Adjectives that Aren’t:
An ERP-Theoretical Analysis of Adjectives in Spanish

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THESIS
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<th>Description</th>
<th>Masculine</th>
<th>Gender</th>
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<tr>
<td>ACC</td>
<td>accusative case</td>
<td>masc</td>
<td>masculine</td>
</tr>
<tr>
<td>Ant/Post</td>
<td>anterior/posterior</td>
<td>N</td>
<td>noun</td>
</tr>
<tr>
<td>AP</td>
<td>adjective phrase</td>
<td>n</td>
<td>little noun</td>
</tr>
<tr>
<td>Cl</td>
<td>classifier</td>
<td>neut</td>
<td>neuter gender</td>
</tr>
<tr>
<td>CIP</td>
<td>classifier phrase</td>
<td>NOM</td>
<td>nominative case</td>
</tr>
<tr>
<td>CP</td>
<td>complementizer phrase</td>
<td>NP</td>
<td>noun phrase</td>
</tr>
<tr>
<td>D</td>
<td>determiner</td>
<td>nP</td>
<td>little noun phrase</td>
</tr>
<tr>
<td>DP</td>
<td>determiner phrase</td>
<td>Num</td>
<td>numeral</td>
</tr>
<tr>
<td>F</td>
<td>functional</td>
<td>NumP</td>
<td>numeral phrase</td>
</tr>
<tr>
<td>fem</td>
<td>feminine</td>
<td>pl</td>
<td>plural</td>
</tr>
<tr>
<td>Foc</td>
<td>focus</td>
<td>PP</td>
<td>prepositional phrase</td>
</tr>
<tr>
<td>FocP</td>
<td>focus phrase</td>
<td>sg</td>
<td>singular</td>
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<tr>
<td>FP</td>
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<td>IP</td>
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SUMMARY

This thesis investigates the syntactic status of adjectives in Spanish through a cross-disciplinary perspective, incorporating methodologies from both theoretical linguistics and neurolinguistics, specifically, event-related potentials (ERPs). It presents conflicting theories about the syntax of adjectives and explores the ways that the processing data gleaned from ERP research can help resolve the conflicting approaches.

Theoretical research has shown that although two surface positions exist for adjectives in Spanish (prenominal and postnominal), the underlying structure for these positions is more complex than the simple merging of an adjective before or after the noun. However, the exact details of this underlying structure are a source of discord among researchers. Whereas there is basic agreement that there are at least two base generated positions for adjectives (e.g., Alexiadou, 2001; Bernstein, 1992, 1993; Cinque, 2010; Taboada, 2010), the location of this base generation within the syntactic structure is a point of conflict. Some authors claim that adjectives participate in specifier merge to at least two different functional projections dominating NP (e.g., Cinque, 2010; Taboada, 2010), whereas others claim that certain adjectives have head status, selecting for NP and projecting their own features (e.g., Bartlett & González-Vilbazo, 2013; Bernstein, 1993). Still other authors propose a third position exists for focalized adjectives (e.g., Demonte, 2005; Taboada, 2010), which raise from their base-generated position. Further, the word class status of certain adjectives receives varying analyses, with authors claiming that some (Bartlett & González-Vilbazo, 2013; Bernstein, 1993) or all (Cinque, 2010) prenominal adjectives are functional elements. Thus, a consensus analysis of adjectives does not exist within theoretical linguistics literature.
SUMMARY (continued)

In this dissertation, I approached these theoretical disagreements from a processing standpoint, analyzing the theoretical adjective structures through ERP data. Specifically, I examined the adjectives’ (a) potential movement, (b) word class status, and (c) morphosyntactic agreement properties by comparing the electroencephalogram (EEG) of native Mexican speakers of Spanish as they read determiner-adjective-noun or determiner-noun-adjective sequences in Spanish. Results indicated that Spanish adjectives were not all processed in the same way. Prenominal adjectives showed evidence of processing distinctions in the correctly agreeing form, with the set of adjectives proposed to be moved elements displaying a sustained LAN compared to a base-generated counterpart. This was taken as evidence to support Demonte’s (2005) and Taboada’s (2010) that this set of adjectives is, in fact, moved from a base-generated position. The investigation into the adjectives’ word class status was inconclusive because a general lexical-functional processing distinction could not be established for the participants. Finally, agreement processing revealed a basic split between prenominal and postnominal adjectives, with prenominal gender agreement violations eliciting a P600 and postnominal ones eliciting a LAN/P600, in addition to an N400-type component for the set of adjectives with multiple semantic meanings. The agreement results themselves did not serve to clarify any particular aspect of the controversial syntactic structure, but they may have implications for the general theoretical concepts of agreement and concord.

Overall, the combination of theoretical and neurolinguistic methodologies helped to clarify some the controversies surrounding the syntactic structure of adjectives, although questions still remain. The present study contributes to an understanding of brain and
SUMMARY (continued)

language by employing a dual-field approach to unresolved linguistic issues, thus elucidating details about competence and processing that increase our knowledge of the structure and mechanisms of human language grammar.
1 INTRODUCTION

Understanding linguistic processing, or how language is processed in the brain, is important to an overall understanding of human language, yet processing is often studied in isolation from theories of linguistic competence (an implicit knowledge of one’s language, as proposed by Chomsky, 1965). Because of this, many ideas that arise from work in theoretical linguistics remain unconnected to data on processing. However, neurolinguistic techniques, among them event-related potentials (ERPs), have the potential to connect the two, closing the gap between linguistic theory and linguistic processing (Clahsen, 2007; Marantz, 2005). Through the identification and association of ERP components with linguistic phenomena, neurolinguistics provides a venue to test theoretical hypotheses. Conversely, by making use of the established ERP components that arise in association to certain linguistic constructions, theoretical linguists can use neurolinguistics to establish ties among related phenomena. Taken together, a sharing of the minds between the two fields has the potential to deepen our understanding of human language.

Theoretical linguistics has several branches, all of which can be approached from an experimental, neurolinguistic standpoint. This dissertation focuses on elements of both syntax (phrase structure) and morphosyntax (agreement). Specifically, this study investigates the syntactic status of attributive adjectives and their relatively local (within the DP) morphosyntactic agreement properties. Adjectives are a good venue of study because several theories on their syntactic and morphosyntactic properties already exist within the theoretical literature, yet the work has not led to a conclusive, standard theory. Further, adjectives’ morphosyntactic agreement properties make them well suited for ERP studies and indeed, some ERP studies have focused on the properties of adjectives. In this dissertation I
combine evidence from the two perspectives, theory and processing, to present a more complete picture of adjectival modification.

1.1 Summary of the Problem

Adjectives are pervasive in the languages of the world, yet they display a large amount of morphosyntactic variation, including variation in word order with respect to the nouns they modify. Some adjectives are prenominal, occurring before the noun, whereas other adjectives are postnominal, coming after their noun, as shown in examples (1a) and (1b), respectively, for Spanish.

(1) a. la mera verdad
   the mere truth
   ‘the mere truth’

b. un documento constitucional
   a document constitutional
   ‘a constitutional document’

Whereas some languages have mostly prenominal adjectives, for example, English (*the girl pretty), other languages have mostly postnominal adjectives, for example, Basque (mutiko-azkarr-a ‘guy-intelligent-the’, not *azkar-mutiko-a ‘intelligent-guy-the’; Taboada, 2010). However, as is evident from the example in (1) still other languages, among them Spanish, have an abundance of both pre- and postnominal adjectives. The question that arises from these facts is why there is variation, especially within a single language. Why does more than one position exist for adjectives? The simple answer would
be that not all adjectives are the same. What, then, are the differences that drive this 
adjectival variation?

There are many potential sources of variation, and my dissertation focuses on two: (a) 
differences in syntactic structure and (b) differences in word class. In terms of syntactic 
structure, previous proposals have placed adjectives in many positions, including, but not 
limited to, adjuncts of NP (e.g., Svenonius, 1994), specifiers of NP (e.g., Bosque & Picallo, 
1996, for relational adjectives), specifiers of some functional element in NP’s extended 
projection (e.g., Cinque 1994, 2010), and heads that select for an NP complement (e.g., 
Abney, 1987). The second source of variation that I address is word class – lexical versus 
functional. Although adjectives are often thought of as lexical items due to the semantic 
content they carry, many proposals, some of them quiet recent, claim that the syntactic 
category “adjective” contains both lexical and functional elements (e.g., Bartlett & González- 
Vilbazo, 2013; Bernstein, 1993; Cinque, 2010), making them analogous to other word 
categories such as prepositions, which are also composed of items from both word classes 
(e.g., van Riemsdijk, 1990, 1998). Thus, neither the syntactic status of adjectives nor their 
word class has an accepted standard of analysis within the theoretical linguistics literature.

In order to inform these controversial areas of research, it is helpful to study a 
language that has adjectival variation itself. My dissertation focuses on Spanish because it 
has both pre- and postnominal adjectives. These adjectives can be categorized into four broad 
types, two of which have both a pre- and a postnominal version (PREchange, POSTchange, 
PREnochange, POSTnochange) and two of which are only grammatical in one of the two 
positions (PREonly, POSTonly). These types are summarized in Table 1 and described more 
thoroughly in section 2.1.2.1.
Table 1

*Types of Spanish Adjectives*

<table>
<thead>
<tr>
<th>Type</th>
<th>Prenominal modification</th>
<th>Postnominal modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREonly</td>
<td>un mero hombre</td>
<td>*un hombre mero</td>
</tr>
<tr>
<td></td>
<td>‘a mere man’</td>
<td></td>
</tr>
<tr>
<td>PRE/POSTchange</td>
<td>un simple hombre</td>
<td>un hombre simple</td>
</tr>
<tr>
<td></td>
<td>‘just a man’</td>
<td>‘a man of few means’</td>
</tr>
<tr>
<td>PRE/POSTnochange</td>
<td>un bello chico</td>
<td>un chico bello</td>
</tr>
<tr>
<td></td>
<td>‘a beautiful boy’</td>
<td>‘a beautiful boy’</td>
</tr>
<tr>
<td>POSTonly</td>
<td>*un constitucional documento</td>
<td>un documento constitucional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>‘a constitutional document’</td>
</tr>
</tbody>
</table>

In this dissertation, I incorporate the adjective types from Table 1 into some of the analyses previously mentioned. Specifically, the structure I investigate to help account for these adjective types combines elements from the syntactic proposals of Bernstein (1992, 1993), Cinque (2010), and Taboada (2010) with elements from the word class proposals of Bartlett and González-Vilbazo (2013), Bernstein (1993), and Cinque (2010); this structure is presented in (2). The question marks in the structure indicate the controversies within theoretical linguistics that I am attempting to inform with my dissertation study. The details of the structure are discussed in section 2.1.
To help clarify the controversies still present within theoretical linguistics, my dissertation examines the nature of adjectives through experimental investigation, which is motivated by these differing theoretical perspectives. Specifically, I use ERPs, which measure the electroencephalogram (EEG) to specific linguistic events, to shed light on the theoretical debates. By employing an ERP methodology to probe the details of the syntactic structure in (2), I hope to achieve the following:

- To explore distinctions among the six adjective types related to differences in syntactic structure
- To investigate word class differences among adjectives
- To examine gender agreement on the different adjective positions

The first two goals, examination of differences in syntactic structure and differences in word class, will help clarify the position of the adjectives both relative to the noun and relative to each other. The third goal probes an aspect of the Spanish language not yet
mentioned: rich morphological agreement. Spanish is a language which displays both gender and number agreement on adjectives, as demonstrated in example (3) for gender.

(3)

a. chico simpático  
   boy_{masc.sg} nice_{masc.sg}

b. *chico simpática  
   boy_{masc.sg} nice_{fem.sg}

Example (3a) displays the grammatically agreeing adjective *simpático* ‘nice,’ which agrees in gender with the noun *chico* ‘boy.’ Example (3b), on the other hand, shows the gender violation *simpática*, marked in bold.

ERP studies on adjectives have taken advantage of this agreement, investigating the processing differences of agreeing and non-agreeing adjectives. Although this type of research has shown potential differences in the agreement processing of pre- and postnominal adjectives (Davidson & Indefrey, 2009; and Sabourin & Haverkort, 2003, for prenominal; Barber & Carreiras, 2005; Martín-Loeches, Nigbur, Casado, Hohlfeld, & Sommer, 2006; and Schacht et al., 2010, for postnominal; see section 2.2.3), this has rarely been investigated within a single language. To my knowledge, Foucart (2008) is the only study to present both pre- and postnominal agreement within one language, French, and the study itself was not designed to investigate potential differences among native speakers but instead looked at second language learning. Thus, my dissertation helps fill this gap in processing knowledge by examining agreement violations on both pre- and postnominal adjectives in Spanish as a native language.

Another set of ERP work has investigated the effects of syntactic structure itself on processing (see section 2.2.4 for details), although not all of the studies were designed to
explore adjectives specifically. Some of these studies examined processing across varying amounts of structural distance (as measured by within- or across-clause modification) but have been inconclusive as to whether structural distance is (e.g., Jiang & Zhou, 2009) or is not (e.g., Alemán-Bañón, Fiorentino, & Gabriele, 2012) reflected in processing. Other studies looked at linguistic movement and uniformly determined that moved structures elicit a specific type of processing relative to their unmoved counterparts (e.g., Kluender & Kutas, 1993, for wh-movement; Ueno & Kluender, 2003, for scrambling). My dissertation applies the movement findings to the adjective structure I proposed in (2) to look for evidence of moved adjectives. It also offers additional evidence of processing effects across different levels of syntactic hierarchy, which helps build the ERP literature on this topic.

Finally, my dissertation examines potential word-class differences in adjectives by relating the ERP components found at the different positions to those found in ERP studies on open-class (lexical) versus closed-class (functional) words. Although several ERP studies have found differences in the ERP components elicited to lexical and functional words (e.g., Brown, Hagoort, & ter Keurs, 1999; Neville, Mills, & Lawson, 1992), other studies have claimed that no processing differences exist between the word classes (e.g., Van Petten & Kutas, 1991; Osterhout, Bersick, & McKinnon, 1997). Further, in these ERP word class studies adjectives were either not examined (e.g., Nobre & McCarthy, 1994) or were assumed to be lexical and were grouped with nouns and verbs (e.g., Brown et al., 1999). One study, Osterhout et al. (1997), even chose to remove adjectives from their analysis based on their high amount of variation in comparison with other lexical categories. It seems, then, that an experimental investigation into the nature of the word-class of adjectives is warranted, and my dissertation fills this gap in both the ERP and the theoretical literature.
In sum, the present dissertation project aims to clarify part of the theoretical debate on adjective structure, as well as add to a growing body of ERP linguistics literature, by (a) examining differences in the online processing of adjectives that appear in different syntactic locations within the DP, (b) probing a potential processing difference between word classes, applied both to adjectives and to the Spanish language in general, and (c) investigating variation in the online processing of morphosyntactic agreement violations on pre- and postnominal adjectives. In order to accomplish these tasks, I recorded EEGs for native Mexican Spanish speakers as they read Spanish phrases containing adjectives in both pre- and postnominal position, with the goal of providing a clearer picture of the adjectives’ underlying properties. The results from this dissertation have impacts both on adjective theory and on our knowledge of language processing.

1.2 Organization of the Dissertation

This dissertation is organized as follows: Chapter 2 reviews both the theoretical (section 2.1) and ERP (section 2.2) literature in relation to adjectives and concludes with a presentation of my research questions and hypotheses (section 2.3). Chapter 3 presents the methodology used for data collection and analysis; it starts with a description of the participants (section 3.1) and stimuli (section 3.2); followed by the details of the experimental procedure (section 3.3), EEG recording and processing (section 3.4), and behavioral and ERP analysis (section 3.5). Results and discussion are presented separately for each research question: Chapter 4 analyzes correctly agreeing adjectives, chapter 5 examines the issue of word class, and chapter 6 tackles adjective agreement. Each of these results and discussion chapters is organized as follows: Behavioral results are reported first,
followed by ERP results and a discussion of these results in relation to the research question at hand. In addition, chapter 5 contains a description of the participants analyzed in that portion of the study because they differed from those examined in the rest of the dissertation (section 5.1). Finally, chapter 7 summarizes the dissertation’s findings (section 7.1), discusses possible implications of the work (section 7.2), and offers some concluding remarks (section 7.3).
2 BACKGROUND

In this chapter, I present background literature relating to the syntax and morphosyntax of adjectives. I begin in section 2.1 with a discussion of the theoretical considerations I used in adopting the adjective structure in example (2) in chapter 1. The second part of this chapter, section 2.2, reviews ERP literature related to different aspects of adjectives. I close with section 2.3, where I lay out my research questions (RQs) and hypotheses, which I present in relation to the theoretical and experimental work presented in the previous sections.

2.1 Theoretical Background

The theoretical review begins with an overview of adjective positions found across languages in section 2.1.1. This is followed by a presentation of more detailed syntactic differences that exist in these positions in a single language, Spanish, as well as two attempts at a syntactic structure to encompass these differences, Taboada (2010) and Bernstein (1993) (section 2.1.2). The theoretical review continues in section 2.1.3 with a presentation of Cinque’s (1994, 2010) series of functional heads that host adjectives and in section 2.1.4 with a discussion of certain semantic properties of adjectives. Finally, the section closes with a summary of the theoretical adjective literature in section 2.1.5.

2.1.1 Introduction to adjectives.

Adjectives have a variety of distributions in different languages. Taboada (2010), building on the classification of Demonte (2005), identifies four types of languages: (a) those that have mostly prenominal adjectives (e.g., English, (1)), (b) those that have mostly
postnominal adjectives (e.g., Basque, (2)), (c) those that display both (e.g., Spanish, (3)), and (d) those that display both and that have adjectives with enclitic determiners (e.g., Romanian, (4)), which is in essence a subgroup of the third type.

(1)  a. the brown dog
    b. *the dog brown

    (English)

(2)  a. mutiko azkarr-a
guy intelligent-the
‘the intelligent guy’
    b. *azkar mutiko-a
    intelligent guy-the

    (Basque; Taboada, 2010, p. 81, (17))

(3)  a. las manzanas rojas
    the apples red
    b. las rojas manzanas
    the red apples
‘the red apples’

    (Spanish; Taboada, 2010, p. 103, (89)-(90))

(4)  a. împarat-ul bun
    emperor-the good
b. bun-ul împarat

good-the emperor

‘the good emperor’

(Romanian; Cornilescu, 1995, as cited in Demonte, 2005)

The existence of both pre- and postnominal adjectives naturally brings about the question, why do languages have two adjective positions? Are there characteristics that distinguish the two? In order to address these questions, I first review some differences in the pre- and postnominal adjective positions, using Spanish as an exemplar language, and then I discuss theories that attempt to account for these differences, focusing particularly on Taboada’s (2010) proposal, which draws a parallel between the syntactic structure of adjectives and that of adverbs proposed by Cinque (1999).

### 2.1.2 Prenominal versus postnominal adjectives.

In order to investigate the differences between the two adjective positions, it is helpful to focus on a language that has both; I have chosen Spanish. In this section, I motivate the syntactic structure of adjectives presented in example (2) in chapter 1, repeated here as (5).
First, I review Taboada’s (2010) claim that adjectives come in two types: higher and lower (section 2.1.2.1), along with her stance on adjective movement. I then expand upon her structure by incorporating a lexical-functional analysis of adjectives, focusing on Bernstein (1993) and Bartlett and González-Vilbazo (2013), both of which are presented in section 2.1.2.2. I then incorporate these theoretical stances in an intermediate syntactic structure in section 2.1.2.3.

### 2.1.2.1 Higher and lower adjectives – Taboada (2010).

Taboada (2010) identifies four groups of adjectives, as seen in examples (6)-(9). The names in bold are my shorthand for each group and do not come from Taboada. Example (6) shows PREonly adjectives, which must be placed prenominally (6a). This adjective group is ungrammatical when placed postnominally (6b).
(6) *Prenominal only (PREonly)*

a. un mero hombre  
   the mere man  
   ‘the mere man’  
   (Taboada, 2010, p. 103, (85))

b. *un hombre mero  
   the man mere  
   (Taboada, 2010, p. 103, (86))

PRE/POST change adjectives, shown in (7), appear in both pre- and postnominal environments, but their semantic meaning, in terms of truth values, changes according to their position, as in (7a) for the prenominal version and (7b) for the postnominal one.

(7) *Prenominal or postnominal with different meanings (PRE/POSTchange)*

a. un simple hombre  
   a simple man  
   ‘just a man’  
   (Taboada, 2010, p. 114, (120))

b. un hombre simple  
   a man simple  
   ‘a simple man’  
   (according to consultants: ‘a man of few means’)  
   (Taboada, 2010, p. 114, (121))
PRE/POSTnochange\(^1\) adjectives, given in example (8), appear both pre- (8a) and postnominally (8b), but their general meaning does not change or just changes minimally. Bernstein (1993) points out that there can be a slight change in meaning in these cases, but the distinction is that the prenominal adjective receives a nonrestrictive (identifying an inherent quality) reading, whereas the postnominal adjective receives a restrictive (selecting a noun with a particular quality) reading. Taboada supports this minimal meaning change, noting that the prenominal version simply carries “focus, emphasis, or subjectivity” (Taboada, 2010, p. 101).

(8) *Prenominal or postnominal with no change in meaning* (PRE/POSTnochange)

a. las casas blancas
   the houses white
   ‘the white houses’

b. las blancas casas
   the white houses
   ‘the white houses’

(Taboada, 2010, p. 119-120, (133))

POSTonly adjectives, shown in example (9), cannot appear to the left of the noun (9a); instead, they must be used in postnominal position, as in (9b).

(9) *Postnominal only* (POSTonly)

a. *una constitucional reforma
   a constitucional reform

(Taboada, 2010, p. 85, (31))

\(^1\) PRE/POSTnochange and PRE/POSTchange adjectives will be referred to using either the PRE or the POST prefix when referring to a specific position, that is, a PRE/POSTnochange adjective in prenominal position is a PREnochange adjective. PRE/POSTnochange and PRE/POSTchange are the category names.
b. una reforma constitucional
   a reform constitutional
   (Taboada, 2010, p. 85, (28))

In parallel to Cinque’s (1999) characterization of higher and lower adverbs, which base generate above and below the VP, respectively, Taboada groups the adjectives into higher and lower categories. Higher adjectives base generate above the nP, which is the position to which the noun raises; therefore, these adjectives are prenominal. Lower adjectives base generate below this nP and, thus, are postnominal. Two of the four adjective types presented in (6)-(9) fit easily into this division: PREonly adjectives have to be located before the noun; therefore they must base generate above nP and, consequently, are higher adjectives. POSTonly adjectives, on the other hand, must be positioned after the noun, hence they are lower adjectives, based generated below nP. The other two adjective types, PRE/POSTchange and PRE/POSTnochange, are more difficult to fit into the higher and lower dichotomy because they can appear both pre- and postnominally. A comparison of their syntactic distribution with that of the easy-to-classify PREonly and POSTonly adjectives will help to determine in which of the two categories they belong.

Table 2 presents a summary of the syntactic tests (noted by both Bernstein, 1993, and Taboada, 2010) that can be used to group the four adjective types from examples (6)-(9).

Starting with predicative readings, Bernstein (1993) and Taboada (2010) both show that adjectives identified as higher by Taboada cannot be used in predicative structures, whereas all postnominal adjectives, as well as the PREnochange adjectives, (the lower group) can, as shown in example (10). In (10a) it is ungrammatical to use a PREonly adjective predicatively. Example (10b) shows that PREchange adjectives can only appear predicatively
Table 2

*Syntactic Division of Higher and Lower Adjectives*

<table>
<thead>
<tr>
<th>Group</th>
<th>Adjective type</th>
<th>Predication(^{a,b})</th>
<th>Coordination w/ lower adj.(^{b})</th>
<th>Gradability(^{a,b})</th>
<th>Elliptical constructions(^{a})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
<td>PREonly, PREchange</td>
<td>no (10a,b)</td>
<td>no (11d,e)</td>
<td>no (13a,b)</td>
<td>no (14a,b)</td>
</tr>
<tr>
<td>Lower</td>
<td>PREnochange, all POST groups</td>
<td>yes (10c,d)</td>
<td>yes (11a,b,c)</td>
<td>yes (13c,d)</td>
<td>yes (14c,d)</td>
</tr>
</tbody>
</table>

\(^a\) Bernstein, 1993  
\(^b\) Taboada, 2010

with their postnominal meaning. Example (10c) shows that PREnochange adjectives can appear in predicative structures and retain their meaning. Finally (10d) shows that POSTonly adjectives may appear in predicative structures.

(10)  
\(a.\) *la verdad es mera*

> the truth is mere

(Tagdoa, 2010, p. 249, (8))

\(b.\) *el hombre es simple*

> the man is simple

‘the man is simple’ (i.e., the man is not very sophisticated; the reading where he is ‘just a man’ is not possible)

(Tagdoa, 2010, p. 117, (125))
c. las flores sonolorosas
   the flowers are fragrant
   ‘the flowers are fragrant’
   (Bernstein, 1993, p. 52, (92a))

d. el documento es constitucional
   the document is constitutional
   ‘the document is constitutional’
   (based on Taboada, 2010)

The second syntactic test to aid in our higher and lower adjective division is adjective coordination. Taboada notes that higher adjectives may only be coordinated with other higher adjectives, and lower with lower, but the two may not be combined. Example (11a) shows that two lower adjectives, in this example, two PREnochange adjectives, can be coordinated. These same two adjectives can be focalized, and coordination is still grammatical, as shown in (11b). Further, two different types of lower adjectives can be coordinated, as in example (11c), where a POSTnochange adjective is coordinated with a POSTonly adjective. However, the same is not true of combinations of higher and lower adjectives. A higher and lower adjective cannot be combined, whether the higher precedes the lower, as in (11d), or the lower precedes the higher, as in (11e). Finally, example (12) shows that two higher adjectives, in this case a PREchange and a PREonly, can be combined without problem, showing that the issue is with the type of adjective used in coordination, not with the coordination itself.
(11) a. *two lower adjectives (POSTnochange)*:

un hombre triste y necio

‘a man sad and silly’

(Taboada, 2010, p. 118, (127))

b. *two lower adjectives focalized (PREnochange)*:

un triste y necio hombre

‘a sad and silly man’

(Taboada, 2010, p. 118, (128))

c. *two lower adjectives (POSTnochange with POSTonly)*:

un documento valioso y constitucional

‘a valuable and constitutional document’

(my example, based on Taboada, 2010, p. 117-118)

d. *a higher and a lower adjective*:

*la mera y triste verdad

‘the mere and sad truth’

(Taboada, 2010, p. 118, (129))

e. *a lower and a higher adjective*:

*la triste y mera verdad

‘the sad and mere truth’

(my example, based on Taboada, 2010, p. 118)
(12) two higher adjectives:

la pura y mera verdad
‘the pure and mere truth’

(Taboada, 2010, p. 118, (126))

In addition to the distinction in adjective coordination, both Bernstein (1993) and Taboada (2010) note that the two groups show differences in terms of gradability. Higher adjectives are not gradable (example (13a) for PREonly and (13b) for PREchange), whereas lower adjectives, be they focalized (PREnochange, (13c)) or in situ (POSTnochange, (13d)), are.

(13)  

a. *la muy mera verdad

‘the very mere truth’

(Taboada, 2010, p. 249, (7))

b. *el muy viejo amigo

the very old friend

‘the very long-time friend’ (only works with the reading ‘the very old friend’)

c. el muy simpático hombre

‘the very nice man’

d. el hombre muy simpático

‘the man very nice’

((b-d) are my own examples, based on the arguments in Bernstein, 1993, p. 53-54, and Taboada, 2010, p. 84, 249)

A further test for the two groups is found in Bernstein (1993). She notes that PREonly and PREchange adjectives, which Taboada identifies as the higher group, cannot appear in
elliptical nominal constructions, whereas those from the lower group can. Example (14a) shows that PREonly adjectives are ungrammatical if the noun is elided. PREchange adjectives may only appear in elliptical constructions with their postnominal meaning, as shown in example (14b). However, all types of lower adjectives may appear in elliptical nominal constructions, be they POSTchange, as demonstrated in the previous example, PRE/POSTnochange, as shown in (14c), or POSTonly, as shown in (14d).

(14) a. *(Compré) uno mero.
   bought.1sg one mere

b. (Compré) uno viejo.
   bought.1sg one *former/old
   ‘(I bought) a *former one/old one.’

c. (Compré) uno bello.
   bought.1sg one beautiful
   ‘(I bought) a beautiful one.’

d. (Compré) uno plano.
   bought.1sg one flat
   ‘(I bought) a flat one.’

   (my examples, based on Bernstein, 1993, p. 53)

It appears, then, that PREonly and PREchange pattern together on the one hand, and POSTchange, PRE/POSTnochange, and POSTonly pattern together on the other. The former group obligatorily appears before the noun and thus composes the higher adjective category. The latter group can appear after the noun and makes up the lower adjective category. Taboada (2010) proposes the following structure to encompass these two categories:
Both adjective groups are claimed to be specifiers of the functional head $F^0$. This is based on Cinque’s (1994) analysis, which will be detailed in section 2.1.3. The noun raises from N to the next highest available head position and also must pass through $n$. To check features on a lower adjective, it raises to the lower $F^0$ and then to $n$. Lower adjectives are, thus, postnominal, shown in the structure in (16)

The higher adjectives from the structure in (15) base generate above $n$. The noun raises from N to $n$ and then continues to the upper $F^0$ to check features on the higher adjective. However, the higher adjective remains prenominal, as in example (17):
The structures proposed thus far account for POSTchange, POSTnochange, and POSTonly as lower adjectives (structure (16)) and PREonly and PREchange as higher adjectives (structure (17)). What remains to be discussed is the location of the prenominal position of the PRE/POSTnochange adjective type, which was identified as a lower adjective. We can see from (16) that these adjectives base generate between NP and nP and that when they remain in this position, they are postnominal. In order to account for the prenominal word order, Taboada (2010) adopts a strategy proposed by Demonte (2005): that the adjective has raised to some type of focus phrase FocP.² Demonte’s claim is based on Bolinger’s (1967) observation that typically postnominal adjectives appearing in a prenominal position have received some sort of focalization, along with the defocalization of accompanying elements. For example, *vinieron en opuesta dirección* ‘they came from the opposite direction’ involves the focalization of the adjective *opuesta* ‘opposite’ and the defocalization of the noun *dirección* ‘direction’ (example from Demonte, 2005, p. 25).

² Luis López (p.c.) notes that this position may not always carry focus. The FocP, then, may be more accurately called by a different name, perhaps StyleP to refer to the stylistic use of fronting. However, for purposes of this dissertation, I refer to the position as FocP and the adjectives as focalized, in accordance with Demonte (2005) and Taboada (2010).
Incorporating this FocP into our syntactic structure gives us (18), where the lower adjective base generates below $nP$ and raises to SpecFP to receive some type of focus.

(18)

(modified, Taboada, 2010, p. 120, (134b))

Incorporating all of the proposed adjective positions – higher, lower, and focalized, along with the corresponding type names – gives the structure in (19):

(19)

(based on Taboada, 2010)
Thus, we have a tentative analysis for the syntactic structure of adjectives, parallel to that of adverbs (Cinque, 1999), accounting for the word order facts presented in (6)-(9), and supporting the grouping of syntactic characteristics summarized in Table 2. This is not, however, the end of the story. Other authors propose modifications of this structure. In the next sections, I discuss some of these proposals, beginning with Bernstein (1993), who argues that Taboada’s (2010) higher adjective group is actually made up of functional elements that are syntactic heads. I will show support for this analysis by reviewing a recent code-switching study (Bartlett & González-Vilbazo, 2013) that employs the concept of functional adjectives. I end the section with modifications of the syntactic structure presented in (19), incorporating elements of the analyses to be discussed in this section.

2.1.2.2 Lexical versus functional adjectives.

In this section I first review the characteristics of functional elements. Then I discuss Bernstein’s (1993) analysis of adjectives as functional heads and relate it to Taboada’s (2010) proposal. Finally, I support the concept of functional adjectives with Bartlett & González-Vilbazo’s (2013) discussion of functional adjectives in code-switching.

Functional categories.

A general distinction of lexical versus functional categories exists in theoretical linguistic literature (e.g., Abney, 1987; Gallmann & Lindauer, 1994; see Chametsky, 2000, for a critical review of several authors’ treatments of functional categories), as well as in neurolinguistic literature (e.g., Guo, Peng, & Yan, 2008; Neville et al., 1992; Nobre, Price, Turner, & Friston, 1997), child development literature (e.g., Brown & Hanlon, 1970; Shi,
Werker, & Morgan, 1999), and literature on aphasia (e.g., Bradley, Garrett, & Zurif, 1980; Schwartz, Saffran, & Marin, 1980). Although the line between the two word classes is often unclear, Abney (1987) defines lexical elements (Abney’s “thematic” elements) as those that contain descriptive content, their “link” to the world, and generally denote functions of type \(<e, t>\).³ Lexical elements include nouns, verbs, and at least some types of adjectives and adverbs.

Functional elements, on the other hand, may be identified by the following characteristics, taken from Abney (1987, p. 43-44, (1-5)):

(20) a. Functional elements constitute closed lexical classes.
   b. Functional elements are generally phonologically and morphologically dependent. They are generally stressless, often clitics or affixes, and sometimes even phonologically null.
   c. Functional elements permit only one complement, which is in general not an argument. The arguments are CP, PP, and…DP. Functional elements select IP, VP, NP.
   d. Functional elements are usually inseparable from their complement.
   e. Functional elements lack…“descriptive content.” Their semantic contribution is second-order, regulating or contributing to the interpretation of their complement. They mark grammatical or relational features, rather than picking out a class of objects.

³ Abney (1987) admits that transitive and ditransitive verbs are not typically thought of as being type \(<e, t>\), but he justifies them using an “extreme” form of event semantics. The details of his proposal are not important here; the distinction is simply that lexical elements typically take individuals and map them to truth values, whereas the arguments of functional elements are predicates.
Whereas a functional element need not possess each and every characteristic, the characteristics in (20) are a good place to start when looking to identify functional categories.

Several categories are commonly thought of as being functional. Kayne (2005, p. 12-14) provides an extensive list of these commonly agreed-upon functional elements including, but not limited to, complementizers, reflexive morphemes, phi-feature agreement morphemes, third person pronouns, demonstratives, determiners, numerals, classifiers, universal quantifiers, conjunctions, possessive morphemes, case morphemes, modals, negation, and morphemes expressing mood, aspect, and tense. Kayne also includes some elements that are not always identified as functional, based on the properties listed in Abney (1987) and on the syntactic parameters associated with them, which he identifies as a property of functional elements. These additional functional items include certain nouns (such as body, thing, place, one) and certain adjectives (such as other, same, good, few, and little). Related to adjectives, he also has degree words among his list of functional elements, including enough (p. 45), very (p. 13, (30)), and comparative and superlative words (p. 13, (30)).

Cinque (2010) also makes use of the concept of functional adjectives, stating that a particular type of modification, direct modification (which will be detailed in section 2.1.3), occurs with functional adjectives only. He supports the claim of functional adjectives by appealing to their closed-class status (see characteristic (20)), particularly in languages such as Yoruba, and he also notes that in certain Uto-Aztecan languages, many adjectives are

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4 Along the lines of Chomsky (1995), Kayne (2005) limits syntactic parameters to belonging to functional elements and proposes that “every functional element made available by UG is associated with some syntactic parameter” (p. 11, (7)).

5 Few is originally listed as a “quantity word” (Kayne, 2005, p. 13, (28)) but is later analyzed as a functional adjective (p. 40).
prefixes attached to the noun (see characteristic (20)). Further, he cites aphasia studies that find that certain adjectives are impaired along with other function words.

The concept of functional adjectives has been proposed by a number of authors for a number of languages. These include English (Abney, 1987), Romance languages (Bernstein, 1993), Swedish (Santelmann, 1993), Greek (Androutsopoulou, 1996), Basque (Artiagoitia, 2006), Taiwanese (Bartlett & González-Vilbazo, 2013), and Korean (Kim, in press). It seems quite possible, then, that adjectives come in two types: the commonly accepted lexical variety and some type of functional variety. The next section reviews one such analysis of functional adjectives: Bernstein (1993), who claims that certain prenominal adjectives show the characteristics of a functional head.

**Adjectives as functional heads – Bernstein (1993).**

Bernstein (1992, 1993) divides adjectives broadly into predicative and non-predicative.6 Predicative adjectives, demonstrated in example (21), are adjuncts that have two distributions, either attached to NumP or NP. Bernstein assumes that nouns in Romance languages raise to Num for singular/plural marking (along the lines of Picallo, 1991, and Valois, 1991). Because nouns in Romance move to Num, predicative adjectives that are adjuncts to NumP are prenominal, as in example (21a). Postnominal predicative adjectives, on the other hand, are adjuncts to NP, thus remaining below the noun, as in example (21b). Finally, non-predicative adjectives, which are represented in (22), are claimed to be heads7

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6 Note that Bernstein’s predicative adjectives are those that may appear in predicative constructions. They are still called predicative adjectives even when appearing in what other authors would call attributive position.

7 Bernstein adopts a head analysis for this type of adjectives to help explain the distribution of adjectives seen in Table 2. The appearance of these types of adjectives in elliptical constructions is prohibited based on her assumption that these adjective heads must select for an overt NP. Further, predication is prohibited because predication (based on Chomsky, 1992) would require a DP adjunct to N, not an NP complement.
that select for a NumP complement. Since N raises to Num, these non-predicative adjectives are always prenominal.

(21) a. DP
   \[\text{D} \quad \text{NumP} \]
   \[\text{las} \quad \text{AP} \quad \text{NumP} \]
   \[\text{olorosas} \quad \text{Num} \quad \text{NP} \]
   \[\text{flores} \quad \text{N} \]
   \[\text{ti} \]

las olorosas flores
the fragrant flowers
‘the fragrant flowers’

(Bernstein, 1992, p. 109, (11))

(22) DP
   \[\text{D} \quad \text{AP} \]
   \[\text{un} \quad \text{A} \quad \text{NumP} \]
   \[\text{mero} \quad \text{Num} \quad \text{NP} \]
   \[\text{accidente} \quad \text{N} \]
   \[\text{ti} \]

un mero accidente
a mere accident
‘a mere accident’

(Bernstein, 1992, p. 115, (30))

Using my terminology, POSTchange, PRE/POSTnochange, and POSTonly adjectives would be adjuncts because they all show predicative uses, as was seen in (10b-d). The postnominal groups would be NP adjuncts, whereas PREnochange would be a NumP
adjunct. PREonly and PREchange would be heads because they can never be used predicatively, as was shown in examples (10a,b). They would select for a NumP complement.

Bernstein (1993) goes a step further and claims that predicative adjectives are lexical, whereas non-predicative adjectives are functional. As functional characteristics of non-predicative adjectives, Bernstein identifies the following: (a) They are closed-class, allowing only a small number of adjectives (see characteristic (20a)); (b) they permit only one complement, specifically, a NumP (see characteristic (20c)); and (c) they lack the type of semantic content typically seen with lexical heads (see characteristic (20e)). For this last point, Bernstein cites the use of non-predicative adjectives as modifiers in Italian, such as that seen in example (23). Here the non-predicative adjective gran ‘big/really’ is used to modify the adjectival phrase bella casa ‘nice house.’ She claims that this use in a modification structure shows that an adjective such as gran is devoid of much of the descriptive content seen in lexical elements.

(23) una gran bella casa

‘a really nice house’

(Italian; Bernstein, 1993, p. 78, (170a))

In summary, then, for Bernstein all postnominal adjectives are lexical, but prenominal adjectives may be lexical or functional, depending on whether or not they are predicative, respectively. Using my terminology, the non-predicative adjectives, PREonly and PREchange, would be functional elements, located in a head position, and all others would be lexical, located in an adjunct position. This gives us the overall structure in example (24).
Additional support for the head status of functional adjectives is found in the code-switching literature. In the next section, I examine Bartlett and González-Vilbazo’s (2013) analysis of functional adjectives in Taiwanese.

*Further support for adjectives as functional heads – Bartlett & González-Vilbazo (2013).*

Bartlett & González-Vilbazo (2013) make a claim similar to Bernstein’s (1993) that some adjectives are functional heads. In supporting their proposal, they use Spanish-Taiwanese code-switching to provide evidence for functional adjectives that are syntactic heads. Code-switching involves the alternation between two (or more) languages within a discourse and is viewed as an expression of the language faculty. This phenomenon can be examined to help clarify structures that are opaque within a simple monolingual context (González-Vilbazo et al., in press; González-Vilbazo & López, 2011, 2012). Bartlett and González-Vilbazo (in press, 2013) investigate code-switching in languages with different sets of functional heads; that is, a functional head in L2 is not a syntactic element existing in the
L1. Bartlett and González-Vilbazo (in press) propose that a code-switch cannot occur in such cases, meaning the L1 cannot select for an L2 complement that is not in its repertoire of syntactic categories. Bartlett and González-Vilbazo (2013, in press) provide a variety of examples where switches involving a Spanish element and a Taiwanese classifier, an element not present in Spanish, are illicit, demonstrated in example (25). Here the Spanish determiner\(^9\) *estos* ‘these’ cannot grammatically be followed by the Taiwanese classifier *tai* ‘Cl\(_{\text{big objects}}\)’.

\[
\begin{align*}
(25) & \quad *\text{estos}\ t\text{ai}\ \text{cchia}^{10} \\
& \quad \text{these } \text{Cl}_{\text{big objects}}\ \text{car} \\
& \quad \text{‘these cars’} \\
& \quad (\text{Bartlett & González-Vilbazo, 2013, p. 68, (4a)})
\end{align*}
\]

However, these switches can occur when a different Taiwanese projecting head dominates the ClP, thus acting as an “intervener” between the Spanish element and the classifier. This is demonstrated with the numeral head in example (26). Here, a switch between the determiner *estos* and the Taiwanese numeral *go* ‘five’ is perfectly acceptable.

\[
\begin{align*}
(26) & \quad \text{estos}\ g\text{o}\ t\text{ai}\ \text{cchia} \\
& \quad \text{these } 5 \text{Cl}_{\text{big objects}}\ \text{car} \\
& \quad \text{‘these five cars’} \\
& \quad (\text{Bartlett & González-Vilbazo, 2013, p. 68, (4b)})
\end{align*}
\]

---

\(^8\) Note that \(L1\) and \(L2\) are not indicative of the order of acquisition of the languages or the speakers’ relative dominance in each. They merely serve as labels for a bilingual’s two languages. 

\(^9\) Bartlett & González-Vilbazo (2013) take the demonstrative to be present in \(D\) at some point in the derivation. I use “determiner” to describe the demonstrative for ease of exposition.

\(^{10}\) As is conventional in the code-switching literature, elements of each language are shown in a different style of type. Here, Taiwanese is written in plain type and Spanish in italics.
The difference in the ability of a Spanish head to select a Taiwanese classifier complement is demonstrated by the tree diagrams in (27). Example (27a) is an expansion of the ungrammatical code-switch from (25). The dotted line indicates the failure of Merge that occurs due to the Spanish determiner’s lack of a [select ClP]-type feature. In (27b), on the other hand, which is an expansion of the grammatical code-switch in (26), the determiner can and does select for the NumP headed by a Taiwanese element because Spanish determiners possess a [select NumP]-type feature, represented by the unvalued Num feature in brackets. The classifier feature is effectively hidden by the NumP.


Bartlett & González-Vilbazo, 2013, p. 72, (8)-(9)

Given this distribution, a Spanish determiner can only select for a phrase containing a classifier when that classifier has already been selected by another head, such as the numeral head in (27b). It turns out that an additional intervening head is provided by a small set of adjectives, including tua ‘big’ and se ‘small,’ which occur immediately in front of the classifier, a distinct syntactic position from the majority of Taiwanese adjectives, which are located after the classifier and before the noun. The preclassifier adjectives can be part of a code switch, as example (28) shows. In this example, a switch between the Spanish determiner este ‘this’ and the Taiwanese preclassifier adjective tua is grammatical.

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11 These prenominal/postclassifier adjectives are also commonly used the modifying particle e, but importantly, the tua and se-type adjectives are not (Bartlett & González-Vilbazo, 2013). This provides further support that the tua and se-type adjectives base generate in different locations than “typical” adjectives.
The determiner cannot be selecting for the ClP since it does not possess this selectional feature; instead it is selecting for some other phrase that has already selected for the ClP and has, effectively, blocked it from the view of the determiner. Bartlett & González-Vilbazo (2013) claim this phrase is headed by the adjective, which they refer to as a size word. Just as the determiner selected for NumP in example (27b), it selects for SizeP in example (29).

(29) \[ D [uSize] \quad \text{SizeP} [Size] \]

Since these size adjective elements serve to “block” the classifier and permit a code-switch, it is theorized that they are projecting heads, just as the numeral is a projecting head in example (27). Size\(^0\) selects for the ClP and projects its own features to form a SizeP. The D in (29) then selects for this SizeP because, unlike Cl, Size is an element recognized by the Spanish DP. Further, Bartlett & González-Vilbazo (2013) claim these size words are functional elements, possessing some of the characteristics that Abney (1987) identified as being associated with functional categories (identified in (20)), among them being that they
are closed class (characteristic (20a)),\footnote{Liu (2010) also includes tshim ‘deep,’ tshen ‘shallow,’ and tng ‘long’ in this group of adjectives; however, this does not change the interpretation of this group as being closed class.} that they permit only one complement (these adjectives must select for a classifier, characteristic (20c)), and that they are inseparable from their complement (characteristic (20d)). The overall claim, then, is that this small group of adjectives comprise a functional category that heads its own phrase. I apply this conclusion in the next section to revise Taboada’s (2010) adjective tree, which was presented in example (19).

### 2.1.2.3 An interim analysis.

The analyses just presented demonstrate a lack of consensus as to the syntactic status of adjectives. Thus far, we have seen Taboada’s (2010) claim that adjectives are part of two broad groups, higher and lower, that are located in the specifier of a higher and a lower functional phrase,\footnote{Note that for Taboada’s analysis, the presence of the functional head is obligatory because agreement is always mediated via $F^0$. The idea of this functional head appears in other analyses as well, including Cinque (1994, 2010), which will be discussed in section 2.1.3. For the purposes of the present study, I have no tests to reveal if the adjectives must base generate in the specifier of a functional head or if it is sufficient to say they base generate in the specifier of NP for lower adjectives and $n\text{P}$ for higher ones.} respectively, where agreement with the noun takes place. Whereas Bernstein (1992, 1993) presents a similar general division of adjectives, Bernstein (1993), as well as Bartlett and González-Vilbazo (2013), proposes that certain prenominal adjectives are functional elements that head their own phrase. Incorporating these two analyses into our tentative structure brings us to the syntactic structure in (30). Taboada’s proposal for lower postnominal and raised, focalized adjectives is maintained,\footnote{Note that Bernstein’s (1992, 1993) predicative group of adjectives, which corresponds to Taboada’s (2010) lower adjectives, are placed not as adjuncts of NP/NumP but as specifiers in SpecFP, in line with the proposed structure from Taboada (2010). I do this because (a) I adopt the more recent analysis that N incorporates with $n$ and not Num (Adger, 2003), and (b) I adopt a specifier analysis based on its broad use in the current literature. In addition to Taboada (2010), this use includes works by Cinque (1994, 2010), Laenzlinger (2000), and Scott (2002), among others.} but the treatment of the higher adjectives as lexical specifiers of FP is presented in parallel to Bernstein’s and Bartlett and...
González-Vilbazo’s theory that these higher adjectives are actually functional heads. Thus, the structure presents two competing analyses: PREonly and PREchange adjectives are located both as specifiers of FP and as heads of FP (with the thought that FP would actually be AP in the latter case).

Specifically, Taboada’s (2010) lower adjectives, which correspond to Bernstein’s (1992, 1993) predicative adjectives, are all base generated in a lower SpecFP that selects for NP/rootP; this position corresponds to my POSTchange, POSTnochange, and POSTonly adjectives. If the N incorporates into n as it does in Spanish, these adjectives are postnominal. Following Demonte (2005), my POSTnochange group may be focalized and raised to a higher position, SpecFocP, thus becoming PREnochange adjectives, where they are prenominal. All of the adjectives that base generate low are considered lexical by both Taboada and Bernstein, and I adopt this position as well. Taboada’s higher adjectives, which correspond to Bernstein’s non-predicative adjectives, base generate above n so that they are always prenominal; this position corresponds to my PREonly and PREchange adjectives.
Based on Taboada’s analysis, both PREchange and PREonly are in the specifier of the higher FP that dominates nP, and she considers both groups to be lexical. However, according to Bernstein and Bartlett and González-Vilbazo (2013), my PREonly and PREchange adjectives would be functional heads that select for nP. This difference in the potential position and word class of higher adjectives remains controversial using the syntactic techniques described above. The present investigation employs experimental techniques, to be described in section 2.2, to help shed light on the issue.

2.1.3 Additional theories on the syntax of adjectives – Cinque (1994, 2010).

Although I have presented a theoretical justification for the combined analysis in (30), the theories used are far from being the only proposals on adjective syntax. In this section I review a widely discussed syntactic analysis of adjectives – that presented in Cinque (1994). I then discuss additional aspects of the theory adopted in Cinque (2010). Although I will not adopt Cinque’s stance on adjective structure, for reasons to be provided below, portions of his theory have been incorporated into many works, including Taboada’s (2010) theory, thus a basic understanding of the ideas is important. Further, certain pieces of his analysis, specifically, his arguments on functional adjectives, are quite applicable to the study at hand. After presenting the main points of Cinque (1994, 2010), I discuss them in terms of my project and what my results may or may not say about the theory itself.

Cinque (1994) focuses neither on a broad grouping of adjectives nor on a lexical-functional distinction. Instead, he proposes a series of functional heads in which adjectives are generated in specifier positions. The noun is thought to raise to different positions in this series of heads such that both prenominal and postnominal adjective ordering can be

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15 Again, the FP would actually be AP in this case, headed by the functional adjective.
achieved. Cinque bases his proposal on the common adjective word orders found across languages, which are provided in (31).

(31) a. Serialization of adjectives in event nominals

\[
\text{poss[essive]} > \text{cardinal} > \text{ordinal} > \text{speaker-or[iented]} > \text{subj[ect]-or} > \text{manner} > \text{thematic}
\]

b. Serialization of adjectives in object-denoting nominals

\[
\text{poss} > \text{cardinal} > \text{ordinal} > \text{quality} > \text{size} > \text{shape} > \text{color} > \text{nationality}
\]

(Cinque, 1994, p. 96, (25))

Cinque adopts the idea that adjectives are phrases, base-generated in the specifiers of various functional heads, over the idea that they modify nouns via an adjunct position, claiming that the benefits gained from an in-specifier analysis over an adjunction one outweigh the increase in functional projections proposed within the DP. Among the evidence for an in-specifier analysis, he cites that the serializations in (31a,b) lend themselves more to a series of functional heads, claiming this “naturally” provides an ordering system. Adjunction, on the other hand, does not provide intrinsic ordering.\(^{16}\) He also points to a limit on the number of non-coordinated attributive adjectives that may appear in a single DP (approximately seven): A limited number of functional projections would lead to a limited number of adjectives, while adjunction has no built-in limit.\(^{17}\) Finally, Cinque refers to word order facts: specifiers are left-branching in Romance and Germanic languages, so having prenominal adjectives follows cleanly from having adjectives generated in the specifier position, whereas this must be stipulated for adjunction. Postnominal adjectives in Romance,

\(^{16}\) Adjunction ordering, though, could be imposed at the interface (Luis López, p.c.).

\(^{17}\) It is possible, though, that this limit is one of working memory and not of a specific number of functional heads (Luis López, p.c.).
then, are a result of noun-raising. Cinque does not entertain adjectives as projecting heads, as they would block this noun-raising.

In summary, Cinque (1994) proposes that adjectives base generate in the specifiers of a series of functional projections which are found across languages and that noun movement accounts for their position as pre- or postnominal. This work has come under heavy criticism for, among other things, its inability to generate several word orders that are attested in the literature (Malouf, 2000; Truswell, 2009; among many others) and its inability to account for adjectives that change in meaning (Larson, 1998).

Cinque (2005, 2010) adjusts quite a few features of his earlier analysis, although he does maintain that adjectives occur in specifier positions and part of his ordering system. As for the differences, most notably, he acknowledges that noun movement cannot account for the word order facts across languages and that a different source is needed to provide this ordering system. He proposes that adjectives come in two varieties, a proposal echoed by others (e.g., Alexiadou, 2001; Demonte, 2005; Sproat & Shih, 1988). According to Cinque’s (2010) proposal, the more detailed of the two Cinque works, one type of adjectives is merged as a phrasal specifier of a functional projection above N; he calls this direct modification. A second type of adjectives forms as a reduced relative clause; this is known as reduced relative clause modification, also called indirect modification (after Sproat & Shih’s, 1988 similar proposal; see also Kayne, 1994), and this type of structure merges in the specifier of an even higher functional projection above N. Cinque claims that reduced relative clauses in Romance languages are always postnominal. In order to achieve this ordering, the NP and

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18 Note that reduced relative clause modification is briefly discussed in Cinque’s (1994) work, but the Merge position of this type of modification and its relation to the more direct type of modification is not addressed.
any direct modification adjectives above it move in a “roll-up”\textsuperscript{19} fashion to the complementizer position above the relative clause, noting that the complementizer itself may not be overt. Direct modification APs may wind up in pre- or postnominal position, depending upon the extent to which the NP raises.

Cinque notes that the two types of adjective modification are associated with different semantic properties. For example, direct modification is associated with nonrestrictive, individual-level, and nonintersective readings, along with the potential for idiomatic interpretation, whereas indirect modification is associated with restrictive, stage-level, and intersective readings, as well as literal interpretation (see Cinque, 2010, p. 27, (6) for a complete listing of each type’s properties). As noted, indirect modification is always postnominal in Romance, whereas direct modification may be pre- or postnominal. As a result, ambiguities in the semantic readings just described can only occur in postnominal position, the place where both types of modification occur. This is demonstrated in examples (32)-(33) for individual- and stage-level readings in Italian.

(32) Prenominal adjective – direct modification only

a. Le invisibili stelle di Andromeda esercitano un grande fascino

the invisible stars of Andromeda have a great fascination

b. ‘Andromeda’s stars, which are generally invisible, have a great fascination’ – \textit{individual-level}

c. # ‘Andromeda’s generally visible stars, which happen to be invisible now, have a great fascination’ – \textit{stage-level}

(Italian; modified, Cinque, 2010, p. 7, (3))

\textsuperscript{19} This roll-up movement creates a mirror-image order between pre- and postnominal adjective orderings.
(33) Postnominal adjective – direct and indirect modification possible

a. Le stelle invisibili di Andromeda sono moltissime
   the stars invisible of Andromeda are very-many

b. ‘Andromeda’s stars, which are generally invisible, are very many’ – individual-level

c. ‘Andromeda’s generally visible stars, which happen to be invisible now, are very many’ – stage-level

(Italian; modified, Cinque, 2010, p. 7, (4))

In example (32), the adjective must be a direct modification one because of the adjective’s prenominal position; therefore, only the individual-level reading is possible (compare (32b) to (32c)). For the postnominal adjective in example (33a), however, the reading is ambiguous; both direct and indirect modification can exist postnominally, and as a result, both individual-level (33b) and stage-level (33c) readings exist.

In addition to their semantic properties, each adjective type is suggested to have different syntactic properties as well. These include (a) syntactic distance from the noun, with indirect modification APs merging higher in the structure than direct modification ones; (b) adjective ordering, with direct modification being rigidly ordered and indirect modification having flexible order; and (c) predication, with only indirect modification being possible in predicate position. The first difference, distance from the noun, is a result of Cinque’s predicted merge positions. He bases the higher merge position of indirect modifiers on the adjectival ordering of languages with participial reduced relative clauses, such as German. The second syntactic property attempts to account for the undergeneration of adjective orders that occurred from his earlier (1994) analysis. Reduced relative clause
modification is predicted to involve free word order based on the lack of ordering effects found in non-reduced relative clauses (see also claims made by Sproat and Shih, 1988). By proposing that these reduced relative clauses show free variation in word order, many of the problematic adjective ordering cases are covered, yet he still maintains the semantically based order of several adjectives in the direct modification category. The third difference, predication, falls out from the groupings themselves – adjectives that cannot participate in predicative modification are, by definition, part of the direct modification category.

Cinque’s (2010) proposed adjective structure can account for much more empirical data than his earlier work. However, it still runs into the same problem of undergeneration of adjective orders. He notes that languages such as English do not appear to have rigid ordering of direct modification and suggests that this is due to one of several reasons: (a) the adjectives are actually reduced relative clauses, (b) the same adjective appears as both a direct and an indirect modification AP, (c) the adjectives modify in parallel, belonging to separate intonational phrases, and (d) they have multiple options for positions within the direct modification hierarchy, as is suggested to account for former alleged thief versus alleged former thief (p. 30). Needless to say, allowing for multiple positions within a “rigid” order is quite contradictory and, thus, draws into question the need to maintain this aspect of his analysis. This part of the analysis is also questioned by Compton (2012), who shows that a rigid direct modification system cannot account for the adjective orders occurring in Inuktitut, a dialect of the Eskimo-Aleut group, despite the fact that the adjectives clearly belong to Cinque’s direct modification category. Further, Kim (in press) shows that both the syntactic order and the semantic groupings of the two adjective types are too restrictive to
account for adjective modification in Korean. It seems, then, that at least portions of
Cinque’s analysis cannot be sustained.

The question for the present study is, can the other aspects of Cinque’s (2010)
analysis be incorporated into the proposed structure in (30)? It turns out Cinque’s categories
map quite well onto Taboada’s (2010) categories already incorporated into the structure.
Cinque’s indirect (reduced relative clause) modification group, which are the only adjectives
that can appear in predicative constructions, must make up the lower adjective group, which I
have identified as containing POSTchange, POSTnochange, and POSTonly adjectives (I
return to PREnochange adjectives shortly). The direct modification group comprises the
higher adjective category, made of PREonly and PREchange adjectives.

The PREnochange adjective category is problematic in Cinque’s theory because he
claims that all reduced relative clause modification APs are postnominal in Romance
languages. This is obviously not the case for the PREnochange group. Cinque would likely
identify this group as being one of the adjective types that have both a direct and an indirect
modification structure. The prenominal PREnochange version would be the direct
modification counterpart of the postnominal reduced relative clause POSTnochange
adjectives. Thus, he would place PREnochange as base generating with the other two
prenominal groups (although each would be located in its own functional projection above
the noun).

The main difference in trying to incorporate Cinque’s analysis into the structure I
propose to test is the actual placement of the groups themselves. Whereas Taboada (2010)
has the lower adjectives generating lower in the structure than the higher ones, Cinque (2010)
reverses the two positions, such that lower adjectives (his indirect modification group) occur
high in the structure. Given the neurolinguistic processing measures I use in the present study, I do not expect to be able to differentiate between the relative ordering of the two groups, thus, I choose to adopt Taboada’s structure for testing with the knowledge that certain results are not necessarily incompatible with Cinque’s theory of the merge location of adjectives. However, my processing data may be able to provide information on two aspects of Cinque’s structure: (a) the grouping of PREnochange adjectives, which Taboada places with lower adjectives and which Cinque places with his equivalent of Taboada’s higher adjectives; and (b) word class, as Cinque identifies all direct modification adjectives (which are equivalent to my PREonly, PREchange, and PREnochange groups) as being functional (recall his argumentation, presented in section 2.1.2.2), whereas Taboada identifies them all as lexical. The details of the processing data I gathered are covered in section 3.2. For now, it is sufficient to incorporate these additional aspects of structure into the tree I propose to test, shown in (5) and repeated here as (34):
Entries in the syntactic structure in (34) that are marked with question marks are those that receive competing interpretations from different authors, and they are also the structures I hope to elucidate via my investigation on adjective processing. Specifically, my study may reveal information on (a) the proposed raising of PREnochange adjectives, (b) the proposed differences in word class within the prenominal adjective groups, and (c) general differences in the overall processing of prenominal and postnominal modification (which will be investigated via agreement violation structures, described in section 2.2.3).

Before discussing the processing methodology I use in this study, I will discuss an often-cited semantic division of adjectives, and I will show how it maps onto the syntactic structure in (34).

2.1.4 Semantic division of adjectives – intersective, subsective, and intensional.

The structure that I propose to test (in (34)) is based on syntactic distinctions among the adjective groups. However, adjectives also possess important semantic characteristics which group them together in different ways. The literature abounds with attempts to map semantic groupings to syntactic structure, but it generally agrees that semantic groupings alone are not enough to account for the distribution of adjectives (e.g., Demonte, 1999; Taboada, 2010; Truswell 2009). In this section, I discuss a major semantic division of adjectives: intersective, subsective, and intensional. I first review each type’s general characteristics, then I show how they fit with the structure I propose to test, concluding along with the literature that semantic groupings and syntactic position do not correlate one-to-one.

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20 This common division of adjectives is discussed and applied by many authors. The definitions and examples I use in this section come from Chierchia & McConnell-Ginet (1990) unless otherwise noted.
Adjectives are often broadly grouped into three types: intersective, subsective, and intensional. Intersective adjectives are predicates that express a property, and the interpretation of a noun-intersective adjective pair is the intersection of the sets described by each. For example, *pink tadpole* is the intersection of objects that are pink and objects that are tadpoles. This intersective interpretation shows the following entailment, where (35a) entails both (35b) and (35c).

(35)  

a. Pavarotti is a pink tadpole.

b. Pavarotti is pink.

c. Pavarotti is a tadpole.

(Chierchia & McConnell-Ginet, 1990, p. 371, (42))

Examples of intersective adjectives, identified in Peters & Peters (2000), include shapes (*round, square*, etc.), colors (*blue, yellow*, etc.), nationalities (*Mexican, American*, etc.), and materials (*wooden, plastic*, etc.).

Subsective adjectives are also predicates that express properties, but they do not receive a simple intersective interpretation because they are dependent upon the context in which they occur. As such, subsective adjectives are interpreted relative to the noun they modify. For example, *large tadpole* refers to an object that is a tadpole and that is big relative to tadpoles in general. However, compared to an animal such as an elephant, it would no longer be considered large. The entailment is as in (36), where (36a) entails (36c) but not (36b).

(36)  

a. Pavarotti is a large tadpole.

b. Pavarotti is large.
c. Pavarotti is a tadpole.

(Chierchia & McConnell-Ginet, 1990, p. 371, (43))

Subsective adjectives include words describing size (big, narrow, etc.) and those describing quality (good, new, etc.) (Peters & Peters, 2000).

Finally, intensional adjectives, unlike the other two types, are nonpredicating and do not express properties. Instead, they modify them; they can be interpreted as functions which map properties to properties, without selecting any kind of subset from the noun they modify. As (37) shows, the intensional adjective in (37a) entails neither (37b) nor (37c) but instead entails (37d).

(37) a. Pavarotti is a former tadpole.

b. *Pavarotti is former.

c. Pavarotti is a tadpole.

d. Pavarotti was a tadpole.

(Chierchia & McConnell-Ginet, 1990, p. 371, (44))

As examples of intensional adjectives, Peters & Peters (2000) include the following categories: temporal adjectives (former, future), modal adjectives (certain, possible (as in ‘potential’)), emotive adjectives (poor (as in ‘pitiable’)), manner adjectives (poor (as in poor liar)), object-related adjectives (criminal), and emphaser adjectives (outright).

As is evident from the examples, intersective (35b) and subsective (36b), adjectives can be used predicatively, whereas intensional adjectives generally cannot (37b), although there are exceptions.21 This lets us know that intersective and subsective adjectives belong to Taboada’s (2010) lower adjective category because that is the category that allows for

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21 Some exceptions include the object-denoting class, which generally may be used predicatively (e.g., that offense was criminal). However, as a whole, the category does not have a predicative use, although they may have predicative counterparts (e.g., poor ‘pitiable’ versus poor ‘not rich’).
predication. Considering the types of adjectives that occur in the intersective group (see examples, above), it appears that intersective adjectives are composed of PRE/POSTnochange and POSTonly adjectives. Subsective adjectives, on the other hand, appear to consist of POSTchange adjectives because they are adjectives that would be ambiguous upon a prenominal reading. Intensional adjectives are more difficult to fit into the higher and lower adjective split; most of them must be higher adjectives (PREonly, PREchange) because they cannot occur in predicative constructions, however the exceptions, such as the object-related class, can occur predicatively and are, therefore, lower adjectives.

Thus, it seems that semantic divisions alone are not sufficient to predict the syntactic position of adjectives. However, we see that the semantic division of intersective, subsective, and intensional can be teased apart to fit into the proposed syntactic structure. Intersective adjectives are part of the lower adjective group consisting of PRE/POSTnochange and POSTonly. Subsective adjectives make up the other portion of the lower adjective group and comprise POSTchange adjectives. Finally, most intensional adjectives belong in the higher adjective group, PREonly and PREchange; however, certain intensional classes are lower adjectives, likely of the PRE/POSTnochange and/or POSTonly groups.

2.1.5 Theoretical summary.

A review of the literature has led me to adopt the syntactic structure in (5), repeated here as (38), as a basis for my experimental analysis of adjectives. This structure takes the basic syntactic analysis of Taboada (2010) and combines it with elements of Bernstein (1993) and Cinque (2010). An attempt to correlate this structure to a common semantic analysis of adjectives revealed that the categories must be further divided to account for the
distribution of adjectives; as such, the labels in the tree reflect the syntactic divisions only. The reader is reminded that the elements of the structure which may be able to be further examined using the processing data collected in the present study are indicated by question marks.

In the next section, I discuss the background for the experimental portion of my dissertation to see what evidence can be gleaned for the structure in (38) and to see what gaps remain in our knowledge.

(38)

2.2 Event-Related Potentials (ERPs) Background

ERPs, which reveal real-time cognitive processes time-locked to a stimulus, have proven useful in the understanding of linguistic processing. They provide information on when and how the processing occurs in the brain and indicate, to a limited extent, where these processes occur. In what follows, I will discuss how ERPs work (section 2.2.1);
identify the established ERP components that are associated with certain linguistic events (section 2.2.2); discuss ERP work in association with adjectives (section 2.2.3), syntactic structure (section 2.2.4), and the theoretical distinction between lexical and functional items (section 2.2.5); and summarize what remains to be examined in relation to processing adjectives in one’s native language (section 2.2.6).

2.2.1 ERP basics.

ERPs show the neural responses of the brain to a particular internal or external stimulus. They reflect voltage changes in an ongoing EEG recorded from electrodes placed near the scalp. These voltage changes are evoked by a target stimulus, such as a specific word or sound (Luck, 2005a). Researchers use ERPs to help them identify when and how particular processes occur in the brain, and to a certain degree, where the neural generators producing the voltage changes are located (Steinhauer & Connolly, 2008).

These changes are not typically large enough to be seen from a single stimulus occurrence for an individual subject; instead, the voltages for the occurrences of the same types of stimulus are averaged both within and across subjects, and the result is a waveform of brain activity with a series of positively and negatively deflected peaks (Luck, 2005a), as shown in Figure 1.

These deflections are called components and consist of three parts: latency, polarity, and distribution. Latency refers to the number of milliseconds after the presentation of a stimulus that the component starts or peaks; polarity is either positive, typically plotted down on a graph, or negative, typically plotted up; and distribution refers to the particular

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22 Note that the term component also has a use that goes beyond its physical description. ERP components are often defined in relation to the cognitive function to which they relate (Otten & Rugg, 2005).
Figure 1. A sample waveform showing positive and negative deflections. Based on Luck, 2005a, p. 8.

Electrodes where the component occurs, which reflect the places on the scalp which show a particular activation. In addition, the amplitude, or height of the deflection, of a component is often measured (Luck, 2005a).

Different components are thought of as corresponding to different cognitive processes. Specifically, components with a different polarity and/or distribution are considered to reflect distinct neural generators, whereas differences in latencies and amplitudes reflect different levels of activation of a single generator (Hahne & Friederici, 2001; Otten & Rugg, 2005). Components are generally labeled with N or P to reflect their negative or positive polarity, respectively, and either the latency in milliseconds or a number to indicate what position the peak has in the overall waveform (Luck, 2005a). For example the N280 is a negativity at 280 ms post-stimulus, and the P3 is a positivity that is the third deflection in the waveform.

23 Different scalp distributions could also result from different relative activation of the same set of neurogenerators (Otten & Rugg, 2005).
This descriptive aspect is not always present in component names, however. Many common components (P3, P600, etc.) are used to label a variety of similar distributions; for example, a P600 may appear before or after 600 ms, and a LAN (left anterior negativity) may not always be anterior. Although each use of the component name is not identical, they are used to describe similar phenomena (Luck, 2005b), many of which will be described in section 2.2.2.

Linguistic ERP experiments are often set up on a violation paradigm, which involves comparing the waveforms for an ungrammatical word to those of a grammatical one (see Kutas, Kiang, & Sweeney, 2012, for a general description and review of several ERP paradigms). Data from ERP experiments are usually shown graphically using these waveforms, either showing both waves (grammatical and ungrammatical) in separate lines or by subtracting the grammatical wave from the ungrammatical one to create a difference wave. In addition, voltage maps, which indicate overall voltages across the scalp, are often used. Like the waveforms, these voltage maps generally show the voltage difference between the grammatical and ungrammatical stimuli. From these waveforms and voltage maps, several linguistic components have been identified. These will be described in the next section.

### 2.2.2 ERP components to language processing.

ERP studies have been run for a variety of linguistic phenomena and have yielded several well-studied language components. Some of the most commonly found and studied include the N400, the (early) left anterior negativity (or (E)LAN), and the P600, which I have grouped into those that reflect lexical processing (the N400; see section 2.2.2.1) and those
that reflect grammatical processing ((E)LAN/P600; see section 2.2.2.2). It is important to note that the lexical/grammatical processing distinction is not a clear-cut one; for example, some studies have reported P600 effects for lexical processing (e.g., Kuperberg, Sitnikova, Caplan, & Holcomb, 2003), and others have reported N400 effects for syntactic processing (e.g., Osterhout, 1997). However, these components are often elicited to lexical and grammatical structures as indicated, and the division is helpful as an introduction to ERP components. Although the N400, (E)LAN, and P600 are not the only components that will be important in my study on adjectives, they provide a base upon which I can make predictions.

2.2.2.1 Lexical processing – the N400.

The N400 is a centroparietal negativity that occurs approximately 400 ms after the presentation of a stimulus (Kutas & Hillyard, 1980; see Lau, Phillips, & Poeppel, 2008; Kutas & Federmeier, 2011 for recent reviews). Its presence has been confirmed cross-linguistically (Friederici, 1997; Hinojosa, Martin-Loeches, & Rubia, 2001), and it was initially identified for words which violated the semantic content of the sentences in which they appeared, as in (39).

(39) He took a sip from the transmitter.

(Kutas & Hillyard, 1980, p. 203)

Here the word transmitter is not semantically coherent with the sentence context and hence constitutes a lexical/semantic violation.

The N400 is generally bilateral for auditory stimuli and somewhat right-lateralized for visual stimuli. It both starts earlier and lasts longer for auditory as compared to visual
stimuli and is slightly more anterior for auditory stimuli (Kutas & Federmeier, 2011). An N400 to auditory stimuli is shown in Figure 2.

![N400 waveform and voltage map](image)

**Figure 2.** Example of an N400. (a) An N400 waveform, violation in pink and control in blue. (b) An N400 voltage map, violation minus correct condition, negativity in blue. Adapted from Morgan-Short, 2008.

In the waveform in Figure 2, the pink line represents a semantic violation, such as that in (39), and the blue line represents its grammatical counterpart (which would be along the lines of *he took a sip from the cup*). As can be seen, the waveform for the semantic violation has a negative peak around 400 ms that is much larger than that present in the control condition. The voltage map in Figure 2, which shows the difference in voltage between the violation and control conditions, gives the distribution of this negativity on the scalp, with darker blue indicating more negative voltages. As can be seen, the negativity is centroparietal, even extending into the frontocentral region, and is fairly bilateral.
The amplitude of the N400 is modulated by a variety of factors (for a review see Kutas & Federmeier, 2011). These include ease of integration into the context, with hard-to-integrate words having larger negativities (King & Kutas, 1995); word frequency, with low frequency words showing larger negativities (Holcomb & Neville, 1990); and word class, with amplitudes being highest for content words (Kutas & Hillyard, 1983). In addition, amplitudes are larger for words with high-density orthographic neighborhoods24 (Holcomb, Grainger, & O’Rourke, 2002) and lower for word repetitions (Bentin & Peled, 1990; Hinojosa, Martín-Loeches, & Rubia, 2001), for words that occur late in the sentence (Van Petten, 1995), and for words that have been semantically and/or phonologically primed (Bentin, McCarthy, & Wood, 1985; Nobre, Allison, & McCarthy, 1994). Concreteness affects several aspects of the N400, with amplitudes being larger for concrete words (i.e., table) than abstract words (i.e., liberty) and effects for concrete words being longer lasting and having a more anterior distribution (Holcomb, Kounios, Anderson, & West, 1999).

Latencies and distributions for the N400 are also modulated by several factors. Latencies are shorter for primed words (Nobre et al., 1994) but longer for words that are presented quickly (Hinojosa, Martín-Loeches, & Rubia, 2001). Faster word presentation also has distributional effects, with rapid presentation being associated with a more frontal distribution. Finally, the distribution is affected by word categories; for example, the N400 evoked by verbs is more anterior than that evoked by nouns (Sitnikova & Holcomb, 1999).

Although the N400 has been taken to be an indication of post-lexical processes involved with semantic integration (Friederici, 1997; Hinojosa, Martín-Loeches, & Rubia, 2001), there has been some general discussion as to its domain specificity because studies using related and unrelated pictures have shown N400 effects (McPherson & Holcomb,

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24 These are words whose spellings are highly similar to other words.
Further, N400 effects appear to incorrectly answered arithmetic problems (Niedeggen, Røesler, & Jost, 1999) and have even been affected by the priming of odors (Castle, Van Toller, & Milligan, 2000). Kutas and Federmeier (2011) note that the N400 seems to be more related to meaning in general, not just to meaning related to linguistic contexts.

In summary, the N400 is a centroparietal negativity occurring approximately 400 ms after stimulus presentation, the timing, size, and distribution of which can be affected by a variety of linguistic and non-linguistic factors. It is associated with lexical retrieval and semantic integration and is therefore often considered a semantic ERP component.

### 2.2.2.2 Grammatical processing – the (E)LAN/P600.

The ERP components associated with grammatical processing are the (E)LAN and the P600. They are covered in the next two subsections.

*The (E)LAN.*

The LAN and the ELAN are typically associated with morphosyntactic and syntactic processing (Neville, Nicol, Barss, Forster, & Garrett, 1991). Although the validity of the ELAN as an ERP component has been called into question (Steinhauer & Drury, 2012), I briefly review it here for the sake of clarity. An ELAN is generally found for pure syntactic violations, such as the phrase structure violation in (40), and a LAN is generally found for morphosyntactic processing, as with the agreement violation in (41).

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25 I use the term *LAN* in this review because it is the name commonly used for the component in the literature. However, for clarity in my results section, I will only use LAN if the component is left-lateralized; if it is bilateral, I will refer to it as an *AN* (anterior negativity) and if it is right-lateralized, I will use the term *RAN.*
(40) a. The man admired Don’s sketch of the landscape.
   
   b. *The man admired Don’s of sketch the landscape.

(Neville et al., 1991, p. 153, (2), (5))

(41) a. Every Monday he mows the lawn.
   
   b. *Every Monday he mow the lawn.

(Coulson, King, & Kutas, 1998, p. 33, (7b,a))

In (41), the verb *mow does not agree with the singular pronoun *he; it should be *mows. This type of violation involves a syntactic relation across phrase boundaries, as the verb must look to the noun for number agreement. The violation in (40), however, is purely syntactic, involving no cross-phrasal boundaries. Here, the position of the words *of and *sketch has been switched, a typical design for word category/phrase structure violations, resulting in the failure to build a proper syntactic phrase structure.

The LAN and ELAN are both topographically similar (although both can show quite a bit of variation), being left-lateralized to bilateral and relatively anterior, but the ELAN generally occurs before 250 ms after stimulus presentation, whereas the LAN typically occurs between 300 and 500 ms post-stimulus. The LAN26 is represented graphically in Figure 3.

I continue this section with a quick glance at the ELAN. The ELAN is hypothesized to represent first-pass parsing as the parser builds up the phrase structure necessary to interpret a sentence (Friederici, 2002; Friederici & Mecklinger, 1996). Friederici and Mecklinger (1996) found that an ELAN is only elicited by phrase structure violations, such as that which was seen in (40), above, where a particular word category does not fit into the phrase structure being built. Semantic and morphosyntactic (agreement) violations, which

26 The ELAN would show a similar distribution but in an earlier time window.
Figure 3. Example of a LAN. (a) A LAN waveform, violation in red and control in blue. (b) A LAN voltage map, violation minus correct condition, negativity in blue. Adapted from Morgan-Short, 2008.

occur during later stages of processing, do not elicit this effect. However, Steinhauer and Drury (2012) critique studies that have found this component and note that they suffer from context/baseline issues that may result in the ELAN being nothing more than a spill-over effect.

As noted above, the LAN is generally associated with morphosyntactic processing, such as agreement violations (including subject-verb agreement (41), noun-adjective gender (42a,b) and number (42a,c) agreement, and case agreement (43)), and verb tense violations (44). It can also appear for phrase structure violations that are contextually balanced (e.g., Hagoort, Wassenaar, & Brown, 2003).

(42) a. El piano
    the\textsubscript{masc.sg} piano\textsubscript{masc.sg}

    b. *La piano
    the\textsubscript{fem.sg} piano\textsubscript{masc.sg}
c. *Los piano

\text{the}_{\text{masc.pl}} \text{piano}_{\text{masc.sg}}

(Barber & Carreiras, 2005, p. 150)

(43) a. The plane took us to paradise and back.

b. *The plane took we to paradise and back.

(Coulson et al., 1998, p. 33, (5b,a))

(44) a. seeped

b. *sept

(Morris & Holcomb, 2005, p. 966)

LANs also occur for long-distance dependencies such as relative clauses (e.g., King & Kutas, 1995) and wh movement (e.g., Kluender & Kutas, 1993), but in these cases, they often are sustained, continuing well past 500 ms after stimulus presentation, and may index different processes that the more transient LAN (Kluender & Münte, 1998). I return to the sustained LAN in section 2.2.4.2, but I focus this subsection on the localized LAN component.

The general appearance, size, and distribution of the LAN are affected by individual differences, including native speaker proficiency (Pakulak & Neville, 2010), as well as by syntactic complexity (Vos, Gunter, Herman, Kolk, & Mulder, 2001). Due to these, and likely other, reasons, the LAN does not reliably appear in all of the conditions listed in (40)-(44); however, when it is present in processing, it is viewed as a form of automatic processing of grammatical violations (Friederici, 2002). Overall, the LAN may not be domain specific, as it is tied to violations which affect proceduralized cognitive operations, including non-linguistic rule-based sequencing and structural unifications (Hoen & Dominey, 2000).
However, regardless of domain specificity, the LAN is generally understood to be a marker of grammatical (morpho)syntactic processing.

*The P600.*

The second component associated with grammatical processing is the P600, a centroparietal positive shift occurring 500-1000 ms post-stimulus (Osterhout & Holcomb, 1992; called the “syntactic positive shift” by Hagoort, Brown, & van Groothusen, 1993; see Figure 4).

![Waveform](image1)
![Voltage map](image2)

*Figure 4.* Example of a P600. (a) A P600 waveform, violation in red and control in blue. (b) A P600 voltage map, violation minus correct condition, negativity in blue, positivity in red. Adapted from Morgan-Short, 2008.
As the figures show, the violation condition is more positive than the correct condition in the centroposterior electrodes during the P600 time window.

Like the LAN, the P600 is associated with both syntactic and morphosyntactic processing (Friederici & Mecklinger, 1996; Osterhout & Holcomb, 1992) and is particularly associated with controlled reanalysis. It has been found cross-modally (Hagoort & Brown, 2000) and cross-linguistically for violations of phrase structure (e.g., Osterhout & Holcomb, 1992; see (40), above), agreement (e.g., Hagoort et al., 1993; Osterhout & Mobley, 1995; see (41)-(43), above), verb argument structure (e.g., Friederici & Frisch, 2000; see (45)), verb tense (e.g., Coulson et al., 1998; see (44), above), and subjacency (e.g., McKinnon & Osterhout, 1996; see (46)). In addition, P600s are evoked by garden path sentences (e.g., Osterhout & Holcomb, 1992; see (47)); and syntactically complex sentences (e.g., Kaan, Harris, Gibson, & Holcomb, 2000; see (48)), neither of which contains a violation.

(45) *Anna weiß, dass der Kommissar den Banker abreiste und wegging.

Anna knows that the inspector the banker departed and left.

(Friederici & Frisch, 2000, p. 481, (8b))

(46) a. I wonder whether the candidate was annoyed when his son was questioned by his staff member.

b. *I wonder which of his staff members, the candidate was annoyed when his son was questioned by ___j.

(McKinnon & Osterhout, 1996, p. 500, Table 1(1-2))

(47) The broker persuaded

(a) the man to sell the stock.

(b) to sell the stock was sent to jail.

(Osterhout & Holcomb, 1992, p. 787, (1))
(48) Emily wondered who the performer in the concert had imitated for the audience’s amusement.

(Kaan et al., 2000, p. 164, (2a))

Several factors can affect the amplitude and latency of the P600. Both the amplitude and the latency are a factor of the complexity of reanalysis, with more complex sentences inducing larger amplitudes and later latencies (Friederici & Mecklinger, 1996). The P600 is often affected by non-syntactic factors, as well, including semantic information (Martin-Löeches et al., 2006), processing strategies (Steinhauer & Connolly, 2008), and experimental tasks and salience (Coulson et al., 1998). The amplitude is also a factor of probability, with low-probability sentences inducing larger amplitudes (Gunter, Voss, & Mulder, 1995; Coulson et al., 1998; although see Osterhout, McKinnon, Bersick, & Corey, 1996, for the claim that the P600 is not probability sensitive).

Several recent studies (e.g., Bornkessel, Schlesewsky, & Friederici, 2002; Kuperberg et al., 2003; van Herten, Kolk, & Chwilla, 2005) have indicated that the P600 may also be elicited in non(morpho)syntactic contexts. This work examines thematic role animacy violations such as that found in example (49). The studies show that a P600 is elicited to improperly occurring inanimate subjects/objects.

(49) a. For breakfast the boys would only eat toast and jam.

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

(Kuperberg et al., 2003, p. 118, Table 1(1-2))

In this example, the verb eat requires an animate subject; eggs is inanimate and cannot fulfill the role of subject here. The authors interpret the violation as a semantic one. However, at least some syntax is involved in the structure because assignment of thematic roles occurs

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27 Low probability sentences are those that end in a semantically plausible, yet not completely expected, way.
during syntax. The verb, *eat*, assigns the agent role to its external argument and the patient role to its internal one. Hale and Keyser (1992) go as far as to claim that theta roles are nothing more than syntactic configurations. It is possible, then, that the P600 found in this type of study is more related to a violation that occurs during syntax (i.e., an erroneous assignment of theta roles to the incorrect position).

Whether or not the P600 is elicited to semantic-type stimuli, it is reliably seen with syntactic complexity and to the violations described above. Various interpretations have been offered, including (morpho)syntactic (re)analysis and repair (e.g., Osterhout, Holcomb, & Swinney, 1994), (morpho)syntactic integration difficulty (e.g., Kaan et al., 2000), and structure-building operations (Gouvea, Phillips, Kazanina, & Poeppel, 2010). Regardless of the specific interpretation adopted, the P600 is seen as an indicator of (morpho)syntactic processing for a variety of linguistic events.

### 2.2.2.3 Summary of common ERP components to linguistic events.

In summary, the N400 is commonly linked to semantic processing, and the LAN and P600 have been shown to reflect morphosyntactic and syntactic processing, although as noted at the outset, this division is not necessarily clear-cut. I will now review ERP studies involving adjectives and show how these three components seem to play a role in adjective processing.

### 2.2.3 ERPs to adjectives.

ERP studies involving adjectives generally take advantage of the fact that in many languages, adjectives show gender, number, and/or case agreement with the nouns they
modify. This research involves a violation paradigm: a direct comparison of the grammatically agreeing form with a form having a number, gender, and/or case violation, as shown for gender in example (3) in chapter 1, repeated here as (50). Example (50a) shows the grammatically agreeing adjective *simpático ‘nice’, whereas example (50b) shows a gender agreement violation (in bold) on the same adjective.

(50) a. chico simpático
    boy_{masc.sg} nice_{masc.sg}
    ‘nice boy’

b. *chico simpática
    boy_{masc.sg} nice_{fem.sg}

Comparisons of adjective agreement are also often made to determiner agreement, which functions much in the same way, as indicated for gender in Spanish in (51). Compare the determiner *el ‘the_{masc}’ in (51a) to the determiner *la ‘the_{fem}’ in (51b). The determiner *la is used with singular feminine Spanish nouns, but *chico ‘boy’ is masculine and requires *el, so a gender agreement violation occurs in (51b).

(51) a. el chico
    the_{masc.sg} boy_{masc.sg}
    ‘the boy’

b. *la chico
    the_{fem.sg} boy_{masc.sg}

This particular paradigm was used by Barber and Carreiras (2005), who built off of Barber and Carreiras’ (2003) investigation into noun-adjective agreement violations on word pairs in Spanish. In their 2005 two-part experiment, they tested both determiner-noun and
noun-adjective agreement violations in Spanish. In the first experiment, participants were shown word pairs (determiner-noun or noun-adjective) that either completely agreed (52a), had a violation in number agreement (52b), or had a violation in gender agreement (52c).

(52) a. el piano/ faro alto
    the\textsubscript{masc.sg} piano\textsubscript{masc.sg}/ lighthouse\textsubscript{masc.sg} high\textsubscript{masc.sg}
b. *los piano/ *faro altos
    the\textsubscript{masc.pl} piano\textsubscript{masc.sg}/lighthouse\textsubscript{masc.pl} high\textsubscript{masc.sg}
c. *la piano/ *faro alta
    the\textsubscript{fem.sg} piano\textsubscript{masc.sg}/lighthouse\textsubscript{masc.sg} high\textsubscript{fem.sg}

(Barber & Carreiras, 2005, p. 140)

They found a LAN as well as a posterior N400 for both violation conditions for determiner-noun agreement but only a posterior N400 for noun-adjective agreement.

In their second experiment, they used the same word pairs and violations but embedded them in the context of a sentence. Additionally, the adjectives were placed in predicative (post-copular) position, as in (53). As with the word pairs experiment, violations were made on both determiners and adjectives. Gender and number violations are shown on determiners in (53b) and (53c), respectively, and are shown on adjectives in (53e), and (53f), respectively.

(53) a. El piano estaba viejo y desafinado.
    The\textsubscript{masc.sg} piano\textsubscript{masc.sg} was old\textsubscript{masc.sg} and off-key\textsubscript{masc.sg}
    ‘The piano was old and off-key.’
b. *La piano estaba viejo y desafinado.
    the\textsubscript{fem.sg} piano\textsubscript{masc.sg} was old\textsubscript{masc.sg} and off-key\textsubscript{masc.sg}
c. *Los piano estaba viejo y desafinado.

\[ \text{the_{masc.pl}} \text{ piano_{masc.sg}} \text{ was old_{masc.sg} and off-key_{masc.sg}} \]

d. El faro es alto y luminoso.

\[ \text{the_{masc.sg}} \text{ lighthouse_{masc.sg} is high_{masc.sg} and bright_{masc.sg}} \]

e. *El faro es alta y luminoso.

\[ \text{the_{masc.sg}} \text{ lighthouse_{masc.sg} is high_{fem.sg} and bright_{masc.sg}} \]


\[ \text{the_{masc.sg}} \text{ lighthouse_{masc.sg} is high_{masc.pl} and bright_{masc.sg}} \]

(Barber & Carreiras, 2005, p. 151)

Here, LAN/P600s were found for both violation types (determiners and adjectives) and for both types of agreement (gender and number), with the P600 to adjectives being larger than the P600 to determiners.

Overall Barber and Carreiras (2005) found a difference between the ERP components to agreement in word pairs and in sentential contexts, with P600s being absent in the word-pair condition. They attribute this difference to the fact that sentential contexts required the use of syntactic structure, whereas the word pair context may have been a simple matching of lexical features, which may also explain the appearance of an N400 in the word-pair context.

Martin-Loeches et. al (2006) also looked at agreement violations on adjectives in Spanish, examining the effects of syntactic, semantic, and combined violations. Focusing on the syntactic-only violations, which are of most relevance to the present study, the authors examined postnominal adjectives (54a) that disagreed in both gender (54b) and number (54c). The two violation conditions were combined in analysis.
As in the Barber and Carreiras (2005) study on adjectives embedded in sentences, the authors found a LAN/P600 for violations of noun-adjective agreement. No particular analysis of the two components is made because of the article’s focus on syntax-semantics interplay. The importance for the present study, though, is the presence of the LAN/P600 to the violation.

In an additional study on Spanish postnominal adjectives, Schacht et al. (2010) examined agreement violations in the context of a larger study integrating external semantic and syntactic information. They presented participants with postnominal adjective-noun pairs presented in sentential contexts, as in (55).

(55) a. La fiesta lujosa empieza.
    the party\textsubscript{fem} luxurious\textsubscript{fem} starts
    ‘The luxurious party starts.’

b. *La fiesta lujoso empieza.
    the party\textsubscript{fem} luxurious\textsubscript{masc} starts

(Schacht et al., 2010, p. 4)
As with the two previously mentioned studies, the authors found a LAN/P600 for violations of noun-adjective agreement, which they take to indicate grammatical processing of the agreement violation (LAN) and reanalysis of the error (P600).

Unlike Barber and Carreiras (2005), Martín-Loeches et al. (2006), and Schacht et al. (2010), who looked at postnominal adjectives, Sabourin and Haverkort (2003) investigated prenominal adjective agreement in Dutch. They recorded ERPs to agreement violations on prenominal adjective-noun pairs embedded in Dutch sentences. Examples of the violations are in (56), where (56a) has the adjective *klein* ‘small’ showing grammatical, neuter agreement with the noun *kind* ‘child,’ whereas (56b) has a gender agreement violation on *kleine*, which, instead of being neuter, displays the morpheme for common gender.

(56) a. een klein kind
   a small-Ø_neut child_neut
   ‘a small child’

b. *een kleine kind
   a small-e_common_gender child_neut

(modified, Sabourin & Haverkort, 2003, p. 180, (4))

In contrast to Barber and Carreiras (2005), Martín-Loeches et. al (2006), and Schacht et al. (2010), the agreement violation was shown to elicit only a P600, but no LAN. It is difficult to determine, though, whether this result is due strictly to positional differences of the adjective (prenominal for Sabourin and Haverkort, postnominal for the others) or to a difference in languages.
Davidson and Indefrey (2009) also investigated prenominal adjective gender agreement violations but used a different Germanic language, specifically, German. They measured the ERP responses to agreement violations in three-word phrases, which were made up of dative-marked prenominal adjective-noun pairs embedded in prepositional phrases, as in (57). In example (57a), the adjective *kleinem ‘little’ matches the neuter gender of the noun it modifies, *Fenster ‘window.’ However, in example (57b), the adjective *kleiner has incorrect feminine agreement.

(57) a. mit kleinem Fenster
    with little_{neut} window_{neut}

b. *mit kleiner Fenster
    with little_{fem} window_{neut}

(Davidson & Indefrey, 2009, p. 437, my glosses)

Like Sabourin and Haverkort (2003), for the violation condition, Davidson and Indefrey found a P600 but no LAN or N400 (as might have been expected from the lack of sentential context). Again, it is hard to determine if the differences found in the studies were due to adjective position or language.

Finally, a single study to date, Foucart (2008), has examined both pre- and postnominal agreement within the same language, specifically French. The study, which was designed to investigate second language learners’ processing of the two adjective positions, compared correct and violation agreement on prenominal (58) and postnominal (59) adjectives embedded in sentences.

28 They also examined declension class violations.
29 They also had four-word phrases, but the violations on these structures are not relevant here.
The native speaker control group in their study showed a P600 to the agreement violations for both adjective positions. The prenominal stimuli in the Foucart study, then, display a P600 to agreement violations, just as seen with the Dutch and German studies. The postnominal stimuli, contrary to the results found for Spanish, show only a P600, lacking a LAN. However, a frontocentral-to-central negativity does appear for the postnominal violation stimuli, although it did not reach significance in the omnibus ANOVA (see p. 87, Figure 5, in Foucart, 2008, especially electrodes FC5, C3, and CP5). No such negativity is apparent for prenominal violation stimuli. Because the study was designed to investigate second language acquisition, the omnibus ANOVA included factors not typical in first language studies. A different grouping of factors may have shown significant LAN-type effects for the postnominal agreement violations.

In summary, although overall there is some disagreement as to the ERP components elicited by agreement violations on adjectives, there is generally a (LAN)/P600 pattern that
occurs to adjective agreement violations. However, this P600 may be absent if there is not sufficient syntactic structure to require reanalysis, as happens with word pairs (Barber & Carreiras, 2005) but not three-word phrases (Davidson & Indefrey, 2009).

Couching these results in terms of syntactic structure, a pre- and postnominal difference arises. In sentential contexts, prenominal adjective agreement violations elicit a P600 (Davidson & Indefrey, 2009; Foucart, 2008; Sabourin & Haverkort, 2003), whereas agreement violations on postnominal adjectives generally elicit a LAN/P600 (Barber & Carreiras, 2005; Martin-Loeches et al., 2006; Schacht et al., 2010). Although the difference could be language-related, there is at least the possibility that pre- and postnominal adjective agreement violations elicit different ERP components and are, therefore, processed distinctly. However, this is a simple two-way split and does not reflect all of the hierarchical differences present in the syntactic structure I test, presented throughout the chapter and repeated here as (60).
The syntactic structure shows up to four distinct positions for adjectives, yet ERP studies on adjectives only show evidence for a pre-/postnominal division. Perhaps there are other processing differences that occur within the prenominal adjective types that could help us distinguish the three potential adjective positions that occur there. The next section will deal with these more refined levels of syntactic hierarchy.

2.2.4 ERPs and syntactic complexity.

As can be seen in the structure in (60), there are potentially three prenominal adjective positions in Spanish. Whereas the two options for the positions of PREonly and PREchange adjectives are within the same phrase (the upper FP, which would be an AP if they were heads), PREnochange adjectives are predicted either to raise from a lower base-generated position to the specifier of FocP or to base generate with PREonly and PREchange in the specifier of FP. If the PREnochange adjectives move to FocP, this movement would create an additional syntactic complexity not present for the other two prenominal adjective groups. Two types of studies could potentially be relevant to the question of complexity. The first set, which I cover in section 2.2.4.1, claim to address hierarchical considerations involving adjectives, and the second set, in section 2.2.4.2, deal with moved structures. I start the discussion with a look at studies involving syntactic hierarchy.

2.2.4.1 Adjectives, agreement, and syntactic hierarchy.

In this subsection, I review three studies that investigate some aspect of hierarchical structure relating to adjectives: O’Rourke (2008), Jiang and Zhou (2009), and Alemán Bañón
et al. (2012). From these studies, I summarize potential effects that may be seen in the adjectives from the present study.

\textit{O'Rourke (2008)}

O’Rourke’s (2008) dissertation was designed to investigate a potential distinction in morphosyntactic agreement processing in two conditions: non-hierarchical (determiner-noun agreement) and hierarchical (noun-adjective agreement). Her theory is that determiner-noun agreement does not involve any hierarchical syntactic structure but instead relies on transitional probabilities between the two. Adjective-noun agreement, on the other hand, is postulated to involve syntactic relations. To the extent that her theory is correct, her results that both types of agreement elicit LAN/P600s could be taken to mean that both syntactic and non-syntactic relations are processed in the same way; however, her conclusion is that her theory is not correct and that both types of agreement processing involve syntactic hierarchy. Because of this and several methodological issues,\textsuperscript{30} I will not focus on her study, as it does not appear to truly investigate differences in syntactic hierarchy. Instead, I will view it as additional evidence that postnominal adjective agreement violations evoke a LAN/P600 pattern.

\textit{Alemán Bañón, Fiorentino, & Gabriele (2012)}

Alemán Bañón et al. (2012) investigated potential differences in agreement processing due to structural distance, which they define as the number of intervening syntactic phrases. In order to hold linear distance constant, they compared “within phrase”

\textsuperscript{30} O’Rourke’s participants included six left-handers which likely affected the lateralization of her components and makes them difficult to use for direct comparison to my data. Further, her participants had an average age of exposure to English of 11, which could have affected their processing of Spanish.
postnominal attributive adjective agreement\textsuperscript{31} after the adverb 	extit{muy} ‘very’ (\ref{61a}) to “across phrase”\textsuperscript{32} predicative adjective agreement after the copular 	extit{ser} ‘to be’ (\ref{61b}).

\begin{exe}
\begin{exe}
\item[(\ref{61a})] a. El banco es\textsubscript{DP} [un edificio muy seguro/*a] y el juzgado también.
\par
the bank is a building\textsubscript{masc} very safe\textsubscript{masc/*fem} and the courthouse too
\par
‘The bank is a very safe building, and the courthouse is, too.’
\item b. El cuento\textsubscript{VP} [es anónimo/*a] y el manuscrito también.
\par
the story\textsubscript{masc} is anonymous\textsubscript{masc/*fem} and the manuscript too
\end{exe}
\end{exe}

(\textit{modified, p. 53, Table 1, Alemán Bañón et al., 2012})

For both types of agreement, the authors found a P600 elicited to agreement violations (be they of gender or number). Thus, it does not appear that structural distance, as measured in this study affects agreement processing.\textsuperscript{33} There are several additional factors to consider, however.

First, it is unclear if the across-phrase agreement in a copular construction truly crosses a phrase. For example, González-Vilbazo and Remberger (2005) and Remberger and González-Vilbazo (2007) claim that for the noun and adjective in copular constructions are generated within the same predication phrase (PrP) before the noun moves to SpecTP. If agreement occurs before this movement, it really was not cross phrasal.

\textsuperscript{31} Alemán Bañón et al. (2012) examined both gender and number agreement, but I provide examples of gender agreement only since they are the most relevant to the present study. Notably, they found no gender and number differences in processing.

\textsuperscript{32} Note that the Barber and Carreira’s (2005) study examined agreement at the beginning (determiner-noun) and middle (noun-predicative adjective) of sentences, which could also be seen as within and across phrase agreement, but conclusions would be difficult to draw given that they examined agreement on different syntactic categories.

\textsuperscript{33} The authors note that the waveforms are more positive overall for within phrase agreement, and claim that this may be due to but due to distance effects on the formation agreement dependencies. However, it should be noted that differences in the preceding context for the within and across phrase structures make this finding difficult to interpret.
Second, based on the studies reviewed in section 2.2.3, we would expect a LAN/P600 for the postnominal attributive agreement violation shown in (61a), not just a P600. However, it is possible that the adverb induces some effects in both the correct and violation versions; the authors even note a visual LAN in the attributive agreement waveforms not present in the predicative ones. If postnominal attributive agreement in general elicits a LAN/P600, and predicative agreement a P600 only, then we would see a difference in within- and across-phrase agreement processing measured in the Alemán Bañón et al. (2012) study. This may be difficult to apply to the present dissertation study, though, due lack of clarity surrounding what makes up within-phrase agreement.  

Although the authors state that their within-phrase agreement occurs because both elements are located inside of the DP, it is unclear if all elements in a DP would participate in within-phrase agreement. For example, given the syntactic structure I test in (60), there are several phrase heads within the DP (and several more exist, e.g., Num, etc.); how many of these can be crossed and still be considered “within phrase”? If everything in the DP is within the same phrase for agreement purposes, no potential differences could be found for the adjectives under consideration in my dissertation. In summary, then, this type of processing does not seem to offer us any additional clues into structural hierarchy, much like what was found with the O’Rourke (2008) study.

**Jiang & Zhou (2009)**

In an additional study on syntactic hierarchy, Jiang and Zhou (2009) compared grammatical and ungrammatical occurrences of the Mandarin ba particle, which serves to

---

34 A further complication in the Alemán Bañón et al. (2012) study is that nearly half (11 of 24) of the participants in the study were fully bilingual, and their processing may be distinct from that of monolingual natives, yet this is not addressed by the authors.
initiate specific adjectival and adverbial modification structures involving the structural auxiliaries *de-* (adjectival) and *di-* (adverbial). Example (62) shows the bracketed syntactic structures for both types of *ba* modification structures. The adjectival version (62a) converts lexical elements into adjectives and is considered a “lower-level” structure because the *ba* particle and the nominal modifier are dominated by one and the same phrase, the NP, similar to Alemán Bañón et al.’s (2012) within-phrase condition. The adverbial version (62b), on the other hand, is used to convert lexical elements into adverbs and is dubbed the “higher-level” structure because an NP intervenes between the *ba* and the node dominating the verbal modifier, the VP, which is parallel to Alemán Bañón et al.’s (2012) across-phrase condition.

(62) a. Lower-level (adjective) structure – within phrase

\[[\text{VP} \left[ \text{NP} \text{ *ba* [NP *de-phrase* N]]} \right] \text{ V}]\]

b. Higher-level (adverb) structure – across phrase

\[[\text{VP} \left[ \text{NP} \text{ *ba* [NP N]]} \right] \text{ [VP *di-phrase* V]]}\]

(based on Jiang & Zhou, 2009, p. 1284, Figure 1)

In accordance with the differences in structure, differences in ERP components were found between the two levels. For the grammatical comparison, the lower-level structure elicited an overall more negative wave. The ungrammatical comparison, which switched the adjectival and adverbial morphemes, resulted in a LAN for violations of the lower-level structure and a RAN/N400\(^{35}\) for violations of the higher-level one. Whereas the authors initially believed the violations to involve phrase structure, further analysis led them to conclude that they were dealing with morphosyntactic agreement violations (*de*- versus *di-*)

\(^{35}\) The authors note that the N400 was due to semantic constraints on the structures presented (Jiang & Zhou, 2009).
on the modifier). Thus, they found that agreement violations on structures involving different levels of syntactic hierarchy elicit distinct ERP components.

Just as with the previously mentioned study, these results are difficult to apply to my Spanish adjectives. Although there is potentially more structural complexity for the moved PREnochange adjectives than the other two prenominal types, they all occur within a DP (NP for the Mandarin structure), unlike the Mandarin construction, where one involves agreement within the NP and one involves agreement across a VP. Further, contextual confounds in the grammatical comparison draw that portion of the results into question. However, I take the finding that structures involving different amount of syntactic complexity elicit distinct ERP components to indicate that some type of processing difference could appear for other hierarchically based distinctions, perhaps even those within a DP. I now turn to a different set of studies related to syntactic complexity, specifically, to those related to the concept of syntactic movement.

### 2.2.4.2 The processing of syntactic movement.

Syntactic movement, such as that proposed to occur for PREnochange adjectives, has received a great deal of attention in contemporary linguistic theoretical work (e.g., Bobaljik, 2002; Chomsky, 1977; Kayne, 1994; Lasnik and Sato, 1991; Merchant, 2001; Ross, 1967). More recently, there has been a surge in ERP work investigating moved linguistic elements. These ERP studies generally report on the filler (moved element) and gap (trace/base-generated position), as exemplified in (63).
The studies have looked at several different types of movement constructions, including the subject and object relative clauses seen in (63a) and (63b), respectively; wh-movement, such as embedded clause wh indirect object raising, shown in (64); direct object scrambling, shown in (65); and direct object topicalization, presented in (66). Note that for all examples, the base generated position for the moved element is indicated by an indexed trace $\tau$ and the moved element in contained in indexed brackets.

(64)  a. The patient met the doctor while the nurse with the white dress showed the chart during the meeting.

b. The patient met the doctor [to whom] the nurse with the white dress showed the chart $t_i$ during the meeting.

(modified, p. 157, Table 1, Gouveia et al., 2010)

(65)  a. Kaiken-de shacho-wa hisho-ga bengoshi-o sagasieiru to itta.

at- meeting presidentTOP secretaryNOM lawyerACC was-looking forCOMP said

---

36 The exact stimuli tested for each topic vary by study. For example, some wh movement studies have looked at short and long-distance embedded wh object movement (e.g., Phillips, Kazanina, & Abada, 2005), others have examined embedded subject and object wh movement (e.g., Fiebach, Schlesewsky, & Friederici, 2002) and still others have examined additional wh expressions. The examples given are merely for general descriptive purposes.

37 The marker $\tau$ is used mark the base generated position but should not be taken as preference for a particular theoretical position on movement. Copy theories, trace theories, etc., are compatible with the concepts tested in these studies.

at-meeting lawyer_{ACC} president_{TOP} secretary_{NOM} was-looking for_{COMP} said

‘At the meeting, the president said that the secretary was looking for the lawyer.’

(Japanese; modified p. 177, Table 1, Hagiwara, Soshi, Ishihara, & Imanaka, 2007)

(66) a. *Short-object topicalization (control)*

[Den Abschied], bedauert die Anstaltsleiterin ti da Hans charmant ist

the saying-goodbye regrets the superintendent as Hans charming is

und die Krankenschwester einem befreundeten Jungarzt nachweint.

and the nurse a friend junior.doctor after.cries

‘The saying-goodbye, the superintendent regrets, because Hans is charming and

the nurse is bemoaning the loss of a junior doctor friend of hers.

b. *Long-object topicalization*

[Den Abschied]i wird, da die anderen Kollegen schon wieder tuscheln,

the saying-goodbye will as the other colleagues already again whisper

die Krankenschwester einem befreundeten Jungarzt ti erleichtern wollen.

the nurse a friend junior.doctor make.easy want

‘The saying good-by, the nurse is going to want to make easier for a junior

doctor friend of hers, as the other colleagues are already whispering again.’

(German; p. 349, (7)-(8), Felser, Clahsen, & Münte, 2003)

Research on movement generally finds a sustained (L)AN for the moved element

itself (the filler position) that continues until some point when the moved element can be

integrated into the syntactic structure (Felser et al., 2003; Fiebach, Schlesewksy, &
Friederici, 2002; Hagiwara et al., 2007; King & Kutas, 1995;\textsuperscript{38} Kwon, 2008; Matzke, Mai, Nager, Rüsseler, & Münte, 2002; Müller et al., 1997; Phillips, Kazanina, & Abada, 2005; Ueno & Kluender, 2003, 2009).\textsuperscript{39} This (L)AN is interpreted across studies as indexing the recruitment of, and maintaining the moved element in, working memory (Felser et al., 2003; Fiebach et al., 2002; Hagiwara et al., 2007; Matzke et al., 2002; Phillips et al., 2005; Ueno & Kluender, 2003, 2009).

In addition to the (L)AN elicited to the filler, a P600 (Felser et al., 2003; Fiebach et al., 2002; Gouvea et al., 2010; Hagiwara et al., 2007; Kaan et al., 2000; King & Kutas, 1995; Kwon, 2008; Müller et al., 1997; Packard, Ye, & Zhou, 2011; Phillips et al., 2005; Ueno & Kluender, 2003) and/or transient AN (Hagiwara et al., 2007; Kluender & Kutas, 1993; Matzke et al., 2002; Ueno & Kluender, 2003) is generally elicited at the point of integration, which can be at the gap itself (e.g., Gouvea et al., 2010; Phillips et al., 2005) or earlier (when thematic relations are established between DPs; e.g., Fiebach et al., 2002; Hagiwara et al., 2007). The P600 is thought to index the integration of the moved element, possibly involving thematic integration (e.g., Hagiwara et al., 2007; Phillips et al., 2005), whereas the localized AN is thought to involve the retrieval of the filler from working memory (e.g., Kluender & Kutas, 1993; Ueno & Kluender, 2003). Table 3 presents a summary of these ERP movement study findings.

As seen in Table 3, studies investigating moved syntactic elements identify at least a (L)AN or a P600 to moved structures, and many find both. The interpretation of the AN-type components is always related to working memory, and the interpretation of the P600

\textsuperscript{38} As will be noted in Table 3, I interpret King & Kutas’ (1995) finding of a sustained anterior positivity for subject relatives to be a sustained anterior negativity for object relatives, in line with other relative clause research (e.g., Kwon, 2008; Müller et al., 1997)

\textsuperscript{39} Kluender & Kutas (1993) find a LAN as well, but they only analyze a 300-500 ms time window, thus the claim cannot be made that the component was sustained.
<table>
<thead>
<tr>
<th>Study</th>
<th>Language</th>
<th>Structure</th>
<th>Relevant Results</th>
<th>Interpretation</th>
</tr>
</thead>
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<td>Scrambling (obj)</td>
<td>Sustained LAN from filler to end of sentence, LAN at 2\textsuperscript{nd} NP</td>
<td>Maintenance of filler in WM; Retrieval of filler from WM</td>
</tr>
<tr>
<td>Hagiwara et al. (2007)</td>
<td>Japanese</td>
<td>Scrambling (obj)</td>
<td>Sustained AN from filler to pregap (3\textsuperscript{rd} NP)</td>
<td>Maintenance of filler in WM</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Early, broad P600 at pregap for long scramble, RAN for short scramble</td>
<td>Syntactic integration</td>
</tr>
<tr>
<td>Ueno &amp; Kluender (2003)</td>
<td>Japanese</td>
<td>Scrambling &amp; Wh (matrix: wh obj\textsubscript{in situ/scrambled}; dem obj\textsubscript{in situ/scrambled})</td>
<td>Dem &amp; wh – sustained AN between filler &amp; gap, Dem – P600 after filler &amp; before gap, Dem &amp; wh – LAN at gap, Dem – additional P600 at gap</td>
<td>Maintenance of filler in WM; Syntactic integration; Retrieval of filler from WM</td>
</tr>
<tr>
<td>King &amp; Kutas (1995)</td>
<td>English</td>
<td>Relative Clause\textsuperscript{a}</td>
<td>Single word analysis – LAN for object-relative, Multiword analysis – slow, frontal positivity for subject-relative\textsuperscript{b}</td>
<td>WM load; Ease of processing/integration for subject-relatives</td>
</tr>
<tr>
<td>Müller et al. (1997)</td>
<td>English</td>
<td>Relative Clause</td>
<td>Sustained AN, becoming broader, from relative clause to end of sentence for object-relatives</td>
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<td></td>
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<td>Kwon (2008)</td>
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<td>Relative Clause</td>
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<td>Packard et al. (2011)</td>
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<td>Relative Clause</td>
<td>P600 for subject-gap</td>
<td>Syntactic integration (subject gaps harder to process in Mandarin)</td>
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<tr>
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<td></td>
<td>Matrix questions (object movement) – LAN after filler (analyzed for 300-500 ms only)</td>
<td>Maintenance of filler in WM</td>
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<tr>
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<td></td>
<td></td>
<td>Embedded questions – LAN after embedded object (not subject) filler (analyzed for 300-500 ms only)</td>
<td>Maintenance of filler in WM; wh subjects either don’t move or don’t require WM storage because of immediate integration</td>
</tr>
<tr>
<td>Kluender &amp; Kutas (1993)</td>
<td>English</td>
<td>Wh ((un)grammatical, embedded yes/no, wh, if, that)</td>
<td>Embedded questions – LAN at object gap position (analyzed for 300-500 ms only)</td>
<td>Retrieval of filler from WM</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Embedding; \textsuperscript{b} Wh subjects
Table 3 (continued)

*Summary of ERP Literature on Syntactic Movement*

<table>
<thead>
<tr>
<th>Study</th>
<th>Language</th>
<th>Structure</th>
<th>Relevant Results</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaan et al. (2000)</td>
<td>English</td>
<td>Wh (embedded wh object, <em>whether</em>)</td>
<td>Small N400 at wh-word</td>
<td>Not interpreted</td>
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<td>Expt. 1</td>
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<td>P600 at embedded verb</td>
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<tr>
<td>Fiebach et al. (2002)</td>
<td>German</td>
<td>Wh (embedded subject/object wh, <em>whether</em>)</td>
<td>Sustained LAN for object (not subject) fillers; higher amplitude &amp; broader distribution for low WM individuals</td>
<td>Maintenance of filler in WM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P600 for long &amp; short-distance object (not subject) fillers at second NP</td>
<td>Syntactic integration</td>
</tr>
<tr>
<td>Phillips et al. (2005)</td>
<td>English</td>
<td>Wh (short/long-distance embedded wh, <em>that</em>)</td>
<td>Sustained AN from filler to gap for short, long</td>
<td>Maintenance of filler in WM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P600 at gap</td>
<td>Syntactic integration; P600 later for longer dependencies</td>
</tr>
<tr>
<td>Ueno &amp; Kluender (2009)</td>
<td>Japanese</td>
<td>Wh &amp; Scrambling (see Ueno &amp; Kluender, 2003)</td>
<td>Sustained RAN between wh (moved or <em>in situ</em>) and Q particle</td>
<td>Maintenance of filler in WM</td>
</tr>
<tr>
<td>Gouvea et al. (2010)c</td>
<td>English</td>
<td>Wh &amp; Agreement ((un)grammatical wh obj<em>indirect</em>, <em>while</em>, garden path)</td>
<td>Early anterior “P600” + typical P600 for wh movement at gap</td>
<td>In both cases P600 latency reflects retrieval time, duration &amp; amplitude reflect structure-building processes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LAN/P600 for wh movement + agreement violation at gap</td>
<td></td>
</tr>
<tr>
<td>Felser et al. (2003)</td>
<td>German</td>
<td>Wh &amp; Top (raising &amp; obj top, non-finite wh object &amp; long/short obj top)</td>
<td>Sustained LAN for wh, long-object topicalization, &amp; raising from subject NP following adjunct clause until dative NP</td>
<td>Maintenance and retrieval of filler from WM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P600 at subcategorizing verb for wh only</td>
<td>Syntactic integration</td>
</tr>
</tbody>
</table>

*Note. WM = working memory; obj = object; dem = demonstrative; Top = topicalization. All objects are direct objects unless otherwise indicated.*

*a Relative clause studies generally do not investigate the gap position because it is contextually different across subject and object relative clauses (Packard et al., 2011). All relative clause studies reported compare subject relatives to object relatives.*

*b This effect could also read as a sustained AN for object-relatives, in line with other studies.*

*c Gouvea et al. (2010) only examined the gap (verb) position.*
component is related to integration. However, it is also notable that distance, either linear or hierarchical, seems to influence the processing of these structures. Studies investigating short distance movement (e.g., subject wh raising) have found a lack of ERP effects (Fiebach et al., 2002; Kluender & Kutas, 1993).

The idea of thematic integration is also important within the ERP movement literature. All of the work in Table 3 reports on some type of moved DP that receives a thematic role from an element in the sentence. It is not known if movement in general, that is, movement of elements not involving theta roles, will elicit any movement-related processing. Thus, the relationship of this literature to the moved adjective position in the present study is indirect at best. However, if all movement, not just thematically related movement, recruits working memory, we might expect that the PREnochange adjectives, which are moved, display different processing components than the non-moved PREonly and PREchange adjectives. Further, if syntactic integration occurs regardless of the presence of theta marking, we might expect a P600 and/or localized AN to be elicited when the PREnochange adjective is integrated into the structure. Identifying this type of processing in relation to PREnochange adjectives would provide support for Demonte’s (2005) and Taboada’s (2010) analysis that they are, in fact, moved structures.

Now that I have reviewed ERP studies related to adjective syntax, I close this section with a discussion of an additional possible source of variation of prenominal adjectives – word class. I review ERP studies on lexical and functional words and relate them to my proposed adjective structure.
2.2.5 ERPs and word class.

In addition to the ERP components evoked by semantic, syntactic, and morphosyntactic violations detailed in section 2.2.2, ERP research in general has noted a difference in the components elicited by open-class (lexical) and closed-class (functional) words. As described in section 2.1.2.2, closed-class words are those that serve some kind of grammatical role in a sentence, such as determiners, and they lack descriptive content. Open-class words, on the other hand, are heavy with lexical meaning and have an association with something in the real world. They include nouns, verbs, and at least some types of adjectives and adverbs (Abney, 1987). This is potentially informative to the syntactic structure in (60) because it may serve to help locate the prenominal adjectives on the tree; specifically, PREonly and PREchange adjectives are predicted to be either functional syntactic heads or lexical specifiers, or they are predicted to be functional specifiers along with PREnochange adjectives.

Research on potential ERP differences to lexical and functional words has been mixed. Some authors claim that the two evoke distinct ERP components, reflecting different neural generators for the word classes (Brown et al., 1999; Guo et al., 2008; Hinojosa, Martín-Loeches, Casado, et al., 2001; Neville et al., 1992; Nobre & McCarthy, 1994; Pulvermüller, Lutzenberger, & Birbaumer, 1995). Others, however, have concluded that the differences found are quantitative, meaning that the components differ only in terms of amplitude and/or latency, and that they do not represent distinct neural production (Brunelliere, Hoen, & Dominey, 2005; King & Kutas, 1998; Münte et al., 2001; Osterhout, Allen, & McLaughlin, 2002; Osterhout et al., 1997; Van Petten & Kutas, 1991). This second group of authors generally claims that the quantitative differences are due to differences in
frequency and/or word length, which are inherent in the two word types\textsuperscript{40} and that there are no underlying processing differences between lexical and functional words.

Although the two camps of research have different conclusions as to the qualitative and quantitative ERP differences for the two word classes, both have found at least some differences in the ERP components generated by each class. I review a sample of literature supporting processing distinctions for the two word classes in Table 4. This is followed by Table 5, which reviews literature claiming that no underlying processing differences exist between the two classes. In both tables, the final column lists potentially confounding variables that I have identified, not to point out errors in the studies, as many are inherent in the designs, but instead to point out potential reasons for the various conclusions the authors have reached.

As can be seen in the tables, the results for open and closed-class words seem contradictory. Both qualitative and quantitative differences are generally found between the two classes; however some authors conclude that these are an epiphenomenon of word frequency and/or length. Something else obvious from the tables is that the ERP literature on word class differences is littered with confounds, some of them unavoidable given the chosen paradigms. Let us look at two of the most common confounding variables – length/frequency and preceding context – in more detail.

The first factor to consider is the effects that length and frequency differences typically have on ERP components. Hauk and Pulvermüller (2004) studied the effects of word length and frequency on ERPs. They found that word length most affected the latency of the ERP response, with longer words showing higher amplitudes early on, from 100-150 ms (and, thus, having earlier latencies), and shorter words having higher amplitudes from

\textsuperscript{40} Function words, in general, tend to be shorter and more frequent (King & Kutas, 1998).
<table>
<thead>
<tr>
<th>Study, language</th>
<th>Stimuli</th>
<th>Syntactic categories</th>
<th>Frequency, length</th>
<th>Lexical results</th>
<th>Functional results</th>
<th>Interpretation</th>
<th>Confounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neville et al. (1992)</td>
<td>English Sentences</td>
<td>N, V, Adj</td>
<td>Art, D, P, Conj</td>
<td>Considered(^a) (lexical only)</td>
<td>N400</td>
<td>N280 + N400-700</td>
<td>N280 marks functional processing</td>
</tr>
<tr>
<td>Nobre &amp; McCarthy (1994)</td>
<td>English Words/nonsense</td>
<td>N, P, Conj, Art</td>
<td>Functional more frequent, length balanced</td>
<td>N400</td>
<td>N280 + small N400</td>
<td>N280 marks functional processing</td>
<td>Frequency not balanced, no stats for N280, also appeared for pseudowords</td>
</tr>
<tr>
<td>Brown et al. (1999)</td>
<td>Dutch Prose</td>
<td>N, V, Adj</td>
<td>Art, P, Conj</td>
<td>Balanced(^b)</td>
<td>Anterior</td>
<td>Anterior</td>
<td>N400-700 distinguishes word classes</td>
</tr>
<tr>
<td>Guo et al. (2008)</td>
<td>Mandarin Sentences</td>
<td>N, V, Adj</td>
<td>P, Aux, V</td>
<td>Balanced</td>
<td>N400</td>
<td>N280 + anterior</td>
<td>All components distinct, mark word classes</td>
</tr>
<tr>
<td>Pulvermüller et al. (1995)</td>
<td>German Words</td>
<td>N, V, Pn, Aux V</td>
<td>Balanced</td>
<td>Bilateral</td>
<td>N160 + left-lateral</td>
<td>Left-hemisphere advantage for functional processing</td>
<td>None apparent</td>
</tr>
<tr>
<td>Hinojosa, et al. (2001)(^c)</td>
<td>Spanish Words</td>
<td>N, V, Conj</td>
<td>Balanced/considered (functional only)</td>
<td>Bilateral</td>
<td>N260</td>
<td>Recognition potential, an early indicator of semantic processing</td>
<td>Lateralization of RP distinguishes word classes; functional processing only</td>
</tr>
</tbody>
</table>

\(^a\) Considered means that, although frequency and/or length were not balanced, they were factored into the analysis.

\(^b\) Balanced, without any additional notes, indicated that both frequency and length were balanced across lexical and functional categories.

\(^c\) This refers to the Hinojosa, Martin-Loeches, Casado, et al. (2001) article.

\(^d\) Recognition potential, an early indicator of semantic processing.
Table 5

Summary of ERP Word Class Studies Refuting a Word Class Processing Distinction

<table>
<thead>
<tr>
<th>Study, language, Stimuli</th>
<th>Syntactic categories</th>
<th>Frequency, length</th>
<th>Lexical results</th>
<th>Functional results</th>
<th>Interpretation</th>
<th>Confounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>VanPetten &amp; Kutas (1991)</td>
<td>English Sentences</td>
<td>Frequency considered; length not balanced, not indicated if considered</td>
<td>Right-lat. N400; length affected by only semantic context</td>
<td>Left-lat. N400; N400; CNV; interpretation</td>
<td>Only word class difference is laterality difference in N400; authors don’t consider this sufficient to distinguish class processing</td>
<td>Three left-handed participants; ambiguous words deemed closed class</td>
</tr>
<tr>
<td>Osterhout et al. (1997)</td>
<td>Prose, scrambled prose</td>
<td>N, V</td>
<td>N350 + N450 + N400-700 (normal prose only)</td>
<td>Frequency, length, word category affect latency; word category affects distribution</td>
<td>Word class x hemisphere interaction in N280 window attributed to component overlap; distributional difference in mixed-prose condition not examined</td>
<td></td>
</tr>
<tr>
<td>King &amp; Kutas (1998)</td>
<td>English Sentences</td>
<td>Not reported</td>
<td>Considered</td>
<td>N330</td>
<td>Frequency affects latency</td>
<td>All high frequency words functional &amp; all low frequency lexical (they state this isn't a confound)</td>
</tr>
<tr>
<td>Münte et al. (2001)</td>
<td>Words (Expt 1), Sentences (Expt 2)</td>
<td>Frequency considered; no length balancing</td>
<td>N280 + N400 + N400-700 (very high frequency only)</td>
<td>Frequency, length cause all differences; N400-700 may reflect grammatical processing of articles</td>
<td>Frequency, length, &amp; number of words different between same-named groups; length not balanced across frequency groups in isolated word study</td>
<td></td>
</tr>
</tbody>
</table>
Table 5 (continued)

**Summary of ERP Word Class Studies Refuting a Word Class Processing Distinction**

<table>
<thead>
<tr>
<th>Study, language</th>
<th>Stimuli</th>
<th>Syntactic(^a) categories</th>
<th>Frequency, length</th>
<th>Lexical results</th>
<th>Functional results</th>
<th>Interpretation</th>
<th>Confounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osterhout et al. (2002)</td>
<td>N, V</td>
<td>Prose</td>
<td>Art, P, Pn, Aux V</td>
<td>N300 + N400 +</td>
<td>N300 + N450 +</td>
<td>Left anterior N300 + for N300, correlated to length &amp; frequency N400-700</td>
<td>Length affects latency, amplitude; syntactic category affects latency for N300, correlated to length &amp; frequency</td>
</tr>
<tr>
<td>Brunelleiere et al. (2005)</td>
<td>N, V Sentences</td>
<td>French</td>
<td>Frequency &amp; length balanced</td>
<td>Bilateral</td>
<td>Distribution of N280 related to structural complexity</td>
<td>Post-stimulus baseline; no way to check complexity</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>Prose</td>
<td>Considered</td>
<td>N450</td>
<td>N280</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. N = noun; V = verb; Adj = adjective; Art = article; D = determiner; P = preposition; Conj = conjunction; Aux = auxiliary; Pn = pronoun.

\(^a\) The lexical categories included in each study are listed above the line; the functional categories are listed below it.

\(^b\) Considered means that, although frequency and/or length were not balanced, they were factored into the analysis.

\(^c\) Contingent negative variation.

\(^d\) Osterhout et al. (1997) also examined adjectives as part of the lexical class, but they were removed from analysis due to variability in the results.

\(^e\) See Münte et al. (2001), Table 1, p. 93.
150-400ms (later latencies). Word frequency affected the amplitude of the waves, with less frequent words showing higher peak amplitudes than more common words from 150-190 ms and from 320-360 ms. Unlike studies such as King and Kutas (1998) and Osterhout et al. (1997), Hauk and Pulvermüller’s study showed no latency effects for word frequency. They speculate that the difference may be in the divisions of word frequency used: For example, the very rare words used by King and Kutas (1998) and Osterhout et al. (1997) may not have been known to participants and could have been processed as pseudowords.

It seems, then, that length affects latency, and frequency affects amplitude but not latency. Reviewing the studies from Tables 4-5, ERP differences for the two word classes were related to latency (King & Kutas, 1998; Münte et al., 2001; Osterhout et al., 1997; Osterhout et al., 2002), distribution (Brown et al., 1999; Brunelierre et al., 2005; Hinojosa, Martín-Loeches, Casado, et al., 2001; Pulvermüller et al., 1995; VanPetten & Kutas, 1991), and/or the appearance of additional components, generally for functional items (Guo et al., 2008; Neville et al., 1992; Nobre & McCarthy, 1994; Münte et al., 2001; Osterhout et al., 1997; Osterhout et al., 2002). If we follow Hauk and Pulvermüller’s finding that length and frequency affect latency and amplitude, respectively, we still cannot account for the various differences seen in distribution and number of components. Even if we consider different components to be related to latency (for example, two components could run together and appear as one due to latency changes), we have several observations of distributional differences that remain. Thus, it does not seem likely that all of the processing differences found were due to length and/or frequency confounds, which supports the idea that the word classes may, in fact, be processed in a distinct manner.

Interestingly, the authors lean more toward frequency factors to explain their results, which actually should have been more likely to affect amplitude, as opposed to length, which may have been more likely to affect latency.
Additionally, it should be noted that the studies that conclude that word classes do not have distinct neural generators typically rely on correlations – if a particular component is correlated to length and/or frequency, it is assumed that these are the contributing factors, not word class. However, correlation should not be taken as causation, and this cannot be taken as a definitive finding against differences in word class. Further, several studies (Brown et al., 1999; Guo et al., 2008; Hinojosa, Martín-Loeches, Casado, et al., 2001; Pulvermüller et al., 1995) have shown processing differences even when length and frequency were balanced, so, as concluded above, taking word classes to have distinct neural generators seems like a reasonable possibility.

The second confounding factor to consider in these studies is the context of the presentations. Most studies (8 out of 12 in Tables 4-5) examine the ERP components only to words embedded in sentences; only a single study that refutes processing differences investigates isolated words at all (Münte et al., 2001). This means that the preceding context might not have been the same for both word classes. As mentioned in the theoretical discussion on lexical and functional items (section 2.1.2.2), functional elements generally take IP, VP, and NP complements. Two-thirds of this list (VP and NP) are generally lexical elements, meaning that many of the lexical-class words in the ERP studies were likely preceded by functional elements (for example, in *the dog*, the open-class ‘dog’ is preceded by the closed-class ‘the’), although some would still be preceded by other lexical-class items (for example in *I bought groceries*, ‘groceries’ is both lexical and preceded by the lexical element ‘bought’). Guo et al. (2008) even go as far as to say functional words are never
followed by other functional words. Although this cannot be true (think of a prepositional phrase, for example *on the table*, which has the functional *the* preceded by the functional *on*), it does point out that lexical-class words potentially occur in functional contexts more than functional-class words themselves do. Truly valid ERP comparisons should be done using stimuli presented under the same contextual conditions (Stephen J. Luck, p.c.), and since the studies reviewed above don’t mention this factor, the authors may not have completely considered its potential effects on their results.

Perhaps the most valid word class research, then, is that done on isolated words, due to the lack of contextual confounds. As seen in Tables 4-5, this work generally has noted processing differences between the two words classes. However, the differences they have noted vary, including the N280 in Nobre and McCarthy (1994) and left lateralization of components in Pulvermüller et al. (1995) and Hinojosa, Martín-Loeches, Casado, et al. (2001). Even the isolated word study refuting qualitative processing differences, Münte et al. (2001), found word class differences, including differential effects of frequency on the N400, an N400-700 for very high frequency function words, and a potential late positive component for lexical items in electrodes PO1/2, which was not considered because these electrodes were not included in analysis. Considering the results from these studies, an electrophysiological difference in lexical and functional processing is, at minimum, a possibility; however, to see if such a difference is present in the adjectives under

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42 The authors comment this when discussing late negativities in their data, claiming that they may occur because the listener/reader knows that an open-class word is forthcoming, which is an argument also used in Brown et al. (1999), among other studies.

43 It should be noted, and often is by authors of this type of study, that processing of isolated words may vary from the processing of words in sentential contexts.

44 The authors claim that this component exists only for the very high frequency category, but their ANOVA follow-ups reveal that the high frequency category is not significantly different from the very high frequency category in the 400-700 ms time window.

45 See Münte et al. (2001), p. 94, Figure 1.
investigation in the current study, the processing difference must first be more clearly established.

2.2.6 ERP summary.

In this section, we have seen that information about adjective processing can be taken from three ERP sources: (a) agreement studies, (b) studies on syntactic complexity, and (c) studies on word class. A review of agreement studies revealed that morphosyntactic violations in context produce a LAN/P600 for postnominal adjectives and a P600 for prenominal ones. Whereas some studies on syntactic complexity do not appear to relate directly to the study at hand, movement studies reveal that a moved element is generally associated with a sustained (L)AN at the moved element and a (L)AN and/or P600 at the point of integration, and this could, potentially, be applied to adjective movement. Finally, studies on word class are inconclusive on whether a processing difference exists between the two word classes and, if it does, what this differences actually is. Additional testing is necessary to see if ERP components related to word class can help refine the syntactic structure of adjectives originally proposed in chapter 1 and repeated here again as (67).
2.3 Research Questions and Hypotheses

In order to address the theoretical and experimental issues presented, my dissertation investigates the following broad research question: Do the different types of adjectives in Spanish display differential processing? The question will be answered by the following subquestions:

- **RQ1** (adjective type): Do the six adjective types display differential processing in their correctly agreeing forms in either pre- or postnominal position?

- **RQ2** (word class): If the adjective types differ in processing, is there any evidence that this is related to a lexical/functional distinction among Spanish adjectives?

- **RQ3** (agreement): Can gender agreement give us any additional evidence of processing differences among Spanish adjective types, that is, are gender agreement
violations on the various types of pre- and postnominal adjectives in Spanish processed in the same way?

As evidenced in the syntactic structure in (67), there is a lack of consensus as to the syntactic analysis of adjectives. I base my hypotheses on the elements of the structure that have at least two authors supporting the analysis, and I address the competing analyses in the general discussion and conclusions section in chapter 7. Based on the syntactic structure in (67), then, and the ERP evidence reviewed, the following is hypothesized:

*Hypothesis for RQ1.* Grammatically ordered and agreeing prenominal adjectives will display processing differences as evidenced in the ERP waveforms. Specifically, PREonly and PREchange adjectives, which base generate in a prenominal position and may be functional elements (Bartlett & González-Vilbazo, 2013; Bernstein, 1993), will be distinct from PREnochange adjectives, which are moved from a postnominal position (Demonte, 2005; Taboada, 2010) and are lexical items (Bernstein, 1993; Demonte, 2005; Taboada, 2010). I predict that the differences seen in processing will be related to word class, addressed in RQ2.

No differences are expected for the postnominal groups because they are all hypothesized to base generate in the same syntactic position and are thought to be lexical elements (Bernstein, 1993; Cinque, 2010; Taboada, 2010).

*Hypothesis for RQ2.* Due to the lack of consensus in the ERP literature on word class, this research question will first involve an additional investigation to determine what (if any) processing components distinguish lexical from functional words. Based on the context-

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46 The reader is reminded that movement is not predicted to elicit any processing differences due to the short linear and hierarchical distance covered (see Fiebach et al.’s (2002) and Kluender & Kutas’ (1993) work on subject versus object wh movement).
balanced studies on isolated words (Hinojosa, Martin-Loeches, Casado, et al., 2001; Nobre & McCarthy, 1994; Pulvermüller et al., 1995), I predict that a processing difference will exist between the two classes. Specifically, lexical items will elicit at least one bilateral negativity in an early (200-500 ms) time window (Hinojosa, Martín-Loeches, Casado, et al., 2001; Nobre & McCarthy, 1994; Pulvermüller et al., 1995), whereas functional items will elicit an early N280-type negativity (Nobre & McCarthy, 1994) and/or a left-lateralization of early (200-500 ms) negativities (Hinojosa, Martin-Loeches, Casado, et al., 2001; Pulvermüller et al., 1995). In relation to the adjective stimuli, I predict that similar functional processing will occur to the grammatically ordered and agreeing PREonly and PREchange adjectives examined in RQ1. All other grammatically ordered and agreeing adjective types, which are claimed to be lexical elements (Bernstein, 1993; Cinque, 2010 for postnominal; Taboada, 2010), will elicit a bilateral negativity between 200 and 500 ms.

Hypothesis for RQ3. The different adjective types will not be processed in the same way but instead will show a division based on adjective location. Pre- and postnominal adjectives are predicted to be distinct, with gender agreement violations on prenominal adjectives displaying P600 (as was seen in Davidson & Indefrey, 2009; Foucart, 2008; and Sabourin & Haverkort, 2003) and gender agreement violations on postnominal adjectives displaying a LAN/P600 (as was seen in Barber and Carreiras, 2005; Martín-Loeches et al., 2006; and Schacht et al., 2010). Although participants will not see violations in sentential contexts, it is predicted that unlike Barber and Carreiras’s (2005) word pairs, the three word chunks will require enough processing for the appearance of a P600 (as seen in Davidson & Indefrey, 2009) because they involve two applications of Merge (in the sense of the

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47 Hinojosa, Martín-Loeches, Casado, et al. (2001) actually examined the recognition potential, a component not under analysis here, although the left lateralization may still apply to other components, as seen in the Pulvermüller et al. (1995) study.
Minimalist Program; Chomsky, 1995 et seq.) and subsequent morphosyntactic agreement operations.
3 METHODOLOGY

This chapter describes the methodology used for my dissertation study. I start with a description of my participants in section 3.1. This is followed with the details of my stimuli in section 3.2, which is subdivided into a section on the critical stimuli (section 3.2.1) and the distractor stimuli (section 3.2.2), along with a brief explanation of the division of the stimuli into blocks (section 3.2.3). I then go through the experimental procedure in section 3.3 and tackle the details of the EEG recording and processing in section 3.4. The chapter closes in section 3.5 with an overview of the statistical tests I used for data analysis.

3.1 Participants

Participants included 40 native Mexican Spanish speakers (17 men) who were in Chicago, IL at the time of testing and were paid for participation. All participants were 21-40 years old ($M = 28.95$, $SD = 5.44$), were right-handed according to a modified version of the Oldfield (1971) inventory, had normal or corrected-to-normal vision, and had no neurological impairments. All participants identified Spanish as their primary language, and they used Spanish at least 50% per day on average based on self-reports. Additional criteria used for participant selection included completing schooling through age 14 in Mexico, having a high school diploma, and having minimal non-Spanish language exposure before age 14.

Upon behavioral analysis of the participants (to be reported in section 4.1), it was discovered that not all participants agreed with the adjective judgments predicted by the descriptive distribution provided in section 2.1.2.1. As such, a behavioral criterion was established to analyze only those participants clearly agreeing with the distribution from the
literature (along the lines recommended by Handy, 2005). This group comprised 22 of the original 40 participants (8 men), all of whom were at least 65% accurate on the grammaticality judgment task (GJT) to be described in section 3.3. This criterion, in addition to all criteria considered for determining participant inclusion, is detailed in Appendix A. One participant (female) was removed from analysis due to excessive EEG artifacts. Thus, the analysis section reports on 21 speakers (8 men). Table 6 summarizes the demographic characteristics of this subset of the participant population.

Table 6

Demographic Characteristics of Included Participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>28.81</td>
<td>4.92</td>
</tr>
<tr>
<td>Years of formal education</td>
<td>14.33</td>
<td>2.10</td>
</tr>
<tr>
<td>Percentage/day of Spanish use</td>
<td>74.76</td>
<td>18.32</td>
</tr>
<tr>
<td>Age of arrival to U.S.</td>
<td>21.76</td>
<td>4.77</td>
</tr>
<tr>
<td>Age of Acquisition of English (significant exposure)</td>
<td>17.00</td>
<td>5.06</td>
</tr>
<tr>
<td>Spanish proficiency</td>
<td>4.69</td>
<td>.56</td>
</tr>
<tr>
<td>English proficiency</td>
<td>3.03</td>
<td>.95</td>
</tr>
</tbody>
</table>

a All participants had minimal exposure to English in their elementary and/or middle school classes, as this is typical in the Mexican educational system. However, classes met no more than three hours/week, and all participants indicated that their learning in these situations was minimal.

b Average of self-indicated reading and writing proficiency (1-5 Likert scale).

c Average of self-indicated reading, writing, speaking, and comprehension proficiency (1-5 Likert scale).

48 An analysis of all participants is presented in Appendix F.
3.2 Stimuli

3.2.1 Critical stimuli.

Stimuli consist of Spanish three-word phrases (word triads) framed around a set of 28 critical adjectives. Word triads were chosen instead of full sentences for several reasons. First, word triads are shorter than full sentences; as a result, participants could see more stimuli in a smaller amount of time, and thus, a complete paradigm of adjective word orders and gender agreement errors could be covered while still allowing for a sufficient number of judgments per triad. Second, word triads involve two applications of Merge and Agree, which Davidson and Indefrey (2009) showed to be sufficient for the elicitation of a P600. Finally, the use of word triads is comparable to previous experimental paradigms, including Barber and Carreira’s (2005) use of word pairs and Davison and Indefrey’s (2009) use of word triads; hence it seems to be experimentally valid.\(^{49}\)

The 28 critical adjectives used in the word triads included four PREonly adjectives, and eight adjectives each in the groups PRE/POSTchange, PRE/POSTnochange, and POSTonly (see Table 7). Ideally all groups would have consisted of eight different adjectives, but only four PREonly adjectives could be identified. All adjectives had distinct male and female agreement forms to allow for clear agreement violations to be created. In addition, the four lists were balanced for syllable length and frequency.\(^{50, 51}\)

\(^{49}\) Although there may be ERP effects on the first and last words simply due to their position in the triad, this should not have affected the overall analysis because these words were either (a) part of a violation paradigm, so any effects for word position were controlled for, as they were matched for violation and control stimuli; or (b) compared to other words in the same position (e.g., comparing all correctly agreeing prenominal adjectives), so the effect should have been the same for all words in that position.

\(^{50}\) Frequencies come from the natural logs of the frequency counts found in the combined corpora of the 1900s from the *Corpus del Español* (Davies, 2002-).

\(^{51}\) The PREonly adjective *mero-mero* ‘best/top’ did not appear in the *Corpus del Español*. However, the native Mexican Spanish speakers who participated in the behavioral pilot unanimously agreed that it is actually more
Table 7

*Critical Adjectives Included by Adjective Type*

<table>
<thead>
<tr>
<th>Adjective type</th>
<th>Adjectives used in critical stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PREONLY</strong></td>
<td>mero</td>
</tr>
<tr>
<td></td>
<td>‘mere’</td>
</tr>
<tr>
<td><strong>PRE/POSTchange</strong></td>
<td>antiguo</td>
</tr>
<tr>
<td></td>
<td>‘antique’</td>
</tr>
<tr>
<td></td>
<td>malo</td>
</tr>
<tr>
<td></td>
<td>‘bad’</td>
</tr>
<tr>
<td><strong>PRE/POSTnochange</strong></td>
<td>bello</td>
</tr>
<tr>
<td></td>
<td>‘beautiful’</td>
</tr>
<tr>
<td></td>
<td>perfecto</td>
</tr>
<tr>
<td></td>
<td>‘perfect’</td>
</tr>
<tr>
<td><strong>POSTonly</strong></td>
<td>abierto</td>
</tr>
<tr>
<td></td>
<td>‘open’</td>
</tr>
<tr>
<td></td>
<td>plano</td>
</tr>
<tr>
<td></td>
<td>‘flat’</td>
</tr>
</tbody>
</table>

common than *mero*. As a result of this insight, I decided to remove *mero-mero* from the frequency analysis and use just the frequency counts for the other three PREonly adjectives.
In addition, a behavioral pilot was run on all adjectives in the list to ensure native speaker agreement on the pre/postnominal positioning of the adjectives. Eight native speakers saw word triads presented one word at a time through EPrime and indicated if the triad was acceptable in Spanish (“Good”) or not (“Bad”). After making all judgments, participants were given lists of the items they had marked as “Bad” and asked to correct them. This was done to confirm that the errors found were, in fact, syntactic in nature. Each participant saw three-fourths of the adjectives, meaning that a total of six judgments were collected per adjective. Adjectives were only considered for the ERP study if at least five of the six judgments on word order corresponded to the groupings in Table 2.

This behavioral testing accounts for most of the adjectives in Table 7. However, my goal was to match all groups for syllable length and frequency so as to avoid their potential effects on the ERP data (recall the discussion in section 2.2.5), and after the original round of behavioral testing, there were not enough agreed-upon adjectives that could be matched for length and frequency in all categories. Because of this, additional small pilots were run to complete the lists. These small pilots consisted of asking native Mexican Spanish speakers for their judgments on the specific items in question. As with the original behavioral pilot, six judgments were collected per item and five out of the six native speakers had to agree on the acceptability of the word order for the adjectives to be considered.\footnote{Note that although care was taken to control for confounding factors, the context in which pre- and postnominal adjectives occur could not be controlled. Prenominal adjectives always occur before nouns and (in the present study) after determiners, and postnominal adjectives always occur after nouns. Because of this, the correct conditions for pre- and postnominal adjectives were not directly compared.}

The word triads consisted of one of two word orderings: determine-adjective-noun (prenominal order) or determiner-noun-adjective (postnominal order), as in examples (1a) and (1b), respectively.
(1)  a. la simpatico vaca
      the\textsubscript{fem} nice\textsubscript{fem} cow\textsubscript{fem}

      ‘the nice cow’

   b. la vaca simpática
      the\textsubscript{fem} cow\textsubscript{fem} nice\textsubscript{fem}

   ‘the nice cow’

For PRE/POSTchange and PRE/POSTnochange adjectives, this ordering resulted in two
different yet grammatical phrases. For PREonly and POSTonly, one of the orderings was
ungrammatical, as indicated in example (2) for the PREonly adjective *mero.*

(2)  a. el mero autor
       the\textsubscript{masc} mere\textsubscript{masc} author\textsubscript{masc}

      ‘the mere center’

   b. *el autor mero
       the\textsubscript{masc} author\textsubscript{masc} mere\textsubscript{masc}

Each adjective group included 32 triads: For PREonly, each adjective was used in 8
examples, whereas for all other groups each adjective was used in 4 examples.\(^{53}\) The
adjectives were paired with 1 of 32 nouns (16 masculine and 16 feminine), none of which
had adjectival uses so as to avoid confounding word categories.\(^{54}\) These 32 nouns were used
in all groups so that length and frequency were automatically balanced, which facilitated
direct comparison of the groups. A summary of the word order stimuli (including examples)
is in Table 8. Note that the target word was always the adjective.

\(^{53}\) This admittedly left the door open for repetition effects, which could affect a potential N400, attenuating it for
the PREonly adjectives because they occurred twice as often as the other types (Bentin & Peled, 1990;
Hinojosa, Martin-Loeches, & Rubia, 2001). However, the other adjectives types were used multiple times as
well. Further, PRE/POSTchange, PRE/POSTnochange, and POSTonly adjectives were also used in the
distractor stimuli, which will be described in section 3.2.2, so the overall number of repetitions among at least
these adjective groups was relatively even.

\(^{54}\) This was verified by looking up the entry for each noun on the Real Academia Española website,
Table 8

*Examples of Word Order Stimuli*

<table>
<thead>
<tr>
<th>Adjective type</th>
<th>Prenominal order</th>
<th>Postnominal order</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREonly</td>
<td>el mero autor</td>
<td>el autor *mero</td>
</tr>
<tr>
<td></td>
<td>‘the mere author’</td>
<td></td>
</tr>
<tr>
<td>PRE/POSTchange</td>
<td>el antiguo centro</td>
<td>el centro antiguo</td>
</tr>
<tr>
<td></td>
<td>‘the old center (of town)’</td>
<td>‘the antique center (of town)’</td>
</tr>
<tr>
<td>PRE/POSTnochange</td>
<td>el bello cuadro</td>
<td>el cuadro bello</td>
</tr>
<tr>
<td></td>
<td>‘the beautiful painting’</td>
<td>‘the beautiful painting’</td>
</tr>
<tr>
<td>POSTonly</td>
<td>el *abierto juego</td>
<td>el juego abierto</td>
</tr>
<tr>
<td></td>
<td>‘the open game’</td>
<td></td>
</tr>
</tbody>
</table>

The pre- and postnominal orderings of the adjective types accounted for 256 stimuli, 192 of which represented correct stimuli and the other 64 of which represented violations of word order. In addition, all of the stimuli were paired with gender agreement violation counterparts, where a gender agreement violation was made on the adjective, either in prenominal (3) or postnominal (4) position (agreement violations in bold).

(3)  a. la simpática vaca
     the\textsubscript{fem} nice\textsubscript{fem} cow\textsubscript{fem}
     ‘the nice cow’

   b. *la simpático vaca
     the\textsubscript{fem} nice\textsubscript{masc} cow\textsubscript{fem}
(4)  a. la vaca simpática
    \( \text{the}_\text{fem} \ cow_\text{fem} \ nic_\text{fem} \)
    ‘the nice cow’

b. *la vaca simpático
    \( \text{the}_\text{fem} \ cow_\text{fem} \ nic_\text{masc} \)

The inclusion of agreement violations brought the total number of stimuli up to 512, of which 192 were correct and 320 were violations. A summary of the critical adjective stimuli is found in Appendix B, Tables B1-B4.

3.2.2 Distractor stimuli.

The critical word order and adjective agreement stimuli were mixed with three types of distractor stimuli: determiner agreement violations, presented in section 3.2.2.1, correctly agreeing lexical and functional stimuli, presented in section 3.2.2.2, and additional distractor stimuli, presented in section 3.2.2.3.

3.2.2.1 Determiner agreement stimuli.

In addition to the adjective agreement violations, gender agreement violations were created on determiners. This was to allow for direct comparison with other studies (e.g., Barber & Carreiras, 2005) and to verify that expected effects were occurring (i.e., the data collection itself was successful, determined via the appearance of expected components in previously tested situations). In most studies of determiner-noun agreement, determiner agreement violations involved a determiner immediately followed by a noun (five out of seven studies reviewed by Molinaro, Barber, & Carreiras, 2011 used this experimental setup,
with the other two coming from the same dataset). For this reason, 32 determiner violations were created for postnominal word triads, as demonstrated in example (5).

(5) a. la vaca simpática
    \[ \text{the}_\text{fem} \text{cow}_\text{fem} \text{nice}_\text{fem} \]
    ‘the nice cow’

b. *el vaca simpática
    \[ \text{the}_\text{masc} \text{cow}_\text{fem} \text{nice}_\text{fem} \]

In these examples, the critical word for identifying the violation was the noun because it is at the point of reading *vaca ‘cow’ in (5b) that the agreement violation on the determiner becomes apparent: It should have been feminine.

In order to balance for the number of pre- and postnominal adjective stimuli in a violation condition, 32 determiner agreement violations were also created for prenominal word triads, as in example (6).

(6) a. el mal niño
    \[ \text{the}_\text{masc} \text{bad}_\text{masc} \text{child}_\text{masc} \]
    ‘the bad child’

b. *la mal niño
    \[ \text{the}_\text{fem} \text{bad}_\text{masc} \text{child}_\text{masc} \]

In this case, the agreement error becomes evident upon presentation of the adjective *mal in (6b), although note that the location of the error (determiner or adjective) is not clear until presentation of the noun.

Because the agreement violations involve the difference between correct and violation conditions, both pre- and postnominal determiner violations should be identical
because any difference of word category (measuring the determiner agreement violation on adjectives in prenominal word triads and on nouns for postnominal ones) should be subtracted out. However, this should be verified before combining the types into one analysis. As mentioned, these stimuli served as a check to show that the experimental setup was working. As such, they do not form part of the stimuli analyzed in chapters 4-6. See Table C1 in Appendix C for a list of all determiner stimuli.

### 3.2.2.2 Lexical and functional stimuli.

The inclusion of the 64 determiner agreement errors brought the stimuli total to 576: 192 correct and 384 violation. In order to balance for the overall number of correct and violation stimuli, additional correct distractor stimuli were added. In this subsection, I describe the lexical/functional distractors, which contributed an additional 144 stimuli.\(^{55}\)

These distractors included four groups of 36 word triads involving lexical items (nouns) and functional items (quantifiers), used to examine a potential lexical-functional difference in Spanish. The nouns and quantifiers were balanced for frequency,\(^ {56}\) letter length, and syllable length. As mentioned in section 2.2.5, a common confound in research on a lexical/functional processing distinction involves the context in which the words occur. In order to control for this, one set of the lexical-functional stimuli (32 triads each) occur in the starting position of the triad, as in example (7a) for lexical/noun stimuli and (7b) for functional/quantifier stimuli.

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\(^{55}\) Participants in the pilot version of the study (\(n = 12\)) saw a different set of lexical and functional stimuli (192 total) that were not balanced for context. Because of this, the pilot stimuli are not analyzed in subsequent sections. These stimuli are available for reference in Appendix D, Tables D1-D6.

\(^{56}\) Again, frequency balancing was based on the log frequency taken from the combined corpora of the 1900s from *Corpus del Español* (Davies, 2002-).
A complication potentially occurs with the nouns, though. Although Spanish does have NPs that are headed by nouns, in practice nouns rarely occur without determiners, so it is possible that processing was affected by the lack of the determiner. However, piloting of the stimuli showed that, at least behaviorally, word triads headed by nouns were considered acceptable by native speakers. Finally, the adjectives used with the functional stimuli presented here did include some examples of the critical adjectives in order to help control repetition effects (see footnote 53). All functional stimuli were balanced between pre- and postnominal adjective examples.

In an attempt to determine if any problems exist with the first word analysis (for example, participants may blink more often, thus reducing the number of data points, or they may not be completely focused on the word when it first appears) a second set of lexical/functional stimuli (32 triads each) were created using the same nouns and quantifiers placed in the second position of the triad, as in example (8a) for lexical/noun stimuli and (8b) for functional/quantifier stimuli.

(8) a. una casa redonda

a house round

‘a round house’
b. es algún tema

is.3sg some topic

‘it’s some topic’

Note that for these second-word stimuli, the preceding context is not balanced. Although the first word of each type is a function word (the determiner *una* ‘a’ and the copular verb *es* ‘is’ for these examples), it was not possible to balance the two types of function words in terms of length and frequency. Further, one of the quantifiers, *ningún* ‘none,’ is ungrammatical in this second position because it is an unlicensed negative polarity item (Aranovich, 2007). Because this could potentially affect its processing, *ningún* cannot be analyzed with the rest of the functional items in this position. It was included merely to avoid potential repetition effects of the other words. The exclusion of *ningún* thus creates an imbalance in terms of length and frequency between the nouns and quantifiers, making interpretation of this set of stimuli difficult. As such, the analysis does not include this this particular set of stimuli. However, it may be useful to see if the effects are similar to or different from those found at the contextually balanced first word position. All lexical and functional distractor stimuli can be found in Tables C2 (first word) and C3 (second word) in Appendix C.

### 3.2.2.3 Additional distractor stimuli.

The lexical/functional stimuli contributed an additional 136 correct and 8 violation (due to the second position *ningún* stimuli), bringing the totals to 328 correct and 392 violation. In order to correct for the correct/violation imbalance, an additional 64 general

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57 These stimuli were not given during pilot testing and were only added to balance the final correct and violation stimuli counts for the later portion of the study.
distractor stimuli were created. They were constructed from the adjectives used for PRE/POSTchange, PRE/POSTnochange, and POSTonly stimuli but were combined with different nouns than those used for the critical stimuli. These adjectives were used to help eliminate any potential repetition effects seen for PREonly adjectives (see footnote 53), which consisted of only four adjective examples repeated eight times each as opposed to the other groups, which had eight adjectives repeated four times each (see section 3.2.1, especially Table 7). Additional distractor stimuli consisted of 32 prenominal and 32 postnominal word triads containing determiners, adjectives, and nouns in the appropriate word order, thus balancing for the overall presentation of pre- and postnominal adjective stimuli, bringing the total number of stimuli to 784. The additional distractor stimuli are located in Table C4, Appendix C.

3.2.3 Stimuli blocks.

Stimuli were pseudorandomized so that no more than three correct or incorrect items, nor more than three of any adjective type, occurred in a row. Stimuli were divided into 16 blocks of 48 word triads each during pilot data collection ($n = 12$, 9 of whom were included in final data analysis) and 16 blocks of 49 word triads each during subsequent data collection ($n = 28$, 12 of whom were included in final data analysis). Each block was balanced for correct and violation stimuli, adjective type, number of critical adjective stimuli, number of pre- and postnominal adjective stimuli, and number of each type of distractor stimuli.

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58 Pilot testing involved 768 stimuli.
3.3 Procedure

The session started with a consent form, followed by a handedness form (adapted from Oldfield, 1971) to ensure that participants were right-handed. After, participants performed an Elicited Imitation Task\(^{59}\) (EIT; Ortega, 2000) which was adapted to Mexican Spanish. Finally, participants completed a written practice triad task to help prepare them to make acceptability judgments during the ERP portion of the experiment.

After the behavioral portion, ERP setup and testing began. During setup, participants filled out a language background and medical history questionnaire.\(^{60}\) Sentences were presented visually through EPrime (Psychology Software Tools, Inc.), one word at a time (Rapid Visual Serial Presentation) on a CRT monitor approximately 120 cm from the participant. The presentation began with a fixation cross at the center of the screen for 1000 ms, followed by the stimulus phrase, with each word presented for 400 ms (SOA of 800 ms). The length of the SOA was designed so as to minimize processing overlap between words. All words in the phrase started with a lowercase letter, and there was no punctuation. A question mark appeared 400 ms after the last word and remained on the screen until the participant indicated his/her response (up to 5000 ms). A blink screen then appeared for 2000 ms, followed by the fixation cross preceding the next stimulus phrase, thus repeating the cycle.

Participants were instructed to read each phrase for acceptability and indicate whether each phrase was “Good” or “Bad” using a left and right mouse click, respectively. Participants completed 19 practice phrases prior to seeing experimental stimuli so that they

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\(^{59}\) The EIT, like the DELE (Montrul, 2005) to be described below, is a measure of proficiency. Pakulak and Neville (2010) showed that proficiency can play a role even in monolingual speech, therefore these proficiency measures were included to help ensure that all participants had a similar level of Spanish knowledge.

\(^{60}\) During pilot testing, this questionnaire was given before the EIT task.
were used to blinking between stimuli. If blinks were problematic or if there were any questions about the use of the left and right mouse buttons, the practice phrases were repeated until improvement was shown.

Experimental items were presented in 16 blocks, with each participant viewing 1 of 16 block orders and all participants viewing half of the items. The order of these blocks varied as follows: Participant 1 saw blocks 1-8, participant 2 saw blocks 9-16, participant 3 saw blocks 2-9, participant 4 saw blocks 10-16, then block 1, and so on. This allowed for an even number of judgments on all items and balanced for participant fatigue on any individual block.

Participants were given the opportunity for a break after each block. An extended break occurred at the end of the third and sixth blocks. During these extended breaks, participants completed the modified Diplomas de Español como Lengua Extranjera (DELE; ‘Diplomas of Spanish as a Foreign Language’) proficiency test (Montrul, 2005). The Cloze test occurred during the first extended break; the multiple-choice test was given during the second extended break. These forced breaks were designed to help reduce participant fatigue, and the DELE (like the EIT; see footnote 59) was used to ensure that all participants had the same level of Spanish because there was some variance in educational background (see Table 6, above). At the end of ERP testing, participants completed a computerized non-verbal working memory task\textsuperscript{61} (symmetry span; Unsworth, Heitz, Schrock, & Engle, 2005).

\textsuperscript{61} This task was not added until the full version of the study. An attempt was made to contact pilot participants in order to obtain a working memory score for them, but this could only be accomplished for two of them.
3.4 EEG Recording and Processing

EEG was continuously recorded using ASA-lab (ANT) 4.7.9 software. Recording was performed in DC mode with a sampling rate of 512 Hz from 32 passive Ag/AgCl electrodes in a Waveguard Cap (ANT) placed according to the 10-20 system. Specifically, data was collected from the electrodes in Figure 5, which also indicates the electrodes to be analyzed.

![Figure 5](http://www.ant-neuro.com/products/caps/waveguard/layouts/32/)

*Figure 5. Electrodes used for EEG recording. Midline electrodes in blue, medial electrodes in pink, and lateral electrodes in green. Adapted from [http://www.ant-neuro.com/products/caps/waveguard/layouts/32/](http://www.ant-neuro.com/products/caps/waveguard/layouts/32/).*
Electrode AFz was used as the ground electrode. Impedances were kept under 5 kΩ, and the signal was amplified by an AMP-TRF40AB Refa-8 amplifier. The vertical electrooculogram (VEOG) and horizontal electrooculogram (HEOG) were recorded from electrodes placed above and below the right eye and on each temple, respectively. Electrodes were referenced online to the average of all electrodes.

After recording, problematic electrodes were interpolated using ASA-lab (ANT) 4.8.1 software. Subsequent data processing was performed using Matlab version R2009a, equipped with EEGLab version 9.0.7.6b and ERPlab version 2.0.0.0 software. The EEG was epoched into 1400 ms chunks, including 200 ms before the stimulus and 1200 ms after it. This raw data was filtered offline using an IIR Butterworth filter with a high pass of .10 Hz, a low pass of 20.0 Hz, and a filter slope of 12 dB/octave. Stepwise artifact rejection was performed on all EEG channels using a 35 µV threshold, a 10 ms step, and a 400 ms moving window. Any epoch with at least one channel that exceeded the threshold was removed from analysis. Only participants with less than 30% rejections were included in subsequent analyses.

Electrodes were re-referenced offline to the average of the mastoids. Grand average ERP waveform figures presented in this dissertation were processed with a 10 Hz low-pass presentational filter; however, all analyses were performed without this filter.

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62 The amplifier automatically filters incoming EEG data with a digital FIR filter with a cutoff frequency of .27 times the sample frequency. For my data, this resulted in a cutoff frequency of 138.24 Hz.
63 Due to recording problems with the EOG, EOG channels could not be used for detection of eye blinks. However, visual inspection of the artifact rejections showed that the parameters used were effective at removing blinks.
3.5 Analysis

3.5.1 Behavioral analysis.

Before discussing the analysis procedures themselves, a note on the calculation of behavioral accuracy scores is in order. As indicated in section 3.1, participants varied in their acceptance on each adjective type. Additionally, some of them differed on the actual adjectives they accepted within each type. For example, one participant systematically accepted *supuesto* ‘supposed’ in both pre- and postnominal position, despite the fact that it is thought to be a PREonly adjective. However, he routinely accepted the other three PREonly adjectives only in prenominal position. For this participant, then, *supuesto* does not have a PREonly distribution, but instead has a PRE/POSTnochange-type distribution. If the goal is to investigate this participant’s processing of PREonly adjectives, *supuesto* needs removed from analysis; I want to average in only the processing to adjectives of the proper type. As such, I removed any individual adjective that strayed from the predicted distribution for all categories before both behavioral and ERP analysis. In an attempt not to eliminate adjectives needlessly, adjectives selected for removal had to show the incorrect distribution in at least 75% of cases. Out of the 21 included participants, this affected 6 participants for PREonly, 2 participants for PRE/POSTnochange, 9 participants for POSTonly, and 0 participants for PRE/POSTchange.64 Behavioral accuracies are reported after removal and, thus, reflect this change.

For the behavioral analysis itself, accuracy scores were analyzed because d’ scores could not be calculated for the behavioral data for all research questions. (For example, for the prenominal correct comparison for RQ1, there was only a correct form for all adjectives;

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64 The potential effects of this elimination on the number of trials averaged for each adjective type (Luck, 2005b) are considered in the results sections.
due to the absence of a violation form, false alarms, needed to compute d’, could not be calculated). The accuracy scores from the GJT were analyzed in three groups, one in relation to each research question. For RQ1 (adjective type), two separate repeated measures ANOVAs with the within-subjects factor Type\textsubscript{PRE} (PREonly, PREchange, PREnochange)/Type\textsubscript{POST} (POSTonly, POSTchange, POSTnochange) were run to ensure that participants judged each adjective type in a similar fashion. For RQ3 (agreement), two separate 3 x 2 repeated measures ANOVAs with the within-subjects factors Type\textsubscript{PRE}/Type\textsubscript{POST} and Agreement (correct, violation) were performed in order to confirm that participants performed in a similar fashion for all adjective violations. This pre- and postnominal division in types was done for both RQ1 and RQ3 to account for the fact that the analyses for the two different positions were not directly compared. In addition, for RQ2 (word class), the GJT accuracy for the lexical/functional stimuli were analyzed in a repeated measures ANOVA examining the factor Class (lexical, functional) to ensure that participants were similar in their judgments of both. Significance was at $p < .05$ for all ANOVAs.

### 3.5.2 ERP analysis.

For ERP analysis, the EEGs to critical words were time-locked and averaged across participants using a 200 ms pre-stimulus baseline correction. Analysis was contingency-based, therefore only stimuli to which participants responded correctly were included in the analysis.\textsuperscript{65} The time windows to be analyzed for all research questions involving the adjective stimuli (RQ1 – adjective type and RQ3 – agreement) include the standard 300-500 ms LAN/N400 window and the also standard 600-900 ms P600 window. Visual inspection determined the need for additional analysis windows. Time windows for RQ2 (word class),

\textsuperscript{65} A non-contingency-based analysis of the included participants ($N = 21$) is located in Appendix G.
which asks if lexical and functional items are processed distinctly in the brain, included a 250-350 ms N280/early negativity window (e.g., Nobre & McCarthy, 1994; Pulvermüller et al., 1995) and a 300-500 ms N400 window (Nobre & McCarthy, 1994). Adjustments to the planned analysis windows were determined by visual analysis.

In order to address the study's research questions, mean amplitudes were averaged over the following electrodes of interest (see Figure 5): F3/4, F7/8, FC1/2, FC5/6, C3/4, T7/8, CP1/2, CP5/6, P3/4, P7/8 for the laterality analysis, and Fpz, Fz, Cz, Pz, and Oz for the separate midline analysis. All analyses performed for each time window involved repeated measures ANOVAs. For all ANOVAs involving Type, prenominal and postnominal adjectives were analyzed separately. Note that this was a requirement for the comparison of the correctly agreeing types because the preceding context differed for the two groups (see footnote 52). For the comparison of the agreement violation stimuli, the contextual differences could arguably be washed out in the difference waves; however the most informative comparisons for the present study occurred within the pre/postnominal groups themselves, thus these analyses were performed separately as well.

The laterality ANOVA for RQ1 (adjective type) comprised two separate 3 x 2 x 2 x 5 repeated measures ANOVAs examining the within subjects factors Type\textsubscript{PRE}/Type\textsubscript{POST},\textsuperscript{66} Hemisphere (left, right), Laterality (medial, lateral), and Ant/Post (frontal, frontocentral, central, centroposterior, posterior). The laterality ANOVA for RQ2 (word class) involved a 2 x 2 x 2 x 5 repeated measures ANOVA looking at Class, Hemisphere, Laterality, and Ant/Post. Finally, the laterality ANOVA for RQ3 (adjective agreement) included two separate 3 x 2 x 2 x 2 x 5 ANOVAs with the within subjects factors Type\textsubscript{PRE}/Type\textsubscript{POST},

\textsuperscript{66} The subscripts \textit{pre} and \textit{post} are only provided when listing the factors for analysis. Because the results themselves are separated by position (prenominal and postnominal), the subscripts are not subsequently listed to avoid redundancy.
Violation, Hemisphere, Laterality, and Ant/Post. For all RQs, separate analyses were run on the midline. These analyses removed the Hemisphere and Laterality factors and incorporated a modified Ant/Post with the following five levels: prefrontal, frontal, central, posterior, occipital. This modified Ant/Post is labeled as Ant/Post_{mid} in subsequent sections. For all effects violating sphericity, a Greenhouse-Geisser correction was performed. Corrected degrees of freedom are reported in these cases.

Significant \((p < .05)\) main effects and interactions in the omnibus ANOVAs were followed-up to determine the distribution of the effect. These follow-ups all employed Bonferroni corrections for multiple comparisons. When multiple main effects and/or interactions were found, only the most encompassing interactions were followed up (e.g., if an Agreement x Hemisphere and an Agreement x Hemisphere x Ant/Post interaction occurred, only the latter, which encompasses both of the variables of the former, was followed up). In addition, planned lower-level comparisons by type were performed for RQ3 (agreement) to verify the effects noted in the omnibus analysis (along the lines recommended by Picton et. al., 2000) and to examine any additional effects that may have been overlooked due to insufficient statistical power (Oken & Chiappa, 1986).

The next three chapters report the results of these analyses. Chapter 4 discusses RQ1 (adjective type), chapter 5 is dedicated to RQ2 (word class), and chapter 6 covers RQ3 (agreement).
4 ADJECTIVE TYPE ANALYSIS

This chapter presents the results and discussion of the portion of the experiment related to RQ1 (adjective type), which asks if there are any processing differences among the correctly agreeing pre- and postnominal adjective types. I analyze only the correctly placed adjectives here because they are the ones that indicate how the brain treats the grammatical items. Section 4.1 presents the behavioral results from the GJT, section 4.2 gives the ERP results, and section 4.3 provides a discussion of the data.

4.1 Behavioral Results – Adjective Type

Accuracy\(^{67}\) data on the GJT is reported in Table 9.

<table>
<thead>
<tr>
<th>Position</th>
<th>Adjective type</th>
<th>(M)</th>
<th>(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenominal</td>
<td>PREonly</td>
<td>83.99</td>
<td>11.43</td>
</tr>
<tr>
<td></td>
<td>PREchange</td>
<td>92.74</td>
<td>8.91</td>
</tr>
<tr>
<td></td>
<td>PREnochange</td>
<td>84.39</td>
<td>8.28</td>
</tr>
<tr>
<td>Postnominal</td>
<td>POSTchange</td>
<td>92.42</td>
<td>6.77</td>
</tr>
<tr>
<td></td>
<td>POSTnochange</td>
<td>92.79</td>
<td>7.01</td>
</tr>
<tr>
<td></td>
<td>POSTonly</td>
<td>89.50</td>
<td>8.44</td>
</tr>
</tbody>
</table>

\(^{67}\) Recall that \(d'\) cannot be used because there is not a corresponding correct and violation version of each adjective. Accuracy is defined as correctly indicating “good” when presented with the stimuli from this section.
Two separate repeated measures ANOVAs were run, one for the prenominal adjectives and one for the postnominal ones, each investigating the factor Type_{PRE}/Type_{POST}. The prenominal ANOVA revealed a main effect for Type (F(1.573, 31.457) = 9.006; p = .002). This effect was due to PREchange adjectives being answered overall more accurately than the other two prenominal groups (p = .011 for PREonly comparison; p = .000 for PREnochange comparison). The postnominal ANOVA revealed no significant effects, thus postnominal adjectives were judged with the same accuracy across types.

4.2 ERP Results – Adjective Type

This section is divided into two parts: the first, section 4.2.1, presents the results for prenominal adjectives, and the second, section 4.2.2, presents those of the postnominal adjectives. For both, a 3 x 2 x 2 x 5 repeated measures ANOVA investigating the factors Type_{PRE}/Type_{POST}, Hemisphere, Laterality, and Ant/Post was run for both a 300-500 ms and 600-900 ms time window. Separate analyses were run for the midline (Type_{PRE}/Type_{POST}, Ant/Post_\text{mid}) for the same two time windows. The entire set of waveforms for both pre- and postnominal correctly agreeing adjectives can be found in Figures E1 and E2, respectively, in Appendix E. In the sections that follow, representative electrodes are shown to illustrate results.

4.2.1 Prenominal adjectives.

In terms of RQ1, PREnochange adjectives were predicted to differ from PREonly and PREchange because (a) they move from a postnominal position, unlike the two base-generated types, and (b) they are lexical items, whereas the other two types may be
functional. PREchange and PREonly were not predicted to be differentially processed because they were theorized to base generate in the same location and be of the same word class. Grand average ERP waveforms for the prenominal adjectives are shown in Figure 6.

Figure 6. Waveforms for correctly agreeing prenominal adjectives (PREonly, PREchange, PREnochange).

Note. Time scale (x-axis) in ms. Voltage (y-axis) in µV.

As seen in Figure 6, PREnochange adjectives show a negative shift starting at about 300 ms and continuing throughout the time frame both frontally and through the midline.
PREonly and PREchange are more similar in voltage, with PREchange being slightly more negative, also frontally and through the midline. The next two subsections present the statistical analysis of these potential effects for both a 300-500 and 600-900 ms time window.

### 300-500

For the 300-500 ms time window, the ANOVA for the laterality analysis revealed a main effect for Type ($F(2, 40) = 4.002, p = .026$) and a Type x Laterality interaction ($F(2, 40) = 3.599, p = .037$). Follow-ups on the interaction indicated that PREnochange was significantly more negative for both medial ($p = .018$) and lateral ($p = .044$) electrodes than PREonly, with the effect being strongest medially. There were no significant differences between PREchange and the other two prenominal types. The midline analysis produced a main effect for Type, with PREnochange again being more negative than PREonly and with PREchange not differing from the other two types. Overall, then, PREnochange displayed a broad negativity compared to PREonly.

### 600-900

For the 600-900 ms time window, the ANOVA again revealed a main effect for Type ($F(2, 40) = 3.283, p = .048$) and additionally yielded two interactions: Type x Hemisphere ($F(2, 40) = 3.222, p = .050$) and Type x Ant/Post ($F(4.141, 82.824) = 2.581, p = .041$). Follow-ups of the Type x Hemisphere interaction showed that PREnochange was more negative than PREonly in the right hemisphere ($p = .008$). Follow-ups for the Type x Ant/Post interaction indicated that PREnochange was more negative than PREonly for the frontocentral ($p = .003$), central ($p = .028$), and centroposterior ($p = .028$) regions. As with
the earlier time window, PREchange did not differ from either PREonly or PREnochange. The midline analysis revealed no significant main effects or interactions. The negativity for PREnochange was thus both right-lateralized and fairly frontocentral, possibly a type of extended AN effect.

Because the negativity for PREnochange in comparison to PREonly seemed to extend across both time windows, I ran an additional repeated measures ANOVA for the extended time window 300-900 ms. This ANOVA revealed a main effect for Type (F(2, 40) = 4.646, p = .015) and a Type x Ant/Post interaction (F(4.116, 82.324) = 2.922, p = .025). Follow-up of the latter indicated that PREnochange was more negative than PREonly for frontal (p = .029), frontocentral (p = .000), central (p = .009), and centroposterior (p = .009) electrodes. Just as with the two time windows already reviewed, PREchange did not differ from PREonly or PREnochange. This midline analysis revealed a main effect for Type (F(2, 40) = 4.606, p = .016), which was due to PREnochange being more negative than PREonly for all midline electrodes (p = .011). Again PREchange did not differ from PREonly or PREnochange. Thus, it does appear that the AN-type negativity for PREnochange compared to PREonly is a sustained negativity extending through both of the previously analyzed time windows.

4.2.2 Postnominal adjectives.

The hypothesis for RQ1 stated that the various postnominal adjectives would not elicit different types of processing in either time window because all are proposed to base generate in the same location and to be of the same word class (lexical). Grand average waveforms for the postnominal adjectives are in Figure 7.
Descriptively, the three waveforms are fairly similar, with no clear differences in the early time window. The largest visual differences appear to be a positivity for POSTchange in the midline and a positivity for POSTonly in the posterior midline, both starting around 600 ms. The statistical analysis of the waveforms follows.

Figure 7. Waveforms for correctly agreeing postnominal adjectives (POSTchange, POSTnochange, POSTonly).

Note. Time scale (x-axis) in ms. Voltage (y-axis) in µV.
300-500 ms

Corresponding to the visual observations, within the 300-500 ms window, there was no main effect for Type nor were there any interactions for either the laterality-based or the midline analysis. Therefore POSTchange, POSTnochange, and POSTonly did not show any significant differences in processing for the early time window.

600-900

Despite the apparent positivities for POSTchange and POSTonly, the ANOVA for the 600-900 ms window echoed the results from the earlier time window. There were no main effects or interactions in either the laterality or the midline analysis. Thus, the three postnominal types did not differ from each other in this time window either.

4.2.3 Interim summary – adjective type.

For the prenominal adjectives, PREnochange was predicted to elicit different components than PREonly and PREchange. This prediction was indeed borne out, with PREnochange showing an extended, rather broad AN-type component. Postnominal adjectives, on the other hand, were predicted to show similar processing across types. The lack of significant effects in both the 300-500 and the 600-900 ms windows support this prediction. The overall results for correctly agreeing adjectives are summarized in Table 10 for reference.
Table 10

Summary of ERP Results for Correctly Agreeing Pre- and Postnominal Adjectives

<table>
<thead>
<tr>
<th>Position</th>
<th>Time windows (ms)</th>
<th>300-500</th>
<th>600-900</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenominal</td>
<td>Broad negativity for PREnochange</td>
<td>Sustained AN for PREnochange</td>
<td>compared to PREonly</td>
</tr>
<tr>
<td>Postnominal</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

4.3 Discussion – Adjective Type

In this section, I analyze the agreement results in terms of RQ1 (adjective type). I begin with postnominal adjectives, which were not predicted to show any processing differences among the types. The results support this prediction because there are no significant effects or interactions, as noted in section 4.2.2 and Table 10. This lack of processing differences reinforces the proposal that POSTchange, POSTnochange, and POSTonly are similar syntactic elements.

Prenominal adjectives, on the other hand, were predicted to elicit distinct ERP components. Specifically, PREnochange adjectives were predicted to show different processing components than those elicited by PREonly and PREchange. The data presented in Section 4.2.1 partially support the hypothesis. PREnochange adjectives elicited a broad, sustained AN-type component compared to PREonly, as predicted, but did not differ from
PREchange, which partially refutes my hypothesis. What could account for this lack of difference?

It is important to note that although I have considered PREchange to pattern with PREonly because of the meaning types present only in the prenominal form, there is a version of PREchange that behaves like PREnochange adjectives. This could be seen in example (13) in chapter 2, repeated here as (1a).

(1)  a. el muy viejo amigo
    ‘the very old friend’/ # ‘the very long-time friend’

b. el amigo viejo
    the friend old
    ‘the old friend’/ # ‘the long-time-friend'

As (1a) shows, when modified by muy ‘very,’ the PREchange adjective actually receives a postnominal reading, shown in (1b), thus appearing like a PREnochange adjective. Although without the adverb, the salient reading (and the one identified in pilot testing) is unique, it is quite possible that both versions of the word were activated in the lexicon during the presentation of the word triads used in my study. If that was the case, then we would expect the PREchange adjective to behave both like a PREonly and like a PREnochange, which, in fact, it did, showing no significant differences from either type.68 The PREchange waveform even seems to float between the PREonly and the PREnochange waveforms in Figure 6, adding visual support to the idea that PREchange is a combination of the other two types. The particular experimental presentation used in this dissertation, then, is not sufficient to tease apart the different uses of the PREchange adjectives. Future work should place these

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68 Note that it is possible that the behavioral differences noted in section 4.1 affected the ERP, but given that analysis is done on correctly answered items only, this seems unlikely.
adjectives within a more restrictive context to see if isolating a particular meaning helps to clarify their structural position.

Taking only the other two prenominal forms, PREonly and PREnochange, into consideration, my hypothesis is supported – PREnochange and PREonly display differential processing. The difference seen, a sustained AN, looks very much like the sustained ANs elicited to moved structures (recall section 2.2.4.2 and Table 3); therefore the AN for PREnochange adjectives may be indicative of the extra processing required to move this adjective type from its base-generated, postnominal position. However, this finding would be surprising given previous research on short-distance movement (Fiebach et al., 2002; Kluender & Kutas, 1993). Thus, before pursuing this line of interpretation further, I examine RQ2 to see if any of the differences found in the prenominal adjectives may be attributed to word class. I return to the idea of movement in the general discussion in section 7.1. In the next two sections, I take a closer look at other possibilities for interpretation, first by examining word class and later by investigating agreement.
5 WORD CLASS ANALYSIS

In this chapter, I examine a possible explanation for the different ERP components elicited in chapter 4. Specifically, I look for evidence related to RQ2 (word class), which asks if the differences seen between PREnochange and PREonly are related to differences in word class: PREnochange appears to be a lexical element, whereas PREonly appears to be a functional one. Keep in mind my original prediction hypothesizes that PREchange patterns like PREonly, being a functional element; however, given the lack of effects seen in chapter 4, it would not be surprising to see PREchange appear as a combination of the other two types.

As summarized in section 2.2.5, the ERP literature has not established clear components that are associated with lexical versus functional processing, with some authors identifying different components related to word class (see Table 4) and others claiming that differences are due to confounding factors (see Table 5). In order to determine if word class is a possible explanation of the difference seen between PREnochange and PREonly, I need to establish what a difference in word class looks like for my speakers. As such, in this section, I examine part of the distractor stimuli discussed in chapter 3, specifically, the lexical (noun)-functional (quantifier) first position\(^69\) stimuli described in section 3.2.2.2.

Ideally, the participants used in determining this general word class difference would be the same as those used for the rest of the dissertation study. However, these stimuli were not implemented until after pilot data was collect; as such, the participant pool is different. I begin this chapter with a description of the participants used in this portion of the analysis in

\(^{69}\)The reader is reminded that the second position stimuli is not analyzed for the following reasons: (a) although both lexical and functional items begin with a functional element, this element could not be balanced for length and frequency, thus resulting in contextual confounds; and (b) one of the functional elements, ningúin ‘none,’ is not grammatical in second position, thus resulting in an uneven number of stimuli items, in addition to length and frequency issues, as described in section 3.2.2.2.
section 5.1, followed by an analysis of the behavioral data in section 5.2. The ERP results are reported in section 5.3, and section 5.4 discusses the results in relation to the negative component found for PREnochange in section 4.2.1.

5.1 Participants for Lexical/Functional Study

Participants for the lexical/functional portion of the study comprise the 28 individuals (12 males) who participated in the full version of the study. Of this number, 1 was eliminated from analysis due to task failure (failing to answer the GJT prompt questions; female), 1 was eliminated for being a behavioral outlier (male), and 2 were eliminated due to excessive EEG artifacts (1 male, 1 female). This section reports, then, on 24 participants (10 males), all of whom meet the general inclusion criteria described in section 3.1.

5.2 Behavioral Results – Word Class

Accuracy\textsuperscript{70} data on the GJT is reported in Table 11. A repeated measures ANOVA looking at the factor Class revealed a main effect for Class ($F(1, 23) = 63.237, p = .000$) because participants were significantly more accurate on lexical stimuli than on functional ones.

\textsuperscript{70} Recall that d’ cannot be used because there is not a violation condition. Accuracy is defined as correctly indicating “good” when presented with the stimuli from this section.
### Table 11

**GJT Accuracy (% Correct) for Lexical and Functional Stimuli**

<table>
<thead>
<tr>
<th>Word Class</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>lexical</td>
<td>95.1</td>
<td>4.87</td>
</tr>
<tr>
<td>functional</td>
<td>84.0</td>
<td>6.63</td>
</tr>
</tbody>
</table>

---

#### 5.3 ERP Results – Word Class

In this section I present the results of a 2 x 2 x 2 x 5 repeated measures ANOVA investigating the factors Class, Hemisphere, Laterality, and Ant/Post and a 2 x 5 midline analysis repeated measure ANOVA that takes into account the factors Class and Ant/Post$_{mid}$. The entire set of waveforms for the stimuli are in lexical and functional stimuli can be found in Figure E3 in Appendix E.

Visual inspection of the grand average waveforms, shown in Figure 8, indicates that lexical items are more negative than functional ones starting at around 500 ms and extending until around 800 ms. No effects are apparent in the early time windows (250-350/300-500 ms).

This apparent lack of effects is supported by the statistical analysis. Both the 250-350 ms window and the 300-500 ms window revealed no significant main effects or interactions of the two word classes.
Figure 8. Waveforms (left) and voltage map (right) for lexical (noun) and functional (quantifier) stimuli. The voltage map represents the difference of the functional minus the lexical stimuli at each electrode for the 500-800 ms time window.

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).

Based on visual inspection of the waveforms, I chose to add a later analysis window, of 500-800 ms. However, neither the laterality-based ANOVA nor the midline ANOVA revealed significant effects or interactions. For the noun and quantifier stimuli presented in this portion of the experiment, then, there are no significant differences between the two word classes.
5.3 Discussion – Word Class

In this section, I consider the results of the lexical-functional analysis in light of RQ2 (word class), which asks if the processing differences seen among prenominal adjectives in section 4.2.1 are the result of the adjectives belonging to distinct word classes.

According to the lexical-functional results from my study, lexical and functional processing cannot be distinguished in terms of ERP components, at least not using the electrodes and processing methods employed by this study.71 There are no significant differences in processing between the two word classes. However, there may be several reasons for the lack of significance found. The first is simply that lexical and functional items are processed in the same manner. This supports conclusions by Van Petten and Kutas (1991) and Osterhout et al. (1997), among others (see the references in Table 5), who also concluded that the two do not differ. However, an additional confound exists for my study – for some reason,72 participants did not judge the lexical and functional items in the same way. Accuracy was significantly higher on lexical items than on functional ones. It is possible that these differences hide a potential difference in processing. This could have affected, for example, the strength of statistical analysis, because only correct answers were analyzed. This means that functional items had less data points than lexical items, so some strength in the analysis may have been lost. Further, and as mentioned in section 3.2.2.2, it is not natural for a Spanish noun to start a sentence, so seeing a noun as the first word of the phrase might have affected processing. Although participants judged these stimuli as correct, it is possible

71 As mentioned in section 3.5.2, I analyze mean amplitude over a time window. Several word class studies (e.g., Nobre & McCarthy, 1994; Münte et al., 2001) measure both mean amplitude and peak latency and or amplitude, so perhaps with a measure that examines latency, my study would produce significant results. However, Luck (2005b) points out that measuring peak latencies and amplitudes can lead to misinterpretation of the results.
72 I do not have a solid guess as to the reason for the difference in acceptability. Brief pilot testing before the full study indicated that the functional triads were acceptable. Future testing should attempt this type of setup again, but should pilot the stimuli on a much larger sample before recording EEG.
that their brains reacted a different way to the unexpected noun. In appears, then, that my
data do not support a lexical-functional distinction in processing, nor do they definitively rule
out the possibility that a difference exists.

It is interesting to note that a smaller subset of participants leads to a trend in the
results (although still no significant components are found). A repeated measures ANOVA
on the 500-800 ms window\(^{73}\) analyzing just the participants who were also included in the
adjective stimuli analysis (\(n = 12\))\(^{74}\) revealed a trend to a main effect of Class (\(F(1, 11) =
4.587, p = .055\)) and a near trend to a Class x Laterality interaction (\(F(1, 11) = 3.175, p =
.102\)). These near effects were due to lexical stimuli being more negative than functional
stimuli, particularly for medial electrodes (\(p = .048\)). This tendency also shows up in the
midline, where a trend to an effect of Class (\(F(1, 11) = 3.622, p = .084\)) appears, with lexical
items still tending to be more negative than functional ones. Why this trend occurs with a
smaller subset of the population is a bit mysterious, but perhaps these participants (the ones
who also performed well on the adjectives) were just better at the task in general. Thus, it is
possible that testing a slightly larger population of “good” participants would reveal effects
supporting a difference in the processing of word class.

What does this mean for my analysis of PREonly and PREnochange adjectives? I
predicted that the two differed because of word class status, with PREonly being functional
and PREnochange being lexical. However, if lexical and functional elements do not differ in
the processing elicited, the differences seen between PREonly adjectives and PREnochange
adjectives cannot be due to a distinct word class status. If, on the other hand, processing
differences do exist that I was unable to identify with my stimuli (or that would appear with a

\(^{73}\) The earlier two windows still reveal no effects for this participant subset.

\(^{74}\) These participants were still more accurate in judging lexical stimuli than functional ones (\(F(1, 11) = 22.680, p = .001\)).
more appropriate subset of participants), a word class distinction between the two adjective
types is still a possibility.

Let us reconsider the prediction made in association with RQ2 (word class). Based on
previous research, I hypothesized that PREonly\textsuperscript{75} adjectives would differ from PREnochange
with the former eliciting at least one early negativity with a left lateralization and the latter
eliciting a more bilateral negativity. Even though my lexical/functional stimuli did not show
this distinction, if my adjective stimuli did differ in this manner, it could indicate a word
class difference may be at play. Looking back at Figure 8, and the results reported in section
5.3, PREnochange elicits a bilateral negativity, but no left hemisphere advantage is apparent
for PREonly. Nevertheless, the difference seen, a broad, sustained negativity for
PREnochange adjectives, is quite similar to a negativity found for lexical items by
Pulvermüller et al. (1995), which started visually at around 350 ms in their data and
continued throughout the recording epoch. However, Pulvermüller et al.’s negativity was
only significant via a peak amplitude analysis (which they labeled as a \textit{minima}); they
reported no effects for a mean amplitude analysis over their later time windows
(Pulvermüller et al., 1995, pp. 364-365). Thus, the negativity found for PREnochange is
actually distinct from word class results seen in the literature (see Tables 4-5 for a review). In
fact, when sustained negativities are found to be related to word class, they typically occur to
the functional items, not the lexical ones (e.g., Brown et al., 1999; Münte et al., 2001).\textsuperscript{76}
However, the negativity in PREnochange is similar to the negative trend for lexical items

\textsuperscript{75} The hypothesis also encompassed PREchange adjectives, but due to the results reported in section 4.2.1 and
the potential that both forms of the adjective were activated, I leave them aside in this analysis.

\textsuperscript{76} Interestingly, visual analysis of the waveforms for second word lexical/functional stimuli in my study reveals
a sustained negativity for the functional (quantifier) stimuli, although recall that these stimuli occur in different
contexts that the lexical ones, in addition to their potential problems with length and frequency due to removal
of one item (see section 3.2.2.2).
seen in my analysis of a subset of the participants. It appears that further testing of a potential lexical/functional processing distinction is still needed before any strong claims can be made, but the potential for PREonly and PREchange to differ because of word class remains a possibility.

Due to the lack of certainty surrounding the question of word class, we need to continue to explore other reasons for the appearance of the sustained negativity to PREnochange adjectives. Before discussing other possibilities (in chapter 7), I explore the results of the agreement violation study to see what it can tell us about the syntactic structure of adjectives.
6 AGREEMENT ANALYSIS

In this chapter, I examine an additional aspect of adjective processing that may shed light on the theoretical differences among adjective types: morphological agreement. Here I explore RQ3 (agreement) by looking at the processing of gender agreement violations for each adjective type. In section 6.1 I present the behavioral results of the study, followed by the ERP results in section 6.2. Section 6.3 discusses the implications of the results for adjective theory.

6.1 Behavioral Results – Agreement

Accuracy data on the GJT are reported in Table 12.

Two 3 x 2 ANOVAs, one for each adjective classification, were run, each investigating the factors adjective Type\textsubscript{PRE}/Type\textsubscript{POST} and Agreement on the accuracy data from the GJT. The prenominal ANOVA revealed a main effect for Agreement ($F(1, 20) = 26.420, p = .000$) and a Type x Agreement interaction ($F(1.551, 31.030) = 11.69; p = .000$). Follow-ups on the interaction indicated the following: For all prenominal adjective types except PREchange, participants were more accurate in identifying violation stimuli as incorrect than they were at identifying correct stimuli as such ($p = .000$ in both cases). The lack of difference in the PREchange category is likely due to participants’ high accuracy on identifying agreeing PREchange adjectives as correct, which was reported in section 4.1.

The postnominal ANOVA revealed only a main effect for Agreement ($F(1, 20) = 36.704, p = .000$). This effect was due to participants being more accurate on the violation condition than on the correct condition for all adjective types ($p = .000$).

\footnote{Although d’ can be calculated for the agreement data, analysis is performed on the accuracy data to be consistent with the analyses for the other two research questions.}
Table 12

*GJT Accuracy (% Correct) for All Correct and Violation Adjective Stimuli*

<table>
<thead>
<tr>
<th>Classification</th>
<th>Adjective type</th>
<th>Agreement&lt;sup&gt;a&lt;/sup&gt;</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenominal</td>
<td>PREonly</td>
<td>C</td>
<td>83.99</td>
<td>11.43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V</td>
<td>97.60</td>
<td>4.20</td>
</tr>
<tr>
<td>PREchange</td>
<td>C</td>
<td>92.74</td>
<td>8.91</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>94.40</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td>PREnochange</td>
<td>C</td>
<td>84.39</td>
<td>8.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>96.45</td>
<td>5.47</td>
<td></td>
</tr>
<tr>
<td>Postnominal</td>
<td>POSTchange</td>
<td>C</td>
<td>92.42</td>
<td>6.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V</td>
<td>99.71</td>
<td>1.28</td>
</tr>
<tr>
<td>POSTnochange</td>
<td>C</td>
<td>92.79</td>
<td>7.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>99.09</td>
<td>3.03</td>
<td></td>
</tr>
<tr>
<td>POSTonly</td>
<td>C</td>
<td>89.50</td>
<td>8.44</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>98.83</td>
<td>3.17</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> C indicates correct gender agreement, and V indicates an agreement violation.
6.2 ERP Results – Agreement

I report on the ERP data in two sections: the first, section 6.2.1, presents the results for prenominal adjectives, and the second, section 6.2.2, provides the postnominal adjective results. For both sections, two 2 x 3 x 2 x 2 x 5 repeated measures ANOVAs investigating the factors Agreement, Type\textsubscript{PRE}/Type\textsubscript{POST}, Hemisphere, Laterality, and Ant/Post were run for both a 300-500 ms and 600-900 ms time window. Separate analyses were run for the midline (Agreement, Type\textsubscript{PRE}/Type\textsubscript{POST}, Ant/Post\textsubscript{mid}) for the same two time windows. The entire set of waveforms for the agreement data for both pre- and postnominal adjectives can be found in Figures G4-G9 in Appendix G. Here I present a few select electrodes for illustrative purposes, along with voltage maps that display the difference wave with the correct condition subtracted from the violation one.

6.2.1 Prenominal adjectives.

The hypothesis for RQ3 predicted that prenominal adjectives would display a P600 for the agreement violation condition, regardless of type. Thus, I expect no effects or interactions in the 300-500 ms window and an Agreement x Ant/Post interaction in the 600-900 ms window, with no interactions involving Type.

Grand average waveforms of the prenominal adjectives types, as well as voltage maps that display violation minus correct condition for both of the analyzed time windows, are found in Figures 9-11.
Figure 9. Waveforms (left) and voltage maps (right) for correct and violation PREonly adjectives. The voltage map represents the difference of the violation minus the correct condition at each electrode for the 300-500 ms (upper) and 600-900 ms (lower) time windows.

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).
Figure 10. Waveforms (left) and voltage maps (right) for correct and violation PREchange adjectives. The voltage map represents the difference of the violation minus the correct condition at each electrode for the 300-500 ms (upper) and 600-900 ms (lower) time windows.

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).
Visual inspection of the PREonly waveforms in Figure 9 indicates that the violation condition is more negative than the correct condition for frontal and central midline electrodes during the 300-500 ms window. In addition, there is a large positivity for the violation condition in the posterior electrodes starting at 600 ms post-stimulus. This is also seen in the PREchange waveforms in Figure 10, although the early negativity for the violation condition extends more to the lateral electrodes. Finally, no hint of a negativity is present for the PREnochange adjectives, in Figure 11. There is, however, a large central-to-
posterior positivity for the violation condition starting at around 400 ms post-stimulus. The statistical analyses for these potential effects are presented in the next two subsections.

300-500 ms

The omnibus ANOVA for the earlier time window revealed no effects or interactions involving Agreement in either the laterality or midline analysis, supporting the prediction of no AN. However, planned lower-level analysis by Type showed an Agreement x Hemisphere x Laterality x Ant/Post interaction for PREchange adjectives only ($F(4, 80) = 2.835, p = .030$). Follow-ups on this interaction were significant for central and centroposterior electrodes in the lateral portion of the left-hemisphere only ($p = .026, .027$, respectively), thus indicating a left-lateralized, central negativity for the violation condition in PREchange adjectives. Lower-level analyses for PREonly and PREnochange were not significant, supporting the omnibus ANOVA.

600-900 ms

The omnibus ANOVA for the later time window showed a main effect of Agreement ($F(1, 20) = 5.785, p = .026$), an Agreement x Laterality interaction ($F(1, 20) = 9.497, p = .006$), an Agreement x Hemisphere x Laterality interaction ($F(2, 20) = 14.656, p = .001$), an Agreement x Ant/Post interaction ($F(4, 2.454) = 43.100, p = .000$), and an Agreement x Laterality x Ant/Post interaction ($F(4, 1.767) = 3.562, p = .044$). Follow-ups on the Agreement x Hemisphere x Laterality interaction revealed that violation was more positive than correct for both lateral ($p = .003$) and medial ($p = .007$) electrodes in the right hemisphere. The laterality portion of the interaction was due to a trend toward positivity in
the violation condition for medial but not lateral electrodes in the left hemisphere ($p = .054$). A follow-up on the Agreement x Hemisphere x Ant/Post interaction indicated that violation was more positive than correct for central ($p = .003$), centroposterior ($p = .000$), and posterior ($p = .000$) electrodes in the right hemisphere and for centroposterior ($p = .003$) and posterior ($p = .000$) electrodes in the left hemisphere. Taken together, these interactions show a slightly right-lateralized P600 for the violation condition across prenominal adjective types. This was also seen in the midline analysis, where an Agreement main effect ($F(1, 20) = 6.048, p = .023$) and an Agreement x Ant/Post$_{mid}$ interaction ($F(2.276, 45.512) = 17.724, p = .000$) emerged. Follow-ups on the interaction revealed positivity for the violation condition in central ($p = .011$), centroposterior ($p = .000$), and posterior ($p = .000$) regions, again indicating a P600.

This P600 across prenominal adjective types was corroborated by the planned, lower-level analysis by Type, where all three prenominal adjective groups had at least an Agreement x Ant/Post interaction. The interaction for PREonly adjectives occurred in both the laterality ($F(1.932, 38.639) = 11.646, p = .000$) and midline ($F(2.315, 46.301) = 3.274, p = .040$) analyses. In both cases violation was more positive than correct for posterior electrodes only ($p = .022$ for laterality, $p = .032$ for midline), thus indicating a P600.

The lower-level ANOVA for PREchange adjectives showed an Agreement x Hemisphere ($F(1, 20) = 5.761, p = .026$), an Agreement x Laterality ($F(1, 20) = 4.560, p = .045$), an Agreement x Ant/Post ($F(1.980, 39.600) = 12.170, p = .000$), and an Agreement x Hemisphere x Laterality ($F(1, 20) = 4.846, p = .040$) interaction for the laterality analysis and an Agreement x Ant/Post$_{mid}$ interaction in the midline analysis. Follow-ups on the Agreement x Ant/Post interaction revealed that violation was more positive than correct for
centroposterior ($p = .032$) and posterior ($p = .009$) regions for the laterality analysis and for posterior ($p = .005$) and occipital ($p = .008$) regions in the midline analysis. Follow-ups to the Agreement x Hemisphere x Laterality interaction were not significant. Overall, then, the P600 for PREchange agreement violations is similar to that of the PREonly violations, but it covers a slightly larger portion of the scalp.

Finally, the lower-level ANOVA for PREnochange adjectives showed an Agreement x Ant/Post ($F(2.082, 41.630) = 11.242, p = .000$), an Agreement x Hemisphere x Ant/Post ($F(2.528, 50.560) = 3.101, p = .043$), and an Agreement x Hemisphere x Laterality interaction ($F(1, 20) = 5.790, p = .026$) in the laterality analysis and an Agreement x Ant/Post$_{mid}$ ($F(2.491, 49.821) = 5.643, p = .004$) interaction in the midline analysis. Follow-ups of the Agreement x Hemisphere x Ant/Post interaction revealed a centroposterior ($p = .011$) and posterior ($p = .049$) positivity for the violation condition in the left hemisphere and a central ($p = .006$), centroposterior ($p = .002$), and posterior ($p = .005$) positivity in the right hemisphere. Follow-ups of the Agreement x Hemisphere x Laterality interaction revealed medial ($p = .022$) and lateral ($p = .011$) positivity for the violation condition in the right hemisphere only. Follow-ups of the midline interaction showed positivity for the violation condition in the centroposterior ($p = .020$), posterior ($p = .009$), and occipital ($p = .001$) regions. The overall distribution, then, is slightly more right-lateralized than PREonly and PREchange but is still indicative of a P600.

### 6.2.2 Postnominal adjectives.

The hypothesis for RQ3 predicted that postnominal adjectives would display an AN/P600 for the agreement violation condition, regardless of type. Thus, I expect an
Agreement x Ant/Post (and possibly x Hemisphere) interaction in the 300-500 ms time window and an Agreement x Ant/Post interaction in the 600-900 ms time window, with no interactions involving Type. The grand average waveforms for the postnominal electrodes, along with the voltage maps of the differences waves (violation minus correct) for both time windows, are given in Figures 12-14.

Figure 12. Waveforms (left) and voltage maps (right) for correct and violation POSTchange adjectives. The voltage map represents the difference of the violation minus the correct condition at each electrode for the 300-500 ms (upper) and 600-900 ms (lower) time windows.

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).
Figure 13. Waveforms (left) and voltage maps (right) for correct and violation POSTnochange adjectives. The voltage map represents the difference of the violation minus the correct condition at each electrode for the 300-500 ms (upper) and 600-900 ms (lower) time windows. 

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).
Figure 14. Waveforms (left) and voltage maps (right) for correct and violation POSTonly adjectives. The voltage map represents the difference of the violation minus the correct condition at each electrode for the 300-500 ms (upper) and 600-900 ms (lower) time windows.

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).

Visual inspection of the POSTchange waveforms in Figure 12 indicates a left-lateralized negativity for the violation condition in the 300-500 ms window. This negativity continues in the left frontal and midline frontal electrodes starting at around 600 ms, with no hint of a P600-type component. The waveforms for POSTnochange adjectives, in Figure 13, show a large, left-lateralized frontal negativity for the violation condition in the 300-500 ms window, as well as a positivity for the violation condition in the midline and posterior electrodes in the 600-900 ms window. Finally, the waveforms for POSTonly adjectives, provided in Figure 14, indicate a frontal negativity for the violation condition from around
300-450 ms and a positivity for the violation waveform in the central midline and all of the posterior electrodes from around 600-900 ms. The potential ANs and P600s seen in the visual analysis are statistically analyzed in the following sections.

300-500 ms

Analysis of the midline results in the 300-500 ms time window revealed no significant effects for either the omnibus or the lower-level ANOVAs; thus the results for this section report only the laterality analysis.

In the early time window, the omnibus ANOVA revealed an Agreement x Hemisphere x Ant/Post interaction ($F(4, 80) = 4.954, p = .001$). Follow-ups on this interaction showed that the violation condition was more negative than the correct one for all regions in the left hemisphere, although most so for the frontal ($p = .001$) and frontocentral ($p = .001$) regions ($p = .002, .01, .017$ for the central, centroposterior, and posterior regions, respectively). In the right hemisphere, violation was more negative than correct for the frontocentral region only ($p = .044$). This is indicative of a left-lateralized AN for all adjective types.

However, planned lower-level analysis by Type indicated that the left-lateralized AN was only present in two of the adjective types. Analysis on POSTchange adjectives revealed an Agreement x Hemisphere x Ant/Post ($F(4, 80) = 5.078, p = .018$) and an Agreement x Laterality x Ant/Post interaction ($F(4, 80) = 4.888, p = .046$). Follow-ups on the former interaction indicated that violation was more negative than correct for the frontocentral ($p = .042$) and central ($p = .03$) regions of the left hemisphere only, consistent with the left
lateralization of the negativity seen in the omnibus ANOVA, albeit with a slightly more centralized distribution. Follow-ups to the latter interaction revealed no significant effects.

Lower-level analysis on POSTnochange also revealed an Agreement x Hemisphere x Ant/Post interaction ($F(2.873, 57.462) = 4.424, p = .008$). Follow-ups to this interaction showed that violation was more negative than correct in the left frontal region only ($p = .01$), again consistent with a left-lateralized AN.

Finally, the lower-level ANOVA on POSTonly adjectives revealed no significant effects in the early time window. Although on the surface this seems like POSTonly violations elicit no AN component, analysis of a smaller time window, 300-450 ms, revealed a trend to a main effect of Agreement ($F(1, 20) = 3.602, p = .072$) and a trend to an Agreement x Hemisphere x Ant/Post interaction ($F(1.907, 38.138) = 3.572, p = .090$) in the laterality analysis. Follow-ups of the interaction indicate that violation tends to be more negative than correct for frontal ($p = .064$), frontocentral ($p = .073$) and central ($p = .075$) electrodes in the left hemisphere and frontocentral ($p = .066$) electrodes in the right hemisphere. No significant or trending main effects or interactions emerged in the midline analysis of the reduced time window. Thus, there is a trend to a left-lateralized AN for POSTonly adjectives in the 300-450 ms window.

**600-900 ms**

The omnibus ANOVA for the later time window revealed a main effect for Agreement ($F(1, 20) = 4.859, p = .039$) and several interactions not involving Type: Agreement x Laterality ($F(1, 20) = 6.078, p = .023$), Agreement x Ant/Post ($F(1.637, 32.739) = 14.199, p = .000$), Agreement x Hemisphere x Ant/Post ($F(2.519, 50.381) = 10.147, p = \ldots$)
.000), and Agreement x Hemisphere x Laterality x Ant/Post \((F(4, 80) = 4.261, p = .004)\). In addition, one interaction did involve Type, contra my prediction: Type x Agreement x Laterality \((F(2, 40) = 4.429, p = .018)\). The Agreement x Hemisphere x Laterality x Ant/Post and Type x Agreement x Laterality interactions were followed up.

Follow-ups on the Agreement x Hemisphere x Laterality x Ant/Post interaction revealed that violation was more positive than correct for centroposterior \((p = .004)\) and posterior \((p = .002)\) regions of the medial region of the left hemisphere; for central \((p = .001)\), centroposterior \((p = .000)\), and posterior \((p = .000)\) regions of the medial region of the right hemisphere; and for frontocentral \((p = .035)\), central \((p = .003)\), centroposterior \((p = .000)\), and posterior \((p = .001)\) regions of the lateral region of the right hemisphere. This pattern is consistent with a slightly right-lateralized P600. This was supported by the midline analysis, which yielded an Agreement x Ant/Post\text{mid} interaction \((F(1.799, 35.981) = 13.597, p = .000)\). Follow-ups indicated that violation was more positive than correct for central \((p = .015)\), posterior \((p = .000)\), and occipital \((p = .001)\) electrodes, again suggesting the presence of a P600.

Additionally, the Agreement x Hemisphere x Laterality x Ant/Post follow-ups from the laterality analysis indicated that violation was more negative than correct in the frontal electrodes located in the lateral region of the left hemisphere \((p = .007)\). This was not seen in the midline analysis. Thus, a sustained LAN appears to be present.

As for the interaction involving Type, follow-ups to the Type x Agreement x Laterality interaction indicated that violation was more positive than correct in both the medial \((p = .013)\) and lateral \((p = .049)\) regions in POSTnochange adjectives but not for the other two types. This was supported by the midline analysis, which revealed a Type x
Agreement interaction \( (F(2, 40) = 3.77, p = .032) \), with follow-ups showing that violation was more negative than correct for POSTnochange only \( (p = .017) \). It appears, then, that the P600 which appeared in the Agreement x Hemisphere x Laterality x Ant/Post interaction was driven, in large part, by POSTnochange adjectives.

Finally, the planned lower-level comparison by Type revealed an even clearer distinction among adjective types. For POSTchange adjectives, the overall ANOVA showed an Agreement x Hemisphere \( (F(1, 20) = 10.283, p = .004) \), Agreement x Ant/Post \( (F(1.86, 37.208) = 4.183, p = .025) \), Agreement x Hemisphere x Ant/Post \( (F(3.014, 60.276) = 3.565, p = .019) \), and Agreement x Hemisphere x Laterality x Ant/Post \( (F(4, 80) = 2.798, p = .031) \) interaction. The latter interaction was followed up. This follow-up indicated that violation was more negative than correct for both medial \( (p = .043) \) and lateral \( (p = .038) \) frontal electrodes in the left hemisphere, along with lateral frontocentral electrodes in the left hemisphere \( (p = .03) \). This appears to be a sustained LAN, the left lateralization of which is supported by the lack of effects/interactions found in the midline analysis for POSTchange adjectives.

The overall ANOVA for POSTnochange adjectives revealed a main effect for Agreement \( (F(1, 20) = 6.257, p = .021) \), an Agreement x Hemisphere interaction \( (F(1, 20) = 7.868, p = .011) \), an Agreement x Laterality interaction \( (F(1, 20) = 11.033, p = .003) \), an Agreement x Ant/Post interaction \( (F(1.336, 26.711) = 8.856, p = .003) \), and an Agreement x Hemisphere x Ant/Post interaction \( (F(2.379, 47.584) = 8.184, p = .000) \). Two of the interactions were followed up. The first, Agreement x Laterality, indicated that violation was more positive than correct for both medial \( (p = .013) \) and lateral \( (p = .049) \) electrodes. The second, Agreement x Hemisphere x Ant/Post, indicated that violation was more positive than
correct for centroposterior \( (p = .002) \) and posterior \( (p = .003) \) electrodes in the left hemisphere and for frontocentral \( (p = .043) \), central \( (p = .005) \), centroposterior \( (p = .001) \), and posterior \( (p = .000) \) electrodes in the right hemisphere. This is indicative of a right-lateralized P600, similar to that seen in the omnibus ANOVA. This was supported by the midline analysis, which revealed a main effect of Agreement \( (F(1, 20) = 6.818, p = .017) \) and an Agreement x Ant/Post\textsubscript{mid} interaction \( (F(1.474, 29.48) = 7.014, p = .006) \). Follow-ups to the interaction revealed that violation was more positive for correct for central \( (p = .006) \), posterior \( (p = .000) \), and occipital \( (p = .000) \) electrodes, again indicative of a P600.

The lower-level analysis performed on POSTonly electrodes revealed an Agreement x Ant/Post interaction \( (F(1.587, 31.743) = 5.404, p = .014) \). Follow-ups to this interaction were insignificant, with the interaction likely being due to a trend to a P600 in centroposterior \( (p = .079) \) and posterior \( (p = .061) \) electrodes. The midline analysis also revealed an Agreement x Ant/Post\textsubscript{mid} interaction \( (F(1.84, 36.796) = 4.709, p = .017) \), but again, follow-ups were not significant, with the interaction being due to a positive trend for the violation condition in central \( (p = .100) \), posterior \( (p = .059) \), and occipital \( (p = .056) \) electrodes. Overall, then, POSTonly agreement violations only show a trend to a P600.

6.2.3 Interim summary – agreement.

Overall, the omnibus ANOVAs revealed that gender agreement violations on prenominal adjectives elicited a P600 component, whereas gender agreement violations on postnominal adjectives elicited a LAN/LAN-P600 pattern. However, planned lower-level analyses indicated that variability exists in the processing of agreement violations on each
adjective type. This variability by type, along with the omnibus ANOVA results, are summarized in Table 13. These results are considered in light of RQ3 in the next section.

Table 13

*Summary of ERP Results for Agreement Violations in Pre- and Postnominal Adjectives*

<table>
<thead>
<tr>
<th>Position</th>
<th>Adjective type</th>
<th>Time windows (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>300-500</td>
</tr>
<tr>
<td>Prenominal</td>
<td>Overall</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PREonly</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PREchange</td>
<td>Left central negativity</td>
</tr>
<tr>
<td></td>
<td>PREnochange</td>
<td>-</td>
</tr>
<tr>
<td>Postnominal</td>
<td>Overall</td>
<td>LAN/broad negativity</td>
</tr>
<tr>
<td></td>
<td>POSTchange</td>
<td>Left central negativity</td>
</tr>
<tr>
<td></td>
<td>POSTnochange</td>
<td>LAN</td>
</tr>
<tr>
<td></td>
<td>POSTonly</td>
<td>-/AN$^\ddagger$ (300-450 ms)</td>
</tr>
</tbody>
</table>

*Note.* All effects are for the violation condition relative to the correct one. Effects are significant ($p < .05$) unless marked with a ‘$^\ddagger$’ indicating a trend to an effect.

6.3 Discussion – Agreement

RQ3 (agreement) looked for differences in gender agreement violation processing based on adjective type. I predicted that pre- and postnominal adjective agreement violations
would elicit distinct results based on previous research – prenominal agreement violations would elicit a P600 only, whereas postnominal agreement violations would elicit an AN/P600. The results of the omnibus ANOVAs, summarized in Table 13, mostly support this prediction. Prenominal adjective agreement violations did not elicit any components in the 300-500 ms time window and elicited a P600 in the 600-900 ms window. Postnominal adjective agreement violations, on the other hand, elicited a LAN in the early time window and a P600 in the later one. In addition to the late P600, postnominal adjective agreement violations also elicited a LAN in the late time window. However, a closer look at Table 13 reveals that the LAN in the late time window was actually present only in POSTchange adjectives. In fact, differences from the overall pattern really stemmed from just this adjective type and its prenominal counterpart, PREchange. In light of this, I first discuss the overall difference seen between the pre- and postnominal adjective positions, then I discuss possible reasons for the distinct components elicited to processing agreement violations on PRE/POSTchange adjectives.

My overall results support a basic distinction in the ERP components elicited to pre- and postnominal adjectives. This corroborates much of the previous literature, which generally shows a P600 to agreement violations on prenominal adjectives and a LAN/P600 to agreement violations on postnominal ones (Davidson & Indefrey, 2009; Foucart, 2008; and Sabourin & Haverkort, 2003 for prenominal; Barber & Carreiras, 2005; Martín-Loeches et. al, 2006; and Schacht et al., 2010 for postnominal). In order to determine the underlying reason for this difference, it is important to consider any possible confounds in the stimuli. One potential confound, at least for my set of adjectives, is the location of the violation: It is

78 I consider the trending effects for POSTonly adjectives to be consistent with the omnibus ANOVA. This will be addressed below.
on the adjective itself. This means that in the case of prenominal adjectives, upon encountering the gender agreement violation, participants do not yet know what the gender of the noun is – all they know is that *something* is wrong, either with the determiner or with the adjective. This can be seen in example (2). This word pair could be completed, for example, with both *calle ‘streetfem,’* making the adjective incorrect, or with *cuarto ‘roommasc,’* making the determiner incorrect. When the agreement violation appears, the participants have not yet seen the noun and do not know if it is masculine or feminine.

\[(2) \quad *\text{la bonito } \underline{\quad \quad} \quad \text{thefem prettymasc}\]

In the case of postnominal adjectives, on the other hand, the violation occurs after the noun – the agreement violation is clearly on the adjective and could not possibly be on the determiner, as demonstrated in example (3), where the agreement violation occurs after the noun. The postnominal adjective *bonito ‘prettymasc’* is the only possible location of the gender agreement error.

\[(3) \quad *\text{la calle bonito} \quad \text{thefem streetfem prettymasc}\]

Could we expect this difference in experimental setup to produce the difference in ERP components found? Although I cannot completely discount the idea, further consideration of the confound, along with experimental designs in other literature, make it seem unlikely.

For starters, other studies of prenominal adjectives have found only a P600 to violation stimuli even when the violation occurs on the noun. Both Davidson and Indefrey (2009) and Foucart (2008) presented prenominal adjective stimuli where the violation was
not apparent until presentation of the noun, and both still noted only a P600 to the prenominal gender agreement violations. Further, if we were to expect the difference to be due to the participants’ lack of knowledge of the noun’s gender, we might expect some kind of processing that indicates that the adjective is being held in working memory (and likely the determiner as well) until the noun’s gender can be identified. An ERP component that has been associated with working memory is the sustained AN (see Table 3), which is distinct from the more localized AN seen for agreement violations. Moreover, there is no such sustained AN in the case of prenominal adjective agreement violations. Thus, it seems that the processing differences seen between pre- and postnominal adjectives are likely not due to a simple difference in the structural location of the violation.

A second possibility for the general pre- and postnominal processing differences is, perhaps, an overall difference in how prenominal versus postnominal structures are processed. Let’s say that the presence of a determiner causes the parser to immediately expect a noun. If that is the case, the appearance of an adjective immediately after the determiner could elicit the occurrence of particular processing related to the unexpected structure (and this might occur both for correct and for the violation prenominal adjective stimuli since they each have an adjective following the determiner). What would this violation of expectations look like? As discussed in section 2.2.2.1, a violation of expected meaning would generate an N400; however, in our case, we likely would not be violating any semantic expectations but, instead, would be violating an expected structure. This may appear something along the lines of a word category violation, which produces an AN/P600 pattern (recall section 2.2.2.2). If at least a small anterior negativity tends to appear for prenominal adjectives (even correctly agreeing ones) in general, this could nullify the effect
of any AN which would appear due to the agreement violation, assuming that the effects
would not be additive between the unexpected word category and the agreement violation (in
line with the findings of Rossi, Gugler, Hahne, & Friederici, 2005). The presence of an AN-
type negativity in the correct condition gains support from the waveforms themselves. Figure
15, representing a subset of the electrodes from Figures 11 and 13 (PREnochange and
POSTnochange correct/violation waveforms, respectively), shows a negative-going wave
around 300 ms for the prenominal correct version (represented by the blue line in (a)). This is
the exact time frame in which an AN for an agreement violation would be expected to occur.

![Waveforms](image)

**Figure 15.** Electrode F7 for POSTnochange (a) and PREnochange (b) correct and violation
agreement stimuli.

*Note.* Correct stimuli in blue, violation in red. Time scale (x-axis) in ms. Voltage (y-axis) in µV.

The postnominal correct version, indicated by the blue line in (b), does not show the same
sort of negative peak. If this negativity for PREnochange, indicated by an arrow, is a property
of prenominal adjectives in general (which it appears to be based on visual inspection of Figures 9-11), we would never expect to see an additional AN for the violation condition.\footnote{Note that I will address the case of PREchange adjectives, where a negativity occurs to the violation stimuli, below.}

The P600, on the other hand, still appears for the agreement violation for one of two reasons: (a) The presence of the unexpected prenominal adjective does not elicit a P600, or (b) the P600 effects are additive, as has been shown for combined violations when one involves features of increased salience (Nevins, Dillon, Malhotra, & Phillips, 2007). It would not be unreasonable to propose that a gender agreement violation on an adjective is salient, thus an additive P600 in the violation condition is a possibility.

We have, then, a reason for the general P600 versus AN/P600 difference seen in agreement violation processing between pre- and postnominal adjectives. Something about the prenominal setup is different than the postnominal one: The unexpectedness of the adjective appearing after the determiner elicits an AN, both in the correct and in the violation condition. This prevents the appearance of an additional AN to the agreement violation because the effects are not additive. Postnominal adjective agreement violations, however, do elicit an AN because they do not have the early negative-going wave in the control condition (see Figures 7 and 15), thus I propose that the parser does not treat them as an unexpected word category.

Although the omnibus ANOVA showed a pre- and postnominal split in processing, the planned lower-level analysis of my data revealed that there is variation in agreement processing, even within the prenominal and postnominal categories themselves. The majority of this difference stems from the PRE/POSTchange adjective group, along with a small difference in the POSTonly adjective group. I start briefly with a look at POSTonly,
discussing why they really are not different than the general pattern, then I turn to the PRE/POSTchange group.

POSTonly adjectives, as summarized in Table 13, did not show any agreement violation effects in the two main time windows analyzed. However, the violation did elicit a trend to a LAN within a smaller time window, 300-450 ms, which is still well within the time frame when LAN effects can be expected to appear (Steinhauer & Connolly, 2008). The same occurred for the later time window, where POSTonly agreement violations showed a trend to a P600. Although the trends in both time windows were not statistically significant, it is important to point out that this adjective type had less usable data points than the other adjective types. This was due to the great variation in the acceptability of this type of adjective in a prenominal setting. POSTonly adjectives were predicted to only be acceptable after the noun, but for specific examples (although, importantly, not for the category as a whole), several participants accepted them prenominally (e.g., accepting both la redonda mesa and la mesa redonda ‘the round table’), as explained in section 3.5.1. This means that for those specific cases and for those specific participants, the adjective which was supposed to have a POSTonly distribution actually had a PRE/POSTnochange distribution. Because of this, these particular examples were removed from analysis for the participants in question, with the goal of including strictly POSTonly adjectives in the analysis. Although this was done for all adjective types, POSTonly adjectives were by far the most commonly removed (compare 9 participants with adjectives removed for POSTonly to 2 for POSTnochange and 0 for POSTchange). Thus, it is perhaps due to a lack of data points that we find only a trend to a LAN and P600 for POSTonly. Further testing of these adjectives would support my analysis that they do, in fact, elicit a LAN/P600 to agreement violations.
It appears, then, that POSTonly and POSTnochange behave as predicted by the omnibus ANOVA, as do PREonly and PREnochange. Why do PRE/POSTchange differ from this overall pattern? Let us begin with a review of what constitutes this adjective class. In postnominal form, these adjectives should not differ from POSTnochange; they theoretically base generate in the same location, and they are accepted as lexical items. In prenominal form, however, they are a hybrid of two types: PREonly and PREnochange (recall the discussion in section 4.3). The most salient reading identified by participants during pilot testing was the reading that can be obtained only in prenominal position (e.g., ‘former’ for viejo, not ‘old’). However, modifying the phrase, for example with a degree term, results in a reading where the adjective retains its postnominal reading (see example (1) from chapter 4). A difference, then between the PREchange group and all other adjectives is the number of meanings they have. How could this affect the components elicited to agreement violations?

As seen in Table 13, PREchange agreement violations elicited an early, somewhat central, negativity. One possibility is that this negativity is due to increased semantic activation for this adjective type. Perhaps, despite the salient reading, both meanings were activated in prenominal (and, perhaps, postnominal, as well) position. Given the ties among lexical items in the brain (e.g., Bentin et al., 1985), this seems like a logical possibility. This activation of multiple meanings would occur both in the correct and in the violation condition, but because the multiple meanings would be activated with or without an agreement violation, it seems that no additional processing of this semantic activity should be needed for the violation condition itself. However, a negativity is elicited to the violation condition in these cases. Given that the difference between PREchange and the other prenominal adjectives is related to semantics, I propose that the negativity elicited to
agreement violations on PREchange adjectives is an N400 elicited by semantic activation and not an AN elicited by the agreement violation itself. This is in line with the previous discussion that ANs do not occur to agreement violations on prenominal adjectives because of the AN that I propose occurs in the correct condition, but what evidence is there that the component elicited by PREchange agreement violations actually is an N400? For starters, the effect seen is quite centralized, not the more anterior distribution that might be expected with an agreement violation. Further, as discussed above, ANs are not additive (Rossi et al., 2005), so we would not expect an additional AN to occur along with the one elicited by correctly agreeing prenominal adjectives. N400s, however, have been shown to be additive with AN effects (e.g., Hagoort, 2003; Ye, Luo, Friederici, & Zhou, 2006), so the appearance of an N400 above and beyond the appearance of the AN would not be unexpected.

If the component elicited to agreement violations in the PREchange adjectives is an N400, why does it not have a typical N400 distribution? I suggest that the distribution is the result of component overlap.\(^{80}\) The N400, which typically has a bilateral-to-right-lateralized centroposterior distribution (see section 2.2.2.1), is partially “covered” by the right-lateralized, centroposterior P600. This results in the left-lateralized, central N400 seen with PREchange agreement violations. Future work should test this claim of an N400 to prenominal agreement violations when multiple semantic meaning are activated. This could be accomplished by examining a prenominal-only language that has overt morphological agreement between adjective and noun (German, Dutch, etc.) and comparing the agreement processing of adjectives with multiple meanings, such as bright (light intensity/intelligent) and dull (not sharp/boring/unintelligent), with the agreement processing of single-meaning

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\(^{80}\) The concept of component overlap has been suggested by other authors, as well (e.g., Steinhauer & Drury’s (2012) analysis of early and sustained negativities as interrupted by overlap with P600s).
adjectives. I predict agreement violations on the multiple-meaning adjectives will produce the same type of left-lateralized N400/P600 seen for PREchange in the present experiment, whereas single-meaning adjectives will elicit the typical P600 only.

Finally, let us examine POSTchange adjectives, which differed from the general LAN/P600 pattern elicited by agreement violations in postnominal adjectives. POSTchange did display a LAN in the 300-500 ms time window, as expected for postnominal agreement (with the centralized aspect of it perhaps owing to part of an N400, as with the PREchange agreement violations). However, instead of a P600 in the 600-900 ms window, these adjectives displayed a sustained LAN, which appeared to continue from the earlier time window. Structurally, we have no reason to assume that this adjective type is any different than POSTnochange because they display the same syntactic characteristics, summarized in Table 2 in section 2.1.2.1. Similarly, there are not any obvious semantic differences between POSTnochange and POSTchange because in postnominal position, POSTchange offers only one reading of the adjective. However, as noted for PREchange, it is quite possible, indeed likely, that multiple meanings are activated, even in postnominal position. But an increased semantic activation would be predicted to involve an N400, as argued for PREchange, not a sustained negativity. It would be helpful, then, to see what interpretations sustained negativities have received in the ERP literature to help deduce what difference in POSTchange agreement violations elicited the sustained negativity.

Sustained negativities often receive one of three explanations: (a) working memory recruitment (e.g., Matzke et al., 2002; and other references from Table 3), (b) spillover effects (Steinhauer & Drury, 2012), and (c) DC offset effects (Steinhauer & Drury, 2012). Working memory is often implicated in structures involving syntactic movement, which
creates a long-distance dependency (recall Table 3 and discussion in section 2.2.4.2). In the case of POSTchange adjectives, there is no theoretical movement to the postnominal position, and if we were to predict movement, we would expect the same sustained negativity for POSTnochange adjectives because the two types are syntactically identical in the postnominal position. It is possible that increased semantic activation could somehow involve working memory and elicit a sustained negativity, but then we would predict that PREchange would show this same negativity, which it does not. Thus, recruitment of working memory does not seem like a plausible explanation for the negativity.

Spillover effects occur when a particular word elicits ERP effects downstream, appearing as an effect in a later word. However, in my study, the context (the same determiner and noun) did not differ between correct and violation condition (or among correct/violation conditions, for that matter), thus spillover effects seem unlikely if not impossible. Finally, DC offset effects occur during baseline correction, when two waves differ greatly in their baseline. Again, this is most likely to occur because of differences in the context preceding the target word, and in the case of my adjectives, the preceding context did not differ. DC offset effects, then, also seem like an unlikely culprit.

An additional possibility for the sustained negativity in the POSTchange violation condition relates to proficiency of my speakers. Pakulak and Neville (2010) noted that lower proficiency native speakers displayed a sustained negativity to word category violations whereas higher proficiency native speakers displayed a P600. To see if proficiency affects the results, I reanalyzed my data, using proficiency as a variable. First, I calculated a Z-score for the raw EIT and DELE proficiency test scores. Then, I created a composite proficiency score, which was an average of participants’ EIT and DELE Z-scores. Next, I calculated the
value of the difference wave (violation minus correct) for each participant for all analyzed electrodes in the 600-900 ms time window. Finally, I entered this difference in voltage, along with the individual DELE, EIT, and composite proficiency scores, into a one-tailed Pearson’s \( r \) correlation, based on the prediction that less proficient speakers would be the ones driving the sustained negativity.

This correlation was not significant (taken as \( p < .05 \)) for any of the electrodes with any of the proficiency scores. Rerunning the correlation with the average of a subset of electrodes, specifically, those showing the sustained negativity (F7, F3, FC5, FC1), was not significant either. Thus, it appears that proficiency was not the cause of the late negativity for POSTchange adjectives. However, a slightly different analysis is informative to the question. I began by splitting my participants into low and high proficiency groups based on a median split of the composite proficiency score (11 in the high group, all scoring above zero; 10 in the low group, all scoring below zero). Based on Pakulak and Neville (2010), I expected the lower proficiency group to be driving the negativity; however, it was actually the higher proficiency group that showed a larger negativity. Figure 16 displays the waveforms and voltage map (600-900 ms) for the POSTchange condition for the higher proficiency speakers, and Figure 17 displays the waveforms and voltage map (600-900 ms) for the lower proficiency speakers.
Figure 16. Waveforms (left) and voltage map (right) for correct and violation POSTonly adjectives for Higher Proficiency (n = 11) speakers. The voltage map represents the difference of the violation minus the correct condition at each electrode for the 600-900 ms time window.

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).
Figure 17. Waveforms (left) and voltage map (right) for correct and violation POSTonly adjectives for Lower Proficiency (n = 10) speakers. The voltage map represents the difference of the violation minus the correct condition at each electrode for the 600-900 ms time window.

Note. Waveform time scale (x-axis) in ms and voltage (y-axis) in µV. Voltage map color scale from -2 µV (dark blue) to +2 µV (dark red).

I ran a lower-level repeated measures ANOVA for the POSTchange correct and violation stimuli for the 600-900 ms time window, using the same variables described in the methods section. The ANOVA for the higher group resulted in an Agreement x Ant/Post ($F(1.426, 14.256) = 5.900; p = 0.020$) and an Agreement x Hemisphere x Ant/Post ($F(4, 40) = 3.555; p = .014$) interaction. Follow-up of the latter revealed a significant negativity for the violation condition for left, frontal electrodes ($p = .045$) and a trend to a negativity for left frontocentral ($p = .079$) and central ($p = .075$) electrodes. The midline analysis revealed no

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81 I report on the trend here only because of the small participant numbers in each group. A larger group could, perhaps, lead to significance.
significant main effects or interactions. Thus, the higher proficiency group displayed a left-lateralized, sustained negativity, the same effect found overall for the POSTchange adjective type. The ANOVA for the lower proficiency group led to an Agreement x Hemisphere ($F(1, 9) = 11.325; p = .008$) and an Agreement x Laterality x Ant/Post ($F(4, 36) = 2.698; p = .046$) interaction. Neither follow-up was significant, nor were there any significant main effects or interactions in the midline analysis, meaning that the lower proficiency group did not display an anterior negativity for this adjective type. Further, although the effect was not yet trending, the most revealing finding of the follow-ups is a positivity for right posterior electrodes ($p = .123$), which appears in the waveforms in Figure 17 as a small, P600-type component. If this component were to reach significance in a larger sample of participants, we would have the expected P600 for lower proficiency speakers, and a surprising sustained negativity for higher proficiency ones, the opposite of the pattern found in Pakulak and Neville (2010).

It appears, then, that the sustained negativity found for POSTchange agreement violations was due, at least in part, to the proficiency of the speakers. This is interesting because all of the speakers had at least a high school education and performed fairly well on both proficiency measures in the study. Thus, even small differences in proficiency seem to affect processing. Whether this is true for all adjective types (and other structures more generally) remains to be seen, but minimally, this claim can be made for POSTchange adjective agreement. As for an interpretation of the negativity that appeared for the higher proficiency speakers, I propose that it was due to their faster processing of the word triads in this case. The postnominal adjective was the last word participants saw before making a decision on the acceptability of the word triad. Perhaps higher proficiency speakers were able
to reach this stage of processing more quickly than lower proficiency ones; thus, instead of
the typical reanalysis associated with P600 processing, the higher proficiency speakers were
already analyzing the overall acceptability of the word triad, recruiting their working
memory in the process, which resulted in a sustained negativity for this adjective type. This
analysis is supported by the reaction times for each group on the POSTchange adjectives.
Participants in the higher proficiency group responded\(^{82}\) to POSTchange word triads after an
average of 574.08 ms, whereas participants in the lower proficiency group took an average of
702.37 ms. A one-way ANOVA\(^ {83}\) indicated that this difference in reaction times was
statistically significant (\(F(1, 746) = 11.491, p = .001\)). Ideally, I could further support this
claim by correlating the size of the negativity with working memory scores to further support
the idea that working memory is involved; however, not all participants completed the
working memory task, which was added after the pilot portion of the study (discussed in
section 3.3); thus, for the moment the claim remains a hypothesis.\(^ {84}\) Future work could
analyze this proposal and could also investigate why it occurs for some, but not all, adjective
types.

In terms of adjective theory, the agreement violation stimuli do not contribute much
to an argument about underlying structure. It does appear, however, that additional semantic
activation occurs with PREchange (and possibly POSTchange) adjectives that does not occur
for the other types. Further, we saw a difference in the processing of POSTchange adjectives

\(^{82}\) Only reaction times to correct responses were averaged.
\(^{83}\) Note that this is a very rough statistic because the reaction time data were not cleaned for outliers prior to
processing. Further, Whelan (2008) notes that analyzing reaction time data via an ANOVA lowers the power of
the test. However, reaction times, and the details of proficiency differences in general, are outside of the scope
of this dissertation.
\(^{84}\) A correlation with working memory scores on a symmetry span test (Unsworth et al., 2005) and difference
waves both at individual electrodes and at and average of left frontal and frontocentral electrodes revealed no
significant correlations for the subset of participants with working memory scores. This may be due to missing
values in participant scores, the working memory task (nonverbal, whereas others reported in the literature, e.g.
Fiebach et al., 2002, were verbal), or a true lack of an effect.
compared to the other postnominal types, showing that agreement processing may vary even when the syntactic structure is identical; this difference in processing was affected by proficiency, indicating that even small differences in proficiency should be considered in analysis. Finally, we saw a clear distinction between the processing components elicited to violations of prenominal and postnominal stimuli, and I put forth the proposal that prenominal adjectives elicit an AN-type negativity in the correct form, whereas the postnominal adjectives do not.

In the next chapter, I integrate the results reported in this chapter and in the previous two, establishing an overall picture of what they tell us about the adjective structure proposed in example (2) of chapter 1.
This dissertation set out to investigate the relationship between the syntactic structure and processing of adjectives in Spanish. In an attempt to find an answer, I adopted a syntactic analysis, originally presented in example (2) in chapter 1 and repeated here as example (1).

This structure incorporated elements from different authors (Bartlett & González-Vilbazo, 2013; Bernstein, 1992, 1993; Cinque, 2010; and Taboada, 2010) but was inconclusive in several aspects. Specifically, the position of the prenominal adjective types, along with their word class, was in question. In order to help clarify the structure, I used the neurolinguistic processing method of ERPs to garner additional information about the syntactic structure.

This investigation was designed around three research questions. The results for RQ1 (adjective type) revealed that processing differences do occur, at least among the prenominal adjective types: PREnochange adjectives elicited a sustained AN compared to their PREonly
counterparts, whereas PREchange did not differ from the other two. The negativity to 
PREnochange was further examined to determine its relationship with a potential word class 
distinction among the prenominal adjective types (RQ2). The result of this investigation was 
inconclusive; it was unclear both whether the word class distinction exists among the 
adjective types and whether it exists in terms of ERP processing components at all.

An examination of gender agreement violations (RQ3) provided information about 
general word category expectations for prenominal adjectives, where it was suggested that 
adjectives are not the expected category after a determiner. Due to this, prenominal 
agreement violations do not elicit an AN like their postnominal counterparts. Instead, they 
elicit a P600 only. Further, RQ3 provided us with evidence that multiple semantic meanings 
are activated for PREchange adjectives and that this extra activation interacts with gender 
agreement violations to produce an N400 to the violation condition, one that is partially 
blocked by the P600 in the right hemisphere. Finally RQ3 also provided us with evidence 
that native speaker proficiency is an important factor to consider in processing studies, a 
conclusion also reached by Pakulak and Neville (2010). Even the small proficiency 
differences among the participants in the present study led to differential processing. 
Specifically, when divided into a median split based on combined proficiency scores, the 
higher proficiency group displayed a sustained negativity to gender agreement errors, 
whereas the lower proficiency group did not display any late processing components but 
nearly trended to a P600.

Perhaps lost in the shuffle of the information gathered, the appearance of the 
sustained negativity in correctly agreeing PREnochange adjectives was left unresolved. As 
mentioned, attempts to associate it with word class were inconclusive. Another possibility,
briefly considered during the original discussion in chapter 4, involves syntactic movement, the processing components to which were presented in section 2.2.4.2. In the next section, 7.1, I look for additional evidence that the negativity elicited to PREnochange adjectives reflects the movement of these adjectives to a prenominal position. This is followed by potential implications of the study in section 7.2. Finally I close the dissertation in section 7.3 by offering some concluding remarks.

7.1 Adjectives and syntactic movement

As reviewed in section 2.2.4.2, ERP studies investigating moved syntactic elements have generally found a sustained AN/P600 pattern that reflects some aspect of working memory activation and integration into the structure, respectively (see summary and references in Table 3). Although the PREnochange adjectives are claimed to be moved structures in the analysis in (1), I did not expect to see any evidence of this movement in the processing data I collected because short-distance movement has not been shown to elicit any particular ERP components in processing studies (Fiebach et al., 2002; Kluender & Kutas 1993). However, the results of RQ1 (adjective type) showed that PREnochange adjectives elicited a sustained AN compared to PREonly,\textsuperscript{85} precisely the type of ERP component that is expected to be elicited by a moved element.

The question, then, is how we can know if the sustained negativity is related to movement or if it is a different component altogether. In order to find evidence to support the elicitation of the negativity to movement, I explore two avenues: For the first, I attempt to examine evidence that the negativity elicited is associated with working memory; for the

\textsuperscript{85} PREchange is left out of the current discussion because it did not differ from either of the other two types. See section 4.3 for discussion of this adjective type.
second, I look for the other component often found with moved elements – a P600 at the point of syntactic integration.

Working memory is the cognitive construct that it is proposed to be activated when a structure moves form its base-generated position (recall the discussion in section 2.2.4.2 and Table 3). Fiebach et al. (2002) supported this claim when they found that larger negativities were associated with participants with lower working memory spans.\(^{86}\) In my study, I collected a nonverbal measure of working memory, specifically, a symmetry span. However, as mentioned in section 3.3, this portion of the study was not implemented until after the pilot sessions, and not all participants could be brought back in for working memory testing. Thus, I do not have working memory scores for all of the included participants.\(^{87}\) Future work should look for a correlation between individuals’ working memory scores and the negativity found for PREnochange adjectives compared to PREonly ones.

Another way to strengthen the association to movement is to look at the processing elicited at the point of integration of the moved element. In previous studies on movement, the point of integration has been identified as either the base-generated location of the moved element (e.g., Gouvea et al., 2010; Phillips et al., 2005), or a point earlier in the structure when the relationship of the moved element with others in the structure can be identified (e.g., when other case-marked NPs are encountered and the relationship between the two theta roles is determined; Fiebach et al., 2002; Hagiwara et al., 2007). In the case of my prenominal adjectives, there is no theta role, so we look for the point of base generation. This

\(^{86}\) Fiebach et al. (2002) used a reading span task.

\(^{87}\) One-tailed Pearson’s r correlations between the 13 participants with working memory scores and the difference between PREnochange and PREonly voltages in the 300-900 ms time window at each individual electrode was not significant. However, it is difficult to know if this is due to lack of a complete data set, the particular task used (non-verbal symmetry span, as opposed to reading span in Fiebach et al. (2002)), or a lack of a relationship between working memory and the negativity elicited by PREnochange adjectives.
occurs right after the noun, so that is where we should look for evidence of integration. A
P600 for PREnochange compared to PREonly adjectives would provide further support that
PREnochange is a moved element. I time-locked the EEG to the start of the noun after both
PREnochange and PREonly adjectives and averaged it across participants. A selection of the
resulting waveforms are presented in Figure 18. The full set of waveforms can be found in
Figure G10 in Appendix G.

Figure 18. Waveforms for the nouns following correctly agreeing PREonly and
PREnochange adjectives.
Note. Time scale (x-axis) in ms and voltage (y-axis) in µV.
Visual inspection of the waveforms indicates at least three potential effects: (a) an anterior negativity for PREnochange from around 300-400 ms, (b) a sustained anterior negativity for PREnochange starting at around 600 ms, and (c) a posterior positivity for PREnochange starting around 400 ms. To probe these potential effects, I ran a repeated measures ANOVA investigating the lateral analysis factors Type_{PRE}, Hemisphere, Laterality, and Ant/Post and the midline analysis factors Type_{PRE} and Ant/Post_{mid} for a 300-400 ms, 400-600 ms, and 600-900 ms time window.

Analysis of the early time window was not significant for the laterality ANOVA. The midline ANOVA revealed a Type x Ant/Post_{mid} interaction ($F(1.672, 33.444) = 4.645, p = .022$). Follow-ups indicated that PREnochange nouns elicit more negativity than PREonly nouns for prefrontal ($p = .015$) and frontal ($p = .048$) electrodes. This appears to be a very localized AN-type component for PREnochange nouns.

The laterality analysis for the 400-600 ms time window revealed no significant effects or interactions. The midline analysis, on the other hand, revealed a Type x Ant/Post_{mid} interaction ($F(1.654, 33.086) = 3.849, p = .039$). Follow-ups indicated that PREnochange nouns were more positive than PREonly nouns for posterior electrodes ($p = .049$), which is suggestive of an early P600 for PREnochange nouns.

The laterality ANOVA for the 600-900 ms time window revealed a Type x Ant/Post effect ($F(1.532, 30.459) = 3.708, p = .047$) interaction. Follow-ups showed that PREnochange is more positive than PREonly for posterior electrodes ($p = .022$). The midline ANOVA also revealed a Type x Ant/Post_{mid} interaction ($F(1.476, 29.521) = 5.984, p = .012$). Follow-ups to the midline interaction were not significant; the interaction was due to a

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88 Keep in mind that all effects on the noun must be considered in light of the processing differences already found for the preceeding adjectives. Just as with all movement studies, effects of differing context before the gap may show up downstream in the ERP.
tendency of PREnochange to be more positive than PREonly in posterior electrodes. Overall this pattern appears to indicate a P600 for the nouns after PREnochange adjectives.

Thus PREnochange nouns elicit an early, localized AN component, followed by a P600 that starts around 400 ms and continues into the later time window. Interestingly, Ueno and Kluender (2003) also found a localized AN at the gap position for scrambled demonstratives in Japanese, which they associated with filler retrieval. Perhaps this localized AN for the PREnochange noun is similarly related to pulling the filler from working memory. The P600 appears to be related to syntactic integration, as seen with other movement studies. Its early latency is not totally unexpected; Gouvea et al. (2010) claimed that P600 latency reflects retrieval time of the moved element, with faster retrieval time associated with earlier latencies. Given the short linear and hierarchical distance covered by the moved PREnochange adjective and the short amount of time it needed to stay in working memory, quick retrieval time is quite plausible. Overall, then, an examination of processing on the nouns occurring after PREnochange and PREonly adjectives supports the idea that PREnochange adjectives are moved structures.

Now that we have a better idea of why PREchange adjectives are processed differently than PREonly, I consider further implications of my dissertation study, both in terms of the movement proposal just reviewed here and in terms of agreement structures.

### 7.2 Implications

In this section, I briefly suggest two implications of the results of this study. I start with a proposal on movement and processing, and then I return to Cinque’s (2010) proposal
of adjective word class distinctions and show how it might coincide with the linguistic concepts of agreement and concord.

### 7.2.1 Processing movement across phases.

As mentioned previously, the elicitation of ERP components associated with movement is surprising in the situation of PREnochange adjectives because they move over a very short linear and hierarchical distance. As found by both Fiebach et al. (2002) and Kluender and Kutas (1993), subject wh movement, which occurs over a relatively short linear and hierarchical distance as well, does not produce any particular processing pattern, whereas longer-distance object wh movement does. That means that examples such as (2), which shows the raised wh object *wen* ‘who(m),’ elicit the typical sustained AN/P600 pattern previously discussed, but examples such as (3), which shows the raised wh subject *wer* ‘who,’ do not.

(2) Thomas fragt sich, *wen am Dienstag nachmittag nach dem Unfall*

Thomas asks himself, *who*<sub>ACC</sub> on Tuesday afternoon after the accident
der *Doktor verständigt hat.*

*the*<sub>NOM</sub> doctor called has

‘Thomas asks himself who the doctor called on Tuesday afternoon after the accident.’

(3) Thomas fragt sich, *wer am Dienstag nachmittag nach dem Unfall*

Thomas asks himself, *who*<sub>NOM</sub> on Tuesday afternoon after the accident
den *Doktor verständigt hat.*

*the*<sub>ACC</sub> doctor called has
‘Thomas asks himself who called the doctor on Tuesday afternoon after the accident.’

(German; modified, Fiebach et al., 2002, p. 255, Table 1)

Why, then, does short-distance adjective movement elicit movement-type processing whereas short-distance wh movement does not? I would like to put forth the idea that the elicitation of an AN/P600 to moved structures occurs only when the moved element crosses a phase head, most typically thought of as C and v (Chomsky, 2001). This fits fairly clearly with the wh movement data: the subject wh word is base generated above v and may raise to SpecTP and/or to SpecCP. Regardless of its final landing site, it is always located within the C phase. The object wh word, however, base generates below v and raises to SpecCP (Chomsky, 1986); therefore, it leaves the v phase and enters the C one. If we draw a parallel to DPs, as has been suggested by Svenonius (2004) and Hiraiwa (2005), among others, we should have phase heads within the DP as well. Hiraiwa suggests that n is a phase head in the nominal domain, just as v is in the verbal one. Based on the syntactic structure proposed in (1), the PREnochange adjective would base generate below n and raise above it, thus existing in both the n phase and the one above it (probably the D phase). By moving across this phasal boundary, the PREnochange adjective would activate working memory, which is visible in ERP studies as a sustained negativity to the moved element. Future work could systematically examine this proposal to see if it can be upheld across different syntactic structures. If the elicitation of a sustained AN can be established as a valid marker of cross-phasal movement, we would have an additional test of phasal status.

I now turn to a different aspect of the analysis, the investigation into agreement, to examine additional implications for linguistic theory.
7.2.2 Reconsidering Cinque (2010)/Thinking about Agreement and Concord.

In our investigation into pre- and postnominal agreement violations, we saw a systematic difference in the processing of agreement violations – prenominal agreement violations elicited a P600, whereas postnominal ones elicited a LAN/P600 (PRE/POSTchange adjectives notwithstanding). I attributed this difference to the unexpectedness of encountering an adjective after the determiner, as opposed to encountering a noun. However, Osterhout (1997) noted that, for syntactic (and some morphosyntactic) anomalies, LANs are more likely to occur when the violation occurs on an open class word. Perhaps, then, there is a class difference between pre- and postnominal adjectives: prenominal may be functional and postnominal may be lexical.

This division corresponds roughly to that suggested by Cinque (2010), that direct modification, which is often prenominal (at least in Romance), occurs via functional adjectives, and indirect modification, which must be postnominal in Romance, occurs via lexical adjectives (see section 2.1.3). Direct modification can, however, occur postnominally, depending upon how far the NP raises. If the lexical and functional distinction between these two adjective modification types holds, we would always expect a P600 to agreement violations prenominally, and we would expect a LAN/P600 most typically to postnominal violations, but a P600 only would also be possible. This is exactly what is found in the literature, and has been further supported here: prenominal agreement elicits a P600 (e.g., Davidson & Indefrey, 2009), and postnominal agreement can elicit a LAN/P600 (e.g., Martín-Loeches et al., 2006), or a P600 only (Foucart, 2008).

A division in the agreement violation processing between functional and lexical adjectives may also have implications for a different aspect of linguistic theory, specifically,
the notions of *agreement* and *concord*. Agreement, in the sense of Chomsky (2000, 2001), can be canonically thought of in relation to subject-verb agreement. The tense head T probes down the syntactic structure until it reaches the subject NP, which can value T’s uninterpretable person and number features; conversely, the NP can value its uninterpretable case feature via T. Concord, on the other hand is thought by some authors (e.g., Pollard and Sag, 1994, who refer to it as *syntactic agreement*; Wechsler and Zlatic, 2003) to be a different morphosyntactic phenomenon, one that involves the “spreading” of the noun’s features to elements of its extended projection, including determiners and adjectives. The direction of the feature spreading and the mutual valuation of uninterpretable features are not necessary components. Although concord has been proposed to apply to adjectives as a category, regardless of their word class or position in relation to the noun, perhaps a different proposal could apply as well. What if concord spreads features from one lexical head to another (e.g., from a noun to a lexical adjective) and agreement involves a functional head probing a lexical one? Although the Chomskyan concept of agreement would need tweaked to accommodate a functional head that cannot value a feature on the lexical item (as functional adjectives likely would not do), Baker (in press) proposes a modification of Agree that encompasses the traditional concept of concord, so this accommodation seems possible. If concord and agreement are, then, two distinct morphosyntactic processes, we would have yet another reason for the distinction in adjective processing based on position. Future work could consider these ideas and test their plausibility, both for adjectives and for other syntactic structures.
7.4 Conclusion

Throughout this dissertation, I have attempted to clarify a few controversies relating to the theoretical syntactic status of adjectives, presented most recently in example (1) of this chapter. Although not each question mark in the syntactic structure was able to be resolved, we did see evidence that PREnochange adjectives are moved structures, and we reaffirmed that the postnominal adjectives are alike, due to the similar syntactic status they have to each other. The structure in (4) takes this information into account, yet shows that there are still several questions to be answered.

Perhaps the largest remaining question is the word class status of adjectives. Future work should continue to probe this unanswered question, first to determine if processing studies, particularly ERPs, reflect the theoretical difference in word class, and second, to apply this potential difference to adjectives to continue to tease apart the theoretical puzzle.
Even though debates as to the final syntactic status of adjectives remain, this dissertation has pooled theoretical and neurolinguistic resources to investigate a controversial linguistic structure, and the combination of both fields has helped clarify some of the theoretical questions presented in chapters 1 and 2. Further, we have seen potential implications that extend beyond the syntactic structure of adjectives into the realms of linguistic movement (merge) and agreement, two fundamental operations of linguistic structure. The results of this dissertation demonstrate the utility of combining theoretical and neurolinguistic methodologies and show how, together, they can shed light on the structure and mechanisms of human language grammar and its underlying operations.
CITED LITERATURE


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doi:10.1162/0898929052880101


APPENDICES
APPENDIX A

Participant Selection Criteria

*Why not use everyone?*

Two practice items, completed by all participants before entering into the ERP portion of the study, were designed to ensure that participants judged pre- and postnominal adjectives as predicted by the literature. These items, *cinco bellas chicas* ‘five pretty girls’ and *un constitucional document* ‘a constitutional document,’ were not answered “correctly” by everyone, however. As a result, I decided to consider removing these participants from the analysis.

First, I looked at the grand average of all participants using a contingency-based analysis. This set of waveforms was compared to the correct pre- and postnominal waveforms from participants who performed “correctly” on the practice test items *cinco bellas chicas* ‘five pretty girls’ and *un constitucional document* ‘a constitutional document.’ The waveforms were clearly distinct (with basically no effects for prenominal adjectives in the whole group set), so it was determined that participant inclusion should be based on their actual performance on the adjective types, which I am taking to be a reflection of their competence on those items. Importantly, note that it does not have to be the case that participants with lower accuracies necessarily have a different competence than those of higher accuracies. Their lower accuracy could be due to performance factors; finding other faults with the stimuli, for example, semantic incongruencies; or other factors. However, in order to be as conservative as possible with the analysis, for the group average, I only included participants who clearly displayed acceptance of the theoretically proposed distribution of adjective types.

The waveforms and top-level statistical analysis of the correctly agreeing forms for the whole-group contingency-based analysis is presented in Appendix H for comparative purposes.

*Who was eliminated from group analysis?*

I considered several possibilities for removal criteria. Factors considered include the following (note that accuracy must be used in all cases because all adjective conditions do not have a correct and violation counterpart, therefore d’ is not feasible):

1) Performance on the practice task. Participants who either marked *cinco bellas chicas* as incorrect and subsequently indicated that prenominal adjectives were not possible in Spanish (*n = 11*), or participants who indicated that *constitucional* could grammatically be used prenominally (*n = 1*), were eliminated. However, an investigation of actual performance on the task indicated that whereas some participants had low behavioral accuracies related to their claims on prenominal ungrammaticality, others (*n = 4*) performed quite well, showing that perhaps their claim during the practice task was related to metalinguistic knowledge and not to their actual competence. This criterion, then, was not used.
APPENDIX A (continued)

2) Demographic characteristics. Pearson’s $r$ correlations between accuracy on the GJT and the demographic characteristics gender, area of Mexico where raised, number of years of formal education, number of years of formal education in English, age of acquisition of English, number of years in the U.S., and percentage use of Spanish per day were not significant. Therefore, this criterion was not used.

3) Item analysis. For the PREonly adjective condition, participants saw each adjective four times in each position. Item analysis was performed to see if low accuracies were due to an overall dislike of the structure or a dislike of a particular lexical item used in that structure. A lexical item was considered “disliked” if the participant rated at least three of the four instances incorrectly (either disliking it prenominally or liking it postnominally). For six participants, it was determined that one lexical item (the item itself varied among the participants) was either disliked prenominally or liked postnominally, both of which are opposed to the theory presented in the literature and in my dissertation. It seems, then, that their overall competence on the structure is as predicted by theory but that one lexical item that is proposed to only occur prenominally had a different distribution for these participants, and, therefore, was not a true PREonly adjective. This criterion was used. For these participants, the offending adjective was removed from both the prenominal and postnominal conditions so that the average performance of these participants only contained adjectives with the appropriate distribution. Item analysis was then performed for the other adjective types as well. However, due to the fact that participants only see two examples of each adjective for this type, both had to be judged incorrectly at one of the positions (either prenominal or postnominal) for it to be removed. This affected two participants for the PRE/POSTnochange category, nine participants in the POSTonly category, and no participants in the PRE/POSTchange category, in addition to the six participants already mentioned for PREonly. (Note that these numbers come from the group of 21 participants analyzed in the study.)

4) General performance floor. This criterion was used. For all correctly agreeing adjective conditions, only participants who had an accuracy that was above 65% (with the correctly percentages from item analysis included) were included. This 65% cutoff is somewhat arbitrary, but it was chosen (a) because the participants appeared to be answering the GJT at an above-chance rate and judging the adjective types as predicted by the literature and (b) because this allowed a sufficient amount of data points to be entered into the average ERP waveforms. GJT judgments in accordance with the literature were important because the syntactic structure I tested was built around this distribution. Note that participants who had other judgments are not any “worse” at Spanish, but their $l$-dialects were not appropriate for the study at hand.

**Final group for analysis**

After adjusting accuracies based on condition 3 and eliminating participants based on condition 4, all participants were entered into a behavioral outlier analysis, which examined both the correctly agreeing adjective positions along with their agreement violation counterparts. The EEG of this group was processed and averaged in Matlab. As mentioned in
chapter 3, participants with no more than 30% of their EEG rejected for all conditions were included in the final analysis.
**APPENDIX B**

Critical Adjective Stimuli

Table B1

*PREonly Adjective Stimuli*

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### APPENDIX B (continued)

**Table B3**

**PRE/POSTnochange Adjective Stimuli**

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## APPENDIX B (continued)

Table B4

**POSTonly Adjective Stimuli**

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### APPENDIX C

Distractor Stimuli

#### Table C1

*Determiner Violation Stimuli*

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<th>Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feminine</td>
<td><em>el antigua respuesta</em>&lt;br&gt;<strong>el antigua respuesta</strong>&lt;br&gt;<em>el auténtica actriz</em>&lt;br&gt;<strong>el auténtica actriz</strong>&lt;br&gt;<em>el bella sugerencia</em>&lt;br&gt;<strong>el bella sugerencia</strong>&lt;br&gt;<em>el bella diversión</em>&lt;br&gt;<strong>el bella diversión</strong>&lt;br&gt;<em>el bonita calle</em>&lt;br&gt;<strong>el bonita calle</strong>&lt;br&gt;<em>el buena carretera</em>&lt;br&gt;<strong>el buena carretera</strong>&lt;br&gt;<em>el curiosa gallina</em>&lt;br&gt;<strong>el curiosa gallina</strong>&lt;br&gt;<em>el hermosa falda</em>&lt;br&gt;<strong>el hermosa falda</strong>&lt;br&gt;<em>el mala madre</em>&lt;br&gt;<strong>el mala madre</strong>&lt;br&gt;<em>el nueva mesa</em>&lt;br&gt;<strong>el nueva mesa</strong>&lt;br&gt;<em>el perfecta excusa</em>&lt;br&gt;<strong>el perfecta excusa</strong>&lt;br&gt;<em>el rica mujer</em>&lt;br&gt;<strong>el rica mujer</strong>&lt;br&gt;<em>el simpática vaca</em>&lt;br&gt;<strong>el simpática vaca</strong>&lt;br&gt;<em>el sola amiga</em>&lt;br&gt;<strong>el sola amiga</strong>&lt;br&gt;<em>el timida profesora</em>&lt;br&gt;<strong>el timida profesora</strong>&lt;br&gt;<em>el vieja tortuga</em>&lt;br&gt;<strong>el vieja tortuga</strong></td>
</tr>
<tr>
<td>Masculine</td>
<td><em>la antiguo centro</em>&lt;br&gt;<strong>la antiguo centro</strong>&lt;br&gt;<em>la auténtico negocio</em>&lt;br&gt;<strong>la auténtico negocio</strong>&lt;br&gt;<em>la bonito moño</em>&lt;br&gt;<strong>la bonito moño</strong>&lt;br&gt;<em>la buen actor</em>&lt;br&gt;<strong>la buen actor</strong>&lt;br&gt;<em>la curioso rey</em>&lt;br&gt;<strong>la curioso rey</strong>&lt;br&gt;<em>la lindo instructor</em>&lt;br&gt;<strong>la lindo instructor</strong>&lt;br&gt;<em>la lindo héroe</em>&lt;br&gt;<strong>la lindo héroe</strong>&lt;br&gt;<em>la mal niño</em>&lt;br&gt;<strong>la mal niño</strong>&lt;br&gt;<em>la nuevo juego</em>&lt;br&gt;<strong>la nuevo juego</strong>&lt;br&gt;<em>la perfecto proyecto</em>&lt;br&gt;<strong>la perfecto proyecto</strong>&lt;br&gt;<em>la rico padre</em>&lt;br&gt;<strong>la rico padre</strong>&lt;br&gt;<em>la simpático vestido</em>&lt;br&gt;<strong>la simpático vestido</strong>&lt;br&gt;<em>la simpático caballo</em>&lt;br&gt;<strong>la simpático caballo</strong>&lt;br&gt;<em>la solo hombre</em>&lt;br&gt;<strong>la solo hombre</strong>&lt;br&gt;<em>la tímid autor</em>&lt;br&gt;<strong>la tímid autor</strong>&lt;br&gt;<em>la viejo cuadro</em>&lt;br&gt;<strong>la viejo cuadro</strong></td>
</tr>
</tbody>
</table>

*Note.* The determiner agreement violation stimuli are paired with correct versions that are part of the PRE/POSTchange and PRE/POSTnochange stimuli presented in Appendix B.
APPENDIX C (continued)

Table C2

*Lexical and Functional First Word Stimuli*

<table>
<thead>
<tr>
<th>Lexical</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>casa de comercio</td>
<td>algún listo empleado</td>
</tr>
<tr>
<td>casa de muñecas</td>
<td>algún pobre muchacho</td>
</tr>
<tr>
<td>casa en orden</td>
<td>algún verdadero amor</td>
</tr>
<tr>
<td>casa en París</td>
<td>alguna clara idea</td>
</tr>
<tr>
<td>casa sin techo</td>
<td>alguna feliz casualidad</td>
</tr>
<tr>
<td>casa sin ventanas</td>
<td>alguna tímida chica</td>
</tr>
<tr>
<td>día de fiesta</td>
<td>cada bonita voz</td>
</tr>
<tr>
<td>día de mayo</td>
<td>cada curioso ratón</td>
</tr>
<tr>
<td>día de trabajo</td>
<td>cada extraño motivo</td>
</tr>
<tr>
<td>día en cama</td>
<td>cada futurística ciudad</td>
</tr>
<tr>
<td>día por día</td>
<td>cada linda mirada</td>
</tr>
<tr>
<td>día sin sol</td>
<td>cada maravilloso momento</td>
</tr>
<tr>
<td>gobierno de Guatemala</td>
<td>esta bella noche</td>
</tr>
<tr>
<td>gobierno de México</td>
<td>esta simple petición</td>
</tr>
<tr>
<td>gobierno de transición</td>
<td>esta sola muchacha</td>
</tr>
<tr>
<td>gobierno en orden</td>
<td>este nuevo sistema</td>
</tr>
<tr>
<td>gobierno en torno</td>
<td>este perfecto postre</td>
</tr>
<tr>
<td>gobierno sin ley</td>
<td>este simpático doctor</td>
</tr>
<tr>
<td>país con carácter</td>
<td>mucha buena luz</td>
</tr>
<tr>
<td>país de origen</td>
<td>mucha pequeña criña</td>
</tr>
<tr>
<td>país de residencia</td>
<td>mucha rica comida</td>
</tr>
<tr>
<td>país en África</td>
<td>mucho dulce amor</td>
</tr>
<tr>
<td>país en guerra</td>
<td>mucho hermoso cabello</td>
</tr>
<tr>
<td>país sin presidente</td>
<td>mucho precioso metal</td>
</tr>
<tr>
<td>tiempo de calor</td>
<td>ningún auténtico documento</td>
</tr>
<tr>
<td>tiempo de descanso</td>
<td>ningún breve espacio</td>
</tr>
<tr>
<td>tiempo de paz</td>
<td>ningún viejo futbolista</td>
</tr>
<tr>
<td>tiempo en casa</td>
<td>ninguna antigua persona</td>
</tr>
<tr>
<td>tiempo en silencio</td>
<td>ninguna estupenda posibilidad</td>
</tr>
<tr>
<td>tiempo para llamar</td>
<td>ninguna profunda tristeza</td>
</tr>
<tr>
<td>vida al parecer</td>
<td>poca buena amistad</td>
</tr>
<tr>
<td>vida de campo</td>
<td>poca limpia agua</td>
</tr>
<tr>
<td>vida de dolor</td>
<td>poca mala fe</td>
</tr>
<tr>
<td>vida de felicidad</td>
<td>poco gran poesía</td>
</tr>
<tr>
<td>vida en común</td>
<td>poco inevitable fama</td>
</tr>
<tr>
<td>vida en peligro</td>
<td>poco restringido aceso</td>
</tr>
</tbody>
</table>
APPENDIX C (continued)

Table C3

*Lexical and Functional Second Word Stimuli*

<table>
<thead>
<tr>
<th>Lexical</th>
<th>Functional</th>
</tr>
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<tbody>
<tr>
<td>una casa abierta</td>
<td>es algún error</td>
</tr>
<tr>
<td>una casa buena</td>
<td>es algún tema</td>
</tr>
<tr>
<td>una casa española</td>
<td>es algún tipo</td>
</tr>
<tr>
<td>una casa francesa</td>
<td>es alguna distracción</td>
</tr>
<tr>
<td>una casa plana</td>
<td>es alguna historia</td>
</tr>
<tr>
<td>una casa redonda</td>
<td>es alguna razón</td>
</tr>
<tr>
<td>un día abierto</td>
<td>está cada bailarín</td>
</tr>
<tr>
<td>un día bonito</td>
<td>está cada botella</td>
</tr>
<tr>
<td>un día curioso</td>
<td>está cada director</td>
</tr>
<tr>
<td>un día hermoso</td>
<td>está cada estudiante</td>
</tr>
<tr>
<td>un día perfecto</td>
<td>está cada persona</td>
</tr>
<tr>
<td>un día rico</td>
<td>está cada silla</td>
</tr>
<tr>
<td>un gobierno abierto</td>
<td>es esta esquina</td>
</tr>
<tr>
<td>un gobierno antiguo</td>
<td>es esta mesa</td>
</tr>
<tr>
<td>un gobierno complejo</td>
<td>es esta tienda</td>
</tr>
<tr>
<td>un gobierno español</td>
<td>es este ejemplo</td>
</tr>
<tr>
<td>un gobierno francés</td>
<td>es este lápiz</td>
</tr>
<tr>
<td>un gobierno nuevo</td>
<td>es este libro</td>
</tr>
<tr>
<td>un país abierto</td>
<td>hay mucha gente</td>
</tr>
<tr>
<td>un país lindo</td>
<td>hay mucha publicidad</td>
</tr>
<tr>
<td>un país plano</td>
<td>hay mucha tarea</td>
</tr>
<tr>
<td>un país redondo</td>
<td>hay mucho queso</td>
</tr>
<tr>
<td>un país rico</td>
<td>hay mucho ruido</td>
</tr>
<tr>
<td>un país viejo</td>
<td>hay mucho vino</td>
</tr>
<tr>
<td>un tiempo abierto</td>
<td>hay ningún motivo</td>
</tr>
<tr>
<td>un tiempo antiguo</td>
<td>hay ningún pájaro</td>
</tr>
<tr>
<td>un tiempo bonito</td>
<td>hay ningún riesgo</td>
</tr>
<tr>
<td>un tiempo curioso</td>
<td>hay ninguna maestra</td>
</tr>
<tr>
<td>un tiempo hermoso</td>
<td>hay ninguna pared</td>
</tr>
<tr>
<td>un tiempo perfecto</td>
<td>hay ninguna ventanal</td>
</tr>
<tr>
<td>una vida compleja</td>
<td>hay poca harina</td>
</tr>
<tr>
<td>una vida española</td>
<td>hay poca leche</td>
</tr>
<tr>
<td>una vida francesa</td>
<td>hay poca luz</td>
</tr>
<tr>
<td>una vida simpática</td>
<td>hay poco oxígeno</td>
</tr>
<tr>
<td>una vida sola</td>
<td>hay poco polvo</td>
</tr>
<tr>
<td>una vida suelta</td>
<td>hay poco vino</td>
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</table>
### Table C4

**Additional Distractor Stimuli**

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<tr>
<th>Noun gender</th>
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<th>Postnominal</th>
<th>Prenominal</th>
<th>Postnominal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feminine</td>
<td>una dulce voz</td>
<td>una democracia compleja</td>
<td>una gran cantidad</td>
<td>una carta detallada</td>
</tr>
<tr>
<td></td>
<td>una razonable distancia</td>
<td>una comida española</td>
<td>una corta historia</td>
<td>una cara redonda</td>
</tr>
<tr>
<td></td>
<td>una excelente idea</td>
<td>una jota tuerta</td>
<td>una breve pausa</td>
<td>una cosa mala</td>
</tr>
<tr>
<td></td>
<td>una pobre criatura</td>
<td>una letra abierta</td>
<td>una agradable sorpresa</td>
<td>una letra abierta</td>
</tr>
<tr>
<td></td>
<td>una larga distancia</td>
<td>una hoja suelta</td>
<td>una profunda reverencia</td>
<td>una obra bella</td>
</tr>
<tr>
<td></td>
<td>una simple vista</td>
<td>una sociedad española</td>
<td>una fantástica carrera</td>
<td>una superficie plana</td>
</tr>
<tr>
<td></td>
<td>una extraña sensación</td>
<td>una canción francésa</td>
<td>una pequeña cantidad</td>
<td>una tabla redonda</td>
</tr>
<tr>
<td></td>
<td>una feliz ocurrencia</td>
<td>una pelota redonda</td>
<td>una verdadera causa</td>
<td>una pelota plana</td>
</tr>
<tr>
<td>Masculine</td>
<td>un listo plan</td>
<td>un mundo nuevo</td>
<td>un pobre joven</td>
<td>un pie plano</td>
</tr>
<tr>
<td></td>
<td>un cierto punto</td>
<td>un documento auténtico</td>
<td>un largo rato</td>
<td>un ojo tuerto</td>
</tr>
<tr>
<td></td>
<td>un dulce sueño</td>
<td>un número complejo</td>
<td>un profundo silencio</td>
<td>un cabo suelto</td>
</tr>
<tr>
<td></td>
<td>un feliz sobre</td>
<td>un perro tuerto</td>
<td>un gran número</td>
<td>un problema complejo</td>
</tr>
<tr>
<td></td>
<td>un verdadero motivo</td>
<td>un equipo nacional</td>
<td>un extraño fenómeno</td>
<td>un cura tuerto</td>
</tr>
<tr>
<td></td>
<td>un estupendo milagro</td>
<td>un programa francés</td>
<td>un simple hecho</td>
<td>un buey suelto</td>
</tr>
<tr>
<td></td>
<td>un claro entendimiento</td>
<td>un verso suelto</td>
<td>un cierto aire</td>
<td>un plumón negro</td>
</tr>
<tr>
<td></td>
<td>un maravilloso espectáculo</td>
<td>un rostro simpático</td>
<td>un breve rato</td>
<td>un gato tímidio</td>
</tr>
</tbody>
</table>
**APPENDIX D**

Pilot Distractor Stimuli

Table D1

*Pilot Demonstrative Stimuli*

<table>
<thead>
<tr>
<th>Noun gender</th>
<th>Prenominal adjectives</th>
<th>Postnominal adjectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Masculine</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>este dulce niño</td>
<td>este caballo alto</td>
</tr>
<tr>
<td></td>
<td>este escricto instructor</td>
<td>este hombre bravo</td>
</tr>
<tr>
<td></td>
<td>este famoso cuadro</td>
<td>este proyecto complicado</td>
</tr>
<tr>
<td></td>
<td>este fantástico padre</td>
<td>este autor conocido</td>
</tr>
<tr>
<td></td>
<td>este futuro actor</td>
<td>este héroe épico</td>
</tr>
<tr>
<td></td>
<td>este gran centro</td>
<td>este vestido rojo</td>
</tr>
<tr>
<td></td>
<td>este poderoso rey</td>
<td>este juego simple</td>
</tr>
<tr>
<td></td>
<td>este precioso moño</td>
<td>este negocio sucio</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Feminine</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>esta estupenda mujer</td>
<td>esta mesa cuadrada</td>
</tr>
<tr>
<td></td>
<td>esta favorecedora falda</td>
<td>esta carretera directa</td>
</tr>
<tr>
<td></td>
<td>esta fiabile amiga</td>
<td>esta vaca negra</td>
</tr>
<tr>
<td></td>
<td>esta inteligente profesora</td>
<td>esta madre paciente</td>
</tr>
<tr>
<td></td>
<td>esta intuitiva respuesta</td>
<td>esta calle pequeña</td>
</tr>
<tr>
<td></td>
<td>esta maravillosa diversión</td>
<td>esta gallina saludable</td>
</tr>
<tr>
<td></td>
<td>esta precisa excusa</td>
<td>esta sugerencia útil</td>
</tr>
<tr>
<td></td>
<td>esta talentosa actriz</td>
<td>esta tortuga verde</td>
</tr>
</tbody>
</table>
**APPENDIX D (continued)**

Table D2

*Pilot Quantifier Stimuli – Cada ‘Each’*

<table>
<thead>
<tr>
<th>Noun gender</th>
<th>Prenominal adjectives</th>
<th>Postnominal adjectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masculine</td>
<td>cada dulce niño</td>
<td>cada caballo alto</td>
</tr>
<tr>
<td></td>
<td>cada estricto instructor</td>
<td>cada hombre bravo</td>
</tr>
<tr>
<td></td>
<td>cada famoso cuadro</td>
<td>cada proyecto complicado</td>
</tr>
<tr>
<td></td>
<td>cada fantástico padre</td>
<td>cada autor conocido</td>
</tr>
<tr>
<td></td>
<td>cada futuro actor</td>
<td>cada héroé épico</td>
</tr>
<tr>
<td></td>
<td>cada gran centro</td>
<td>cada vestido rojo</td>
</tr>
<tr>
<td></td>
<td>cada poderoso rey</td>
<td>cada juego simple</td>
</tr>
<tr>
<td></td>
<td>cada precioso moño</td>
<td>cada negocio sucio</td>
</tr>
<tr>
<td>Feminine</td>
<td>cada estupenda mujer</td>
<td>cada mesa cuadrada</td>
</tr>
<tr>
<td></td>
<td>cada favorecedora falda</td>
<td>cada carretera directa</td>
</tr>
<tr>
<td></td>
<td>cada fiable amiga</td>
<td>cada vaca negra</td>
</tr>
<tr>
<td></td>
<td>cada inteligente profesora</td>
<td>cada madre paciente</td>
</tr>
<tr>
<td></td>
<td>cada intuitiva respuesta</td>
<td>cada calle pequeña</td>
</tr>
<tr>
<td></td>
<td>cada maravillosa diversion</td>
<td>cada gallina saludable</td>
</tr>
<tr>
<td></td>
<td>cada precisa excusa</td>
<td>cada sugerencia útil</td>
</tr>
<tr>
<td></td>
<td>cada talentosa actriz</td>
<td>cada tortuga verde</td>
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</table>
### APPENDIX D (continued)

Table D3

*Pilot Quantifier Stimuli – Muchos/Pocos ‘Many/Few’*

<table>
<thead>
<tr>
<th>Quantifier</th>
<th>Noun gender</th>
<th>Prenominal adjectives</th>
<th>Postnominal adjectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muchos</td>
<td>Masculine</td>
<td>muchos autores conocidos</td>
<td>muchos dulces niños</td>
</tr>
<tr>
<td></td>
<td></td>
<td>muchos caballos altos</td>
<td>muchos escritos instructores</td>
</tr>
<tr>
<td></td>
<td></td>
<td>muchos hombres bravos</td>
<td>muchos famosos cuadros</td>
</tr>
<tr>
<td></td>
<td></td>
<td>muchos proyectos complicados</td>
<td>muchos poderosos reyes</td>
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<tr>
<td>Feminine</td>
<td></td>
<td>muchas gallinas saludables</td>
<td>muchas inteligentes profesoras</td>
</tr>
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<td></td>
<td></td>
<td>muchas madres pacientes</td>
<td>muchas intuitivas respuestas</td>
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<tr>
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<td></td>
<td>muchas mesas cuadradas</td>
<td>muchas maravillosas diversiones</td>
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<tr>
<td></td>
<td></td>
<td>muchas sugerencias útiles</td>
<td>muchas talentosas actrices</td>
</tr>
<tr>
<td>Pocos</td>
<td>Masculine</td>
<td>pocos fantásticos padres</td>
<td>pocos héroes épicos</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pocos futuros actores</td>
<td>pocos juegos simples</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pocos grandes centros</td>
<td>pocos negocios sucios</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pocos preciosos moños</td>
<td>pocos vestidos rojos</td>
</tr>
<tr>
<td>Feminine</td>
<td></td>
<td>pocas calles pequeñas</td>
<td>pocas estupendas mujeres</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pocas carreteras directas</td>
<td>pocas favorecedoras faldas</td>
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<tr>
<td></td>
<td></td>
<td>pocas tortugas verdes</td>
<td>pocas fiables amigas</td>
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<tr>
<td></td>
<td></td>
<td>pocas vacas negras</td>
<td>pocas precisas excusas</td>
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</table>
APPENDIX D (continued)

Table D4

_Pilot Quantifier Stimuli – Algunos ‘Some’_

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<tr>
<th>Noun gender</th>
<th>Prenominal adjectives</th>
<th>Postnominal adjectives</th>
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</thead>
<tbody>
<tr>
<td>Masculine</td>
<td>algunos autores conocidos</td>
<td>algunos dulces niños</td>
</tr>
<tr>
<td></td>
<td>algunos caballos altos</td>
<td>algunos escíctos instructores</td>
</tr>
<tr>
<td></td>
<td>algunos héroes épicos</td>
<td>algunos famosos cuadros</td>
</tr>
<tr>
<td></td>
<td>algunos hombres bravos</td>
<td>algunos fantásticos padres</td>
</tr>
<tr>
<td></td>
<td>algunos juegos simples</td>
<td>algunos futuros actores</td>
</tr>
<tr>
<td></td>
<td>algunos negocios sucios</td>
<td>algunos grandes centros</td>
</tr>
<tr>
<td></td>
<td>algunos proyectos complicados</td>
<td>algunos poderosos reyes</td>
</tr>
<tr>
<td></td>
<td>algunos vestidos rojos</td>
<td>algunos preciosos moños</td>
</tr>
<tr>
<td>Feminine</td>
<td>algunas calles pequeñas</td>
<td>algunas estupendas mujeres</td>
</tr>
<tr>
<td></td>
<td>algunas carreteras directas</td>
<td>algunas favorecedoras faldas</td>
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<tr>
<td></td>
<td>algunas gallinas saludables</td>
<td>algunas fiables amigas</td>
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<tr>
<td></td>
<td>algunas madres pacientes</td>
<td>algunas inteligentes profesoras</td>
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<tr>
<td></td>
<td>algunas mesas cuadradas</td>
<td>algunas intuitivas respuestas</td>
</tr>
<tr>
<td></td>
<td>algunas sugerencias útiles</td>
<td>algunas maravillosas diversiones</td>
</tr>
<tr>
<td></td>
<td>algunas tortugas verdes</td>
<td>algunas precisas excusas</td>
</tr>
<tr>
<td></td>
<td>algunas vacas negras</td>
<td>algunas talentosas actrices</td>
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APPENDIX D (continued)

Table D5

*Pilot Quantifier Stimuli – Los Muchos/Pocos ‘The Many/Few’*

<table>
<thead>
<tr>
<th>Noun gender</th>
<th>Los muchos</th>
<th>Los pocos</th>
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<tr>
<td>Masculine</td>
<td>los muchos actores</td>
<td>los pocos autores</td>
</tr>
<tr>
<td></td>
<td>los muchos centros</td>
<td>los pocos caballos</td>
</tr>
<tr>
<td></td>
<td>los muchos cuadros</td>
<td>los pocos héroes</td>
</tr>
<tr>
<td></td>
<td>los muchos hombres</td>
<td>los pocos instructores</td>
</tr>
<tr>
<td></td>
<td>los muchos juegos</td>
<td>los pocos niños</td>
</tr>
<tr>
<td></td>
<td>los muchos moños</td>
<td>los pocos padres</td>
</tr>
<tr>
<td></td>
<td>los muchos negocios</td>
<td>los pocos proyectos</td>
</tr>
<tr>
<td></td>
<td>los muchos vestidos</td>
<td>los pocos reyes</td>
</tr>
<tr>
<td>Feminine</td>
<td>las muchas actrices</td>
<td>las pocas amigas</td>
</tr>
<tr>
<td></td>
<td>las muchas calles</td>
<td>las pocas diversiones</td>
</tr>
<tr>
<td></td>
<td>las muchas carreteras</td>
<td>las pocas faldas</td>
</tr>
<tr>
<td></td>
<td>las muchas excusas</td>
<td>las pocas mesas</td>
</tr>
<tr>
<td></td>
<td>las muchas gallinas</td>
<td>las pocas respuestas</td>
</tr>
<tr>
<td></td>
<td>las muchas madres</td>
<td>las pocas sugerencias</td>
</tr>
<tr>
<td></td>
<td>las muchas mujeres</td>
<td>las pocas tortugas</td>
</tr>
<tr>
<td></td>
<td>las muchas profesoras</td>
<td>las pocas vacas</td>
</tr>
</tbody>
</table>
APPENDIX D (continued)

Table D6

_Pilot Quantifier Stimuli – Todos ‘All’_

<table>
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<th>Masculine nouns</th>
<th>Feminine nouns</th>
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</thead>
<tbody>
<tr>
<td>todos los actores</td>
<td>todas las actrices</td>
</tr>
<tr>
<td>todos los autores</td>
<td>todas las amigas</td>
</tr>
<tr>
<td>todos los caballos</td>
<td>todas las calles</td>
</tr>
<tr>
<td>todos los centros</td>
<td>todas las carreteras</td>
</tr>
<tr>
<td>todos los cuadros</td>
<td>todas las diversiones</td>
</tr>
<tr>
<td>todos los héroes</td>
<td>todas las excusas</td>
</tr>
<tr>
<td>todos los hombres</td>
<td>todas las faldas</td>
</tr>
<tr>
<td>todos los instructores</td>
<td>todas las gallinas</td>
</tr>
<tr>
<td>todos los juegos</td>
<td>todas las madres</td>
</tr>
<tr>
<td>todos los moños</td>
<td>todas las mesas</td>
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<tr>
<td>todos los negocios</td>
<td>todas las mujeres</td>
</tr>
<tr>
<td>todos los niños</td>
<td>todas las profesoras</td>
</tr>
<tr>
<td>todos los padres</td>
<td>todas las respuestas</td>
</tr>
<tr>
<td>todos los proyectos</td>
<td>todas las sugerencias</td>
</tr>
<tr>
<td>todos los reyes</td>
<td>todas las tortugas</td>
</tr>
<tr>
<td>todos los vestidos</td>
<td>todas las vacas</td>
</tr>
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APPENDIX E

Full Set of Waveforms from Dissertation Analysis

Figure E1. Waveforms for correctly agreeing prenominal adjectives (PREonly, PREchange, PREnochange). Note. PREonly in orange, PREchange in green, PREnochange in blue.
Figure E2. Waveforms for correctly agreeing postnominal adjectives (POSTchange, POSTnochange, POSTonly).

Note. POSTchange in green, POSTnochange in blue, POSTonly in purple.
Figure E3. Waveforms for lexical (noun) and functional (quantifier) stimuli.  
Note. Lexical in brown, functional in dark green.
Figure E4. Waveforms for correct and violation PREonly adjectives.
Note. PREonly correct in orange, violation in red.
**APPENDIX E (continued)**

*Figure E5.* Waveforms for correct and violation PREchange adjectives.

*Note.* PREchange correct in green, violation in red.
Figure E6. Waveforms for correct and violation PREnochange adjectives.  
Note. PREnochange correct in blue, violation in red.
Figure E7. Waveforms for correct and violation POSTchange adjectives.

Note. POSTchange correct in green, violation in red.
APPENDIX E (continued)

Figure E8. Waveforms for correct and violation POSTnochange adjectives. Note. POSTnochange correct in blue, violation in red.
APPENDIX E (continued)

Figure E9. Waveforms for correct and violation POSTonly adjectives.

Note. POSTonly correct in purple, violation in red.
Figure E10. Waveforms for the nouns following correctly agreeing PREonly and PREnochange adjectives. Note. PREonly in orange, PREnochange in blue.
APPENDIX F

Contingency-Based Analysis of All Participants

This appendix reports on the contingency-based analysis for prenominal and postnominal correctly agreeing adjectives for all participants who were tested for the study (N = 40). From this group, whose general characteristics were described in section 3.1, one was removed from analysis due to task failure (failing to answer the GJT prompt questions; female), two were eliminated due to excessive EEG artifacts (one male), and two were eliminated due to equipment failure (one male). Thus, this appendix analyzes 35 participants (15 males).

The data for all participants was processed as indicated in section 3.4 and analysis is as reported in section 3.5. I report first on the behavioral data, then on the ERP results.

Behavioral results

Table F1 provides the GJT accuracies for all participants. Two separate repeated-measures ANOVAs were run to investigate the factors Type$_{PRE}$ and Type$_{POST}$. The prenominal ANOVA revealed a main effect of Type ($F(1.311, 44.561) = 7.951, p = .004$) due to PREnochange adjectives being responded to more accurately than PREonly ($p = .033$) and PREchange being responded to more accurately than both of the other types ($p = .030$ for PREonly, $p = .015$ for PREnochange). The postnominal ANOVA was not significant, thus all postnominal adjectives types were judged with equal accuracy.
APPENDIX F (continued)

Table F1

*Full Participant Analysis: GJT Accuracy (% Correct) for Correctly Agreeing Adjective Types*

<table>
<thead>
<tr>
<th>Position</th>
<th>Adjective type</th>
<th>M</th>
<th>SD</th>
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<tbody>
<tr>
<td>Prenominal</td>
<td>PREonly</td>
<td>76.27</td>
<td>18.74</td>
</tr>
<tr>
<td></td>
<td>PREchange</td>
<td>86.97</td>
<td>14.43</td>
</tr>
<tr>
<td></td>
<td>PREnochange</td>
<td>79.77</td>
<td>14.54</td>
</tr>
<tr>
<td>Postnominal</td>
<td>POSTchange</td>
<td>91.67</td>
<td>6.53</td>
</tr>
<tr>
<td></td>
<td>POSTnochange</td>
<td>90.85</td>
<td>7.34</td>
</tr>
<tr>
<td></td>
<td>POSTonly</td>
<td>90.05</td>
<td>8.98</td>
</tr>
</tbody>
</table>

*ERP Results*

For the ERP analysis, EEG was time-locked to the critical stimuli and averaged using a 200 ms pre-stimulus baseline. For each of the two time windows (300-500 ms and 600-900 ms) two separate repeated-measures ANOVAs were run investigating the factors Type\textsubscript{PRE}/Type\textsubscript{POST}, Hemisphere, Laterality, and Ant/Post, along with the separate midline analysis for each investigating Type\textsubscript{PRE}/Type\textsubscript{POST} and Ant/Post\textsubscript{mid}. I report on the prenominal adjectives first.
APPENDIX F (continued)

*Prenominal adjectives.*

Grand average ERP waveforms for the prenominal adjectives are displayed in Figure F1. Visual analysis indicates that overall the waveforms look similar for all prenominal adjectives. However, PREnochange has a small frontocentral, slightly left-lateralized negativity from around 400-600 ms, and PREonly shows a sustained positivity beginning around 400 ms in electrode T8. Both the laterality and the midline ANOVAs for the 300-500 ms window revealed no significant main effects or interactions. The laterality ANOVA for the 600-900 ms indicated a Type x Hemisphere interaction ($F(2, 68) = 4.002, p = .023$), but follow-ups were not significant. The midline analysis was not significant. Consistent with the relative similarity seen visually among the waveforms, processing of the correctly agreeing prenominal adjective types did not differ in the full group analysis.

*Postnominal adjectives.*

Grand average ERP waveforms for the postnominal adjectives are displayed in Figure F2. Visual analysis indicates a posterior P600-type positivity for POSTchange and POSTonly adjectives starting at around 600 ms post-stimulus. The laterality and midline ANOVAs for the 300-500 ms time window supported the lack of visual effects revealing no significant main effects or interactions. The laterality ANOVA for the 600-900 ms window revealed a Type x Hemisphere interaction ($F(2, 68) = 4.084, p = .021$). However, follow-ups were not significant. Midline analyses were also not significant. Therefore, the correctly agreeing postnominal adjective types did not differ in terms of processing in the full group analysis.
Figure F1. Full participant (N = 35) waveforms for correctly agreeing prenominal adjectives (PREonly, PREchange, PREnochange). Note. PREonly in orange, PREchange in green, PREnochange in blue.
APPENDIX F (continued)

*Figure F2.* Full participant (N = 35) waveforms for correctly agreeing postnominal adjectives (POSTchange, POSTnochange, POSTonly).

*Note.* POSTchange in green, POSTnochange in blue, POSTonly in purple.
APPENDIX G

Non-Contingency-Based Analysis of Included Participants

In this appendix, I re-analyze the prenominal and postnominal correctly agreeing adjective data for the 21 participants included in the full dissertation analysis, but the ERP averaging is done on a non-contingency basis, that is, all of the participants’ responses (correct, incorrect, and unanswered) were included. I report only on the ERP results because the participant characteristics and behavioral analysis were already covered (sections 3.1 and 4.1, respectively). EEG processing and analysis procedures are the same as those reported in sections 3.4 and 3.5.2, respectively.

**ERP Results**

In this section I report on a 300-500 ms and 600-900 ms time window for both prenominal and postnominal correctly agreeing adjective stimuli. I begin with the prenominal adjectives, then I analyze the postnominal ones.

**Prenominal adjectives.**

Grand average waveforms for the correctly agreeing prenominal adjective stimuli are presented in Figure G1. Visual inspection indicates that PREnochange adjectives are more negative than PREonly for all electrodes starting around 300 ms and are more negative than PREchange adjectives anteriorly during the same time frame. Additionally, PREchange adjectives appear to be more negative than PREonly in posterior electrodes beginning at around 300 ms.
APPENDIX G (continued)

The laterality ANOVA for the 300-500 ms time window showed a main effect for Type ($F(2, 40) = 4.493, p = .017$) and a Type x Laterality interaction ($F(2, 40) = 4.196, p = .024$). Follow-ups indicated that PREnochange was more negative than PREonly for both lateral ($p = .016$) and medial ($p = .010$) electrodes. PREchange did not differ from either of the other two groups. The midline ANOVA revealed a main effect of Type ($F(2, 40) = 5.349, p = .009$). Follow-ups indicated that PREnochange was significantly more negative than PREonly in the midline ($p = .006$). Again PREchange did not differ from the other two prenominal types. Overall, then, for the 300-500 ms time window, PREnochange was more negative than PREonly, and PREchange did not differ from either PREonly or PREnochange, all of which is in line with the analysis reported in the dissertation in section 4.2.1.

For the 600-900 ms window, the laterality ANOVA revealed no significant effects or interactions, nor did the midline analysis. This lack of effects in the later time window is at odds with the sustained negativity found for PREnochange compared to PREonly adjectives in section 4.2.1.

Postnominal adjectives.

Grand average waveforms for the correctly agreeing postnominal adjective stimuli are presented in Figure G2. Visual analysis indicates a posterior positivity for POSTchange and POSTonly beginning around 600 ms. However, the laterality and midline ANOVAs for both the 300-500 ms and the 600-900 ms time windows revealed no significant main effects or interactions. Thus, postnominal adjectives did not differ from each other in the early time window, in agreement with the results presented in section 4.2.2.
Figure G1. Non-contingency-based waveforms for included participants (N = 21) for correctly agreeing prenominal adjectives (PREonly, PREchange, PREnochange).

Note. PREonly in orange, PREchange in green, PREnochange in blue.
Figure G2. Non-contingency-based waveforms for included participants (N = 21) for correctly agreeing postnominal adjectives (POSTchange, POSTnochange, POSTonly).

Note. POSTchange in green, POSTnochange in blue, POSTonly in purple.
APPENDIX H

IRB Approval – Original Submission

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Initial Review (Response to Modifications)

July 7, 2008

Kara Morgan Short, Ph.D.
Spanish, French, Italian and Portuguese
601 S. Morgan St.
1718 UH, M/C 315
Chicago, IL 60607-7117
Phone: (312) 996-5215 / Fax: (312) 413-1044

RE: Protocol # 2008-0496
“The Cognition of Language Acquisition and Processing”

Dear Dr. Short:

Your Initial Review Application (Response to Modifications) was reviewed and approved by the Expedited review process on June 23, 2008. You may now begin your research.

Please note the following information about your approved research protocol:

Protocol Approval Period: June 23, 2008 - June 22, 2009
Approved Subject Enrollment #: 500
Additional Determinations for Research Involving Minors: These determinations have not been made for this study since it has not been approved for enrollment of minors.
Performance Sites: UIC
Sponsor: Office of Social Science Research (OSSR)
PAF#: Not applicable
Grant/Contract No: Not applicable
Grant/Contract Title: Understanding heritage language processing: A unique opportunity for research and community

Research Protocol(s):
  a) The Cognition of Language Acquisition and Processing; Version 1; 06/03/2008
APPENDIX H (continued)

Recruitment Material(s):

a) The Cognition of Language Handout; Version 2; 06/12/2008
b) The Cognition of Language Message; Version 2; 06/18/2008
c) The Cognition of Language Research Form; Version 2; 06/18/2008
d) The Cognition of Language Research Flyer; Version 2; 06/18/2008

Informed Consent(s):

a) The Cognition of Language Research Consent Form; Version 2; 06/18/2008

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.) Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual;

(6) Collection of data from voice, video, digital, or image recordings made for research purposes; and

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

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APPENDIX H (continued)

Please remember to:
→ Use your research protocol number (2008-0496) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure, "UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 355-2908. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Charles W. Hoehne
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

Enclosure(s):

1. UIC Investigator Responsibilities, Protection of Human Research Subjects
2. Informed Consent Document(s):
   a) The Cognition of Language Research Consent Form; Version 2; 06/18/2008
3. Recruiting Material(s):
   a) The Cognition of Language Handout; Version 2; 06/12/2008
   b) The Cognition of Language Message; Version 2; 06/18/2008
   c) The Cognition of Language Research Form; Version 2; 06/18/2008
   d) The Cognition of Language Research Flyer; Version 2; 06/18/2008

cc: Dianna Niebylski, Spanish, French, Italian and Portuguese, M/C 315
    OVCR Administration, M/C 672
APPENDIX I

IRB Approval – Continuing Review

University of Illinois
at Chicago

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Continuing Review (Response To Modifications)

April 17, 2012

Kara Morgan Short, Ph.D.
Spanish, French, Italian and Portuguese
601 S. Morgan St.
1718 UH, M/C 315
Chicago, IL 60607-7117
Phone: (312) 996-5743 / Fax: (312) 413-1044

RE: Protocol # 2008-0496
“The Cognition of Language Acquisition and Processing”

Dear Dr. Short:

Your Continuing Review (Response To Modifications) was reviewed and approved by the Expedited review process on April 16, 2012. You may now continue your research.

Please note the following information about your approved research protocol:

Approved Subject Enrollment #: 500 (254 subjects currently enrolled)
Additional Determinations for Research Involving Minors: These determinations have not been made for this study since it has not been approved for enrollment of minors.
Performance Sites: UIC, Northwestern University
Sponsor: Office of Social Science Research (OSSR)
PAF#: Not available
Grant/Contract No: Not available
Grant/Contract Title: Understanding heritage language processing: A unique opportunity for research and community

Research Protocol(s):

a) The Cognition of Language Acquisition and Processing; Version 3; 06/01/2009
APPENDIX I (continued)

Recruitment Material(s):

a) The Cognition of Language Message; Version 3; 06/01/2009
b) The Cognition of Language Handout; Version 3; 06/01/2009
c) The Cognition of Language Research Interest Form; Version 3; 06/01/2009
d) The Cognition of Language Research Flyer; Version 3; 06/01/2009
e) The Cognition of Language Research L2 Interest Form; Version 4; 09/23/2009
g) The Cognition of Language L2 Handout; Version 4; 09/23/2009
h) The Cognition of Language L2 Research Flyer; Version 4; 09/23/2009
j) The Cognition of Language NS Handout; Version 3; 09/23/2009
k) The Cognition of Language Research NS Interest Form; Version 4; 09/23/2009
m) Forma de La Investigacion de Lenguaje; Version 5; 09/17/2010
n) Convocatoria para la Investigacion: Cognicion de Lenguaje; Version 5; 09/17/2010
o) Convocatoria para la Cognicion de Lenguaje; Version 5; 09/17/2010
p) Mensage de la Cognicion de Lenguaje HN; Version 5; 09/17/2010

Informed Consent(s):

a) Psychology Subject Pool, Educational Debriefing Form; Version 1; 06/01/2009
b) The Cognition of Language Research Consent Form; Version 5, 04/26/2011
c) Forma de Consentimiento del Estudio de Cognicion de Lenguaje; Version 4, 04/26/2011

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category(ies):

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)

Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual., (6) Collection of data from voice, video, digital, or image recordings made for research purposes., (7) Research on
APPENDIX I (continued)

individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

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Please remember to:

➔ Use your **research protocol number** (2008-0496) on any documents or correspondence with the IRB concerning your research protocol.

➔ Review and comply with all requirements on the enclosure, "UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 355-0816. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Alison Santiago, MSW, MJ
IRB Coordinator, IRB # 2
Office for the Protection of Research Subjects

Enclosure(s):

1. UIC Investigator Responsibilities, Protection of Human Research Subjects
APPENDIX I (continued)

2. Informed Consent Document(s):
   a) Psychology Subject Pool, Educational Debriefing Form; Version 1; 06/01/2009
   b) The Cognition of Language Research Consent Form; Version 5, 04/26/2011
   c) Forma de Consentimiento del Estudio de Cognicion de Lenguaje; Version 4, 04/26/2011

3. Recruiting Material(s):
   a) The Cognition of Language Message; Version 3; 06/01/2009
   b) The Cognition of Language Handout; Version 3; 06/01/2009
   c) The Cognition of Language Research Interest Form; Version 3; 06/01/2009
   d) The Cognition of Language Research Flyer; Version 3; 06/01/2009
   e) The Cognition of Language Research L2 Interest Form; Version 4; 09/23/2009
   g) The Cognition of Language L2 Handout; Version 4; 09/23/2009
   h) The Cognition of Language L2 Research Flyer; Version 4; 09/23/2009
   j) The Cognition of Language NS Handout; Version 3; 09/23/2009
   k) The Cognition of Language Research NS Interest Form; Version 4; 09/23/2009
   m) Forma de La Investigacion de Lenguaje; Version 5; 09/17/2010
   n) Convocatoria para la Investigacion: Cognicion de Lenguaje; Version 5; 09/17/2010
   o) Convocatoria para la Cognicion de Lenguaje; Version 5; 09/17/2010
   p) Mensaje de la Cognicion de Lenguaje HN; Version 5; 09/17/2010

cc: Rosilie Hernandez-Pecoraro, Spanish, French, Italian and Portuguese, M/C 315
OVCR Administration, M/C 672
VITA

NAME: Laura Beth Bartlett

EDUCATION: Ph.D., Hispanic Studies, University of Illinois at Chicago, Chicago, Illinois, 2013

M.A., Hispanic Studies, University of Illinois at Chicago, Chicago, Illinois, 2008

B.A., Spanish, Francis Marion University, Florence, South Carolina, 2004

B.S., Biology, West Virginia University, Morgantown, West Virginia, 2002

HONORS: Dean’s Scholar Award, University of Illinois at Chicago, AY 2012

Audrey Lumsden-Kouvel Fellowship, University of Illinois at Chicago, Spring 2012

Chancellor’s Supplemental Graduate Research Fellowship, University of Illinois at Chicago, Spring 2011, 2012

Excellence in Coordinating Award, Department of Hispanic and Italian Studies, University of Illinois at Chicago Spring 2011, 2009, 2008

Excellence in Teaching Award, 200-level, Department of Hispanic and Italian Studies, University of Illinois at Chicago, Spring 2010

Excellence in Teaching Award, Basic Language Program, Department of Hispanic and Italian Studies, University of Illinois at Chicago, Spring, 2008

GRANTS: Research Grant Support Program – Social Sciences, University of Illinois at Chicago: $7000

Provost’s Award for Graduate Research, University of Illinois at Chicago: $1967

VITA (continued)


INVITED TALKS:  

On the Universality of syntactic categories: Evidence from code-switching. (October, 2011). In conjunction with Kay-E. González-Vilbazo. CUNY Colloquium, City University of New York.

PRESENTATIONS:  


VITA (continued)


VITA (continued)


VITA (continued)

Cralli, Karen, Laura Bartlett, Mandy Faretta, & Kara Morgan-Short. 2010, April. *Acquisition of gender agreement in beginning and intermediate L2 Spanish learners.* Poster presented at the the University of Illinois at Chicago Student Research Forum, Chicago, IL.


Morgan-Short, Kara, Laura Bartlett, & Mandy Faretta. 2008, November. *Electrophysiological investigation of bilingual processing: ERP methods for heritage and second language processing.* Ongoing research presented at the University of Illinois at Chicago Talks in Linguistics (TiL), Chicago, IL.


TEACHING EXPERIENCE:

Department of Hispanic and Italian Studies, University of Illinois at Chicago, Chicago, Illinois: Spanish Grammar (SPAN 202), Summer 2012, 2010

Department of Hispanic and Italian Studies, University of Illinois at Chicago, Chicago, Illinois: Introduction to Hispanic Linguistics (TA), (SPAN 206), Fall 2011, Fall 2009

Department of Hispanic and Italian Studies, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish III (SPAN 103), Summer 2011; Spring 2011, 2010; Fall 2007

Department of Spanish, French, Italian, and Portuguese, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish II, SPAN 102, Fall 2007

Department of Spanish, French, Italian, and Portuguese, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish I, SPAN 101, Spring 2007
VITA (continued)

Department of Spanish, French, Italian, and Portuguese, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish Review, SPAN 110, Fall 2006

COORDINATION

Department of Hispanic and Italian Studies, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish III (SPAN 103), AY 2011

Department of Hispanic and Italian Studies, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish I (SPAN 101), AY 2010; AY 2007

Department of Spanish, French, Italian, and Portuguese, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish Review (SPAN 110), AY 2008

Department of Spanish, French, Italian, and Portuguese, University of Illinois at Chicago, Chicago, Illinois: Elementary Spanish II (SPAN 102), AY 2007

EXPERIENCE:

University Mentor for three (3) undergraduate students in the Summer Research Opportunities Program (SROP), Summer 2011, 2012

Organizer for graduate student elections for the Graduate Student Council and the Graduate Committee Student Representative for the Department of Hispanic and Italian Studies, Fall 2011

Supervisor, UIC Bilingualism Research Forum, AY 2010

Supervisor, UIC Talks in Linguistics (TiL), Fall 2009-present

Organizer for graduate student elections for the Graduate Student Council, the Graduate Committee Student Representative, and the Graduate Employees Organization Steward for the Departments of Spanish, French Italian, & Portuguese; Germanic Studies; and Slavic and Baltic Languages and Literatures, Fall 2009

Head Organizer, UIC Bilingualism Research Forum, AY 2008

Head Organizer, UIC Talks in Linguistics (TiL), AY 2008

UNIVERSITY SERVICE:

Graduate Committee Student Representative for the Department of Spanish, French Italian, & Portuguese, AY 2008
VITA (continued)

Organizing Committee, Spanish, French, Italian, & Portuguese Talks in Progress (SFIPtip), Spring 2007-Spring 2008

Student representative to the Graduate Student Council, representing Hispanic Studies, AY 2007

PROFESSIONAL SERVICE:

Conference Abstract Reviewer, 3rd UIC Bilingualism Research Forum, Spring 2012

Conference Abstract Reviewer, 2nd UIC Bilingualism Research Forum, Spring 2011

COMMUNITY SERVICE:

Volunteer, Dominican-American Midwest Association (DAMA), 2008-present

PROFESSIONAL MEMBERSHIP:

Modern Language Association

Cognitive Neuroscience Society