**Left anterior region of interest.** As with the gender conditions, the frontocentral region of interest was analyzed. There was no main effect of violation ($F < 1$), nor were there any interactions involving the violation factor. Because Figure 14 suggests a small and brief increase in the amplitude of a negative potential for number violations – an effect resembling a LAN – an additional analysis was conducted using an abbreviated time frame of 350-500 in an effort to isolate the negativity but to no avail; there was no main effect of violation ($F < 1$). Comparison of Figures 8 and 14 shows that the apparent effect of number agreement violation is much smaller in magnitude than the gender violation effects, and the analyses here indicate that it is too weak to be significant.

Late Positivities (500-800ms)

Though Figure 14 does not indicate that an analysis of late positivity is necessary, the full array of analyses was performed as the P600 is so strongly correlated with
syntactic violations in a sentence context. ANOVAs for midline, dorsal, ventral, and the selected electrodes in the posterior region of interest uniformly showed no significant main effects of violation, nor interactions involving the violation factor (all $F_s < 1$).

**Semantic Congruity**

Figure 15 shows that semantically incongruent sentence continuations elicited much more negative ERPs than congruent continuations, beginning at about 150 ms after word onset and peaking at about 400 ms after onset. This negativity is widely distributed but maximal at central and parietal scalp sites, as illustrated in Figure 16. The timing, polarity and scalp distribution of the incongruity effect here are very consistent with prior descriptions of the N400. Comparisons between this response to semantically inappropriate but grammatically correct words and the earlier and more frontal response to agreement violations (compare Figure 8 to 15, and Figure 9 to 16) helps bolster the conclusion that the negativity associated with grammatical errors is a LAN rather than an N400. Additionally, the enhanced N400 elicited by semantic incongruities as compared to plausible continuations was not followed by an enhanced positive potential, in contrast to the LAN-P600 sequence for agreement violations.
Figure 15 - Grand average ERPs from 24 subjects for critical nouns in sentences which were either a good semantic fit given the previous context or semantically incongruous.
Midline electrodes.

Mean amplitudes of the ERPs were measured in the 300-600 ms latency range in which the difference between congruent and incongruent words was largest. The ANOVA performed on the midline electrodes showed a main effect of violation \(F(1, 23) = 44.0, p < .0001\), and an interaction of violation and AP \(F(6, 138) = 8.74, \varepsilon = .36, p < .005\) reflecting the centroparietal distribution of the congruity effect.

Dorsal electrodes.

An ANOVA on dorsal sites also showed a main effect of violation \(F(1, 23) = 49.5, p < .0001\), and violation by AP interaction \(F(4, 92) = 17.76, \varepsilon = .36, p < .0005\).

Ventral electrodes.

As in the other analyses, an ANOVA on ventral sites revealed a main effect of violation \(F(1, 23) = 39.47, p < .0001\), and an interaction of violation and AP \(F(4, 92) = 7.62, \varepsilon = .47, p < .005\).

The N400 effect was not significantly asymmetric, as there were no interactions between violation and laterality in the analyses of dorsal or ventral sites.

LAN effect of agreement violations compared to N400 effect of semantic violations

Both gender violations and semantic incongruities elicited larger negative potentials than their control conditions of well-formed sentences. Prior research describes the impact of morphosyntactic violations as evident primarily over left anterior scalp (see Chapter 3 of the current analysis, see also Kutas, Van Petten and Kluender 2006), whereas the N400 elicited by semantic incongruities in visual sentences is spatially widespread but largest at central and parietal scalp sites (Van Petten & Luka,
Comparison of Figures 9 and 16 suggest that these two effects have different scalp distributions in the current experiment as well: the enhanced negative potential for gender violations is maximal over frontocentral scalp whereas the enhanced negative potential for semantic incongruities is maximal over parietal scalp.

Topographies of the gender and semantic effects were compared via ANOVAs taking sentence type (gender versus semantic), violation (erroneous versus well-formed), and scalp location as factors, after collapsing across the four varieties of gender agreement violation. Statistical support for the differential scalp distributions of the gender and semantic effects will consist of interactions between sentence type, violation, and a location factor. In the primary analyses above, the impacts of gender disagreement and semantic incongruity were evaluated in different latency windows centered around the peak of the differences, 200-500 versus 300-600 ms, respectively. In the comparative analyses presented below, mean amplitudes of the ERPs were measured in a common latency window of 200-500 ms to avoid confounding latency window with the grammatical versus semantic nature of the sentence error. A second potential confound for the comparative analyses is that the amplitude of the semantic effect is much larger than the amplitude of the gender disagreement effect (compare Figures 8 and 15). The additive nature of the Analysis of Variance procedure is such that differences in the amplitude of two effects can create spurious interactions between type-of-effect and scalp location (McCarthy & Wood, 1985). Amplitudes were thus normalized as recommended by McCarthy and Wood, by dividing each value by the square root of the sum of squared values in each condition, for each participant.
For the midline scalp sites, an ANOVA on normalized data for sentence type, violation, and anterior-to-posterior (AP) scalp distribution yielded a main effect of violation $\left( F(1,23) = 19.6, p < .0002 \right)$, sentence type by violation $\left( F(1,23) = 10.4, p < .005 \right)$, and critically a three-way interaction between sentence type, violation, and the AP factor $\left( F(6,138) = 3.82, \varepsilon = .38, p < .05 \right)$. The latter interaction is the expected result from the anterior versus posterior maxima of the gender agreement versus semantic violations. For the dorsal scalp sites, an ANOVA including the factors above plus laterality similarly yielded a main effect of violation $\left( F(1,23) = 23.7, p < .0001 \right)$, sentence type by violation $\left( F(1,23) = 11.0, p < .005 \right)$, and sentence type by violation by AP $\left( F(4,92) = 5.77, \varepsilon = .70, p < .002 \right)$. Analysis of the ventral scalp sites produced the same pattern of results: main effect of violation $\left( F(1,23) = 22.6, p < .0001 \right)$, sentence type by violation $\left( F(1,23) = 11.4, p < .005 \right)$, and sentence type by violation by AP $\left( F(4,92) = 5.58, \varepsilon = .65, p < .002 \right)$.

Differential lateralization of the gender and semantic effects is also of some interest. As noted above in the primary analyses of the gender violations, the anterior negativity was reliably larger over the left than right sides, as predicted. In contrast, the N400 difference between semantically congruent and incongruent words in visual sentences frequently, but not always, has a small right-greater-than-left asymmetry (Kutas, Van Petten, & Beeson, 1988; Van Petten & Luka, 2006). This was not true of the current results, in that the difference between congruent and incongruent words was slightly (nonsignificantly) larger over the left (Figure 16). The analysis of dorsal scalp sites thus yielded a significant interaction between violation and laterality reflecting the
left-larger-than-right asymmetry for both gender and semantic errors \( (F(1,23) = 6.65, p < .02) \), but no interaction between sentence type, violation and laterality \( (F < 1) \). The analysis of ventral sites yielded no significant interactions between violation and laterality, likely because both effects were smallest at ventral sites as compared to sites closer to, or at the midline.
Figure 16. Topographic maps of the spatial distribution of the difference between semantically appropriate and semantically incongruent nouns in the 300-600 ms latency window. Waveforms are shown for the midline parietal (Pz) site where the effect is largest.
Discussion

Experiment 4 included sets of seven pairs of fully acceptable and ungrammatical sentences: four in which critical words agreed or disagreed in gender with preceding words, two in which critical words agreed or disagreed in number, and one in which critical words formed semantically congruent or incongruent continuations of their sentences. Increased amplitudes of a left-lateralized, frontocentral negative component were observed in the ERP responses to all four sorts of violations of gender agreement as compared to their grammatical controls. The negative component elicited by gender violations had a distinct scalp distribution from the more posterior effect of semantic incongruity, such that we can confidently label the gender violation effect a LAN, in contrast to the enhanced N400 elicited by semantic errors as compared to their semantically congruent controls. For this LAN effect, there were no differences among the four sentence types that varied in whether the disagreeing word was a noun or an adjective, and in the distance between gender agreeing words. However, with respect to later components, in comparison to their grammatical controls, three of the four sorts of gender violations elicited a second, later ERP effect – increased amplitudes of a positive component, or P600, that was maximal over parietal scalp. Among the morphosyntactic violations, some null effects were also observed: when words involved in an agreement structure were separated by a relative clause, no significant P600 effect was present (despite an earlier LAN), and violations of number agreement (whether singular or plural) elicited neither LAN nor P600 effects.
The core hypothesis of Exp. 4 was that electrophysiological responses to violations of gender agreement would differ depending on the distance between elements that should agree, in particular that the distance manipulation would differentially influence the LAN and P600 components. The distance manipulation did produce a dissociation between these two ERP components (although not in the predicted direction), in that the three shorter-distance conditions yielded both LAN and P600 effects, whereas the longest-distance condition yielded a LAN effect unaccompanied by a P600 effect. This dissociation will be taken up below, in the General Discussion. First however, we should consider some surprising null effects, that violations of number agreement elicited no significant ERP effects.

The inclusion of number violations in the stimulus set was originally motivated by the fact that the critical words in one pair of gender conditions – those with immediately adjacent agreeing/disagreeing elements (determiner+noun) – were nouns, whereas the critical words in the other three pairs of gender conditions were adjectives. Two varieties of number disagreement were included in order to provide a contrast between disagreeing nouns (i.e., “una casas”, unexpected plural) and disagreeing adjectives (e.g., “casas nueva”, unexpected singular) when the elements that should agree were immediately adjacent in both cases. My expectation was that both varieties of number disagreement would elicit reliable ERP effects, with little difference between the noun (plural) and adjective (singular) conditions. The outcome was that neither variety yielded significant LAN or P600 effects, although a weak and nonsignificant LAN effect was visible in the ERPs (Figure 13). Although tangential to the original goal of Exp. 4, these null effects
raise questions about the general relationship between morphosyntactic violations and their electrophysiological consequences that should be resolved. 

Participants in Exp. 4 were asked to read for comprehension, and their comprehension of the message conveyed by stimulus sentences was probed via true/false questions that yielded a generally high level of accuracy. In this fairly naturalistic task, with a final goal of comprehension, it is possible that number violations were overlooked altogether, or were less salient than the gender violations. In addition to the possibility of a qualitative difference between number and gender violations, their implementation here contained a potential confound. Number violations occurred early in their sentences (e.g., “Hay casas nueva…”, \textit{There are houses}$_{PL}$ \textit{new}$_{SG}$…) whereas short-distance gender violations occurred later in their sentences (e.g., “Acabo de llegar y creo que la \textit{piano} …”, \textit{I’ve just arrived and I think that the}$_{FEM}$ \textit{piano}$_{MASC}$…). Although there were no possible sentence continuations that could make the sentences with number-violations legal, it is possible that encountering a violation very early in a sentence fosters a “wait and see” strategy in readers, such that the full impact of a violation is not as immediate as when a violation is encountered later in a sentence, and thus less evident in brain activity measured over the first 800 ms after the error.

Complete resolution of the discrepancy between number and gender violations will require research beyond this dissertation. However, Exp. 5 was conducted to begin to evaluate differences in the saliency of number and gender agreement violations in the current stimulus set. The procedures were nearly identical to Exp. 4, except that participants were instructed to immediately report (via button press) the detection of an
error in the materials. Electroencephalograms were not recorded; instead, our interest is in the accuracy and speed of detecting the various types of errors in the stimulus sentences. In addition to providing a global comparison between the number and gender agreement violations, the results may be informative about the relative salience of the shorter- and longer-distance violations of gender agreement.

EXPERIMENT 5

Methods

Subjects

Data were collected from a total of 11 subjects (7 females). All of the subjects were Spanish/English bilinguals for whom Spanish was the native and dominant language. Dominance was established by subjects’ language history. Subjects on average were first exposed to English at age 11. Five subjects had begun to learn English in school before age 11. Four of these subjects had not experienced an immersion setting until after age 11. One subject was born in the United States but had spent large parts of his childhood and adulthood in Mexico, such that only 15 of his 36 years were spent in an English speaking country. All subjects were neurologically normal with normal or corrected-to-normal vision. The ages of the participants ranged from 22 to 37 (average age was 30.2). All of the subjects were right handed. One had sinistral relatives. Subjects were paid for participation. Data from two subjects had to be rejected due to low accuracy and one subject was excluded due to equipment failure.
Stimuli and Procedures

Stimuli were identical to those of Exp. 4., as were the presentation procedures. As in Exp. 4, participants responded to comprehension questions presented after 20% of the sentences, using key presses with their right and left index fingers to signal “true” and “false”. Participants in this experiment were instructed that sentences could include a variety of errors, and that they should press a key under their right or left middle fingers as soon as any problem was detected; hand assignment for the error key was counterbalanced across the two sessions conducted for each participant. The reaction times were time-locked to the presentation of the word containing the agreement violation.

Results

Accuracy

In their responses to the comprehension questions participants had an accuracy rate of 85.5%. In subjects responses to questions which were preceded by sentences in the gender conditions, there was no effect of sentence type or violation in the reaction time or accuracy data, nor were there interactions of sentence type and violation (all Fs < 1).

In the error detection task, participants had an overall accuracy level of 88.1%. On average, 3.31% of all responses were false positives (participants indicated there was an error in a grammatical sentence). The accuracy rate for error detection was 90.33% in the gender conditions and 83.35% in the number conditions. An ANOVA was performed
on the accuracy data which showed that this difference was not significant \((F(1,7) = 4.55, p < 1)\). Among the gender conditions, there were no significant effects of sentence type.

**Reaction Times**

On average, reaction times were 86 ms faster in the gender condition than the number condition. This difference was not significant \((F(1,7) = 2.17, p > .05)\). There was a significant effect of sentence type \((F(3,21) = 5.872, p < .005)\) reflecting that reaction times to the Determiner-Noun errors were faster, while responses to Noun Adjective errors were slower.
Table 8 – Mean Reaction Times for the Gender Conditions in Experiment 5

<table>
<thead>
<tr>
<th>Violation Type</th>
<th>RT (in milliseconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determiner-Noun</td>
<td>936</td>
</tr>
<tr>
<td>Noun-Adjective</td>
<td>1103</td>
</tr>
<tr>
<td>Noun-Copular Verb-Adjective</td>
<td>1012</td>
</tr>
<tr>
<td>Long Distance Condition</td>
<td>1064</td>
</tr>
</tbody>
</table>
DISCUSSION OF EXPERIMENTS 4 AND 5

Having established that speakers are aware of these errors, several conclusions can be drawn from the ERP data. First, with respect to gender agreement, there appears to be no distinction, in terms of eliciting event-related potentials, among the gender agreement structures which involve adjacent or nearly adjacent segments. All elicited a LAN, followed by a P600. The lone deviant is the long distance agreement structure in which a violation of gender agreement failed to elicit a P600, although this was precisely the condition in which a P600 was most expected based in previous findings in the literature. While this result is not consistent with the predictions of this study, the finding that the long distance condition behaved differently than the conditions with adjacent or near adjacent segments is interesting. The LAN, therefore, does not seem to make any distinction between hierarchical analysis of sentence structure and analysis that could be based on transitional probabilities alone. The elicitation of the P600, on the other hand, does seem to be limited to the experimental items in which transitional probability between segments may play a role or, in other words, the items in which the two segments are adjacent or near adjacent. This is a surprising finding given that the P600 is typically associated with violations involving higher level sentence structure, including but not limited to long distance dependencies. However, since the question of distance in gender agreement structures as not been specifically addressed in the ERP literature, it is possible that this effect reflects properties of gender agreement which are distinct from other types of agreement and/or long distance dependencies.
The other critical prediction of the study was that the violations in the determiner-noun condition would pattern differently than the conditions involving noun-adjective agreement. This was only true for the long distance condition. The fact that the determiner-noun violations were not distinguished with any unique effects suggests that the existing accounts of the lack of findings in the picture-word interference paradigm (specifically, that gender is only accessed when necessary to compute agreement and Spanish is a late selection language) are legitimate. This will be more thoroughly discussed in a subsequent section.

The third unexpected finding was that there does seem to be a distinction between gender and number agreement, as there were no effects of violation whatsoever in the number agreement conditions. These divergent effects could be due in part to the near sentence initial position of the critical words in the number conditions. In the number conditions, the critical words were the second or third in the sentence, while in the gender conditions the critical word was, on average, the seventh word in the sentence. Alternatively, this finding may be related to some factor specific to number or number agreement.

**Gender versus Number**

While there have not been many studies contrasting number and gender agreement, there have been many ERP experiments in which number agreement is a factor; Table 9 provides a summary of these.
### Table 9 - ERP studies with number agreement violations in visual sentences

<table>
<thead>
<tr>
<th>Study</th>
<th>Language</th>
<th>Task</th>
<th>Agreement</th>
<th>LAN</th>
<th>P600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kutas &amp; Hillyard, 1983</td>
<td>English</td>
<td>Comprehension</td>
<td>Number, Det-N</td>
<td>Yes</td>
<td>NA</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Number, N-V</td>
<td>Yes</td>
<td>NA</td>
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<tr>
<td>Hagoort et al. 1993</td>
<td>Dutch</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>Yes</td>
<td>Yes</td>
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<td>Osterhout &amp; Mobley 1995</td>
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<td>Acceptability</td>
<td>Number, N-V</td>
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<td>Yes</td>
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<td></td>
<td></td>
<td></td>
<td>Number, N-RPro</td>
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<td>Yes</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Semantic Gender, N-RPro</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td>Osterhout et al., 1996</td>
<td>English</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comprehension</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td>Münte et al. 1997a</td>
<td>German</td>
<td>Comprehension</td>
<td>Number, N-V, adjacent</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number, N-V, distant</td>
<td>---</td>
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<tr>
<td>Münte et al. 1997b</td>
<td>German</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>---</td>
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<tr>
<td>Coulson et al. 1998</td>
<td>English</td>
<td>Comprehension</td>
<td>Number, N-V</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Case, V-Pro</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Study</td>
<td>Language</td>
<td>Task</td>
<td>Agreement</td>
<td>LAN</td>
<td>P600</td>
</tr>
<tr>
<td>------------------------------</td>
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<td>------------------------------------------------</td>
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<td>------</td>
</tr>
<tr>
<td>Kaan et al. 2000</td>
<td>English</td>
<td>Comprehension</td>
<td>Number, N-V, nonadjacent</td>
<td>---</td>
<td>Yes</td>
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<tr>
<td>Vos et al. 2000</td>
<td>Dutch</td>
<td>Comprehension plus word monitoring</td>
<td>Number, N-V</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>De Vincenzi et al. 2003</td>
<td>Italian</td>
<td>Comprehension</td>
<td>Number, N-V</td>
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<td>Yes</td>
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<tr>
<td>Hagoort &amp; Brown 2000</td>
<td>Dutch</td>
<td>Acceptability</td>
<td>Number, N-V</td>
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<tr>
<td>Kaan et al. 2002</td>
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<td>Number, N-V, distant</td>
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<td>Yes</td>
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<tr>
<td>Kaan &amp; Swaab, 2003a</td>
<td>English</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>---</td>
<td>Yes</td>
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<td></td>
<td>N-that-V</td>
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<tr>
<td>Kaan &amp; Swaab, 2003b</td>
<td>English</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hagoort 2003</td>
<td>Dutch</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>---</td>
<td>Yes</td>
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<tr>
<td>Kemmer et al., 2004</td>
<td>English</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number, N-RPro</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Study</td>
<td>Language</td>
<td>Task</td>
<td>Agreement</td>
<td>LAN</td>
<td>P600</td>
</tr>
<tr>
<td>-----------------------------</td>
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<td>------</td>
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<tr>
<td>Wassenaar et al., 2004</td>
<td>Dutch</td>
<td>Comprehension</td>
<td>Number, N-V</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td>Palolahti et al., 2005</td>
<td>Finnish</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Kuperberg et al., 2006</td>
<td>English</td>
<td>Acceptability</td>
<td>Number, N-Cop-V</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td>Barber &amp; Carreiras 2005</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Number, Det-N</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number, N-Cop-Adj</td>
<td>Yes</td>
<td>Yes</td>
</tr>
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<td></td>
<td></td>
<td>Gender, Det-N</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Martin-Loeches et al. 2006</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Number, N-Adj</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Gender, N-Adj</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td>Nevins et al., 2007</td>
<td>Hindi</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
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<td></td>
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<td>Gender, N-V</td>
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</table>
Table 9, continued

<table>
<thead>
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<th>Study</th>
<th>Language</th>
<th>Task</th>
<th>Agreement</th>
<th>LAN</th>
<th>P600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silva-Pereyra &amp; Carreiras, 2007</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Number, N-V</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Person, N-V</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number and Person, N-V</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Note.** Comprehension tasks were those in which participants answered comprehension questions after some subset of sentences, or after all the sentences; acceptability tasks were those in which participants classified each sentence as erroneous or error-free, or responded only to erroneous sentences; the word-monitoring task was to search for the occurrence of a target word. Studies selected on the basis of including violations of number agreement, but other agreement violations noted when included. N, noun; V, verb; Det, determiner; Pro, pronoun; RPro, reflexive pronoun.; Cop, copular verb. Unless otherwise noted, the agreeing/disagreeing elements were immediately adjacent. “Yes” indicates a statistically significant effect; “---” indicates absence of a significant effect.
Of the twenty-three studies described in Table 9, only nine yield LAN effects for number agreement violations, indicating that the LAN in response to number violations is not a very robust effect. Of the experiments which did not show a LAN there are two that were able to record LANs to other sorts of agreement violations. For example, Coulson et al. (1998) did not get a LAN for subject-verb agreement violations but their violations of pronoun case (“…skinned he/his knee”) yielded a substantial effect. Also, Silva-Pereyra et al. (2007) found a dissociation among different varieties of subject-verb agreement, observing a LAN for “double” violations in which the verb disagreed in both person and number with the subject, but not for single violations. Another mixed finding comes from Osterhout and Mobley (1995), who found a LAN for subject-verb number agreement errors, but not for number agreement errors between reflexive pronouns and their antecedents. Aside from these three experiments, the experiments described above were not ambiguous; they either found a LAN for agreement violations or they did not. Given that the LAN was only found in 7 of the 18 studies, the effect does not seem to be very strong or reliable. This is in direct contrast to the research in gender agreement violations which is summarized in Table 10.
<table>
<thead>
<tr>
<th>Study</th>
<th>Language</th>
<th>Task</th>
<th>Agreement</th>
<th>Neg</th>
<th>P600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hagoort &amp; Brown 1999</td>
<td>Dutch</td>
<td>Acceptability</td>
<td>Gender, Det-Adj-N</td>
<td>N400</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Det and N not adjacent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hagoort 2003</td>
<td>Dutch</td>
<td>Acceptability</td>
<td>Gender &amp; Number, Det-Adj-N</td>
<td>N400</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Det and N not adjacent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(syntactic violations were</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>analyzed together)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gunter, et al. 2000</td>
<td>German</td>
<td>Probe verification</td>
<td>Gender, Det-N</td>
<td>LAN</td>
<td>Yes</td>
</tr>
<tr>
<td>Hammer et al. 2005</td>
<td>German</td>
<td>Comprehension</td>
<td>Gender, N-adj, distant</td>
<td>N400</td>
<td>Yes</td>
</tr>
<tr>
<td>Schmitt et al., 2002</td>
<td>German</td>
<td>Comprehension</td>
<td>Gender, N-Pro, distant</td>
<td>N400</td>
<td>Yes</td>
</tr>
<tr>
<td>Nevins et al., 2007</td>
<td>Hindi</td>
<td>Acceptability</td>
<td>Gender, N-V, distant</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number, N-V, distant</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Person, N-V, distant</td>
<td>---</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### Table 10, continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Language</th>
<th>Task</th>
<th>Agreement</th>
<th>Neg</th>
<th>P600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barber &amp; Carreiras 2005</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Number, Det-N</td>
<td>LAN</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number, N-Cop-Adj</td>
<td>LAN</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gender, Det-N</td>
<td>LAN</td>
<td>Yes</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Gender, N-Cop-Adj</td>
<td>LAN</td>
<td>Yes</td>
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<tr>
<td>Martin-Loeches et al. 2006</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Gender, N-Adj</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Number, N-Adj</td>
<td>---</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Semantic, N-Adj</td>
<td>N400</td>
<td>Yes</td>
</tr>
<tr>
<td>Barber, et al., 2004</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Gender, N-Cop-Adj</td>
<td>LAN</td>
<td>Yes</td>
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<tr>
<td>Demestre et al., 1999</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Gender, N-Pro, long distance, 1 or 2 possible antecedents</td>
<td>N400</td>
<td>Yes</td>
</tr>
<tr>
<td>Demestre et al., 2007a</td>
<td>Spanish</td>
<td>Acceptability</td>
<td>Gender, N-Pro, long distance, 2 possible antecedents</td>
<td>---</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Note.** Comprehension tasks were those in which participants answered comprehension questions after some subset of sentences, or after all the sentences; acceptability tasks were those in which participants classified each sentence as erroneous or error-free, or responded only to erroneous sentences; probe verification tasks were those in which participants were shown a
probe word and asked to indicate if the word had been in the previous sentence. Studies selected on the basis of including violations of gender agreement, but other agreement violations noted when included. N, noun; V, verb; Det, determiner; Pro, pronoun; RPro, reflexive pronoun; Cop, copular verb; Adj, adjective. As many gender violations elicited an N400, the “Neg” column refers to either of the negativities. “Yes” indicates a statistically significant effect; “---” indicates absence of a significant effect.
Of the eleven studies detailed above, eight found early negativities associated with gender agreement violations; five an N400 and three a LAN. As has been previously mentioned, this body of literature indicates that adjacent or nearly adjacent violations tend to elicit a LAN (Münte & Heinze 1994, Gunter, Friederici & Schriefers 2000, Barber & Carreiras 2005, Barber, Salillas & Carreiras 2004), while those violations involving longer distance violations tend to elicit an N400 (Hammer et al. 2005, Schmitt et al. 2002, Demestre et al. 1999). The two studies on Dutch (Hagoort & Brown 1999 and Hagoort 2003) did not exactly follow this pattern as their gender agreement violations were nearly adjacent (determiner and noun were separated by one word) and they found an N400.

Event-related potentials emerge from the electroencephalogram (EEG) after averaging multiple segments of EEG to cancel activity that is not time-locked to the events of interest. It should be remembered that the ongoing non-time-locked activity is always of substantially larger amplitude than the ERP, and that the signal-to-noise ratio – and thus power to detect differences between experimental conditions – depends on both the amplitude of the ERP component of interest and the number of trials in the average (as well as the quality of the EEG data, dependent on the experimenter’s success in reducing and rejecting high-amplitude artifacts). In all published cases, as well as in the gender conditions here, the LAN difference between grammatical and ungrammatical words is no larger than 2 μV at its peak, so that it requires considerable power to detect. Like all null effects, absent LAN effects to agreement violations can thus reflect a simple lack of power, rather than the absence of differential brain activity between grammatical
and ungrammatical words. Despite this caveat, the literature survey here suggests that enhanced negative components – of the LAN or N400 variety – are more replicable when elicited by violations of gender agreement as compared to number agreement.

In the current experiment, a LAN effect was elicited by violations of gender but not number agreement. Gender violations were present in 160 experimental sentences, but number violations in only 60, so that I examined whether the differential effects could be attributed to different numbers of trials contributing to the ERP averages. First, I selected a subset of 60 trials with gender agreement by picking the first such trial following every number agreement trial in the stimulus sequence for each participant, and similarly selected 60 gender agreement violations as the first such trials following each number agreement violation. This procedure ensured that the selected trials were distributed throughout the experiment, and because there were eight different randomizations of stimulus sequence, that the selected subsets were not biased toward one or another of the varieties of gender (dis)agreement sentences (Determiner+Noun, Noun+Adjective, etc). The EEG data of each participant were then re-averaged to determine if LAN or P600 effects were apparent for gender violations after this deliberate reduction in power to match that of the number agreement conditions. The ERPs for this subset of gender trials are shown in Figure 16. A LAN effect is barely visible, and was not significant in the frontocentral ROI in which the LAN effect was largest for the full stimulus set (Fz, Fcz, F3, C3, 200-500 ms, $F(1,23) = 0.29$). Combined with the significant LAN effects for gender violations in the full stimulus set, this outcome indicates that considerable power is required to detect the small-amplitude LAN
component, and that the null result for the number agreement violation might simply be the result of insufficient power rather than a genuine difference between violations of gender- and number-agreement. Similar power issues are likely to underlie the mixed results prevalent in the published literature, and the many null LAN effects for number agreement listed in Table 25.

In contrast to the miniscule and nonsignificant LAN effect with 60 gender violation and 60 grammatical sentences, Figure 16 shows that the P600 effect is quite viable with this number of trials. In the parietal ROI showing the largest P600 effect, the impact of gender agreement violation continues to be statistically reliable under reduced power \(F(1,23) = 14.8, p < .001\). A direct comparison of number and gender agreement in an ANOVA with sentence type (gender or number) and violation (grammatical or ungrammatical) thus indicates a larger P600 for violations of gender agreement than of number agreement \(F(1,23) = 3.92, p = .06\).

In contrast to the sparseness of LAN effects for number violations apparent in Table 25, P600 effects have been much more robust – observed in 16 of the 18 reports. One negative case was the study of Kutas and Hillyard (1983). This was the first ERP experiment to incorporate syntactic violations of any variety and was designed to detect fairly early negative components; the analysis epoch was thus too brief to indicate the presence or absence of a P600. In the other negative report, only a small-amplitude, statistically marginal, P600 was observed, in contrast to a larger, clearly significant, effect for violations of pronoun case agreement (Coulson, King, & Kutas, 1998). P600 effects have also been replicable for violations of gender agreement; Table 26 shows
significant effects for all 11 studies. The greater robustness of P600, as compared to LAN effects, is at least partly attributable to the larger amplitude of the P600.

The ease of detecting P600 effects makes their near absence in the number violation conditions of Exp. 4 an issue of some interest. Although statistically significant P600 effects have been reported in nearly every comparison within the published literature, a number of authors have suggested that the amplitude of the P600 varies with the perceived salience of the syntactic error. For instance, three laboratories have manipulated the probability of erroneous as compared to grammatical sentences, and reported larger violation effects when errors are rare and thus less expected (Coulson et al., 1998; Gunter, Stowe, & Mulder, 1997; Hahne & Friederici, 1999; Osterhout, Bersick, McKinnon, & Corey, 1996 report a similar result, but suggest that the probability effect is distinct from the P600 per se). In other experiments, P600 violation effects have been larger in simpler than in more complex sentences. Gunter, Stowe and Mulder (1997) found larger P600 effects for verb tense violations in sentences with subordinate and main clauses in sequence versus those in which the subordinate clause interrupted the main clause (rough translations of the German stimuli are “While a large crowd watched, a small drowning-person was by the hero saved/save.” versus “A small drowning-person was by the hero, while a large crowd watched, saved/save.”). In the Gunter et al. study, the sentence complexity manipulation also increased the distance between (dis)agreeing elements. However, Kaan and Swaab (2003a) also found larger P600 effects in simpler sentences with a complexity manipulation that did not alter the physical distance between (dis)agreeing words. These authors examined number violations in sentences like “The
man in the restaurant doesn’t like the hamburgers/hamburger that are on his plate” to “I cut the cake beside the pizzas/pizza that were brought by Jill”. The additional complexity of the sentences with two noun phrases was confirmed by longer reaction times to judge their acceptability, as compared to the sentences with one noun phrase. In a similar vein, Coulson et al. (1998a) attributed the larger P600 for violations of pronoun case (“skinned he knee”) than for violations of verb number (“he mow the lawn”) to the greater salience of the case violations.

The results of Exp. 5 in the current dissertation indicate that the number violations were less salient than the gender violations, in that participants responded more slowly to indicate their awareness of number violations. The extant literature suggests that a smaller P600 effect might be expected when contrasting less obvious to more obvious morphosyntactic errors. The fact that the number violations of Exp. 4 elicited not just a smaller effect, but a nonsignificant effect remains exceptional. Several aspects of Experiment 4’s design are likely to account for this null effect. Participants were engaged in an active comprehension task, and read sentences with a wide variety of syntactic structures in which errors could occur in multiple sentence positions. In contrast to designs that have mandated an explicit judgment of sentence acceptability and included a more homogeneous stimulus set with errors in a restricted range of sentence positions, these features of the design would not tend to focus attention on particular words as candidates for an error. Additionally, number violations were intermixed with both semantic incongruities and gender violations. Although some previous studies have intermixed semantic incongruities with some variety of morphosyntactic violation
(Hagoort 2003, Martin-Loeches et al. 2006), none have included a variety of error types as large as that here. I suggest that the graded amplitudes of the observed ERP effects – very large amplitude N400s for the semantic contrast, moderate LAN/P600 effects for the gender contrast, and null effects for the number contrast – reflect the relative salience of these errors for readers. As compared to ERP studies in which violations of number agreement might have taken on high importance because of an explicit error-detection task, or because of a background of otherwise acceptable sentences, the negligible impact of number violations in Exp. 4 may indicate that readers found these easy to overlook or relatively trivial in contrast to other violation types.

**LAN and P600 in the parsing of gender agreement**

One of the purposes of this study was to elucidate the significance of the LAN and P600 in sentence processing. I proposed that the LAN reflected violations of the parser’s expectations, based on transitional probabilities, while the P600 was sensitive to violations involving hierarchical syntactic structure. The findings, specifically those in the long distance gender agreement violation condition (the pervasiveness of the LAN, though transitional probabilities alone could not serve to guide the parser and the lack of P600 when hierarchical structure must be computed) prove that this generalization regarding the role of these two potentials is incorrect and an alternate explanation is necessary.

Given the confluence of the error detection data from Experiment 5 and the persistence of the LAN through all gender violation conditions, one conclusion is that the LAN indexes the operation of syntactic error detection device during initial structure
building. This is not a novel proposal, but Friederici’s (1995) description of the LAN, in contrast to the “second pass” repair/reanalysis processes she attributes to the P600. One critical component of Friederici’s account of the LAN is that it is an invariant response to errors (a general error detection device) but the P600 is sensitive to the type of repair/reanalysis required (specifically, she indicates that the latency of the P600 is affected). Hahne & Friederici (2002) provide evidence for this position in their experiment which shows that, although the P600 is modulated by task requirements, the LAN is invariant, suggesting the autonomy of the LAN as an early index of syntactic violations. Gunter, Stowe & Mulder (1997) also provided evidence for the independence of the LAN in an experiment in which the proportion of sentences containing violations in the stimulus set was manipulated (and, thus, the probability of any given sentence containing an error). They found that the P600 was reduced in the stimuli sets which had a higher percentage of errors but the LAN was unaffected. They also found that the P600 was modulated by syntactic complexity, but the LAN was impervious. Both of these findings support Friederici’s proposal that the LAN is an early, automatic index of syntactic violations and the P600 is indicative of a more interactive repair/reanalysis process. The notion of an invariant LAN, however, seems to contradict the findings in the number agreement conditions of Experiment 4, and the existing literature on number agreement (Table 25). However, Friederici’s characterization of the LAN as an invariant index of syntactic violations cannot be dismissed given the considerable power necessary to detect the LAN. It is possible that the power issue is responsible for the lack of a LAN in Experiment 4 and the inconsistent findings with respect to number agreement
violations in the literature. I will consider the LAN, therefore, to be a general index of syntactic violations, with the caveat that it requires substantial power to reach significance as an effect.

In the current experiment, there was no P600 effect for the long distance gender agreement violation. This was surprising, as the P600 is known to be elicited by many types of syntactic violations, including errors between adjacent or near adjacent segments, and long distance dependencies. For example, a P600 is elicited when a reflexive pronoun does not agree with its antecedent. It is also elicited by syntactically complex sentences, which perhaps require additional attention in order to parse the meaning, and garden path sentences, which require a reanalysis of the initial syntactic structure in order to extract the meaning. All of the three contexts described above (binding of anaphora, syntactic complexity and garden path sentences) involve violations or difficulties that are critical to determining the meaning of the sentence. Also, all of these known triggers of the P600 do not involve adjacent or near adjacent segments.

Given the existing research on the P600 and syntactic violations, it is clear that the P600 is often evoked as a repair/reanalyze mechanism in response to long distance violations but, I propose, only when those violations seriously impair the determination of sentence meaning. Exerting the effort to repair a long distance gender agreement error may not be worth the energy (i.e. expenditure of attention or memory resources) for the parser because it is not critical for computing sentence meaning. In this view, when a gender agreement error between two adjacent or nearly adjacent segments is encountered, the LAN is elicited, it signals the error, and, if appropriate, the P600 is reflects the need
to repair/reanalyze the representation. On the other hand, upon encountering a long
distance gender agreement error elicits the LAN but, because the violation elements are
not critical to the meaning of the sentence, there no repair/reanalysis of the sentence.

Sometimes long distance gender agreement errors can invoke an N400 followed
by a P600, as was found by Demestre and colleagues in their studies of adjectives
controlled by PRO in sentences with subject and object control verbs (Demestre, et al.
1999) (see sentences 41 and 42, repeated below).

41a. Pedro₁ ha prometido a Maríaᵢ PROᵢ ser estricto con los alumnos.
Pedro₁ has promised Maríaᵢ PROᵢ to be strict_masc with the students.

41b. *Maríaᵢ ha prometido a Pedroᵢ PROᵢ ser estricto con los alumnos.
Maríaᵢ has promised Pedroᵢ PROᵢ to be strict_masc with the students.

42a. Pedroᵢ ha aconsejado a Maríaᵢ PROᵢ ser educada con la gente.
Pedroᵢ has advised Maríaᵢ PROᵢ to be polite_fem with people

42b. *Maríaᵢ ha aconsejado a Pedroᵢ PROᵢ ser educada con la gente.
Maríaᵢ has promised Pedroᵢ PROᵢ to be polite_fem with people.

(Demestre, et al. 2007a, p. 346

In these cases, I would argue, the violation, due perhaps to this particular agreement
structure, is so salient as to make the parser “think” the word is semantically incongruous.
The P600, then, is invoked to reanalyze and determine the sentence meaning. Kuperberg,
Sitnikova, Caplan, and Holcomb (2003) also found a N400/P600 complex in response to
sentences in which the theta criterion of the matrix verb was violated, and the same
account can be applied.

This account of the P600 is consistent with Kuperberg (2007)’s account of the
function of the P600 which is to mediate conflicting output from the semantic and
combinatorial systems during parsing. I propose that when the semantic interpretation of
the sentence is not at stake, the P600 will only treat as anomalous combinatorial output from words that are adjacent or nearly adjacent because, otherwise, it is not worth the effort.

This proposal is also consistent with the “good-enough” approach proposed by Ferreira and colleagues (Ferreira, Bailey & Ferraro 2002) which holds that sentence meaning, as derived during parsing, is not always a reflection of sentence content and that language processing is often incomplete, but good enough, nonetheless, most of the time. Ferreira and colleagues refer to the findings of Sachs that the language processor builds delicate structure which decays rapidly (Sachs 1967) and, in order to be interpreted, needs support from context. If none of this back-up information is available to reinforce the weak structural representation, an interpretation that is incomplete but good enough will be derived. Ferreira et al. (2002) apply this notion to the parsing of garden-path sentences. They discuss the findings of Christianson, Hollingsworth, Halliwell & Ferreira (2001) which showed that while parsing garden path sentences requires reanalysis, the initial incorrect structure created by the parser lingered causing participants to arrive at a representation in which both meanings are active. They presented subjects with typical garden path sentences like (64) and then asked to answer comprehension questions (65a and b).

64. While Anna dressed the baby played in the crib.

65a. Did the baby play in the crib?

65b. Did Anna dress the baby?
Subjects answered (65a) with 100% accuracy but were less accurate in answering (65b) suggesting that the incorrect parse was still active. Ferreira et al. (2002) count this as evidence that when contextual information to support the linguistic representation (generated by the syntactic parser) is missing the initial most likely parse will interfere. If this happens, the an incomplete “good-enough” interpretation of the sentence may result.

Ferreira et al. indicate that such a mechanism could also account for why comprehenders can understand sentences with grammatical errors due to speaker disfluencies. It seems that grammatically incorrect segments would get incorporated into the semantic representation of the sentences even though their features can’t be matched with the appropriate segments in the sentence. In the case of the gender agreement violations from the current experiment, the violating segment contradicts the structure created by the language processor but, given the lack of semantic contribution of syntactic gender, contextual information won’t necessarily be of any help. In the end, regardless of the gender-marking, the sentence can be interpreted, and though not all of the gender information can be adequately assimilated, the interpretation is “good enough”.

One thing to note about the current experiment is that, in all of the gender agreement conditions, there were no other noun phrases in the sentence prior to the critical word (be it a noun as in the determiner-noun condition or an adjective in the other three conditions). That is to say, at the point of the agreement violation in the determiner-noun condition, there was only one determiner in the sentence that this noun
could possibly be associated with. Likewise, in the adjective conditions, upon encountering the deviant adjective there was only one possible noun that the adjective could modify. It is possible that the lack other agreement candidates contributed to the lack of a P600 (no need to waste the energy), and a “good-enough” interpretation. This proposal can be tested by modifying the current stimulus sentences to include one or more additional NPs. If the lack of effect found in the current experiment is truly due to “parsing laziness” on the part of the P600 (i.e. the tendency to reserve resources when possible) then the intervening noun phrases would not alter the effect, because, due to syntactic gender’s lack of semantic contribution, a “good-enough” interpretation would suffice. On the other hand, if the burden of additional noun phrases, and, therefore, a need to use gender information in parsing (i.e. there is some difficulty or ambiguity associated with the parsing of the gender-marked adjectives), result in a P600 for the long distance gender violation condition, then we could conclude that the P600 is invoked when truly necessary for parsing (in this case, figuring out which noun and adjective refers to).

**Implications for Gender Congruency Research**

One of the motivations of Experiment 4 was to provide an alternate explanation for the lack of gender congruency effects in the picture-word interference paradigm in Spanish as compared to other languages. As was shown in Experiments 1, 2 and 3, and in Costa et al. (1999), there is no effect of gender congruency on the production of bare nouns or noun phrases in Spanish. The lack of effect for bare noun production was explained by adopting the conclusion that La Heij et al. (1998) made for Dutch that
gender is only accessed when it is necessary for the selection of gender marking morphemes, and thus there are no effects in bare noun production. I adopted the explanation of Costa et al. (1999) that, like Italian, Spanish is a language is a “late selection” language in which the determiner cannot be selected until the phonological form of the noun is available, thus reducing any effects that earlier access of gender features at the lemma may have had. The lack of effect for bare noun production was somewhat surprising, given Cubelli and colleagues’ finding of an inhibitory gender congruency effect (Cubelli et al. 2005) but I found that the difference in effect could be explained, within Cubelli et al.’s Double Selection model, by examining specific contrasts in the morphological features of the gender systems of Spanish and Italian (see the Discussion of Experiments 1 and 2 in Chapter 2). While this account of the Spanish data is adequate, I felt a more satisfactory account could be attained via an ERP experiment. I proposed that the lack of effect in noun phrase production was not due to late selection of the determiner (as only a tiny minority of nouns in Spanish require an alternate determiner) but rather to the fact that the determiner-noun sequence is retrieved as one unit without activating any syntactic gender features (the determiner is not selected based on the gender features of the noun, merely directly retrieved as part of the noun). I wanted to prove that the determiner-noun sequence was processed differently from other gender agreement structures in Spanish because it does not have hierarchical structure (i.e. abstract gender features are not used in the selection of corresponding morphemes). My prediction was that gender agreement violations involving the determiner-noun sequences would elicit different ERPs than other types of agreement
violations, specifically that it would elicit a LAN/P600 while other types would elicit only the P600. The results from Experiment 4 did not support this prediction. All four gender violation conditions elicited a LAN and all but the long distance agreement violation condition elicited a P600. The determiner-noun sequence did not distinguish itself in the way I predicted. This indicates that gender is accessed during the processing of the determiner-noun sequence and that this processing is not different between that of the noun-adjective sequence. The findings of the ERP experiment support my original account of the data from Experiments 1, 2 and 3. Spanish is a late selection language in which the determiner cannot be selected until the phonological form of the noun is available, thus any gender congruency effects that may occur at the earlier stage of lemma activation are rendered invisible by the postponement of determiner selection. In regards to bare nouns, gender is not accessed during bare noun production as it is not necessary for the selection of agreement morphemes or the selection of a gender-marked syntactic representation of the noun. The activation of the lemma is all that is required to retrieve the form of the noun.

**Future Directions**

**Intervening Noun Phrases**

As was mentioned in the discussion of Experiment 4, the findings of this experiment can be expanded upon by an additional experiment in which, prior to the presentation of the target word, there are additional noun phrases. The inclusion of additional noun phrases (for which gender features would be accessed during parsing) would create a situation in which extraneous gender activation could influence the
parsing of the critical word. This type of interference has been extensively documented in the behavioral literature on attraction effects (Bock and Miller 1991, Bock and Cutting 1992, Bock, Nicol and Cutting 1999, Bock, Eberhard, Cutting, Meyer and Schriefers 2001, Vigliocco & Nicol 1998 and Bock, Eberhard and Cutting 2004 to name a few). In these studies subjects are asked to complete a sentence based on a preamble (a complex noun phrase with more than one noun). An example of a preamble would be “the key to the cabinets” (Bock & Miller 1991) in which “the key” is the head noun and “the cabinets” is the local noun. Subjects are asked to repeat the preamble and complete the sentence. The critical facet of the target sentence is the inflection of the matrix verb. The matrix verb should match in number with the head noun. Bock & Miller (1991) and many subsequent studies found that if the local noun is plural, the verb will be inflected for a plural subject even if the head noun is singular. This is called an attraction effect (plural marking attracts agreement). Overt gender marking also contributes to the production of agreement errors in that the gender features on a local (specifically the overt gender-marking morphemes) can interfere with the production of gender agreement with the head noun (Vigliocco & Franck 1999, Vigliocco & Zilli 1999, Franck et al. 2008, Antón Mendez et al. 2002). The findings of these experiments (that more agreement errors are produced when there is an overtly marked local noun which differs in gender from the head noun) can be considered to be consistent with Ferreira’s “good-enough” model in that the selection of agreement morphemes proceeds based on what is most convenient or salient (and thus captured in the initial parse), rather than a thorough analysis of the syntactic structure. As the computation of morphological agreement is
sensitive to the presence of intervening segments, it stands to reason that using stimuli like that of Experiment 4 which included additional NPs would render different results in terms of the ERPs. In Experiment 4, the long distance gender violation condition did not elicit a P600. I have proposed that the P600 is not invoked to fix the long distance violation because a long distance gender agreement error is a violation which involves purely formal features which are not critical to the meaning of the sentence and, thus, the repair/reanalyze process would not be worth the energy when an interpretation that is “good enough” can be generated. Including additional NPs prior to the critical adjective would perhaps provide an additional challenge for the parser. If the parser is operating according to a strong interpretation of Ferreira (2002)’s “good-enough” principal, the intervening noun phrases would not alter the effect, because, due to syntactic gender’s lack of semantic contribution, a good-enough interpretation would suffice and the ERPs for these types of violations would be the same as in Experiment 4 (no P600). On the other hand, using a less extreme interpretation of the “good-enough” idea, if the additional NPs interfere with subjects' ability to determine the antecedent of the critical adjective (as suggested by the behavioral literature on attraction effects), and, therefore, there is a need to use gender information in parsing to determine the constituent structure, a P600 in the long distance gender violation condition would be expected, allowing us to could conclude that the reanalysis is only invoked when truly necessary for parsing. Otherwise, a “good-enough” interpretation would suffice.
Opaque and Transparent Gender Marking

The key proposal of Experiment 3 was that in certain circumstances in Spanish, gender agreement could be computed based on morphological features alone – without appealing to the abstract gender features specific to the lexical entry for each noun. This proposal was based on the lack of findings for Experiments 1 and 2, and the findings of the literature on attraction effects. I had hoped that the ERP results would show reduced syntax-related potentials for the determiner-noun condition (the best candidate for purely morphophonologically based gender agreement). This prediction was not borne out.

It is however, not possible to dismiss the role of morphophonological features in the parsing of gender agreement based on one experiment, especially given the behavioral literature on the impact of overt gender marking in attraction effects found by Vigliocco & Franck (1999), Vigliocco & Zilli (1999) and Franck et al. (2008). Indeed, Experiment 3 included both transparent and opaquely marked nouns and there were significant differences in response latencies between the two noun types in the gender decision task involving adjectives. One potential issue in Experiment 4 is that all of the nouns and adjectives which formed the critical agreement structures were all regularly marked for gender. If type of gender marking (opaque versus transparent) had been incorporated as a factor, the issue of the role of morphophonological features in gender agreement could have been more directly addressed. This is another modification to the design of Experiment 4 which could yield informative results in a future ERP study.
Conclusion

Even though the critical predictions of this study were not confirmed, the experiment rendered some very interesting results. The determiner-noun gender agreement violations did not distinguish themselves among the other violation types in the ERP data, nor did the LAN show any distinction among gender agreement structure types (it was uniformly elicited by all four). Nevertheless, there was a distinction the among the gender agreement violations such that the long distance violation did not elicit a P600. This lead to the proposal that while the LAN acts as a general error detection device, reanalysis of the syntactic representation is carried out if it is not costly (i.e. the critical segments are adjacent or nearly adjacent) or if it is truly necessary to the semantic interpretation of the sentence. The lack of a LAN effect in the number violation conditions could be due to the lower saliency of number violations, or it could be due to lack of power. While this generalization regarding the LAN and P600 is founded in an experiment which used Spanish stimuli, it is possible that it can be generalized to other languages.

The fact that the Experiment 4 did not disprove the existing account of the picture-word interference paradigm data for Spanish supports the conclusions made regarding Experiments 1, 2 and 3 that Spanish can be classified as a late selection language and that syntactic representations of each lexical item do not compete for selection in Spanish as they do in Italian. The findings of the ERP experiment provided insights into how gender agreement interacts with sentence processing and raised several questions that can be addressed in future experiments in which the role of the P600 in the
processing of gender agreement and how different morphophonological features of nouns in Spanish may influence the parsing of agreement violations.
Appendix "A"

Stimuli for Experiments 1 and 2

**Gender Congruent Condition**

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<tr>
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buho   plato
caanto beso
caarlo pollo
casco tono
farro disco
gallo cargo
globo arco
hongo cero
palo hielo
pato hueso
pozo acto
vaso gato

Gender Incongruent Condition

Target   Distractor
bota   humo
falda llanto
flecha bano
fresa cuello
hoja pago
mora peso
olla hilo
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In Experiment 1, the auditorily presented baseline distractor was [m:]. In Experiment 2, the visually presented distractor was five Xs as seen in this Appendix.
### Semantic Related Condition

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**Semantic Unrelated Condition**

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**Semantic Baseline Condition**

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Appendix “B”

Sample Stimuli Sentences with Comprehension Questions

Determine + Noun (Grammatical)

No creemos que podemos encontrar la cadena que buscamos.

A mí me gustan la crema y el azúcar en el café.

Sospecho que no puedas medir la energía que usas fácilmente.

Es relevante que hayan hablado sobre la letra que apareció en la muralla.

¿Hablaron sobre la letra?

Creo que van a pedir que el artículo sea escrito por un psicólogo.

Es interesante que no sepan que el espejo fue vendido ayer.

No han podido describir el incendio muy bien.

¿Describieron bien el incendio?

No nos permiten observar el parto de cerca.

¿Pueden observar el parto?

Es evidente que tenemos que controlar el peso por razones de salud.

Deben dejar de pensar y hacer la prueba para que puedan saber por cierto.

No creo que se pueda distinguir el pueblo en el mapa.

Insisten en que sea importante que veamos la ruina antes de irnos.

No entiendo para qué sirve la tecla de que hablas así que no la toco.

---

6 This group of sentences comprises one of the eight stimuli lists used in the experiment. The sentences and corresponding questions are grouped by experimental condition.
No vamos a poder examinar el tejido del órgano.

Me han dicho que es normal que el frío sea insoportable durante esta época.

No me gusta pensar mucho en el tocino porque comerlo no es saludable.

Sabían que nos iban a dar el trabajo más difícil pero no nos avisaron.

Van a tratar de usar el hierro que tienen para que no tengan que comprar más.

¿Usarán el hierro que tienen?

Es posible que tengas el dinero pero yo no lo creo.

No quieren pensar en el gasto del viaje antes de regresar.

Ahora saben que van a estar en la playa para las vacaciones.

¿Van ir a la playa durante las vacaciones?

Es importante que tengamos la llanta en buena condición.

Vamos a tener que pensar en la teoría antes de tratar de probarla.

Creo que quieren saber más sobre el puesto que describiste.

Me doy cuenta de que la industria es importante para la economía.

Dicen que recuerdan la compañía que usamos pero yo lo olvidé.

¿Se han olvidado de la compañía?

Creo que es increíble que la luna esté tan brillante esta noche.

¿Hay luna esta noche?

No sé cómo se hace la cazuela pero mi abuela me enseñará.

Quiero que describan el trato que firmaron.

Me parece que el impuesto será menos de lo que pensaba.

Me alegro de que hayan estudiado la cultura y el lenguaje del país.
Tenemos que pensar en el impacto que tendrán nuestras acciones.

No me parece que el precio sea razonable.

Sé que van a llegar para la cena porque me lo han prometido.

Me parece que necesito la pila que compramos ayer.

¿Compramos la pila hoy?

Yo no puedo distinguir el tono ascendente del descendente.

Me han dicho que no entienden la palabra alemana que usé en el diálogo.

Pienso que es importante que el cultivo siga para que podamos comer.

¿Vamos a comer lo que cultivamos?

No sé qué pasó con la servilleta pero necesito otra.

Creo que han aprendido mucho sobre la prensa y serán buenos periodistas.

**Determiner + Noun (Ungrammatical)**

Siempre ha sido muy difícil limpiar el casa porque es muy grande.

¿Es fácil limpiar esa casa?

Es interesante que insistan en que el carta sea tan elocuente.

Vamos a tratar de pasar por el cascada antes de regresar a la ciudad.

¿Van a ir a la cascada antes de regresar?

Sabemos porque nos han dicho que el distancia no es muy difícil de viajar.

¿Es fácil viajar esa distancia?

No sé si han empezado a buscar el mochila que contiene los papeles.

Me dicen que es importante que la aforo sea limitado a cincuenta personas.
Es posible que nos empiece a interesar la equipo de la otra universidad.

No nos entienden y no conocen la modo de trabajar que nos gusta.

Me parece que me mostraste el novela cuando te visité.

No creo que se dé cuenta de que el oficina es tan grande.

Sabían que no podían ver la organismo sin microscopio.

¿Vieron el organismo sin microscopio?

Me han dicho que no creen que el piedra valga mucho.

Me parece que conozco la terreno de este país aunque soy extranjero.

Me parece que no entiendes la uso razonable del alcohol.

Creo que podré hacer el práctica antes de la audición

Me han dicho que ya quieren el cerveza que compramos ayer.

No sé cómo no vieron la vidrio que se cayó.

¿Se cayó el vidrio?

Me dicen que vieron el mariposa en el jardín.

¿Dicen que vieron una mariposa?

Yo trataré de visitar el costa para divertirme.

Van a tener que escribir sobre la empleo que les gustaría tener.

Piensan que entiendo la cambio que va a ocurrir.

No quieren irse antes de ver la río y bañarse en el agua.

Hoy va a empezar el feria y tenemos que hacer preparativos.

¿Empieza la feria hoy?

No me has dicho dónde está la folleto y lo necesito.
No me di cuenta de que la suelo se congela cuando nieva.

Creo que van a pasar por el plaza cuando hagan las compras.

Es muy importante que la cuidado que reciben los enfermos sea de buena calidad.

Me doy cuenta de que la contacto con los parientes es muy importante.

Es evidente que el riqueza natural del país haya disminuido.

¿Ha aumentado la riqueza natural del país?

No me parece que la gusto de conocernos sea mutuo.

Es importante que tengamos la contrato para el lunes.

Quieren que les cuente la propósito de mi experimento.

Creo que es posible que el tristeza lo esté consumiendo.

Recuerdo que me dijo que el plata vino de México.

¿Dijo que la plata era de Chile?

Yo sé que tú no aguantas bien la fracaso pero te hará más fuerte.

Me acuerdo de que la ritmo de la canción era muy bailable.

Voy a tratar de encontrar el prosa que acompaña al retrato.

Vamos a necesitar encontrar la cuchillo antes de empezar a cocinar.

Dicen que es muy importante evitar el patada del caballo porque es muy fuerte.

Yo me imagino que lleve el faja que le compré.

**Noun + Adjective (Grammatical)**

Queremos quedarnos para poder ver el edificio alto en el centro.

¿Quieren ver el edificio alto?
Es posible que tengamos que revisar el libro grueso que ignoramos.

Nos acordamos de que usaban la cuerda fina en el taller.

Yo entiendo cuando dicen que la fuerza bruta es a veces útil.

Nos han dicho que van a tomar la medida ilógica de contratar a un abogado.

Vamos a tratar de describir el acto vandálico para el reportaje oficial.

Supongo que es normal que el baño privado tenga jabón y champú.

¿Es normal que haya jabón y champú en el baño?

Entendemos que hay que llevar el casco obligatorio para protegerse.

No pude ver ni entrar en el estadio pequeño y me arrepiento de eso.

Creo que voy a intentar tener la ropa limpia para mañana.

Yo sé que es imposible cambiar la tierra seca de esta región pero quiero un jardín.

¿Se puede cultivar esa tierra fácilmente?

Yo no quería irme de la zona tranquila en que vivía.

Es importante que cambiemos el estilo absurdo que quieren adoptar.

¿Quieren adoptar un estilo racional?

No puedo hacer nada para el hueso astillado hasta que lleguemos al hospital.

Sugiero que eviten que la plaga endémica se reproduzca más.

Pienso que les interesa el oráculo venerado y van a consultarlo.

¿Van a consultar el oráculo?

Sabemos que el año formado por doce meses es la base de nuestro calendario.

No deben pensar que el recurso escaso va a durar para siempre.

Me parece que la lengua germana será más fácil aprender que una lengua asiática.
Dicen que han visto la película pésima y no les gustó.
¿Les gustó la película?
Me parece que no usan la lámpara eléctrica porque no funciona bien.
¿Funciona bien la lámpara?
Creo que podrán encontrar el lago inmenso porque no está muy lejos.
Sabemos que la línea discontinua en la calle significa que se puede pasar.
Insisto en que mantengas la pistola descargada para evitar accidentes.
Es evidente que no creen que el destino marcado nos guíe.
Creen que tienen el sueldo adecuado para ir pensando en tener hijos.
A mí me parece que el refresco dañino tiene mucho azúcar.
Voy a tratar de encontrar la bebida destilada que tienes que tomar.
Voy a usar el trigo molido cuando haga el pan.
Me han dicho que la boda cancelada costó miles de dólares.
¿Fue cara esa boda?
Yo entiendo que el odio enraizado en la niñez es difícil de manejar.
Creo que les va a gustar el canto lírico que vamos a tocar.
No sabía que el foco estropeado funcionaría de nuevo.
Nos han dicho que observaron la captura brusca de los ladrones.
¿Fueron capturados los ladrones?
Es evidente que el trono anticuado debe estar en el museo.
No van a preocuparse más por la deuda perdonada pero ahora tendrán cuidado.
No me parece que la esperanza arraigada en emociones irracionales pueda ayudar.
Me han dicho que la droga inhalada es más virulenta que en pastilla.
Me alegro de que la vacuna aprobada por los médicos esté disponible ya.
Vamos a usar la vela fabricada con colorantes no grasos.

_Noun + Adjective (Ungrammatical)_

Creo que debo seguir la avenida espacioso hasta llegar al monumento.
Sé que aquí se vende la bebida gaseoso que buscas.
Digo que he visitado y que la cortina rojo va muy bien en aquella habitación.
¿Se ve bien la cortina roja en aquella habitación?
Yo creo que debes comprar la falda femenino que te probaste.
Creo que vamos a tener el bizcocho tostada luego cuando cenemos.
Es interesante que pensemos usar la idea concebido por ellos.
Me han dicho que hoy la lectura corto es difícil de entender.
¿Será fácil leer la lectura para hoy?
No hemos podido encontrar el cuaderno blanca que buscábamos.
No es posible que veamos el ensayo redactada por el estudiante.
¿El ensayo fue escrito por el estudiante?
Creo que le dijeron que el intestino inflamada es lo que le da tanto dolor.
Pienso que es evidente que el dibujo artística pertenece en el museo.
Es impresionante que hayan traído el disco grabada por el cantante que me gusta tanto.
¿Se olvidaron traer el disco?
Es probable que el gobierno corrupta de este país no se mejore.
Creo que vamos a buscar el arbusto mediana que describieron.

Es evidente que vamos a tratar de encontrar el plato típica de aquí para probarlo.

Espero que puedan entender la poesía compuesto por mi autor favorito.

No vamos a querer traer la toalla mojado porque ya no nos sirve.

Creo que acabo de ver el vaso llena de aceite pero no sé dónde está.

Creo que entraron por la ventana sucio porque ésta no tiene cerradura.

¿Tiene cerradura esa ventana?

Pienso que es posible que el viento húmeda venga del sur.

No sabemos si podremos tener el vino venezolana para esta noche.

Traté de averiguar que el fuego encendida no se podía apagar.

Creo que elegimos la madera feo para fastidiarlos.

No se dan cuenta de que la grasa procesada es horrible para la salud.

¿Es la grasa procesada saludable?

Hemos visto que el muro costosa no protegía la ciudad.

¿Podía el muro proteger la ciudad?

Me dijeron que vieron la marcha sigiloso que pasó por las calles.

A mí me encanta la arena dorado que hay en esta isla.

Me parece que el alivio pasajera nos ayudó a aguantar el estrés.

Me parece que saben que la agencia dirigido por el alcalde está bajo investigación.

¿Están investigando esa agencia?

No les parece que la guerra preventivo sea una buena estrategia.

Recomiendo que sigan la carretera recto hasta entrar en la cuidad.
Pienso que han visto la fábrica pulcro y ya no se preocupan.
Vamos a tratar de encontrar el jugo envasada que te gusta.
A mí no me interesa el recuerdo borrosa del testigo.
A mí me sorprende la conducta excéntrico del profesor.
¿Es sorprendente la conducta del profesor?
No pueden olvidarse de que el peligro camuflada está alrededor.
No han podido encontrar el barco hundida en la bahía.
Tenemos que entender mejor el mito infundida en la imaginación de la gente.
No deben de engañarse porque la paradoja obvio no es fácil de resolver.
Es muy difícil recuperarse de la pérdida inesperado de un pariente.

Noun – Copular Verb – Adjective (Grammatical)
Pienso que prefiero que la camisa sea morada porque me gusta el color.
Me han dicho que el piano está roto y ya no funciona.
¿Funciona bien el piano?
Acabo de notar que el carro está dañado y no podemos usarlo.
¿Se puede usar el carro?
Después de pensarlo mucho decidimos que el cerebro era humano y lo examinamos.
Es posible que el cuento fuera entregado ayer pero no lo recibí.
Me acuerdo de que el durazno estaba fresco y por eso lo disfrutamos tanto.
He oído que dijiste que el ejemplo es crítico para apoyar el argumento.
Creemos que fue esencial que la carrera fuera suspendida por razones de seguridad.
Me dicen que la familia es extensa pero todos viven muy lejos de aquí.

He observado que el barranco es profundo pero fácil de escalar

¿Sería fácil escalar el barranco?

No es posible que la obra sea terminada porque el artista está de viaje.

¿Puede ser que la obra esté terminada?

Me parece que el partido es progresivo pero puede que me equivoque.

No me parece que la pintura sea acrílica pero no sé qué es.

Creo que el sombrero es negro pero puede que no sea cierto.

Dicen que ahora la vida es sana pero antes no vivían muy bien.

Me dicen que la venta está localizada en esta calle.

No pueden entender que la terapia es efectiva e importante.

¿Es importante la terapia?

Me parece que aquí la disciplina es justa pero en otros lugares no es así.

Hemos descubierto que la mancha fue causada por el café que se derramó.

Les va a gustar que el guisado es espeso porque tienen mucho hambre.

¿Querrán comer el guisado?

Creo que el arroyo es lóbrego y no me gusta.

Dicen que la empresa es sostenida por donaciones.

Estamos de acuerdo de que el palacio es hermoso y vale la pena visitar.

Me dicen que la clínica es pionera en esta ciudad.

Me han dicho que la ciencia es concreta pero me parece muy teórica.

Me doy cuenta de que la literatura es panameña pero tiene un carácter inglés.
A mí me parece que el fenómeno es complejo y quiero entenderlo.
Creo que es evidente que la reserva está poblada por varias clases de animales.
Ahora es evidente que el requisito fue impuesto por el presidente de la universidad.
¿Fue el presidente el que impuso ese requisito?
Me parece que la angustia es provocada por situaciones sociales.
Es evidente que la moneda es extranjera así que vamos a guardarla.
¿Es la moneda de este país?
A mí me parece que el abrigo es bonito pero no lo compraré.
Creo que me dijeron que el salario está aumentado este mes.
A mí me parece que el concepto es parecido a lo que propuse yo.
Me acuerdo de que el camino es áspero pero es peor de lo que pensaba.
No saben que la colonia fue devuelta a Francia.
¿Pertenecía la colonia a Francia ahora?
Es posible que la risa sea contagiosa pero no es como una enfermedad.
Dicen que les parece que el capítulo es narrativo así que quiero leerlo.
Creo que el discurso fue metódico así que será fácil de leer.
Me han dicho que la ventaja es tremenda así que quieren vivir en este barrio.

**Noun – Copular Verb – Adjective (Ungrammatical)**

No vimos nada porque la cámara estaba escondida en el reloj.
¿Estaba la cámara en el reloj?
Me parece que la guitarra es acústico y podremos usarla.
Nos aseguraron que la materia era inorgánico y no la usamos.

Es sorprendente que la mesa sea bajo porque no había niños en el sitio.

¿Había niños en ese sitio?

Es impresionante que el grupo esté organizada tan rápidamente.

No me han dicho que la bota está relucido ni dónde está la otra.

Me han dicho que la naturaleza está muerto en esta época.

No me parece que el elemento esté eliminada por completo.

No me han dicho que el número sea exacta pero es una buena aproximación.

No entiendo por qué quieren que el pollo esté frita en aceite de maíz.

¿Quieren que el pollo esté escalfado?

Es importante que el queso esté rallada para que no haya pedazos grandes.

¿Se debe rallar bien el queso?

Me gusta que la tela sea elástico porque me cabe mejor.

Explicaré que es importante que la tortilla sea plano porque no es un soufflé.

Les he enseñado que cuando el verbo está conjugada tiene que reflejar el sujeto.

No sé qué pasó pero el verso está perdida y no lo pueden encontrar.

¿Ha sido econtrado el verso?

Creo que el instituto es educativa así que habrá clases allí.

Es evidente que el efecto es drástica pero sin embargo tenemos que analizarlo.

¿Van a ignorar el efecto?

Trataremos de verificar que la ayuda es otorgado por el presidente.

Se han dado cuenta de que la renta está pagado y pueden relajarse.
Yo prefiero que la orilla sea solitario para que pueda meditar.

Yo recomiendo que el remedio sea recetada por un médico.

Me han dicho que el producto está conservada y se puede venderlo ya.

A mí me parece que el lujo es exclusiva y no es para nosotros.

Me han dicho que el vehículo está alquilada y tendrán que devolverlo.

Temo que la plancha esté enchufado y demasiado caliente.

Deben notar que el paso es relajada porque no tenemos prisa.

Tengo que asegurar que la limpieza sea minucioso porque hoy viene el jefe.

¿Va a llegar el jefe hoy?

Creen que la rutina es odioso pero no pueden cambiarla.

No deben asumir que el pasado esté olvidada porque algunos lo recuerdan.

Me dijeron que la fiesta fue aburrido y se fueron temprano.

Me alegro de que el siglo sea estudiada por los jóvenes.

A mí me parece que la década fue maravilloso pero para ti fue diferente.

Han contado que el robo fue ordinaria pero me pareció horrible.

No es sorprendente que el secuestro fuera espantosa y difícil de olvidar.

Se dan cuenta de que la conquista está estancado pero siguen luchando.

No saben que el tesoro está enterrada porque no tienen un mapa.

¿Están usando un mapa?

Me han dicho que la nobleza es odiado pero no habrá una revolución.

Me parece que el estreno está prevista para mañana.

Entiendo que es difícil porque la disputa fue inconcluso pero la van a resolver.
He notado que la acera es amplio así que la bicicleta podrá pasar.

¿Podremos pasar por la acera en bicicleta?

Long Distance Condition (Grammatical)

La cerámica que decidimos comprar era china y de alta calidad.

¿Vino la cerámica de Japón?

La comida que preparamos hoy estaba designada para los diabéticos.

La moda que estamos imitando es europea y muy diferente.

¿Es esa moda básicamente igual a la nuestra?

El ácido que casi pisamos es peligroso y no debemos tocarlo.

¿Es el ácido peligroso?

El cuarto en donde nos íbamos a quedar era ancho y nuestro equipaje cabía adentro.

El documento que es tan importante está firmado y listo para el juicio.

¿Está listo ese documento?

La manera en que trabajan es contraria a nuestras metas y no nos va a servir.

El consejo que se formó recientemente fue consultado pero no recomendó nada.

El espacio en que tenemos que trabajar es oscuro así que será difícil.

El evento al que van a asistir es deportivo pero no es muy popular.

¿Es muy popular ese evento que van a asistir?

El infierno que describieron es verdadero porque me lo han dicho.

La orquesta que queremos oír es sinfónica y muy impresionante.

La respuesta que nos dieron es falsa y no la podemos aceptar.
La sala que ocuparemos está cubierta pero así es agradable.
La torta que he hecho es chilena y te va a gustar.
El desarrollo que está ocurriendo está asociado con el crecimiento económico.
¿Hay crecimiento económico ahora?
El costo que tengo que pagar es moderado y no me sorprende.
¿Es sorprendente el costo?
El ejercicio que hacemos es físico pero requiere de la mente también.
La manteca que comemos no es nutritiva pero algunos dicen que lo es.
El movimiento en que se involucraron es pacífico porque es contra la violencia.
La piscina en donde nos bañaremos es honda y podemos zambullirnos.
El grado que pueden esperar es reducido y no encontrarán la calidad que buscan.
La dieta que vamos a adoptar está basada en alimentos saludables.
El negocio que hemos investigado es deshonesto y vamos a cerrarlo.
La historia que estamos estudiando es polémica pero esto es normal.
El nido que se cayó está tejido de varios materiales.
La oferta que me han dado es atractiva pero no la aceptaré.
El código que usamos es copiado por criminales a veces.
La estrella que busco está lejana y no la puedo encontrar.
El cielo que vimos al salir estaba nublado e iba a llover.
El helado que les gusta tanto es italiano pero lo hacen por todas partes.
¿Hay que comprar el helado en Italia?
El acuerdo que habían debatido tanto fue pactado por fin.
La cama que acabo de probar es ortopédica y deben de comprarla.
La harina que comimos estaba cocida con huevos y leche.
El respeto que has ganado no es infinito porque todo tiene límite.
El grito que oyeron fue lanzado por la muchacha en la calle.
¿Gritó una chica en la calle?
La ruta que van a tomar es tediosa pero no hay otra opción.
La sopa que vamos a comer es asquerosa pero no hay nada más que comer.
La botella que quiero encontrar es opaca y contiene un buen licor.
La biblioteca que necesitas usar está cerrada durante las vacaciones.

*Long Distance Condition (Ungrammatical)*

La célula que examinamos era maligno y por eso decidimos operar.
¿Era la célula benigna?
La escultura que vimos anteayer fue creado durante la dictadura.
La lista que hemos preparado está completo y ya podemos empezar.
El escenario que se usaría ya estaba construida y listo para la ópera.
¿Estaba listo el escenario?
El momento se hizo tan larga que me puse nervioso.
El motivo que nos confesó no era malvada pero no importa.
El músculo que van a operar está destrozada y requiere mucha atención.
¿Van a operar el músculo destrozado?
El pasillo que tenemos que usar es estrecha y los muebles no pasarán.
El riesgo que corremos está compartida entre todos.

La semana en que viajaremos será lluvioso pero no lloverá mucho.

El teatro que visitamos es romano y me pareció impresionante.

El ejército que ha atacado está sometida y vamos a empezar la ocupación.

¿Está vencido el ejército que atacó?

La belleza que has descrito es efímero y no dura.

La cueva que vamos a explorar está situado en el bosque.

El servicio que ofrecen no es barata sino que cuesta demasiado.

¿Es el servicio que ofrecen barato?

El turismo, como hemos notado, es lucrativa y bueno para la economía.

¿Es el turismo malo para la economía?

El vuelo que elegí es directa y muy conveniente.

La agenda que tengo para hoy es apretado y no podré salir a almorzar.

La guía que compramos está ampliado y tiene más información.

¿Es la guía una buena fuente de información?

El ámbito en que estamos es académica porque es la universidad.

La sábana que yace aquí está arrugado pero pronto la plancharé.

El futuro que tenemos enfrente es incierto pero tratarémos de hacer planes.

La escuela que están investigando es ruso y ofrece clases muy interesantes.

¿Están investigando esa escuela rusa?

El cuento vamos a editar fue inventada por el autor francés.

La sorpresa que tuvimos al llegar estaba reflejado en la cara de mi madre.
El castigo que hemos observado es asiduo y volverá a pasar.

La mentira que decidieron contar fue piadosa pero se sentían culpables.

El semáforo que vi estaba oxidado pero funciona.

¿Funciona ese semáforo?

El oro que veo aquí es sellado de acuerdo con su pureza.

El asalto que ocurrió fue vista por varias personas en la calle.

La salida que propusieron es político porque no quieren que sea militar.

El relato que van a contar es asombrosa así que debemos escucharlo.

La cuchara que vas a usar debe ser sopero para que no falte azúcar.

El atributo que queremos investigar fue mencionada en el informe.

La apatía que existe aquí es bochornoso y no habrá mucho entusiasmo.

La tarea que yo les di está completado y la voy a corregir.

La memoria que tiene está impedido a causa del accidente.

La defensa que montamos fue defectuoso así que no pudimos aguantar ese ataque.

La aventura que tuvimos fue financiado por nuestro jefe.

La cafetera que está allí es plástico y hay café adentro.

**Number Agreement – Singular (Grammatical)**

Una alfombra anudada se vendió ayer por la tarde.

Una bandera sencilla me parece mejor que algo muy vistoso.

Una boca guapa le causó muchos problemas a la joven.

Una caja reforzada es lo que ellos necesitan para guardar las joyas.
¿Quieren guardar las joyas en una caja reforzada?
Una cara pálida puede ser un síntoma de una enfermedad.
Una causa nula no merece mucha atención.
Una bolsa decorada se coloca en el escritorio de cada alumno.
¿Hay una bolsa decorada en cada escritorio?
Una chaqueta mona es lo que necesitas para la entrevista.
Una cita inexacta en tu tesis será un problema.
¿Está bien que la tesis tiene citas inexactas?
Una cocina variada es esencial para ser un buen restaurante.
Una columna torcida no sirve para mucho.
Una corbata aflojada se ve mal pero es más confortable.
Una cubierta externa les ayudará a evitar la lluvia.
Una danza animada es buena para estimular a la gente.
Una ducha frígida siempre sirve para despertarme.
Un abrazo tierno cura muchos dolores e inquietudes.
Un almuerzo casero es muy gustoso.
Un anillo perfecto no es sinónimo una relación feliz.
Un barco cargado de médicos llegará pronto para ayudar a la gente.
Un brazo mecánico hará las operaciones arriesgadas.
Un caldo tibio es agradable cuando hace calor.
Un puerto marítimo le trae muchos beneficios a una ciudad.
Un cigarrillo procesado es algo que debes de evitar.
¿Son saludables los cigarillos procesados?

Un diario detallado mantenido por la víctima describe la experiencia traumática.

¿Ha escrito la víctima sobre su experiencia?

Un cuerpo esbelto es la inspiración de los que quieren adelgazar.

Un fideo sabroso se quedó en la olla.

Un desayuno americano es normalmente muy grande.

Un domicilio urbano tiene muchas ventajas.

Un estado propicio les ofrece muchas ventajas a los ciudadanos.

Un estómago liso y firme es lo que todos queremos.

**Number Agreement – Singular (Ungrammatical)**

Una caras pálida puede ser un síntoma de una enfermedad.

Una espadas robusta es lo que necesitas para el duelo.

Una estatuas griega se cayó durante la noche.

¿Se ha caído un estatua?

Una multas injusta es algo que me enoja.

Una fórmulas errada nos dará una solución mala.

Una fortunas acumulada le da a uno mucho poder.

Una heridas infectada significa mucho dolor para el paciente.

¿Es una herida infectada agradable para el paciente?

Una hierbas acerba huele mal pero puede curar a un enfermo.

Una hojas oblonga se cayó del árbol enorme.
Una iglesias próspera debe de ayudar a la comunidad.

Una jornadas complicada puede causarnos a perder ánimos.

Una juntas celebrada el viernes fue interrumpida por el alarma.

Una llamadas maliciosa nos asustó anoche.

Una luchas legítima que la gente entiende les motiva más a participar.

Una marcas respetada le da confianza al consumidor.

Un gestos graciosos del profesor nos hizo reír durante toda la clase.

¿Hizo algo gracioso el profesor?

Un globos redondo flotó en el aire todo el día.

Un hábitos positivo puede marcar una diferencia grande en la salud.

Un hilos rizado que yacía en el suelo le interesó mucho al gato.

Un huecos sombrío cerca del hogar me inquietaba así que lo tapé.

Un huevos revuelto con pan tostado es lo que pedí para comer.

Un imperios cruento no se preocupa por la condición económica de la gente.

Un impulsos nervioso le hizo dejar caer la copa.

Un individuos adulto no debe portarse así.

Un infartos venoso puede matar a un hombre joven.

¿Son los infartos fatales para los viejos solamente?

Un juegos adictivo le distrae al muchacho toda la noche.

Un mecanismos integrado en el motor mantiene la temperatura apropiada.

Un mercados regulado significa que no habrá grandes fluctuaciones.

¿Hay grandes fluctuaciones en un mercado regulado?
Un pelos suelto se escapó de la mantilla de la señora.

Un pozos negro empezó a gotear cerca de nuestro hogar.

**Number Agreement – Plural (Grammatical)**

Hay marchas arduas que todos los soldados tienen que hacer.

Hay medicinas genéricas en la farmacia cerca de donde vivo.

Hay metáforas sugestivas en aquel poema que me gustan.

Hay miradas severas que parecen apuñalar el corazón.

Hay misas divertidas en esta catedral.

¿Se dan misas en esa catedral?

Hay muñecas rubias y morenas en el mostrador.

Hay orejas perforadas que se infectan y otras que no.

Hay papas asadas y bistec para comer esta noche.

Hay parejas arrestadas por besarse en el bus en aquel país.

Hay personas religiosas que toman mucho alcohol.

¿Hay gente religiosa que toma alcohol?

Hay piernas mutiladas que se pueden reparar.

¿Es imposible reparar una pierna mutilada?

Hay piezas innovadoras en aquella galería.

Hay plumas esponjosas en la almohada que compré.

Hay preguntas incómodas que no se debe de hacer.

Hay promesas quebradas en la mayoría de las amistades.
Hay lavabos mugrientos en el parque nacional.

Hay lechos angostos en las habitaciones del hotel.

Hay méritos destacados en el anuncio que no tienes.

Hay métodos ignorados que son muy útiles.

Hay minutos silenciosos en que mucho puede ocurrir.

Hay mundos recónditos en el universo.

Hay ojos chismosos contemplándonos siempre.

Hay palos chicos que se pueden usar para construir casitas.

¿Son inútiles los palos chicos?

Hay pañuelos bordados en el baúl de mi abuela.

Hay techos agrietados que representan un problema grave.

Hay privilegios moderados que podemos disfrutar.

Hay pronósticos depresivos que desaniman a los pacientes.

Hay protocolos clínicos que no se pueden ignorar.

¿Se puede ignorar todos los protocolos clínicos?

Hay ladrillos rugosos por toda la estructura.

Hay rechazos amorosos de los que uno no se recuperan.

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**Number Agreement – Plural (Ungrammatical)**

Hay proteínas implicada en muchas funciones biológicas.

Hay provincias contigua con la nuestra que tienen mucho crimen.

¿Hay crimen en algunas provincias adyacentes a la nuestra?
Hay puertas blindada que son muy fuertes pero no me gustan.

Hay quejas rechazada a menudo pero a ella a van a escuchar.

Hay referencias auténtica en esta tesis aunque la propuesta parece radical.

Hay cintas métrica que se venden en la universidad.

Hay repúblicas autónoma dentro de ese país.

Hay residencias mixta en que los hombres y las mujeres viven juntos.

Hay ruedas reventada que no se pueden reparar.

¿Se puede reparar todas las ruedas reventadas?

Hay sillas cuadrada que van bien con nuestros muebles.

Hay sonrisas siniestra que me congelan la sangre.

Hay tiendas selecta y elegantes en esa calle.

Hay blusas rayada que son muy bellas.

Hay rebajas súbita en que uno puede comprar mucho.

Hay visitas guiada todos los días.

¿Hay visitas guiadas sólo los viernes?

Hay reflejos rojizo en la peluca que pienso llevar.

Hay refugios atómico por todo el país.

Hay regalos propio para este aniversario.

Hay rollos tremendo de papel higiénico disponibles.

¿Se ha acabado el papel higiénico?

Hay rostros jubiloso en los carteles para la feria.

Hay ruidos insólito en la noche que me dan miedo.
Hay saltos repentino en la frecuencia del sonido.
Hay santos adorado de los cuales nosotros no sabemos mucho.
Hubo segundos agitado en que sufrimos mucha angustia.
Hay teléfonos intacto en aquel rascacielos.
Hay términos técnico que no podemos traducir.
¿Es difícil traducir los términos técnicos?
Hay lazos cariñoso que duran para siempre.
Hay tragos amargo que nos pueden curar nuestra tristeza.
Hay veranos caluroso que pasamos en aquel parque.
Hay zapatos atlético que podremos usar para jugar al fútbol.

**Semantic Condition (Congruent)**

Los psicólogos estudian cómo funciona la mente de la gente.
¿Estudian la mente los psicólogos?
No puedo cenar porque me falta el tenedor con que comer.
Las vacas tienen que estar saludables para producir la leche para nosotros.
Voy a poner tu llavero en el bolso para que no lo pierdas.
No podemos usar el coche porque perdí la llave ayer.
En el bosque los cazadores mataron un tigre sin problemas.
Los vegetarianos no comen ninguna carne de animal.
Hay desiertos y montañas por todo el continente en que vivimos.
¿Hay desiertos en este continente?
Yo cocino con muchos especies en vez de usar mucha sal porque no es saludable.

Esa mujer huele mal porque lleva mucho perfume y fuma.

Vamos a dormir y tienes que apagar la luz y la radio.

Tengo el cabello pegajoso por haberlo lavado con ese champú y suavizante.

El muchacho está resfriado y tiene la nariz muy irritada.

¿Le duele la nariz al muchacho?

Necesitan lavarse y piden que les prestemos el jabón y desodorante.

Vamos a colgar la foto en la pared de tu recámara.

La niña salió al jardín, cogió una fresa y se la comió.

¿Comió un chocolate en el jardín?

Después de aterrizar, nos quedamos en el avión hasta que el capitán nos permitió ir.

Cuando estaban en Hollywood, vieron una estrella del cine en la calle.

¿Vieron una estrella en Chicago?

A los niños no les gustan las espinacas, los guisantes, el apio y el brécol.

Cuando está nevando llevo la bufanda que me tejió mi madre.

El cajero me dio el recibo y un billete de diez dólares.

La policía nos advirtió de la emergencia por la radio.

¿Les avisó la policía?

Tengo que vestirme y ponerme el maquillaje antes de salir.

En la peluquería me depilaron la ceja con cera.

A los hombres en el bar les gusta ver los deportes y el billar por la noche.

En El Salvador, sirven las pupusas con la col picada y especias.
Cuando nació su primer hijo ella le dio el nombre de Tomás por su padre.

¿Le dieron el nombre de Tomás al segundo hijo?

Después de la violencia vino paz pero vamos a ver si dura.

El águila con las flechas y la rama de olivo es el símbolo de nuestro país.

Aunque la chica gritaba no oyeron la voz y no la encontraron.

¿Oyeron a la chica gritar?

Semantic Condition (Incongruent)

En España deben de probar los bocadillos de camión y el gazpacho.

Será difícil nadar contra la merced pero tenemos que hacerlo.

Va a ir al dentista porque le duele mucho el yate que lastimó.

Necesito comprar anteojos nuevos porque se me ha caído una frase de este par.

Hoy voy a ir a la pastelería para comprar el pincel que necesitamos.

En el jardín he plantado la fiebre que me recomendaste.

Vamos a tener que estacionar la moto en el frijol porque no hay más campo.

El corazón es como una bomba que impulsa la imagen por todo el ser.

Ella va a comprar las verduras en el tatuaje antes de regresar.

Cuando lleguemos a Pisa quiero ver la meil inclinada.

En el hotel, tienes que subir en el tomate hasta el quinto piso.

Caminaba en el parque cuando de repente vi la sede en el sendero.

La señora en el vestido de gala ha perdido un tanque de satén.

Acabamos de empezar y ahora estamos en la primera nuez del programa.
El padre de la novia necesita llevar un puente muy elegante.
Creo que ya vienen los bomberos pero el jamón no ha llegado todavía.
No pueden hacer nada porque están a la corriente del jefe.
El actor va a pasear por la bahía en el diente que compró para las vacaciones.
Se calló porque no pudo encontrar la lente apropiada para la despedida.
El artista entró en la galería con la paleta y el pan en la mano.
El niño se enfermó con la gripe y tenía una flor muy persistente.
Tengo el arroz aquí pero no tengo ningún césped ni verdura.
Ella recuerda al hombre porque tiene una foto con la sangre de la cara suya.
La señora se enojó al descubrir que en el hombro de su hijo había un almacén enorme.
Las abejas producen y guardan la torre en la colmena.
En Italia, la pasta, el aceite de oliva y el ascensor son muy importantes.
Van a una reunión de los gerentes en la serpiente de la firma.
Los tiburones nadan con las ballenas en el guante enorme sin pelearse.
Me gusta la mantequilla de cacahuete pero la fase tiene mucha grasa.
En Nueva York hay que viajar por el traje de Brooklyn porque es impresionante.
References


