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BILINGUAL SENTENCE PROCESSING: RELATIVE CLAUSE ATTACHMENT IN ENGLISH AND SPANISH

by

Eva M. Fernández

A dissertation submitted to the Graduate Faculty in Linguistics
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy, The City University of New York

2000

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ABSTRACT

BILINGUAL SENTENCE PROCESSING: RELATIVE CLAUSE ATTACHMENT IN ENGLISH AND SPANISH

by

Eva M. Fernández

Adviser: Professor Dianne C. Bradley

Monolingual studies have shown that the relative clause attachment ambiguity, illustrated by the sample English sentence below, is ultimately interpreted in different ways by speakers of English and Spanish:

1. Someone shot the maid of the actress that was on the balcony.

English speakers tend to attach the relative clause to the lower noun, *actress*, while in the comparable sentence in Spanish, Spanish speakers generally prefer the attachment to be to the higher noun, *maid*. This thesis compares the relative clause attachment preferences of monolingual and bilingual speakers of English and Spanish. Data were collected using a speeded self-paced reading technique, designed to reflect early processing strategies, and an unspeeded questionnaire, in which post-syntactic factors may affect subjects' behavior.

The experiments revealed that English and Spanish monolinguals behave in ways more similar than previously thought. Monolinguals exhibited a low attachment preference in early phases of processing, a preference which in later

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phases (as post-syntactic processes begin to operate) shifted to high attachment. The only evidence of cross-linguistic differences in the monolingual data was to be found in the unspeeded questionnaire task, where the subjects' preferences were in line with previous results: the overall preference for attachment was higher in the Spanish monolingual group than in the English monolingual group.

Bilinguals did not exhibit the same early low attachment preference as the monolinguals did in the speeded task, instead showing an overall lack of preference for one or the other attachment, reading materials in either of their languages. While this could be taken as indicative of bilinguals' not employing syntactic strategies when processing input, it is better interpreted as pointing to the sensitivity of the task itself, which differs with different reader profiles (the bilinguals were overall slower readers than the monolinguals).

In the unspeeded task, the bilingual data indicated language independent processing strategies, with bilinguals using similar strategies (those associated with monolinguals of their dominant language) with input in either language. Spanish-dominant bilinguals tend to have higher ultimate preferences, in both English and Spanish, compared to English-dominant bilinguals, whose off-line preferences are lower, in both English and Spanish.

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In loving memory of my mother, Benita.

New York, NY, August 2000

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CHAPTER 1

INTRODUCTION

1.1 Bilingual Sentence Processing and the Relative Clause Attachment Ambiguity

This thesis presents evidence from an interrelated set of experiments designed to investigate aspects of sentence processing comparing bilinguals and monolinguals, testing materials in English and Spanish, and using speeded and unspeeded measures. The experiments explore on the one hand how the relative clause ambiguity is processed in two different languages, and on the other whether bilingual speakers depend on the language of the input to determine the routines they use to process syntactic structures, or if instead they use a generalized set of strategies with any linguistic stimulus, regardless of the language it is perceived to be in. We will begin with the assumption that it is most plausible to assume that bilinguals follow the same routines or strategies as monolinguals for the bulk of their syntactic analysis, because monolinguals of different languages appear to rely on very similar processing strategies, regardless of the language or the construction being processed. It is only in the case that cross-linguistic differences exist in monolingual sentence processing that *language dependency* in bilingual sentence processing may be properly addressed. If monolinguals use different strategies in two different languages, does the bilingual use monolingual-like strategies in each language (language

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dependency) or only one set of strategies for processing both (language independency)?

The only construction which has to date been shown to differ cross-linguistically is the relative clause attachment ambiguity in sentences like the following:

1. Someone shot the maid of the actress who was on the balcony.

The relative clause in such sentences has different ultimate interpretations in different languages. On average, English speakers show some preference for the attachment of *who was on the balcony* to be to the lower noun, *actress*, while Spanish speakers tend to prefer the attachment to be to the higher noun, *maid*. Given such differing preferences with monolingual speakers of the two languages, we pursue the question of whether Spanish/English bilinguals have preferences, in processing each of their languages, that match those of the respective monolingual groups. That cross-linguistic differences in RC attachment have been documented, in monolingual studies, is a most fortunate fact, since it allows for exploration of the language dependency question in bilingual sentence processing.

The evidence presented in this thesis points to bilingual sentence processing which is language independent. Bilinguals exhibit similar preferences, with the relative clause attachment ambiguity, when processing input in either of their languages. The preferences of bilinguals are those associated with monolingual speakers of their dominant language.

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This thesis further investigates whether the ultimate interpretations of the attachment of the relative clause (in both monolinguals and bilinguals) are the result of initial (syntactic) attachment decisions or of decisions influenced by later (post-syntactic) processing mechanisms. To that end, data collected using a procedure tapping early phases of processing (an "on-line" measure) were compared to data from a procedure in which the effects of post-syntactic processing could not be ruled out (an "off-line" measure).

The results from this investigation point to a model of relative clause attachment preferences in which initial and ultimate preferences are driven by different processes. The evidence presented below shows that in the earliest phases there is a universal preference for low attachment, in accord with a widely observed principle by which local attachments incur less computational cost. The initial low attachment preference may in later phases be rejected in favor of high attachment, when post-syntactic considerations have had a chance to exert their force. Among the post-syntactic factors that have been documented in the literature, we specifically explore the way in which the length of the attaching relative clause affects the ultimately preferred attachment. In general, and in the two languages surveyed (English and Spanish), short relatives remain low, while longer relatives are more likely to seek a higher host.

This investigation has direct implications in the domain of psycholinguistics in general, and of bilingualism specifically. Psycholinguistics has focused almost exclusively on monolinguals in its study of the machinery used in the production and perception of sentences, while studies on bilingualism

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and cognition have concentrated instead on issues related to the mental representation and retrieval of vocabulary items.

The research in bilingual sentence processing presented in this thesis contributes to psycholinguistics, in providing crucial new evidence that addresses certain questions on the nature of the human sentence processing machinery which are currently under debate, in particular, questions about cross-linguistic differences in sentence processing (see discussion below, in Chapter 2). To date, few studies exist which ask whether or not bilinguals are like two monolinguals in one person, as far as psycholinguistic performance is concerned (some exceptions are discussed in Chapter 3). Understanding the nature of bilingual sentence processing also serves as a stepping stone for developing models on the architecture of the bilingual performance mechanisms, which as of now only have available an empirical basis drawn largely from studies pitched at the level of the vocabulary (see, e.g., De Bot, 1992; Poulisse, 1997).

1.2 Overview

The existing evidence on relative clause attachment preferences in monolinguals (from speakers of English and Spanish, as well as from speakers of a number of other languages) is evaluated in Chapter 2, where we additionally discuss methodological and theoretical issues surrounding the study of known differences in cross-linguistic processing strategies. The following chapter, Chapter 3, reviews issues regarding the representation of language in the bilingual, and introduces the concept of language dependency in parsing. This

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chapter also reviews studies that have examined language dependency in sentence processing in bilinguals.

The two background chapters (2 and 3) raise a number of concerns that are taken up in the experimental chapters that follow. An overview of the design of the testing instruments—namely, a pen-and-paper questionnaire study and a self-paced reading study—will first be presented in Chapter 4. These tests were used to collect experimental data from the populations with the language histories of interest. Also in Chapter 4 are outlined the characteristics of the materials used in the experimental tasks. In Chapter 5, the relative clause attachment preferences of Spanish and English monolinguals are examined, to establish baselines which were used in assessing the bilingual data. In Chapter 6, the relative clause attachment preferences of Spanish/English bilinguals are investigated and compared to the monolingual results.

Finally, the set of findings will be evaluated as a whole in Chapter 7, where we examine how the evidence presented in this thesis contributes to current knowledge and future investigations of both the nature of language processing in bilinguals and cross-linguistic differences in parsing.

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CHAPTER 2

CROSS-LINGUISTIC DIFFERENCES IN SENTENCE PROCESSING: THE RELATIVE CLAUSE ATTACHMENT AMBIGUITY

2.1 Introduction

Contemporary research in human sentence processing has revealed a great many facts about how natural language is perceived. At the same time, this research has launched a vast number of questions, many concerning the details of the processes involved in perception, and particularly the routines operating in the syntactic processor, or parser. The Garden Path model (Frazier, 1979; Frazier & Fodor, 1978), the predominant account since the 1970s, contends that all human languages are processed using the same mental machinery. Under this proposal, while there may be certain critical lexical and grammatical differences between languages, the machinery used to project structure on linguistic material is universal, and consequently its operations are invariant, regardless of the language of the input. This chapter describes and evaluates recent evidence which has challenged this proposal, namely, research on attachment preferences in structures containing a complex noun phrase (NP) followed by a relative clause (RC) modifying either of the two nouns in the complex NP.

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Evidence of cross-linguistic variation in the strategies used to process linguistic input could seriously undermine the universalist stance. In their seminal study of parsing differences between languages, Cuetos & Mitchell (1988) found that the RC in sentences like (1) below is preferentially attached low (interpreted as (1a)) by English speakers, but attached high (interpreted as (1b)) by Spanish speakers (given the equivalent Spanish sentence, shown in (1′)):

1. Someone shot the maid of the actress who was on the balcony.
   a. The actress was on the balcony.
   b. The maid was on the balcony.

1.′ Alguien disparó contra la criada de la actriz que estaba en el balcón.

Cuetos & Mitchell reported that, in a questionnaire study, when asked to make a considered choice between alternative interpretations, English-speaking subjects tended to choose the lower site (interpretation (1a)), exhibiting a low attachment preference, while Spanish-speaking subjects tended to choose the higher site, exhibiting a high attachment preference. These results have been replicated in a number of questionnaire studies testing both monolingual and bilingual speakers of English and Spanish (Dussias, in press; Ehrlich, Fernández, Fodor, Stenshoel & Vinereanu, 1999; Fernández, 1995; Fernández & Hirose, 1997; Igoa, 1995; Quinn, in progress; Walter, Clifton, Frazier, Hemforth, Konieczny & Seelig, 1999).

Cuetos & Mitchell (1988) also reported data from a number of self-paced reading experiments where Spanish-speaking subjects were given sentences with the same structure as (1), in some of which the attachment of the RC was disambiguated. These experiments and others attempting to replicate or expand

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on Cuetos & Mitchell's Spanish data, using self-paced reading and eyetracking methodology (Carreiras, 1992; Carreiras & Clifton, 1993, 1999; Clifton, 1988; Mitchell, Cuetos & Zagar, 1990; Mitchell & Cuetos, 1991), all report similar findings: Spanish speakers experience difficulty (as witnessed in increased reading times) when the RC unambiguously attaches to the lower noun (as in the Spanish version of (2b) below, (2'b)), compared to when the stimuli either force high attachment (as in (2a)) or are not disambiguated at all (as in (1)).

2. a. Someone shot the maid of the actor who was on the balcony with her husband. (Forced High)[1]
   b. Someone shot the butler of the actress who was on the balcony with her husband. (Forced Low)

2.' a. Alguien disparó contra la criada del actor que estaba en el balcón con su marido.
   b. Alguien disparó contra el criado de la actriz que estaba en el balcón con su marido.

In contrast to the findings with Spanish speakers, studies using similar self-paced reading tasks with English speakers have found either no reliable attachment preference (Carreiras & Clifton, 1993; Frazier & Clifton, 1996; Henstra, 1996), or a preference for low attachment (Clifton, 1988; Corley, 1995; Frazier & Clifton, 1996; Deevy, 1999)[2]; studies using eyetracking methodology have consistently found a low attachment preference in English (Henstra, 1996; Carreiras & Clifton,

[1] This particular sentence is not fully disambiguated. Although the overwhelmingly preferred reading is for the maid to be on the balcony with her own husband, it could very well be that the actor was on the balcony with the maid's husband, or with somebody else's husband, for that matter. We discuss this experiment in more detail in §2.3.

[2] The reason for the discrepancy among the self-paced reading studies carried out in English may lie in the type of segmentation used, or in the way that materials were disambiguated. This issue is discussed in detail in the sections to come.

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1999). It thus appears that English and Spanish processing differ in some way. The critical question is whether the observed differences reflect differences between the grammars of these languages, or differences in the processing routines used by speakers of these languages (either specifically in the syntactic parsing machinery, or alternatively in some other module of the language processing system).

The discussion in this chapter evaluates the evidence to date on RC attachment in English and Spanish, as well as in a number of other languages, and provides some suggestions as to how these two languages differ, and what these differences mean for the architecture of the human language processing system. Some of these suggestions are tested empirically in the experiments described in Chapters 5 and 6.

Psycholinguistic explanations of RC attachment fall into two general camps. A number of theorists have attempted to explain the observed differences between English and Spanish by proposing that some syntactic processing strategies are language-specific, and that attachment preferences are determined based on previous experience with similar structures. Other theorists have proposed that the differences lie outside the parser, in language-specific aspects of the grammar. We will first examine the theories of the latter kind, in §2.2 (Universalist Accounts), and return to the former in §2.3 (Exposure-Based Accounts). In §2.4 we consider issues related to the ways in which existing experiments have implemented their assessments of the attachment ambiguity.

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The final section (§2.5) outlines an approach to resolving the problems pointed out in the review of the facts and the explanations.

Research on the RC attachment ambiguity has been carried out in an interesting collection of languages. In addition to English and Spanish, the list has grown to include Afrikaans (Mitchell, Brysbaert, Grondelaers & Swanepoel, 2000), Arabic (Abdelghany & Fodor, 1999; Quinn, Abdelghany & Fodor, 2000), Brazilian Portuguese (Finger & Zimmer, 2000; Miyamoto, 1998), Croatian (Lovrić & Fodor, 2000), Dutch (Brysbaert & Mitchell, 1996; Brysbaert, Desmet & Mitchell, in press; De Baecke, Brysbaert & Desmet, 2000; Desmet, Brysbaert & De Baecke, 2000; Mitchell & Brysbaert, 1998; Mitchell, Brysbaert, Grondelaers & Swanepoel, 2000), French (Baccino, De Vincenzi & Job, 2000; Pynte & Colonna, 2000; Colonna, Pynte & Mitchell, 2000; Pynte, 1998; Quinn, in progress; Quinn, Abdelghany & Fodor, 2000; Zagar et al., 1997), German (Hemforth, Konieczny & Scheepers, 1996; Hemforth, Konieczny, Scheepers & Strube, 1998; Hemforth, Konieczny, Seelig & Walter, 1999; Walter, Clifton, Frazier, Hemforth, Konieczny & Seelig, 1999; Walter, Hemforth, Konieczny & Seelig, 1999), Italian (De Vincenzi & Job, 1993, 1995, 1996), Japanese (Kamide & Mitchell, 1996); and Norwegian, Romanian and Swedish (Ehrlich, Fernández, Fodor, Stenshoel & Vinereanu, 1999). The evidence has been gathered using a wide spectrum of methods, including unspeeded questionnaire tasks (with ambiguous or unambiguous fillers; with responses based on binary choice, multiple choice, or sentence-completion) and speeded response tasks (self-paced reading paradigms with moving-window or centered display, with different segmentation

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patterns; and eyetracking paradigms).[3] Furthermore, the studies have tested a broad array of materials, including human and non-human host nouns; different length and frequency of host nouns; different prepositions in the complex NP; different methods of disambiguation; different referentiality of hosts; variations on the number of nouns in the complex NP; and so forth. The results from study to study are at times contradictory (e.g., is the preference for English low or indeterminate on-line? is the preference for French high or low? is the finding of low attachment for Italian an artifact of the methodology or does it truly represent speakers' on-line preferences?). In short, the facts are not altogether as clear as we might wish them to be.

Some of the apparently conflicting results might be related to the particular stage of processing that different tasks tap. By convention, unspeeded tasks are typically associated with off-line processing, while speeded tasks are seen as tapping on-line processing, the early (initial) decisions of the syntactic processor. This distinction is often linked to a theoretical claim that the earliest activities of the parser are uninfluenced by information outside its domain, including meaning (semantic) or contextual (pragmatic) information. However, many practical questions remain: What level of processing is represented by the behavior of subjects in a given psycholinguistic task? To what extent do reading times at a particular region of a sentence, prolonged when the attachment is forced one way compared to when the attachment is either ambiguous or forced the other way, reflect difficulty attributable to structural decisions made by the syntactic

[3] To date, no neuro-imaging studies have tested the RC attachment ambiguity.

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parser alone? Are measurements of eye movements, compared to self-paced reading measures, reliably freer of the influence of post-syntactic information? These questions will re-emerge throughout the discussion in this chapter.

We now turn to the various proposals made in the literature, along with the empirical evidence provided in support of each proposal.

2.2 Universalist Accounts

2.2.1 The Late Closure Principle

Arguments against language-specificity in the parser are rooted in the *Garden Path Hypothesis* (Frazier, 1979; for a review see Frazier & Clifton, 1996; see also Mitchell, 1994), according to which the parser utilizes a set of principles to build structure incrementally, as input is received. The Garden Path Hypothesis assumes that initial attachment decisions about ambiguous material are made exclusively by the parser (without resorting to information outside the parser's domain) and serially (without considering all the possible alternative structures, cf. *parallel* parsing models, and without waiting for evidence coming later in the sentence that may disambiguate ambiguous input, cf. *delay* parsing models). These parsing principles are assumed to be consequences of the basic design of the mental parsing machinery and therefore universal, i.e., they are used by speaker/hearers of all linguistic backgrounds in processing all natural languages.

The earliest proposals of this type listed a sizeable number of principles (see, e.g., Kimball, 1973) but later refinements narrowed down the number of

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independent principles needed to account for all known phenomena. The three principles that have received the most attention in the literature have been *Minimal Attachment*, the *Minimal Chain Principle*, and *Late Closure* (see Frazier & Clifton, 1996, pp. 8-ff.). This chapter focuses on Late Closure, as it is the only principle directly relevant to the phenomenon of interest to this discussion.[4]

Late Closure requires that incoming structure be attached to the (lowest or smallest) phrase currently being processed (Frazier, 1979; Frazier & Fodor, 1978).[5] Consider, for example, the difficulty typically encountered in sentences such as (3):

3. John said that Susan will leave yesterday.

The claim being made is that the difficulty is attributable to the fact that the structure of the sentence violates Late Closure. When it encounters the last word, the parser attaches *yesterday* to the VP currently being processed, *will leave*. When the output of the parser reaches the semantic/pragmatic processor(s), the anomaly of **will leave yesterday* is detected, and the parser is compelled to reanalyze. The only alternative for the parser is to violate Late Closure. This violation leads to the correct interpretation, but at a cost.[6]

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[4] The RC attachment ambiguity under discussion here is not resolved by invoking other parsing principles, such as Minimal Attachment or Minimal Chains. The same number of nodes and chain members is required for high and for low attachment.

[5] Late Closure is a principle about recency or locality, as the Recency Preference principle of Gibson, Pearlmutter, Canseco-González & Hickok (1996) and the principle of Right Association of Kimball (1973).

[6] The cost may actually not come from the *violation* of the parsing principle, but rather from the process of anomaly detection and reanalysis. We leave this issue open.

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Late Closure is attributed to the basic mode of operation of the parser.[7] As such, it is assumed to operate in the same way in all languages. Thus the Spanish sentence (3′), equivalent to the English example in (3), should and does lead to the same experience of (temporary) semantic anomaly as its English correlate.

3.′ Juan dijo que Susana se irá ayer.
Juan said that Susana self go[3rd sg, fut] yesterday

Experimental evidence of the operation of Late Closure in Spanish, in a structure other than the RC attachment ambiguity, will be presented below (§2.2.2.1).

For a sentence like (1), repeated below, Late Closure predicts that the RC will attach low, as an adjunct of the most recent NP, *actress*, yielding interpretation (1a) rather than interpretation (1b).

1. Someone shot the maid of the actress who was on the balcony.
   a. The actress was on the balcony.
   b. The maid was on the balcony.

Cuetos & Mitchell (1998) found that monolingual British English speakers preferred a low attachment interpretation for the RC in (1) 58% of the time, for the 11 (of 24) target items that used human terms (e.g., *maid*, *actress*) in both positions within the complex NP, N1 and N2.[8] However, Cuetos & Mitchell

[7] The explanation differed somewhat between Frazier & Fodor (1978) and Fodor & Frazier (1980), and has never fully stabilized; for further discussion see Fodor (1998).

[8] We will henceforth refer to the higher noun (*maid* in (1)) as N1, and to the lower noun (*actress*) as N2. The term "high" attachment will be used interchangeably with N1 attachment, and "low" attachment with N2 attachment. We refer to attachments that are disambiguated for the high or the low site as forced attachments.

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reported that when the first, or higher, noun was a non-human term, like *book* in (4) below, the preferences of their English-speaking subjects shifted.

4. Peter was looking at the book of the girl that was in the living room.

For the non-human/human subset of the materials (13 of 24 target items), Cuetos & Mitchell's subjects chose N2 as the site of attachment only 31% of the time. (None of the target items in Cuetos & Mitchell's study contained the configuration non-human/non-human or human/non-human in the complex NP, and the category non-human included inanimate objects as well as animals.) Cuetos & Mitchell reported that the difference between the two complex NP types was significant, and attributed the shift to high attachment in English to the use of the relative pronoun *that*, which may have introduced a bias in favor of the non-human host site. (The relative pronoun *who* was used for human/human items.)

This same evidence could, however, be used to suggest that RC attachment may not be subject to the universal principles (Late Closure in particular) that guide structure assignment for other types of phrases, because speakers' preferences are so easily shifted around by introducing variation in the construction, like animacy or a different element in the relativizer position. Moreover, it implies that English speakers and Spanish speakers may not differ so much after all in their attachment preferences. (Spanish speakers given the equivalent questionnaire in Spanish attached the RC to the lower noun an average 37%, a rate quite similar to the overall 43% for English speakers).[9]

[9] The 37% low attachment preference for Spanish speakers is taken from the figures provided by Cuetos & Mitchell (1988, p. 79, Table 1), which do not distinguish between human/human and

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To further probe the behavior of English speakers with sentences like (1), Clifton (1988, reported in Frazier, 1990) attempted to replicate Cuetos & Mitchell's (1988) results by administering a similar (though not identical) unspeeded questionnaire to a new group of English monolinguals. This time, however, the subjects were speakers of American English (rather than British English, as Cuetos & Mitchell's subjects had been). Clifton's subjects chose the lower noun (i.e., the attachment predicted by Late Closure) 46% of the time.

Clifton added a number of manipulations to the original 24 sentences used in the Cuetos & Mitchell (1988) experiment, including variations in the position of the complex NP (subject versus object; see (5a) and (6a) versus (5b) and (6b)), the preposition in the complex NP (*of* versus *near*; see (5) versus (6)), the identity of the relative pronoun (*who* versus *that* versus *which*), and the animacy of the NPs.

5. a. Someone shot the servant of the actress who was on the balcony.
   b. The servant of the actress who was on the balcony was shot.

6. a. Someone shot the servant near the actress who was on the balcony.
   b. The servant near the actress who was on the balcony was shot.

The proportion of N2 responses ranged from 25% to 67%. The preference to attach low was weakest when the higher noun was inanimate, the preposition was *of*, and *which* was used as the relative pronoun. The preference to attach low was strongest when the two nouns in the complex NP matched in animacy,

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non-human/human materials (the ambiguous Spanish relative pronoun *que*—similar to English *that*—was used in all Spanish experimental items). The equivalent 43% *overall* preference for low attachment for English cited here is computed from the figures provided by Cuetos & Mitchell (p. 81, Table 2).

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and the preposition was *near*. (The effect of subject versus object position was not significant in any analysis.)

Considering these findings, Frazier (1990) denies the need to posit special purpose parsing routines in any given language, and proposes that the universality of the parser is being disguised in these materials by some other factor that is not syntactic in nature. She proposes a principle of Relativized Relevance:

> Other things being equal (e.g., all interpretations are grammatical, informative, and appropriate to discourse) preferentially construe a phrase as being relevant to the main assertion of the current sentence (p. 321).

Frazier (1990; see also Clifton, 1988; Frazier & Clifton, 1996) reports an experiment where subjects read sentences like (7), using self-paced reading methodology (segmentation into frames is indicated by slashes):

7. a. The doctor called in / the son of the nurse / who hurt himself.
   b. The doctor called in / the son of the nurse / who hurt herself.

Attachment of the RC is forced here by use of gender-specific reflexive pronouns, to either the higher (7a) or lower (7b) noun. This is therefore a case where other things are *not* equal, because only one grammatical interpretation exists for each sentence. Reading times for the critical final frame were found to be longer with sentences forcing high attachment, like (7a), than with sentences forcing low attachment, like (7b). The interpretation of these results is that the parser, operating by itself, prefers the attachment dictated by Late Closure,

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because Relativized Relevance is not applicable. Had both interpretations been grammatical (e.g., change *nurse* to *boxer* in (7a)), under the Garden Path Hypothesis, the initial choice of the parser for the most recent noun would be revised to the higher noun, since it plays a more prominent role in the sentence. Such a revision would presumably take place in a later processing phase.

De Vincenzi & Job (1993, 1995) report data from Italian monolinguals who were asked to read sentences such as (8), using a non-cumulative version of the self-paced reading paradigm:

8. a. L'avvocato diffida / del padre / della ragazza / che si è tradito / al processo.
the lawyer suspects / of-the father / of-the girl / that self has betrayed[masc] / at-the trial
'The lawyer suspects the father of the girl who betrayed herself at the trial.'

   b. L'avvocato diffida / del padre / della ragazza / che si è tradita / al processo.
the lawyer suspects / of-the father / of-the girl / that self has betrayed[fem] / at-the trial
'The lawyer suspects the father of the girl who betrayed himself at the trial.'

For the critical frame, *che si è tradita(o)*, where the attachment of the RC is disambiguated (by the morphologically gender-marked past participle), the effect of attachment site (high (8a) versus low (8b) attachment) was significant. The critical fourth frame in sentences like (8b) was read faster than in sentences like (8a), suggesting that the initial on-line attachment is to the lower site, the attachment preference predicted by the Late Closure principle. In the same experiment, subjects were asked a question after every sentence, about the antecedent for the relative pronoun:

9. Chi si tradì? — Ragazza o padre
who self betrayed — girl or father

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De Vincenzi & Job assume that answering these questions is influenced by post-syntactic processing (including, presumably, the effects of Relativized Relevance). The Italian subjects responded less accurately, overall, when the attachment was forced to the lower noun, suggesting that high attachment is preferred in a post-syntactic phase. Given this evidence, De Vincenzi & Job argue that Italian speakers attach low initially, on-line, but shift their preference post-syntactically, when thematic and pragmatic considerations come into play. This interpretation of the results is interesting but problematic, particularly in light of the fact that the presumed shift of preference (from low to high attachment) takes place in a case where the ultimate interpretation is *not* grammatical.[10]

De Vincenzi & Job's experimental materials included a second factor: in half of the sentences the complex NP contained the preposition *di* (equivalent to English "of"), and in the other half, *con* (a preposition meaning "with"). The effect of disambiguation (high versus low) interacted with the type of preposition in the data for the question task, but not, however, in the reading time data. Subjects were equally accurate with the forced high and the forced low sentences when the preposition was *con*, but were more accurate in the forced high condition when the preposition was *di*. De Vincenzi & Job propose that N1 is available for attachment only if the RC is within the thematic domain of N1. They point out

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[10] Brysbaert & Mitchell (1996) argue along similar lines regarding their results (discussed below in §2.3.2). In an eyetracking experiment in Dutch, Brysbaert & Mitchell found a disadvantage associated with forced high attachments in first pass reading times. Analyses of cumulative region reading times (see fn. 44, below) indicated, however, a low attachment disadvantage. Brysbaert & Mitchell propose that the early low preference is not a "real" effect, partly because such an interpretation requires explaining "why the transition [from low to high attachment preference] takes place *in the presence of conflicting information*" (p. 680, emphasis in the original).

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that in sentences where the preposition in the complex NP introduces an adjunct to N1 (cf. the sentences with preposition *near*, as in (6) above), this adjunct may in fact be acting as "a barrier for reanalyzing a constituent out of its domain" (p. 205). De Vincenzi & Job thus interpret the differences between English and Italian (and presumably between English and Spanish) as the product of reanalysis.

De Vincenzi & Job's account is very much in the spirit of Frazier (1990). In both accounts, Relativized Relevance is assumed to operate post-syntactically, and does not guide initial attachment. On-line attachments are guided by the universal strategies of the parser, including Late Closure.

This alone, however, does not account for the cross-linguistic variation, evident in the off-line measures. To explain the differences between languages like English and languages like Spanish[11] (let us assume for the moment that Italian falls into this second category), Frazier calls upon additional discourse principles. She notes that English has an unambiguous way of expressing the idea that it was the *maid*, and not the *actress*, who was on the balcony (cf. (1)):

10. Someone shot the actress's maid who was on the balcony.

While Relativized Relevance predicts that, post-syntactically, the preference should be to attach a relative clause to the main assertion of the sentence (i.e., in a sentence like (1), to *the maid*), English perceivers also assume that their interlocutors produce utterances following the Gricean maxim of quantity (Grice,

[11] "Languages like..." here is shorthand for "languages whose ultimate RC attachment preferences are like those in...".

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1975). This maxim requires that the speaker should be precisely as informative as necessary for the purposes of the conversation, providing neither too little nor too much information. Hence, if the speaker of (1) had meant that it was the *maid* who was on the balcony, she would have said so using a sentence like (10), containing the *Saxon genitive* construction *N2's N1*,[12] rather than one like (1). Since the speaker did not utter (10), the perceiver naturally assumes the analysis in which the relative clause modifies the *actress*.[13]

Spanish does not have the unambiguous structure in (10) available, so the Spanish perceiver will follow the preferences dictated by Relativized Relevance and opt post-syntactically for the analysis where the RC modifies N1, the *maid*. Thus this account sees the difference between English and Spanish lying not in the initial choices, but in the interaction of pragmatic considerations and the linguistic repertoire of each language. Listeners of both languages will initially attach low (obeying Late Closure), and while Spanish listeners will ultimately shift their attachment choice to the high site (by Relativized Relevance), English listeners will not (because they follow the Gricean reasoning outlined above).

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[12] Brysbaert & Mitchell (1996) introduce this term to differentiate such possessive constructions from what they aptly name *Norman genitives* (*the niece of the teacher*).

[13] Costantino, Oria-Merino, Heydel, & Sainz (1999) and Oria-Merino, Costantino, Heydel & Sainz (2000) provide evidence from several off-line written production experiments that speakers of languages with alternative possessive constructions are less likely to use the ambiguous *N1-Prep-N2* construction than the unambiguous alternative. Costantino, Oria-Merino and colleagues described to their subjects (in writing) a scenario in which an actress has a maid, and on a balcony is either the maid or the actress. The subjects were then asked to complete sentences such as *Someone shot ____ who was on the balcony*. English speakers only used the (Norman) prepositional possessive *N1-of-N2* when the RC was intended to attach to the genitive N2. When the RC attached to the possessum N1, the preferred construction was the unambiguous Saxon genitive, *N2's N1*, used approximately 80% of the time. In contrast, Spanish speakers, who have no alternative possessive construction, used the Norman genitive structure to express attachments to both the possessum N1 (the maid) and the possessor N2 (the actress).

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De Vincenzi and colleagues have supported their claims with further evidence, replicating the primary findings of their 1993 study, in both Italian (De Vincenzi & Job, 1995) and French (Baccino, De Vincenzi & Job, 2000). De Vincenzi & Job (1995) report on two separate self-paced reading experiments with identical materials and methodology, but with different segmentation patterns as shown below (the sentences are identical to those in (8) above):

11. a. L'avvocato diffida / del padre / della ragazza / chi si è tradita(o) / al processo.
    b. L'avvocato diffida / del padre della ragazza / chi si è tradita(o) / al processo.

In the first experiment, the complex NP was split into two frames (as in the original study; see (11a)), while in the second experiment the complex NP was presented in a single frame (see (11b)). In both experiments, De Vincenzi & Job found a significant reaction time disadvantage in the forced high conditions in the critical frame (*chi si è tradita(o)*).[14] This pattern also emerged using closely matched material in French (Baccino et al., 2000).[15] Furthermore, while the on-line data suggest a high attachment disadvantage in the two languages, both Italian and French speakers were less accurate in answering comprehension questions about forced low attachments (with questions phrased as in (9),

[14] With segmentation as in (11a), the difference between the forced high and the forced low conditions was 135 msec, while with segmentation as in (11b), the difference was 81 msec.

[15] The low attachment finding for French should be accepted with caution. The statistics provided pool the effect of attachment site over *de* ("of") and *avec* ("with") sentences. But while for the *avec* sentences the forced high attachments took 203 msec longer to read than the forced low attachments, the difference between forced low and forced high attachments for the *de* sentences was only 58 msec. There was an absence of interaction between preposition type and site of attachment, but no subanalyses are provided for each of the two preposition types separately.

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above).[16] (The pattern of results was identical in the different segmentation experiments.)

This collection of evidence from Italian and French is at odds with the standard assumption deriving from Cuetos & Mitchell (1988) that languages like Spanish attach high *at all stages of processing* while languages like English attach low. The basic result is that Italian and French have a low attachment preference in certain types of speeded tasks, while the preference is for the higher attachment site both in unspeeded standard questionnaire tasks (Italian speakers attach to the lower site on average only 35%; De Vincenzi & Job, 1993) and in question-answering accuracy in speeded tasks.

Since De Vincenzi first reported on the Italian data (De Vincenzi, 1992), this evidence has been challenged on two grounds. We have already addressed the first criticism, raised in a number of discussions (Carreiras & Clifton, 1993; Cuetos, Mitchell & Corley, 1996; Gilboy & Sopena, 1996), that the segmentation used in the Italian experiments unnaturally biases subjects to attach low, because N1 and N2 are presented in two separate frames. The experiments with different segmentation reported in De Vincenzi & Job (1995) address this problem, and we return to it in §2.4.1 below. The low attachment advantage is obtained with both types of segmentation. The second type of criticism that has been leveled against these data is based on the fact that these studies included, along with items parallel to (1), items with a theta-assigning preposition in the

[16] The decreased accuracy with forced low attachments was only found for materials containing the preposition *de*; no such accuracy difference was found for *con/avec* materials.

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complex NP. Pynte & Frenck-Mestre (1996; see also Frenck-Mestre & Pynte, 2000) demonstrate that French-speaking subjects' attachment preferences can be biased toward low attachment by within-task exposure to sentences containing the lexical preposition *avec* ("with") in the complex NP.

The problem elicited by Pynte & Frenck-Mestre's (1996) findings poses a challenge to be evaluated empirically in the future. However, Pynte & Frenck-Mestre's evidence does not clearly invalidate the Italian and French results, as it comes from a task very different from the one used by De Vincenzi and colleagues, and different from the standard unspeeded and speeded tasks normally used to collect evidence on the RC attachment ambiguity. Pynte & Frenck-Mestre tracked the eye-movements of French speakers as they read (silently) a series of sentences divided into two blocks, each block consisting of 16 sentences containing the RC attachment ambiguity, with morphosyntactic (gender) disambiguation forcing either high or low attachment (disambiguation mixed within a given block). One of the blocks contained sentences using *de* in the complex NP, the other block using *avec*. Subjects who read the *avec* block first had slower reading times, with *de* sentences, at the disambiguating region in the forced high, compared to the forced low attachment condition. In contrast, subjects who read the *de* block first exhibited a clear N1 attachment preference with *de* sentences, revealed by slower reading times at the disambiguating region in the forced low than in the forced high attachment condition.

Blocked presentation orders, as in the Pynte & Frenck-Mestre study, are very unlike the presentation order in, say, a typical on-line self-paced reading

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study. In the latter, target sentences are presented in a pseudo-random order interspersed among many distractor items. This avoids undesired effects induced by any particular order, or by the structure of the target sentences themselves. In fact, the mixed design used by De Vincenzi and colleagues is not the only such design in the literature on RC attachment. Cuetos & Mitchell's (1988) design mixed forced lows with ambiguous sentences, and used that test to determine that there is a disadvantage associated with low attachment. In this case, the inclusion of items forced for low attachment evidently did not bias the subjects to attach low elsewhere. It is therefore difficult to determine whether Pynte & Frenck-Mestre's findings have any relevance in the context of findings from more standard on-line tasks, as well as why the inclusion of materials biased for low attachment should matter more if the bias comes in the form of a preposition rather than in the form of, say, pragmatically-based disambiguation. In effect, it will remain unknown whether *avec/con* sentences are a source of bias in subjects' preferences with *de* sentences until standard on-line experiments have been conducted investigating *de* sentences separately, in both French and Italian.

Let us summarize the discussion so far. Off-line, there appear to be cross-linguistic differences between languages which choose to attach high most of the time and languages which prefer to attach low most of the time. On-line, however, a language may sometimes appear to have a high attachment preference (French: Pynte & Frenck-Mestre, 1996; see also Zagar et al., 1997), or a low attachment preference (French: Baccino et al., 2000), and yet others no

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evident preference at all (English: Carreiras & Clifton, 1993—but see also Carreiras & Clifton, 1999, discussed below, in §2.2.2.2).

A universalist account like the Garden Path model cannot fully account for the existing evidence which suggests that post-syntactic factors subsequently adjust the initial attachment. The Garden Path model does not provide a framework able to deal with the situation when an initial attachment which leads to a grammatical interpretation of the sentence is later reanalyzed given post-syntactic considerations. At issue is why the parser's initial attachment should ever be revised by later processes. Also at issue is how different tasks tap what appear to be different phases of processing. We now turn to the Construal Hypothesis, a later modification of the Garden Path model, which addresses some of these questions.

2.2.2 Construal

The Construal Hypothesis (Frazier & Clifton, 1996) is an extension of Frazier's (1990) Relativized Relevance principle, incorporating a number of other ideas along similar lines. It was developed to account for the problematic RC attachment data, as well as for other phenomena not discussed here (see also Frazier & Clifton, 1998). Construal differs in critical ways from the account invoking Late Closure and reanalysis (based on pragmatics) described in the previous section. In particular, initial attachment of certain types of phrases ("non-primary phrases"—see below) is *not* guided by the universal principles of the Garden Path model.

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Frazier & Clifton (1996) draw a crucial distinction between what they refer to as *primary* and *non-primary* phrases.[17] The Construal thesis makes a novel proposal about non-primary phrases; it claims that while primary phrases are processed using the principles of the Garden Path model, non-primary phrases are *not* processed using these principles. Non-primary phrases are instead *construed* or *associated* (rather than *attached*) to the current processing domain, and interpreted using any and all available information (Frazier & Clifton, 1996, pp. 31-32). Relative clauses are *construed* as follows:

> *Relative Clause Construal Hypothesis*
>
> a. *Associate* a relative clause to the *current thematic processing domain*—the (extended) maximal projection of the last theta assigner.
>
> b. *Interpret* the relative clause with any grammatically permissible material in the associated domain using structural and semantic/pragmatic information.

Under this view, association of a relative clause within the current thematic processing domain makes no initial commitment to a given site for interpreting the relative clause. This avoids having to stipulate that reanalysis of a parsing decision can be launched in the absence of conflict, e.g., when semantic/pragmatic information conflicts with the computationally simpler analysis (preferred by the parser).

In the next section we turn to evidence that primary phrases are attached according to principles such as Late Closure. In §2.2.2.2, we

[17] The category of primary phrases includes the subjects and main predicates of finite or infinitival clauses and the complements and other obligatory constituents of primary phrases. In other words, a primary phrase is a constituent predictable from the structure already computed (e.g., if an IP has already been constructed, a VP within this IP constitutes a primary phrase). Non-primary phrases are all other non-obligatory constituents, including RC adjuncts.

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discuss some evidence, offered by Frazier, Clifton and colleagues, that RCs are associated following the RC Construal hypothesis. This will be followed by discussion of a sizeable amount of evidence suggesting that initial (or early) preferences for speakers of English in particular, as well as for speakers of Spanish, are definitive, for low and high attachment, respectively. This last type of evidence is difficult to interpret under the Construal hypothesis.

2.2.2.1 Processing Primary Phrases

Igoa, Carreiras & Messeguer (1998; see also Igoa, 1995) provide evidence, from a series of experiments with Spanish subjects, that primary and non-primary phrases in Spanish are processed differently. In an off-line questionnaire (Igoa et al.'s, 1998, Experiment 1), subjects were asked about the ambiguities in sentences like the following (the percentages in parentheses next to each example indicate subjects' mean preference, for sentences of that type, to attach the final PP or RC to the lower constituent):[18]

12. a. Raúl vendió el libro que había robado a su amigo. (59% LA)
    Raul sold the book that *pro* had stolen PREP his friend
    'Raul sold the book that he had stolen to/from his friend.'
    b. El profesor castigó a los alumnos con malas notas. (32% LA)
    the teacher punished PREP the students with bad grades
    c. El periodista entrevistó a la hija del coronel que tuvo un accidente. (45% LA)
    the journalist interviewed PREP the daughter of-the colonel that had an accident

[18] The preposition *a* in (12a) (glossed as *PREP*) is a dative case marker. In (12b) and (12c), *a* is an accusative case marker used with human objects.

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The ambiguity in (12a) lies in the fact that *a su amigo* can be the indirect object of the embedded VP or of the matrix VP, both optionally ditransitive verbs. The ambiguous constituent would be a primary phrase at either attachment site. In (12b), the PP *con malas notas* could attach to the matrix VP (as a primary phrase) or to the object *a los alumnos* (as a non-primary phrase). Finally, in the familiar structure in (12c) (cf. (1)), the RC is a non-primary phrase in either of its possible attachments. Igoa et al. report that the attachment tendencies for these three types are all significantly different from one another. Notably, the preference to attach low is strongest in (12a), where both attachments would result in a primary relation, and weakest in (12b), where the lower attachment would result in a non-primary relation (cf. Abney, 1989; Clifton, Speer & Abney, 1991). For sentences like (12c), where both attachments result in non-primary relations, there is a modest (but significant) preference to attach high. These results suggest (i) that the Late Closure choice prevails (albeit not absolutely) in Spanish as far as primary relations are concerned, (ii) that interpretation as primary is generally preferred over interpretation as non-primary, and (iii) that non-primary phrases are possibly processed by relying on types of information different from the exclusively structural information used to attach primary phrases.

Igoa et al. (1998) also present on-line evidence that Late Closure is operational in Spanish in the attachment of primary relations. Subjects read sentences such as the following (using a self-paced reading technique with an incremental moving window):

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13. a. Raúl vendió el libro / que había robado / a su amigo. (Ambiguous)
Raul sold the book / that *pro* had stolen / PREP his friend
'Raul sold the book that he had stolen to/from his friend.'

b. Raúl vendió el libro / que tenía subrayado / a su amigo. (Forced High)
Raul sold the book / that *pro* had underlined / PREP his friend
'Raul sold the book that he had underlined to his friend.'

c. Raúl subrayó el libro / que había robado / a su amigo. (Forced Low)
Raul underlined the book / that *pro* had stolen / PREP his friend
'Raul underlined the book that he had stolen from his friend.'

In (13a), identical to (12a), the indirect object *a su amigo* can attach either to the more recent constituent (the VP in the embedded RC) or to the higher constituent (the matrix VP); in both cases, the attachment is a primary relation. Sentences (13b) and (13c) are the unambiguous counterparts to (13a). In (13b) only the matrix verb can be used ditransitively, and in (13c) only the verb in the embedded RC. The results indicate that Spanish readers experience difficulty in the forced high attachment condition, where Late Closure is violated: Reading times for the critical third frame of sentences like (13b) were slower than reading times for the same frame in sentences like (13a) and (13c), which did not differ from each other.

Igoa et al. (1998) replicate this finding in a second on-line experiment, in which the materials and presentation were slightly modified (see Igoa et al. for details). These results show that Spanish speakers, in making primary phrase attachments, generally follow Late Closure.

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2.2.2.2 Processing Non-Primary Phrases

Construal makes the explicit prediction that RCs (non-primary phrases) will be associated (rather than attached) to the current processing domain, and that the specific interpretation of a given association will vary depending on information contained within the association site and within the RC. This is the premise of the experiments reported in Gilboy, Sopena, Clifton & Frazier (1995), in which Spanish and English monolinguals were administered questionnaires containing ambiguous sentences with three different types of complex NPs, listed in Table 2-1.

Table 2-1: Materials Types in Gilboy, Sopena, Clifton & Frazier (1995)

Type	*Sub-type*	*Example (total number of items)*	*Status of N2*
A	substance quantity	a sweater of wool (8) a cup of sugar (9)	N2 non-referential, argument of N1
B	kinship function possessives inherent possessives representational	the daughter of the colonel (9) the assistant of the lawyer (9) the museum of the city (6) the side window of the plane (9) the picture of the building (9)	N2 referential, argument of N1
B'	alienable possessives	the book of the student (6)	N2 referential, non-argument of N1
C	with prepositions *con* or *with*	the sauce with the steak (9)	N2 referential, non-argument of N1; preposition is a theta-assigner

Gilboy et al. pursue a very detailed examination of factors possibly relevant to RC attachment, with a focus on properties of the host nouns of a post-syntactic nature. For example, both the referentiality and the (non-)argument

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status[19] of N2 are assumed to affect the ultimate interpretations of the RCs. Under the Construal Hypothesis, referential nouns (N2 in complex NP Types B, B′ and C) will be more attractive sites, as will nouns that are not arguments of N1 (N2 in Types B′ and C), and nouns in the domain of a theta-assigning preposition (N2 in Type C). The prediction, then, is that Type A sentences should have the weakest low attachment preference, Type C sentences the strongest low attachment preference, with Type B sentences somewhere between the other two types.

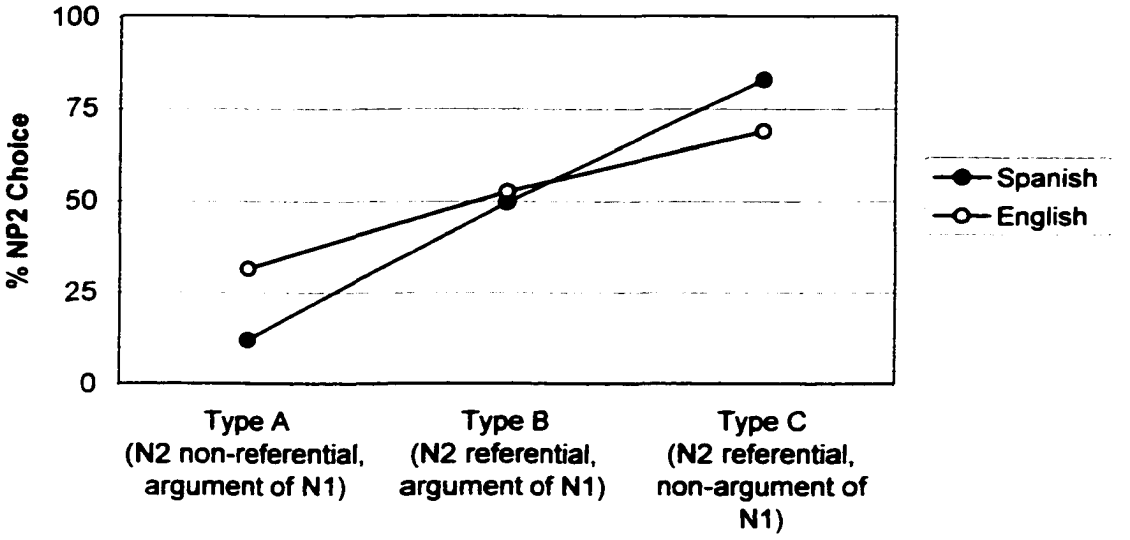

Figure 2-1: Percent N2 choice as a function of N2 referentiality and argument status in Spanish and English (after Gilboy, Sopena, Clifton & Frazier, 1995).

[19] Referential nouns are defined by Gilboy et al. as nouns that introduce discourse entities into a discourse model or correspond to already existing discourse entities (1995, p. 136). The primary criterion Gilboy et al. (1995) use to determine the argument (versus non-argument) status of N2 in their materials is that non-arguments of N1 introduce a new thematic processing domain. For additional criteria used to determine this distinction, see Clifton, Speer & Abney (1991), Hornstein & Lightfoot (1981), Jackendoff (1977), Radford (1988), Schütze & Gibson (1996).

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The chart in Figure 2-1 plots Gilboy et al.'s results for each sentence type, by language (English and Spanish). The results are indicative of a *lack* of systematic differences between the two languages (the apparent differences in the figure are not significant), albeit that there appears to be a greater sensitivity on the part of the Spanish speakers to manipulations of N2 referentiality and argument status.

Figure 2-1 shows support for the predictions made by Gilboy et al. about sentence type. In both languages, the preference to attach low was weakest with Type A items, strongest with Type C items. It thus appears that such manipulations do in fact play a role in attachment preferences, while the differences between the two languages do not.

The compatibility of these data with other off-line results for Spanish and English (e.g., those of Cuetos & Mitchell, 1988) is somewhat unclear. The items tested in such existing studies, and which point to differences between English and Spanish, are most like Gilboy et al.'s Type B items, where no apparent differences exist. It is unclear whether this is due to Gilboy et al.'s experimental design, to the nature of the items themselves, or to procedural or methodological properties of the study that differ from those of the existing studies.

Additional problems with Gilboy et al.'s data are based on questions as to whether the complex NP types result in critical divergence from the complex NP types used in other RC attachment experiments, whether the items are equally natural in the two languages, and whether the manipulation of the pragmatic factors under investigation is uniform (for discussion see Fernández, 1996; see

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also Costantino, Oria-Merino, Heydel & Sainz, 1999). Finally, this study is informative on the role played by post-syntactic factors in the ultimate interpretation of the RC attachment ambiguity. It does not, however, provide insight regarding the initial preferences for the different item types at the earliest phases of processing, before extra-syntactic constructs play any role (Mitchell, Cuetos, Corley & Brysbaert, 1995). To explore this question, one must elicit data on RC attachment preferences using tasks tapping early phases of processing.

Data collected by Carreiras & Clifton (1993, 1999) using two different types of speeded tasks, self-paced reading and eyetracking, provide a glimpse into what might be the early operations of the syntactic processor regarding the RC attachment ambiguity in Spanish and English.[20] In both the self-paced reading and the eyetracking experiments, the materials used by Carreiras & Clifton are disambiguated by means of gender information conveyed through the use of either semantics/pragmatics (as in (14), in both Spanish and English) or morphological agreement features (as in (15), only in Spanish):

[20] The English speakers used by Carreiras & Clifton in their experiments resided in Massachusetts and were mostly speakers of standard American English. The Spanish speakers used by Carreiras & Clifton resided in the Canary Islands, and most likely were speakers of the Canary variety of southern (Andalusian) Spanish. Andalusian Spanish shares many features with Pan-American Spanish, since it was influential in the development of Spanish in the New World, in part because of the role played by the Canary Islands during the period of Spanish colonialism in the New World (Penny, 1991). Canary Spanish is quite different at the level of pronunciation from the northern variety of Spanish spoken by Cuetos & Mitchell's (1988) subjects. However, it appears (given the data available from different studies) that these varieties of Spanish do not differ from each other regarding RC attachment preferences. See also Appendix G.

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14. a. La policía arrestó {a la hermana del criado / al hermano de la niñera} / que dio a luz recientemente dos gemelos.

    b. The police arrested {the sister of the handyman / the brother of the nursemaid} / who recently gave birth to twins.

15. La policía detuvo {al hermano de la portera / a la hermana del portero} / que estuvo acusada(o) de hurto.

    the police detained {the brother of the concierge[fem] / the sister of the concierge [masc]} / who was accused[fem(masc)] of theft

In the self-paced reading studies (three in Spanish, two in English), the materials were presented in two frames (as indicated in the examples above), while in the eyetracking studies (two in Spanish, one in English) each item appeared at once on the screen in its entirety.[21]

The data from the Spanish experiments all reflected an initial preference for high attachment. In the self-paced reading studies (Carreiras & Clifton, 1993), reading times at the critical second frame, where the RC attachment is disambiguated, were slower when the RC was forced to attach low. Likewise, in the eyetracking studies (Carreiras & Clifton, 1999), Spanish speakers spent more overall time reading the disambiguating region (first disambiguating word) of forced low attachments than that of forced high attachments (this pattern was significant in total reading times, but not in first pass reading times). This

[21] Because it was limited to 80 characters per line, the eyetracking presentation spanned two lines in the first Spanish study and in the English study. The complex NP and the RC were always presented on the same line). In the second Spanish eyetracking study, the materials were trimmed (by shortening the RC) so that they would fit on one line.

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preference for N1 attachment was present when the disambiguation was either conceptual (as in (14)) or morphological (as in (15)).

An interesting effect of morphological gender emerged in the eyetracking experiments in Spanish. In both studies, total reading times for sentences requiring a masculine host for disambiguation were read slower than sentences requiring a feminine host. Furthermore, in the study where disambiguation was conceptual, only masculine host sentences exhibited a preference for high attachment, with feminine sentences exhibiting no preference for either site. We return to the issue of using gender for disambiguation in §2.4.2, but note here that Carreiras & Clifton's findings with respect to gender might be related to the markedness of feminine morphology (cf. unmarked masculine).

In the experiments of Carreiras & Clifton, English speakers exhibited a behavior contrasting with that of the Spanish speakers, but rather than finding uniform results across paradigms, each method revealed a slightly different pattern of behavior. In the self-paced reading task, English speakers had no preferred attachment site, while in the eyetracking task they exhibited a low attachment preference.

The lack of any significant effects in the English self-paced reading task is problematic. This finding is opposed to that of Clifton (1988) in a study which also used self-paced reading methodology; as noted earlier, Clifton found that in sentences such as (7), repeated below, reaction times were longer in the forced high attachment condition, reflecting an early low attachment preference. See also Frazier & Clifton, 1996, where a similar study is reported; see also the

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parallel findings in Italian reported by De Vincenzi & Job, 1993, 1995, discussed above.[22]

7. a. The doctor called in / the son of the nurse / who hurt himself.
   b. The doctor called in / the son of the nurse / who hurt herself.

Carreiras & Clifton (1999) address this problem by asserting that their eyetracking finding is more indicative of actual on-line attachment preferences in English than their "null" finding using self-paced reading methodology (in their 1993 study). They consider eyetracking methodology more sensitive than self-paced reading measures. But alternative accounts of these results are possible. To explain why a low attachment preference was obtained in English with sentences disambiguated as in (7) but not as in (14) we might turn to the details of the segmentation: in (7), the complex NP is presented by itself, while in (14) it is presented together with the rest of the matrix sentence. The means by which disambiguation is achieved also differs: disambiguation is morphosyntactic in (7), but semantic/pragmatic in (14).[23] We return to these two critical methodological

---

[22] In discussing these experimental results in particular, Frazier & Clifton (1996) note that they "have no persuasive account of why these sentences [like (7)] result in an apparent late closure preference in English whereas other sentences, without the reflexive pronoun, do not" (p. 79).

[23] A preference in English may be undetectable if the materials do not truly belong to two different conditions, i.e., a forced high attachment condition and a forced low attachment condition. In other words, a number of items that are not fully disambiguated might eliminate differences between the forced high and forced low conditions. Close inspection of Carreiras & Clifton's (1993) materials reveals that, of the 16 experimental sentences, 6 items are not indisputably unambiguous as an example below illustrates.

1. This afternoon I saw $\left\{\begin{array}{c}\text{the daughter of the madman}\\ \text{the son of the madwoman}\end{array}\right\}$ who was trying out some new eyeshadow.

Carreiras & Clifton's sentences are "disambiguated" by semantic/pragmatic information in the RC. However, it is clear that, in at least one if not both of the versions, the presumably implausible reading is, in fact, available. It is unusual, but not impossible, for a man to try on eyeshadow. This lack of disambiguation did not emerge in the Spanish results possibly because the two populations tested (English monolinguals in Massachusetts and Spanish monolinguals in the

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issues in §2.4.1 and §2.4.2. Finally, the low attachment preference with sentences such as those in (7) might have to do with the size of the RC: very short RCs might preferably be attached low (see §2.2.4, below).

Two additional investigations can be cited which have reported an overall low attachment preference in English relative clause attachment, one with British English speakers (Henstra, 1996), the other with American English speakers (Deevy, 1999).

Henstra (1996) carried out two experiments with British English speakers, in which the RC attachment ambiguity was presented in three conditions, as shown below. The complex NPs were modeled after Carreiras & Clifton's (1993) English materials with disambiguation (by pragmatic manipulation of gender; see fn. 23).

16. a. Peter met / the brother / of the hostess / that was / a heavyweight boxer / for a living. (Forced High)
    b. Peter met / the sister / of the host / that was / a heavyweight boxer / for a living. (Forced Low)
    c. Peter met / the brother / of the host / that was / a heavyweight boxer / for a living. (Ambiguous)

The first experiment tracked subjects' eye movements while they read sentences like those in (16), presented in one frame but analyzed into the regions indicated by slashes. The second experiment recorded subjects' reading times in a phrase-by-phrase version of the self-paced reading paradigm; the presentation

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Canary Islands) are sociologically quite distinct. Therefore, the claim that English speakers show no preference for either low or high attachment, on-line, is far from being definitive. For additional discussion, see Chapter 4, §4.3.2.

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format used a moving window, so that groups of dashes (separated internally by spaces to indicate words) were replaced by groups of words, as indicated by slashes in the example above.

In the eyetracking experiment, no effects were found in first pass reading times. The regression and total reading time data showed that the region where the attachment is disambiguated (or not), *a heavyweight boxer* in (16), is read more slowly in the forced high condition (16a) than in either the forced low (16b) or the control (16c) conditions. In the self-paced reading study, on the other hand, no significant differences among the three attachment conditions were found at the critical region.

In an additional eyetracking study, Henstra (1996) manipulated the length (in characters) of the NP hosts, and used grammatical number, rather than pragmatic gender, for disambiguation. The conditions for this additional experiment are illustrated in (17). Attachment was forced by using past forms of *be* unambiguously marked for number (half of the experimental items contained singular N1, plural N2, as in the example, and the other half plural N1, singular N2).

17. a. Sam saw / the physiotherapist / of the dancers / that Karen said / was on TV / last week. (Forced High)
    b. Sam saw / the physiotherapist / of the dancers / that Karen said / were on TV / last week. (Forced Low)

Note that the disambiguating verb is separated from the relativizer *that*, where the ambiguity begins, by a "buffer" region, *Karen said*. The position of the disambiguating verb is comparable to the position of the disambiguating pronoun

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in Clifton's (1988) self-paced reading study using gender-marked reflexive pronouns. The disambiguation is relatively further into the RC than the disambiguation both in Henstra's other experiments (discussed above) using pragmatic gender and in Carreiras & Clifton's (1993, 1999) experiments using grammatical gender, where the disambiguating word is the second word in the RC.[24]

The results from Henstra's second eyetracking study replicate those from the previous one: while no effects were found in first-pass measures, an overall N2 advantage emerged in total reading times.[25]

Deevy (1999) reports a low attachment preference for English speakers, using a presentation similar to the one used by Henstra in her self-paced reading study. In Deevy's experiment, subjects' reading times were recorded as they read material presented in dashes which, word-by-word, were replaced by the

---

[24] How early the disambiguation is encountered in the RC might make a difference in terms of overall preference. Plausibly, a disambiguation that is encountered early in the RC might be more likely than a later disambiguation to induce behavior reflecting a preference for a more recent (low) host, for various reasons. Pynte (1998; see also Pynte & Colonna, 2000) suggests, along these lines, that the low attachment preference found with short RCs in French is attributable to the possibility that the complex NP may not have been fully processed as a unit by the time the attachment decision must be made, at which point only N2 is available for attachment. For more comments on the effect of the length of the attaching RC, see §2.2.4 and the discussion of the experimental results reported in Chapters 5 and 6.

[25] The attachment manipulation was crossed with a manipulation of N1/N2 relative length. N1 was longer than N2 (as in the example sentences in (17)), shorter than N2 (e.g., *the son of the politicians*), or of equal length to N2 (e.g., *the apprentice of the electricians*). The effect of the length of N1 relative to N2, however, was unclear. Henstra's expectation of an interaction of length and attachment site was present only in the region before the disambiguating region, and only in the total reading times. Where N1 was longer or as long as N2, the region before the disambiguating verb was read more slowly in the forced high than in the forced low condition. No preference for forced low or forced high attachment was exhibited by sentences where N1 was shorter than N2. (The difficulty with this finding primarily stems from the fact that the high and low versions were identical through the region in which the response difference was observed.)

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words of each item. The raw reading times were converted into residual reading times,[26] which were used for the statistical analysis.

For disambiguation, in contrast to Henstra's use of pragmatically-based gender, Deevy used syntactic number agreement. The materials for Deevy's experiment fully cross the variables of attachment site (high, low, ambiguous control) and the number of the disambiguating verb in the RC (*was*, *were*):

18. John was excited to meet ... recently starring in a very successful play.

a.	the niece of the actors who was	(Singular Forced High)
b.	the nieces of the actor who was	(Singular Forced Low)
c.	the niece of the actor who was	(Singular Ambiguous)
d.	the nieces of the actor who were	(Plural Forced High)
e.	the niece of the actors who were	(Plural Forced Low)
f.	the nieces of the actors who were	(Plural Ambiguous)

The sentences either are disambiguated ((18a), (18b); (18d), (18e)) at the verb in the RC, *was/were*, or remain ambiguous ((18c) and (18f)). An additional pragmatically-based bias for the low site is encountered later, at the participle, *starring*. The disambiguation in this study is positioned relatively early, immediately following the relative pronoun.

In this experiment, readers exhibited different attachment preferences depending on the type of auxiliary in the RC. (The variables of auxiliary type and attachment interacted in the analyses of the reading times for the auxiliary and the reading times for the following adverb.) When the auxiliary was plural, there

[26] For this analysis, a regression equation is constructed for each participant, using reading times from both filler and target items. Residual reading times are obtained by subtracting the observed reading time per word from the reading time predicted by the regression equation.

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were no significant differences found among the three attachment conditions (forced high (18d), forced low (18e), and ambiguous (18f)).[27] However, with sentences containing singular auxiliaries, the standard preference for low attachment was observed. Forced high attachments took longer to read than forced low attachments. Additionally, both types of forced attachments took longer than ambiguous attachments.

Overall, Deevy's data provide further evidence that the early preference for English is for attaching locally. If we take Deevy's reported results for the disambiguated sentences only, and collapse over number of the auxiliary, there is an overall difference between the forced low and the forced high attachments of 8 msec at the auxiliary, and 44 msec at the adverb, with forced high attachments taking longer to read.

Both Henstra's (1996) and Deevy's (1999) data further support a description of RC attachment in English where the initial attachment is low. However, this finding is complicated by the different manipulations in each of the two studies. We will return to the problem arising out of N1/N2 length differences in §2.2.4 and §4.4, where prosodic segmentation and RC attachment will be discussed, and to the problem of RC number in §2.4.2 and §4.5, where number agreement will be discussed.

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[27] With plural auxiliaries, an interaction was found to be significant between reading times at the region of the adverb *recently* and reading times at the region of the main RC verb *starring* (which was biased in plausibility for low attachment). The lack of differences at the adverb resolved into a reading time advantage for forced low attachments at the main RC verb, compared to the other two conditions containing plural auxiliaries. This same pattern was not obtained with singular auxiliaries.

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2.2.2.3 Summary: Construal

The Construal Hypothesis specifically predicts that there should be no immediate preference in English (or in any language, for that matter) to attach to either the high or the low host. This follows from the proposal that, with RCs and other such non-primary constituents, initially there is association rather than attachment, and therefore no particular structural preference. As we have seen in the preceding discussion, this prediction is not supported by the growing body of evidence that indicates English speakers attach low and Spanish speakers attach high in the early stages of processing; any evidence of a definitive early attachment preference can be problematic for the Construal account. Construal does provide a cohesive explanation for the observed differences between certain languages at later stages in processing (i.e., the response differences observed in unspeeded questionnaire tasks). Under this proposal, English speakers rely on Gricean principles whereas Spanish speakers do not, because of the availability in English (cf. the unavailability in Spanish) of an unambiguous alternative to *N1 of N2* (namely, *N2's N1*). Work on relative clause construal has shown, furthermore, that linguistic manipulations operate in parallel ways in English and Spanish (Gilboy, Sopena, Clifton & Frazier, 1995; for similar evidence in Spanish, see Igoa, 1995, and Igoa, Carreiras & Messeguer, 1998).

However, there is a problem with the Gricean account of the cross-linguistic differences. Under this view, the existence of alternative structures, to express attachment, unambiguously, to the possessum (N1), is what prompts Gricean reasoning in the perceptual machinery. It therefore follows that a

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language will attach low if it has available alternative structures (like English), and otherwise will attach high. It is unclear, then, why speakers of Dutch and Croatian, which *do* have alternative genitives to express attachment to N1, favor the high attachment site (Brysbaert & Mitchell, 1996; Lovrić & Fodor, 2000; Mitchell et al., 2000), while speakers of Romanian, which does not have any such alternative constructions, favor the low attachment site (Ehrlich et al., 1999). For a more complete discussion challenging the Gricean explanation of the cross-linguistic differences, see Mitchell & Brysbaert (1998), Mitchell, Brysbaert, Grondelaers & Swanepoel (2000); see also Oria-Merino, Costantino, Heydel & Sainz (2000).

2.2.3 Attachment-Binding of Relative Clauses

Hemforth and colleagues (Hemforth, Konieczny & Scheepers, 1996; Hemforth, Konieczny, Scheepers & Strube, 1998; Hemforth, Konieczny, Seelig & Walter, 1999; Walter, Hemforth, Konieczny & Seelig, 1999) argue that special parsing routines for modifiers need not be postulated. They have noted that structural attachment, whereby adjacency favors N2 (following a principle such as Late Closure) is sometimes in conflict with preferences resulting from the anaphoric interpretation of modifiers, in attaching constituents, such as RCs, which contain anaphors. The degree of conflict depends on a given language's sensitivity to the anaphoric information involved in the attachment of an RC. In languages such as English, for example, the relative pronoun (*who*, *which*) is frequently replaced by the generalized complementizer (*that*) or omitted

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altogether. Because of this inconsistent use of relative pronouns, English has a decreased sensitivity to anaphoric processes in attaching RCs, but a greater reliance on structural locality principles, hence the low attachment preference observed with English speakers. On the other hand, a language such as German has obligatory relative pronouns, which additionally carry morphological agreement features (case, number and gender). In German there is a stronger sensitivity to the anaphoric binding processes involved in RC attachment. These processes try to bind the relative pronoun to a salient host. N1, being a main discourse referent, is a more salient host than N2 (this pragmatically-based preference for salient hosts is akin to that dictated by Relativized Relevance). Under this account, a high attachment preference is therefore predicted for German.

In support of their proposal, Hemforth and colleagues have provided experimental evidence contrasting RC attachment (in which anaphoric processes apply) with PP attachment (in which anaphoric processes do not apply). The attachment-binding prediction for attaching an RC in German, in a sentence such as (19a) below, is for high attachment, because of the language's sensitivity to anaphoric binding processes. In contrast, in the attachment of a PP, in a sentence such as (19b), the preference should be for low attachment, because the attachment does not involve anaphors.

19. a. Die Tochter der Lehrerin, die aus Deutschland kam, traf Klaus.
the daughter of-the teacher, who[fem] from Germany came, met Klaus

b. Die Tochter der Lehrerin aus Deutschland traf Klaus.
the daughter of-the teacher from Germany met Klaus

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These predictions have been confirmed in several experiments using both unspeeded (questionnaire) and speeded (eye-tracking and self-paced reading) methods (Hemforth et al., 1996, 1998, 1999; Walter, Hemforth et al., 1999).

While this explanation appears to explain the data on German and English correctly, there exist data on Romanian and Croatian which point to problematic aspects of the attachment-binding proposal. Ehrlich, Fernández, Fodor, Stenshoel & Vinereanu (1999) provide data on Romanian, which has an obligatory relative pronoun, *care*, with agreement features. The attachment-binding account predicts a high attachment preference for Romanian. In an off-line questionnaire, Romanian speakers were asked to read (silently and aloud) ambiguous sentences containing the RC attachment ambiguity, and then answer questions orally about the attachment. Romanian speakers overall preferred to attach low (58% attachment to N2).

Lovrić & Fodor (2000) present evidence from Croatian, which has both a featureless complementizer, *sto*, and a standard relative pronoun, *koji*, with agreement features for gender, number and case. Under the attachment-binding account, RCs with *sto* should have a greater tendency to attach low, and RCs with *koji* a tendency to attach high. Using an off-line questionnaire based on Ehrlich et al.'s (1999) instrument, Lovrić & Fodor (2000) report that Croatian speakers exhibited a high attachment preference with ambiguous sentences containing either *sto* (43% attachment to N2) or *koji* (39% attachment to N2).

The attachment-binding account also seems to make incorrect predictions for RCs with relative pronouns in Spanish. In addition to the featureless

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complementizer *que*, Spanish has an inventory of relative pronouns which must agree with their antecedents. The phrases below illustrate some possibilities.

20. a. la criada de la actriz que estaba en el balcón
the maid of the actress that was on the balcony
b. la criada de la actriz la cual estaba en el balcón
the maid of the actress the-one who[fem,sg] was on the balcony
c. la criada de la actriz quien estaba en el balcón
the maid of the actress who[sg] was on the balcony
d. la criada de la actriz a quien / a la que acabo de conocer
the maid of the actress PREP whom[sg] / PREP the-one[fem,sg] that I have just met
e. la criada de la actriz con quien / con la que desayuné ayer
the maid of the actress with whom[sg] / with the-one[fem,sg] that I had breakfast yesterday
f. la criada de la actriz cuyos ojos hipnotizaron al asesino
the maid of the actress whose[masc,sg] eyes hypnotized the assassin

The example in (20a) contains the familiar unmarked complementizer *que*. This form is interchangeable with the relative pronoun in (20b), *la cual*, which must agree in number and gender with its antecedent. According to the proposal by Hemforth and colleagues, such a relative pronoun should increase the likelihood of the interpretation of the RC to be to N1. However, this seems not to be the case, based on both intuitions and anecdotal evidence. Intuitively, (20b) seems biased for low attachment, in contrast to (20a), where high attachment is preferred. (The intuitions for sentences like (20b) have been confirmed with a number of Spanish speakers.) Additionally, when asked if there is a way of forcing the attachment to N2, Spanish speakers very often produce a construction such as that in (20b).

The relative pronoun in (20c), *quien*, is a nominative anaphor morphologically marked for number, and is also permissibly interchangeable with the complementizer in (20a) and the relative pronoun in (20b). However, the

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pronoun in (20c) is more commonly used to introduce a non-restrictive RC.[28] The key fact about (20c) in the context of this discussion is that the non-restrictive RC modifies N2, rather than N1, contrary to the prediction of the attachment-binding account (by which an anaphor that agrees in number with its antecedent is more likely to have a higher antecedent).

The relative pronouns in (20d) and (20e) are oblique forms, and the one in (20f) is a genitive form. It is unclear whether the attachment of RCs with these types of relative pronouns is preferably to the low or to the high site. As with the forms in (20b) and (20c), no experimental evidence exists to date on the preferences of Spanish speakers with these constructions, using either questionnaire or speeded tasks.

Clearly, future studies of these alternatives, about which so little is known, might be able to clarify some of the problematic aspects of the attachment-binding proposal. In the meantime, while the attachment-binding account seems to make the correct predictions for languages like German and English, it does not for languages like Romanian and Croatian, and intuitively for Spanish.

2.2.4 Prosodic Segmentation

Fodor (1998) has proposed that cross-linguistic variation in the parsing of RC attachment ambiguities may be attributable to prosodic differences among languages and that preferences may be partly determined on the basis of the prosodic weight of the attaching constituent relative to that of the host

[28] Intuitively, a restrictive interpretation of (20c) is ungrammatical.

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constituent. In particular, Fodor proposes that the locality effects typically ascribed to the operation of Late Closure may be reducible to the effects of prosodic processing. Supporting this claim with evidence from literature on prosody (Gee & Grosjean, 1983; Bachenko & Fitzpatrick, 1990), Fodor demonstrates how a prosodic constraint, the Same Size Sister Constraint, can account for the generalization that heavier constituents tend to attach higher in the tree than do lighter ones, a generalization Fodor dubs the "anti-gravity law". The language-specific component in Fodor's proposal incorporates the idea that the prosodic patterns of one language differ from those of another and thus exert varying influences on the prosodic processor.

According to the anti-gravity law, if the attaching constituent is prosodically light, there should be an across-the-board low attachment preference for all languages. The attachment of heavier constituents, however, will vary depending on the relative weight of the constituent itself vis-à-vis its possible hosts, and on the language's prosodic patterns. In particular, a required prosodic break at the left edge of the relative should facilitate its upward shift (cf. Gilboy & Sopena, 1996; see also Carreiras, 1992, who induces this effect by introducing a comma after the complex NP), while prosodic continuity between N2 and the RC should favor low attachment (cf. the "gluing" effects discussed in Fodor, 1998).

Fodor (2000; see also Quinn, Abdelghany & Fodor, 2000; Quinn, in progress) has proposed the Implicit Prosody Hypothesis (IPH), which maintains that the default prosodic contour projected during silent reading influences ambiguity resolution. In particular, the parser will prefer the analysis associated

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with the most natural prosodic contour for the construction. This idea assumes that even in silent reading, where the prosodic analysis would necessarily be implicit, rather than explicit (as when speaking or listening), a prosodic analysis is in fact projected.[29]

Fodor's proposal that prosodic segmentation may interact with syntactic attachment decisions makes intuitively correct predictions for a number of other phenomena previously accounted for by invoking the Late Closure principle. In the familiar sentence (1), repeated below, the RC must float up to the higher site encompassing the whole of the complex NP, if it is to attach to a sister of similar size.

1. Someone shot the maid of the actress who was on the balcony.

(Low attachment, to *the actress*, results in an imbalance, with attacher far heavier than attachee.) A similar effect of facilitation of the higher host is evidenced for the lengthened attachees in the (b) versions of the following classic examples of the operation of a locality principle. The experience of temporary anomaly (indicated in the examples below by the boldface exclamation mark) associated with low attachment is ameliorated, or disappears altogether, when the sentence-final phrase is lengthened.

21. Rose sold the book that she had published...
   a. to her friend. **!**
   b. to her unbelievably intelligent but somewhat peculiar friend.

[29] There exists experimental evidence (e.g., Bader, 1998; see also Hirose, 1999) that implicit prosody plays a role in parsing.

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22. ...a gift to a boy...
    a. in a box. !
    b. in a blue and yellow velvet box.

23. John said that Susan will leave...
    a. yesterday. !
    b. when the pompous soprano had finally finished singing the aria.

In fact, Fodor (1998) suggests that postulating Late Closure as an independent parsing principle may no longer be necessary.[30]

Fodor (1998, 2000) considers implicit prosody effects to be rapid and to apply on the first pass. However, including prosody among the set of post-syntactic factors that determine attachment preferences might be more sensible. In fact, we propose here that the initial syntactic analysis is subsequently adjusted given prosodic considerations. Prosodic considerations vis-à-vis the syntax may only be feasible after a prosodic structure has been projected and compared for wellness of fit to the corresponding syntactic structure that has been built previously. Unfortunately, it may be empirically impossible to distinguish an initial attachment dictated by syntactic principles alone from one which has been swayed by prosodic considerations. Every constituent is "short"

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[30] For a similar proposal, see MacDonald (1999), who suggests that the locality effect in the perception of sentences like (3)/(23a) is actually rooted in the nature of speech production. MacDonald notes that both speakers and hearers prefer constructions where a longer constituent, *that Susan will leave*) comes later than a shorter constituent (*yesterday*); cf. *John said yesterday that Susan will leave*; *Yesterday, John said that Susan will leave*). MacDonald argues that this preference stems from a production constraint. In the production of utterances, shorter constituents are ready to be produced earlier, and therefore tend to get placed earlier in the production string. (This idea, although with a different objective, is also discussed in Gibson, Schütze & Salomon, 1996, regarding triple-complex NP ambiguities, and mismatches between perceptual and production data.) MacDonald's proposal, however, does not make any specific predictions for the construction under investigation here, since it does not violate the short-before-long constraint (the constituent *who was on the balcony* is about the same size as *the maid of the actress*).

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(and usually shorter than the phrase structure it is going to incorporate itself into) when only the first few words have been read. If prosodic considerations play a role in initial attachments, then this fact predicts an early locality preference by virtue of the fact that the length of the attaching constituent is, at the time of initial attachment, unknown. (For a similar idea, but without reference to prosody, see Pynte, 1998, and Pynte & Colonna, 2000.)

2.2.4.1 Evidence on the Effects of Implicit Prosody

Two types of evidence exist in support of parts of Fodor's (1998, 2000) proposal regarding the interaction of prosody and parsing. On the one hand, several studies have recently been carried out examining how length manipulations produce anti-gravity effects in Arabic (Abdelghany & Fodor, 1999; Quinn et al., 2000), Croatian (Lovrić & Fodor, 2000), English (Quinn, in progress; Quinn et al., 2000; Walter, Clifton et al., 1999; Walter, Hemforth et al., 1999); French (Pynte & Colonna, 2000; Pynte, 1998; Quinn, in progress; Quinn et al., 2000), German (Walter, Clifton et al., 1999; Walter, Hemforth et al., 1999) and Spanish (Igoa, 1999),.[31] In general, these studies show that the longer an attaching constituent, the more likely it is to attach at a higher site. Viewed another way, very short attachers remain local, while the longer ones are freer to seek higher hosts. However, the anti-gravity behavior of long relatives is not

[31] To date, only one study has found a high attachment preference for relatively short RCs in Spanish (e.g., *que estaba enferma*, "who was sick"). This was an eyetracking experiment in Carreiras & Clifton (1999; see discussion of results above, §2.2.2.2). It is unclear what makes this study different from those cited above.

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seen as being *directly* linked to their length. Under this account, what makes a difference is how length controls prosodic phrasing. If a constituent is longer, it is more likely to be an independent prosodic unit,[32] and therefore, more able to attach non-locally. The core assumption here is that implicit prosody plays a role in sentence processing, and recent evidence suggests that it does (for some relevant evidence, albeit based on a different construction, see Hirose, 1999). But crucially, the effect of length emerges in the same way in a number of languages (see references above), which means that it is not the variable responsible for the cross-linguistic differences.

The second type of evidence has to do with the effect of specific prosodic characteristics of languages. A systematic study of the prosodic and intonational patterns of relevant languages will provide a more precise understanding of what particular language-specific features might determine the propensity of a language to attach high or low. Some preliminary investigations are under way.

Schafer, Carter, Clifton & Frazier (1996), in a study using spoken sentence presentation, examined the effect of pitch accent placement on the resolution of ambiguous relative clause attachments in American English. They found that placing a pitch accent on one of the two nouns in the complex NP significantly increased the likelihood that hearers would interpret the relative clause as modifying that noun. This was the case when the RC was either unaccented (and presumed to convey given information) or accented (presumed

[32] The anti-gravity proposal could include the assumption that the parser assigns syntactic structure within prosodic packages, and prefers not to alter it later. This elaboration on the prosodic account specifically predicts a locality preference *within* prosodic packages only. This idea might be testable using aural stimuli.

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to convey new information). Maynell (1999) presents evidence from two experiments suggesting that the presence of an intonational phrase boundary before the relative clause results in a preference for high attachment. These data (Schafer et al., 1996; Maynell, 1999) show how—given explicit prosody, in the form of auditory stimuli—departure from the default prosodic contour can alter structural preferences.

Quinn et al. (2000; see also Quinn, in progress) instead focus on finding the default prosodic contour in contrastive languages, like French (high attaching) and English or Arabic (low attaching). Native speakers are recorded reading aloud sentences with RC attachments disambiguated to either N1 or N2; measurements are then taken of fundamental frequency (F_0) peaks in N1, N2 and the first stress-bearing word of the RC. An F_0 for a given region that is systematically higher than the F_0 of the preceding region is assumed to be indicative of prominence (and possibly also prosodic independence). For example, a non-prominent (and prosodically dependent) RC might feature the typical sentence-final declination pattern that characterizes most declarative sentences, where there is a tendency for the F_0 to decline gradually over the course of an utterance.[33] On the other hand, a prominent RC might break the declination pattern and have an F_0 peak higher than the preceding F_0 peak in the utterance.

Preliminary results from experiments by Quinn and colleagues indicate that, in sentences with short relatives in sentence-final position (as in most of the

[33] This phenomenon has been observed in a number of languages. It is documented for Spanish by Prieto, Shih & Nibert (1996), and has been extensively studied in English; see, e.g.,

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attachment experiments), there is a general lack of F_0 prominence in the RC, with both forced high and forced low attachments. The short relatives appear to be dependent, prosodically, on the rest of the sentence, and fit neatly into the sentence-final declination pattern. On the other hand, in sentences with long relatives, two different patterns emerge, and do so differently in each of the three languages. The first stress-bearing unit in the RC is prominent in French, but not in Arabic, with RCs that are forced to attach either high or low. The interesting language here is English, where the RC is prominent in the case of forced high attachments, and not prominent in the case of forced low attachments, suggesting that English has greater flexibility in its prosodic patterns than the other two languages. Overall, these results lend support to the idea that constituents are more likely or better able to attach to non-local hosts when they are prosodically prominent, and therefore independent prosodic constituents. While these results are only preliminary, they are indicative of interesting avenues for future research.

2.2.4.2 Summary: Prosodic Segmentation

There is now a significant and growing body of data pointing to the quite possibly universal applicability of anti-gravity behavior of longer constituents, a phenomenon that is plausibly prosody-based. It may well be, then, that implicit prosody plays a critical role in determining certain aspects of attachment, in all languages, and that the effects of this mental projection of prosodic packaging

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Pierrehumbert (1980) and Liberman & Pierrehumbert (1984).

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appear to resemble those of overt prosody present in experimental stimuli. Prosodic phrasing thus seems to affect the parser's preferences, even in silent reading, although it is not altogether clear how early the prosodic effects come into play, that is, if they affect the initial attachment or instead adjust it.

This account of the observed anti-gravity effect does not address the observed cross-linguistic differences in RC attachment. More promising in this second regard is the second type of evidence about the role of implicit prosody. The study of prosodic characteristics of various languages may eventually provide information on critical prosodic differences between languages whose attachment preferences are different.

2.2.5 Summary: Universalist Accounts

The common proposal behind universalist accounts of the cross-linguistic differences in RC attachment preferences is that the preferences emerge not from different routines employed by the parser but rather from different routines or principles applying in post-syntactic phases of language processing. De Vincenzi and colleagues appeal to the role of thematic information, Frazier and colleagues call on discourse principles, Hemforth and colleagues refer to the formal morphosyntactic characteristics of the relative pronoun, and Fodor and colleagues invoke the role of prosodic segmentation preferences. A feasible account of RC attachment preferences might take into consideration some or all of these factors and propose that attachment preferences are multiply determined by a number of variables.

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Playing a key role in all of the above proposals is the universal parser which initially exerts a preference for local attachments. Local (low) attachments, guided by a principle such as Late Closure, are regarded as the computationally simplest analysis, requiring the least amount of effort or memory load on the part of the structure-building machinery. In the following section we examine proposals of a different flavor, in which the locality preference is not necessarily initial, and in which factors external to the processing machinery or the input being processed are taken to be critical in determining the nature of the first analysis.

2.3 Exposure-Based Accounts

2.3.1 Parameterized Models

Cuetos & Mitchell (1988) articulated the first account of cross-linguistic differences in relative clause attachment as the Modifier Straddling hypothesis. Under this proposal, the parser is set to either LC (for Late Closure, yielding low attachment preferences, as in English) or EC (for Early Closure, as it was initially dubbed, yielding high attachment preferences, as in Spanish), on the basis of how nouns and their modifiers are typically ordered in the language. This claim was based on evidence from a series of experiments conducted by Cuetos & Mitchell (1988) and Mitchell & Cuetos (1991; see also Cuetos, Mitchell & Corley, 1996 and Mitchell, Cuetos & Zagar, 1990), which showed that Spanish readers took longer to read the portion of an RC (underlined in (24a)) which

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disambiguates the attachment for the low host, compared to their reading latencies for the same phrase in a variety of other sentence types (24b-e):

24. a. Alguien disparó contra el criado de la actriz / que estaba en el balcón / con su marido. (Forced Low)[34]
someone shot against the servant-masc. of the actress / that was on the balcony / with [poss. pron.] husband

b. Alguien disparó contra la criada de la actriz / que estaba en el balcón / con su marido. (Ambiguous)
someone shot against the servant-fem. of the actress / that was on the balcony / with [poss. pron.] husband

c. Alguien disparó contra el criado y la actriz / que estaba en el balcón / con su marido. (Conjunction)
someone shot against the servant-masc. and the actress / that was on the balcony / with [poss. pron.] husband

d. Alguien disparó contra la actriz / que estaba en el balcón / con su marido. (Short-NP Control)[35]
someone shot against the actress / that was on the balcony / with [poss. pron.] husband

e. Alguien disparó contra la criada del actor / que estaba en el balcón / con su marido. (Forced High)
someone shot against the servant-fem. of-the actor / that was on the balcony / with [poss. pron.] husband

Setting the parameter to LC or EC would be triggered by the general properties of the language. For a pre-modifier language, in which adjectives precede the noun (like English), the setting would be LC. For a post-modifier language, in which adjectives follow the noun (like Spanish), the setting would be EC. The two languages have different devices for expressing double modifications of a

[34] As noted above (fn. 1), this particular sentence is not fully disambiguated. Examination of the Cuetos & Mitchell (1988) materials list indicates that 6 of the 24 target items are possibly ambiguous the way the sentence in (24a) is. The rest are disambiguated semantically/ pragmatically or morphosyntactically. Nevertheless, the disambiguation in the Cuetos & Mitchell experiments appears to have operated in the desired way, particularly given the levels of significance for the results. (It is noteworthy that the ratio of possibly ambiguous to definitely unambiguous sentences in Cuetos & Mitchell's experiment is less than that in a similar study by Carreiras & Clifton (1993), where 6 of 16 sentences are questionable; see fn. 23.)

[35] "Short" here characterizes the NP being modified: a single noun counts as "short" while two nouns, as in *la criada de la actriz*, is "long". For evidence and discussion on lengthening the nouns in the complex NP, see Colonna, Pynte & Mitchell, 2000.

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noun. As an example, to speak about a woman who is the maid of an actress and who is blonde, one might say *the blonde maid of the actress* in English, where the two modifiers flanking the noun unambiguously refer to the *maid*. Spanish, however, lacks the syntactic device to generate such an unambiguous construction and is limited to structures such as *la criada rubia de la actriz*, where the second modifier (*de la actriz*) must straddle the first one (*rubia*). Examination of a wider range of languages showed, however, that this proposal cannot be correct (Brysbaert & Mitchell, 1996): Dutch and German are pre-modifier languages, and by the modifier straddling account are erroneously predicted to prefer low attachment (we return to Dutch attachment preferences in §2.3.2, below; evidence on German was discussed above, §2.2.3).

Gibson and colleagues (Gibson, Pearlmutter, Canseco-González & Hickok, 1996; Gibson & Pearlmutter, 1994; Gibson, Schütze & Salomon, 1996; Gibson & Schütze, 1999; Miyamoto, 1998; Gibson, Pearlmutter & Torrens, 1999) have proposed that a recency principle like Late Closure is universally operative in the parser. They define this as *Recency Preference*, "preferentially attach structures for incoming lexical items to structures built more recently" (Gibson, Pearlmutter et al., 1996, p. 26). To account for the cross-linguistic variation, Gibson and colleagues have proposed that the locality factor competes with a second factor which favors the higher site.[36] This second factor is articulated as

[36] Gibson and colleagues' two-principle model is reminiscent of the attachment-binding proposal discussed in §2.2.3. Both models propose an interaction between two forces, one of which pulls the RC toward the low site, the other toward the high site. The two models differ in the degree to which external (exposure-based) influences determine the strength of the principle responsible for high attachment. In the attachment-binding account, formal morphosyntactic characteristics of the language determine how much the language relies on anaphoric processes in RC attachment. The model proposed by Gibson and colleagues is included in this section, on

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Predicate Proximity in Gibson, Pearlmutter et al. (1996), and is in effect a correlate to Frazier's (1990) Relativized Relevance (see above, §2.2.1), "attach as close as possible to the head of a predicate phrase" (Gibson, Pearlmutter et al., 1996, p. 41).

To demonstrate that the two factors interact, Gibson, Pearlmutter et al. provide data from two on-line reading experiments, one in Spanish and one in English, in which subjects were asked to make grammaticality judgments as they read each word of sentence fragments such as the following, in a non-cumulative word-by-word self-paced reading task:

25. a. the lamps near the paintings of the house that was damaged in the flood
    b. the lamps near the painting of the houses that was damaged in the flood
    c. the lamp near the paintings of the houses that was damaged in the flood

25.′ a. las lámparas cerca de las pinturas de la casa que fue dañada en la inundación
    b. las lámparas cerca de la pintura de las casas que fue dañada en la inundación
    c. la lámpara cerca de las pinturas de las casas que fue dañada en la inundación

In these sentence fragments, the relative is forced to attach to one of the three sites in the triple-complex NP (the host for the relative is italicized). The RC attachment is disambiguated by number agreement (disambiguating morphemes are underlined), at the verb *was* in English, and at both the verb *fue* and the participle *dañada* in Spanish.[37]

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exposure-based accounts of the RC attachment ambiguity, because it does not exclude the possibility of the parameter setting for Predicate Proximity being based on frequency counts. (See Gibson, Pearlmutter et al., 1996, pp. 47-ff.)

[37] Several shortcomings exist in the design and implementation of Gibson, Pearlmutter et al.'s (1996) experiments in Spanish and English. The materials were sentence fragments, not complete sentences, and are therefore not comparable to materials from other studies. Moreover, there was no predicate present to activate Predicate Proximity. Gibson, Pearlmutter et al. did not ensure that the Spanish speakers they tested in fact attached high with two NPs.

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If Recency operates by itself, the pattern of preferences should be N3-N2-N1 (from most local to least local), while if Predicate Proximity operates alone the pattern should be N1-N2-N3 (from closest to, to farthest from the head of the predicate). Gibson, Pearlmutter et al.'s results match neither of the above possibilities. Speakers of both English and Spanish had the same pattern of responses, where N3 was the easiest site for RC attachment, N2 the hardest, and N1 in the middle, suggesting that the two factors, Recency and Predicate Proximity, interact to determine an initial attachment. These results have been replicated in a more recent experiment. Gibson, Pearlmutter & Torrens (1999), report the same pattern of results for Spanish, with materials consisting of complete sentences, in which the NP only contained *de* as the preposition. (A shortcoming of Gibson et al.'s, 1999, materials is the hybrid nature of the NPs concerning animacy features in the nouns; since it is not known to what extent animacy plays a role in determining attachment preferences, not controlling for this variable could have unknown consequences. Some evidence suggests that animacy features do affect attachment; see De Baecke, Brysbaert & Desmet, 2000; Desmet, Brysbaert & De Baecke, 2000.)

Additionally, the critical NP sequence contained at least one theta-assigning preposition (*near*), prepositions which we know, from work by De Vincenzi and colleagues in Italian and French (De Vincenzi & Job, 1993, 1995; Baccino, De Vincenzi & Job, 2000), as well as from work by Gilboy, Sopena, Clifton & Frazier (1995) in English and Spanish, operate differently than *of/de*. Gibson, Pearlmutter & Torrens (1999) address some of these problems. An additional questionable aspect of the experiments by Gibson and colleagues is the fact that the subjects used were not only Spanish speakers, but were also all speakers of English (since they were recruited from the academic community at Cambridge, MA) and therefore bilingual to some extent. The experiments reported in Chapter 6 below show that bilinguals have preferences that diverge from those of monolinguals.

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According to Gibson and colleagues, precisely the character of the interaction between Recency and Predicate Proximity determines the cross-linguistic variation which has been observed. Gibson and colleagues offer the suggestion that word-order differences between languages will influence whether a language assigns more or less priority to Predicate Proximity. Languages with freer word order (e.g., Spanish), which allow arguments to occur after the verb in a non-adjacent position, must activate the verb more strongly and thereby might have a stronger Predicate Proximity requirement than languages with more rigid word order (e.g., English). (For further discussion and examples, see Gibson, Pearlmutter et al., 1996; Miyamoto, 1998.)[38]

Brazilian Portuguese is a Romance language with rigid SVO order. Under this explanation, we should expect Brazilian Portuguese speakers to exhibit a low attachment preference. Using a word-by-word moving window paradigm, Miyamoto tested native speakers of Brazilian Portuguese with sentences like the following:[39]

26. a. A kombi trouxe os supervisores do engenheiro que foram pagos pela empeiteira. (Forced High)
the van brought the supervisor of the engineers that were paid[plu] by-the company

[38] Miyamoto (1998) provides an example of such word-order differences: Spanish allows adverbs to intervene between a verb and its direct object (*Juan besa mucho a María*), while English does not (**John kisses often Mary*). Brazilian Portuguese, like English but unlike Spanish in this respect, does not allow adverbs to intervene between the verb and the direct object.

[39] Miyamoto (1998) included in his experiment a second factor, not discussed here, which compares full relatives, as in the example above, to reduced relatives, e.g., *A kombi trouxe o supervisores do engenheiro pagos pela empreiteira* ("The van brought the supervisors of the engineer paid by the company"). This manipulation was included to compare Gibson and colleagues' account of RC preferences to that of Hemforth and colleagues (discussed in §2.2.3). See Miyamoto (1998) for further discussion.

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b. A kombi trouxe o supervisor dos engenheiros que foram pagos pela empeiteira. (Forced Low)
the van brought the supervisors of the engineer that were paid[plu] by-the company

Analyses of the reading time data indicate that, as expected, forced high attachments (26a) were read significantly slower than forced low attachments (26b). However, this finding, as well as the proposed explanation for the cross-linguistic variation, is complicated by some recent evidence that suggests the off-line preference in Brazilian Portuguese is for the high site.[40]

Gibson and colleagues have introduced an interesting new set of problems to consider, by introducing evidence from attachment to complex NPs with three host nouns.[41] However, their proposal about the interaction of the two factors, Recency and Predicate Proximity, has a post-hoc aspect. The explanation for the preferences exhibited by languages depends crucially on the exact mathematical functions assumed for how each effect varies with distance (from the predicate, from the host noun). Making different assumptions about this could lead to a version of this proposal where highest site or even the middle site is the preferred site, a possibility that is at odds with the available evidence.

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[40] In an on-going investigation of Brazilian Portuguese by Finger & Zimmer (2000), preliminary data suggest that the off-line preference in Brazilian Portuguese is high attachment, as in Spanish. Using a questionnaire and a procedure based on that used by Ehrlich et al. (1999), Brazilian Portuguese speakers have a rate of N2 attachment of 37% with long RCs and 43% with short RCs. Additionally, in a questionnaire constructed using translations of the sentences used by Cuetos & Mitchell (1988), Brazilian Portuguese speakers have a 28% rate of N2 attachment (Finger, personal communication).

[41] We will not discuss the triple-complex NP ambiguity at length here. For additional discussion on triple-complex NPs, see Hocking & Mitchell, 1999; Wijnen, 1998; Wijnen, Troos, & Quené, 1999.

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2.3.2 Tuning

A fully exposure-based parsing account would propose a parser with tendencies entirely derivable from the environment of a speaker. The Tuning Hypothesis (Mitchell & Cuetos, 1991; Cuetos, Mitchell & Corley, 1996; Brysbaert & Mitchell, 1996; Mitchell, Cuetos, Corley & Brysbaert, 1995; Mitchell, 1994; Mitchell & Brysbaert, 1998; Mitchell, Brysbaert, Grondelaers & Swanepoel, 2000) claims that the processor evaluates the statistical frequency of attachments in unambiguous input and derives its structural preferences, when faced with ambiguity, from the frequencies it has computed. For example, a person exposed to input with a higher frequency of unambiguous high attachments, will prefer to attach high when dealing with ambiguous input. Thus the Tuning account can accommodate a certain degree of individual variation on RC attachment preferences, to the extent that input samples can differ, even for the same language (on individual differences, see Corley, 1995, and Brysbaert & Mitchell, 1996; see also discussion in Fernández, 1998). The Tuning model for sentence processing, however, is not a fully exposure-based model since some innate architecture is assumed (Brysbaert & Mitchell, 1996).[42] In this sense, Tuning (along with the rest of the exposure-based accounts discussed above) is not radically different from the universalist accounts discussed in §2.2. In fact, all of the models discussed in this chapter posit a heavy reliance on structural principles for determining the attachment of ambiguous constituents, except with

[42] The bulk of the syntactic analysis done by the parser could in fact be assumed (under a view of modifier attachment as the one proposed by the Tuning hypothesis) to be carried out following the basic principles of the Garden Path hypothesis. It is only in the case of ambiguous modification, as in the RC attachment ambiguity, that exposure to previous input plays a role.

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certain "special" constructions, such as the RC attachment ambiguity. These models stand in contrast to constraint satisfaction theories (e.g., Macdonald, 1999; Thornton & MacDonald, 1999; Thornton, MacDonald & Gil, 1999), not discussed here, which place a greater degree of importance on sensitivity to frequency distributions.

Brysbaert & Mitchell (1996) report data indicating that Dutch has a high attachment bias. In an off-line questionnaire, Dutch native speakers[43] showed a preference to attach high (on average, 62%). Brysbaert & Mitchell also report the findings of two on-line studies, one using self-paced reading, and another eyetracking. In these experiments, subjects read sentences like the following:

27. a. De gangsters / schoten op / de zoon / van de actrice / die / op het balkon / zat / met {zijn / haar} arm / in het gips.
    the terrorists shot PREP the son[masc] of the actress[fem] that[ambig] on the balcony was with {his / her} arm in a cast

    b. De gangsters / schoten op / het zoontje / van de actrice / {dat / die} / op het balkon / zat / met {zijn / haar} arm / in het gips.
    the terrorists shot PREP the little-son[neut] of the actress[fem] {that[neut]. / that[fem].} on the balcony was with {his / her} arm in a cast

In sentence (27a), the disambiguation occurs late in the RC, at the gender-marked possessive pronoun. In (27b), on the other hand, there is an earlier

[43] The subjects used by Brysbaert & Mitchell (1996) were students in a university in Belgium, and were therefore not monolingual speakers of Dutch. Most (if not all) were fluent speakers of French, as well as English, a language they are required to have reading proficiency in, to be able to manage their reading assignments (Brysbaert, personal communication). We return to this in Chapter 3, §3.5.

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disambiguator, at the relative pronoun. Dutch *dat* can only refer to singular neuter nouns (like *zoontje*), while *die* refers to nouns of any gender or number except singular neuter.

The self-paced reading experiment contained four factors: (i) high versus low disambiguation, (ii) early versus late disambiguation, (iii) segmentation (sentences were presented either in one frame or with the segmentation indicated above), and (iv) head type (human/non-human). Head type was not significant in any of the analyses. Overall, forced low attachments took longer to read than forced high attachments (an effect significant by subjects, though marginal by items). The three-way interaction between factors (i), (ii), and (iii) was marginally significant. Planned comparisons indicated that, with segmented presentation, reading times for the last two frames were longer when the sentences were disambiguated for low attachment.

The eyetracking experiment replicated the high attachment preference found in the self-paced reading study. Again, forced low attachments took longer to read than forced high attachments, in cumulative region reading times.[44] This effect was observed with sentences with both late (27a) and early (27b) disambiguation.

Brysbaert & Mitchell report an "initial LC advantage" (p. 680) at the relative pronoun region in the first pass reading time data of the eyetracking experiment,

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[44] Cumulative region reading times are calculated by summing the fixations between the moment the eye crosses the left edge of a given region to the moment the eye crosses the right edge. In contrast to first pass reading times, cumulative region reading times include regressions which may take place within a given region. For more discussion and references, see Brysbaert & Mitchell (1996).

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in the conditions where disambiguation was early. Brysbaert & Mitchell suggest that this finding is due to subjects not picking up on information in the relative pronoun (subjects skipped the region at a rate of 67% in the first pass; 1996, p. 678, fn. 1), and dismiss the result as artefactual rather than indicative of initial preferences.[45]

There is a plausible explanation of the initial advantage with forced low attachments reported by Brysbaert & Mitchell, though it does not necessarily fit in well with the Tuning proposal. The early preference for forced low attachments could be the result of early syntactic strategies that favor local attachments. This early preference could be quickly revised in the presence of additional information biasing for the alternative attachment. In the case of Brysbaert & Mitchell's experiment, the RC is long, and perhaps the prosodic independence of the RC comes into play, pushing for revision of the initial choice. The only serious problem with this explanation, as pointed out by Brysbaert & Mitchell (see fn. 10), has to do with why it should be that, in the presence of confirming information (e.g., gender agreement information) the attachment is forced to the low site, the processor is swayed toward the other site. To deal with this problem however, we might note that certain post-syntactic factors exert a very strong influence on certain syntactic decisions, an influence which may, in fact, override formal agreement. A serious challenge in developing new theories to account for

[45] The superiority of eyetracking over, say, self-paced reading methodology is often cited in the literature. However, the fact that the eyetracker only records fixations is a limitation of the method, since it makes the implicit assumption that no processing is necessarily going on during saccades. Additionally, the use of such small regions for analysis does not seem to take into consideration the possible role of parafoveal vision. That a region is not fixated on is not enough evidence that it has not been seen and processed.

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this is determining which of the post-syntactic factors can override syntactic decisions and which cannot. It should be added that statistical counts on the distribution of unambiguous expressions in the input a given parser has been exposed to through life might also be included in the list of post-syntactic factors determining ultimate attachment.

After participating in the on-line experiments, Brysbaert & Mitchell's subjects were asked to complete questionnaires with ambiguous materials. The off-line rates of attachment to N1 of subjects having been exposed to unambiguous attachments in the on-line reading tasks were 51% following the unsegmented self-paced reading task, 61% following the segmented self-paced reading task, and 56% following the (unsegmented) eyetracking task (compared with the 62% high attachment preference for subjects who had not participated at all in an on-line reading experiment). (An analysis of the data shows that there are marginally significant differences among the three post-on-line reading tasks.) This evidence suggests to the authors that questionnaire biases may change as a function of the preceding experimental session, an interpretation taken as evidence of Tuning (that is, of the influence on parsing decisions on frequency of exposure to unambiguous input) for RC attachment preferences.

Possibly the strongest test of the claim that there is a very direct relationship between the preferences of the parser and the linguistic input it has been exposed to is one which looks for correlations between behavioral and corpus data. A number of studies have focused their efforts on this problem (among others, De Baecke, Brysbaert & Desmet, 2000; Desmet, Brysbaert & De

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Baecke, 2000; Gibson & Pearlmutter, 1994; Gibson & Schütze, 1999; Gibson, Schütze & Salomon, 1996; Hocking & Mitchell, 1999; Igoa, 1996; Mitchell, Cuetos, Corley & Brysbaert, 1995). While some of this work supports the Tuning predictions, the bulk of it seems to contradict them, as the distribution of unambiguous constructions in the corpora does not always match with the perceptual preferences of speakers of the corresponding language. Gibson & Pearlmutter's (1994) corpus analysis corroborates the behavioral findings in Gibson, Pearlmutter et al. (1996) and in Gibson et al. (1999), but other investigations by Gibson and colleagues (Gibson, Schütze & Salomon, 1996; Gibson & Schütze, 1999) have found evidence that behavioral data do not always correlate with the corpus-frequency facts.[46] However, they also note that not finding a direct correlation between behavioral and frequency data does not rule out frequency effects on attachment preferences.

Gibson and colleagues explain the discrepancy in terms of differences between the production and the perception mechanisms. Gibson & Schütze (1999) note that the locality preference operates in both production and perception. However, the additional factor that shifts the low attachment preference in perceptual tasks (a factor such as Predicate Proximity) is a

[46] Gibson & Pearlmutter (1994) analyze the frequency of structures where a RC may attach to one of three possible sites (e.g., *[the computer [near the model [of the building [$_{RC}$ that...*). Gibson, Schütze & Salomon (1996) and Gibson & Schütze (1999) instead consider the case where a fourth NP conjoins to the complex NP with three heads (e.g., *[$_{N1}$ the computer [$_{N2}$ near the model [$_{N3}$ of the building [$_{CONJUNCT}$ and the one...*). In Gibson, Schütze & Salomon's corpus analysis, of the 1141 instances of NPs unambiguously conjoined to one of the nouns in the triple-complex NP, the overwhelming preference was for attachment to N3 (824, 72%), with attachment to N2 a distant second (195, 17%), and attachment to N1 least frequent (122, 11%). This distribution of the corpus frequencies is at odds with evidence from perceptual experiments in which the hierarchy of preferred attachments is N3 best, followed by N1, with N2 least possible.

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disambiguation mechanism, which logically does not apply in production, since the speaker knows the intended meaning, while the perceiver does not.

A severe blow to the Tuning hypothesis comes from corpus data from Dutch, reported in Mitchell & Brysbaert (1998). Given the high attachment preference found in Dutch behavioral studies, the Tuning hypothesis predicts a prevalence of unambiguous high attachments in Dutch corpora. Mitchell & Brysbaert collected and analyzed a random sample, from four different Dutch newspapers and magazines, of 675 sentences containing the sequence N1-*van*-N2-RC. In the sample, the RC was clearly attached to one of the two sites in 469 cases. In the unambiguous subset, only 144 (31%) sentences featured attachment to N1, indicating that the Dutch corpus is at odds with the behavioral preferences of Dutch speakers.

Additional investigations of Dutch corpora have shown that the preference for low attachment prevails, but that it is modulated by characteristics of the host nouns (De Baecke et al., 2000; Desmet et al., 2000). Low attachment is more frequent when the host nouns in the complex NP are both non-human. Human hosts, in N1 (human/non-human) and N2 (non-human/human) positions, appear to be more attractive heads than their non-human counterparts, regardless of their position. Finally, in sentences with complex NPs containing two human nouns, high attachment is more frequent. This result is potentially informative about the existing preference of Dutch readers (and readers of other languages, including Spanish) for forced high attachments, considering especially the fact that most perception studies on RC attachment use sentences with human

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nouns. However, the result should also be considered with caution, since the sentences containing two human heads in the corpus reported by De Baecke et al. (2000) only make up approximately 7.5% of the data analyzed.

The way in which frequency data are analyzed could have important consequences in terms of how well they correlate with behavioral data. The question of the grain at which records are kept by the actuarial mechanism is thus an important one, taken up in some detail in Mitchell et al. (1995), who propose that the record-keeping is done at a relatively coarse grain.

The discrepancy between corpus and behavioral data could be addressed if the Tuning mechanism is seen as applying, rather than on the first parse, on the second pass. Overall, corpus studies in Dutch and English have found a general preference for low attachment, a finding which may reflect the tendencies of speakers of those languages to attach low on the initial analysis. In production, there may be less time for reanalysis (and therefore also less time for post-syntactic factors, including Tuning processes, to apply. This explanation, while tentative, appears to account for some of the contradictory findings reported in this section.

2.3.3 Summary: Tuning

The Tuning hypothesis claims that frequency distributions of the unambiguous input the parser has been exposed to are the dominant factor in determining initial decisions in RC attachment. As such, Tuning stands in opposition to universalist proposals in its account of the origins of the attachment strategies employed by the perceptual mechanism. In general, universalist

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accounts hypothesize that universal, presumably innate strategies guide initial attachment decisions and look elsewhere for an account of the observed differences between languages. For example, Construal accommodates problematic structures by asserting that non-primary phrases are interpreted using both structural and non-structural information, and that the latter can vary across languages; Fodor (1998) handles cross-linguistic differences with an appeal to the prosodic component of the grammar. On the other hand, proponents of the Tuning hypothesis play down the role of such factors in determining initial attachment choices.

As it is currently formulated, however, Tuning faces a number of conflicts with some recent evidence from corpus analysis. The corpus statistics from Brysbaert, Mitchell and colleagues on Dutch, as well as those from Gibson and colleagues on English triple-complex NPs, appear to be contradictory to the existing evidence from perceptual experiments with the same types of constructions, in the corresponding languages. If the Tuning processes are seen instead as operating in a post-syntactic phase, as we have suggested above, some of these contradictions appear less problematic.

Another problem with the Tuning hypothesis has to do with its specification of *how* the processing routines are altered by frequency counts. The parser might actually override Late Closure with, say, an early closure-like strategy in languages with high attachment preferences. Alternatively, there may be no Late Closure at all. An additional possibility is that frequency can speed access, as in the lexicon, to the structure dispreferred by Late Closure.

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Under the Tuning account, it is not clear why locality is the prevalent preference in other constructions (e.g., those studied by Igoa, 1995, and Igoa, Carreiras & Messeguer, 1998); apparently these are not subject to Tuning effects, unlike the RC attachment ambiguity. If this is correct, an explanation is needed for why, if the parser engages in strategy Tuning based on exposure to input, it does so only with certain types of constructions, like RC attachments, but not with all constructions in which attachment ambiguities exist.

2.4 Understanding the Evidence: A Methodological Analysis

Now that we have laid out the facts, and have arrived at a general understanding of the two major categories of proposals on RC attachment, we are in a position to address two methodological issues, an understanding of which will be useful in evaluating the evidence and in determining the best way to further investigate RC attachment preferences. The two issues concern the effects of on-line segmentation (§2.4.1) and the effects of disambiguation in on-line materials (§2.4.2).

2.4.1 On-Line Segmentation and Relative Clause Attachment

Throughout the discussion above, we have encountered different segmentation patterns in the presentation of materials. In this section, the evidence on segmentation is reviewed separately. The way materials are segmented in speeded (and possibly also in questionnaire) presentations might in turn affect the way readers analyze the word string into constituents, with or

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without mediation by implicit prosodic phrasing (Gilboy & Sopena, 1996). Segmentation is a critical methodological problem, not just under a point of view of sentence processing which invokes the role of implicit prosody in determining parsing decisions (as in Bader, 1998, and in Fodor, 1998, 2000). Because segmentation could introduce undesirable effects (cf. Mitchell, 1987), close examination of how and when segmentation biases the interpretation is warranted.

The focus in this section is on segmentation and its impact on syntactic analysis. However, we borrow some constructs from prosodic analysis, to develop a vocabulary with which to describe segmentation. It is sensible to look to prosodic analysis as a model for understanding the effects of segmentation, since in spoken language prosody often plays the role of disambiguator, which might bear some resemblance to the way segmentation has been claimed to bias one or another structural analysis (Cuetos, Mitchell & Corley, 1996; Gilboy & Sopena, 1996). As an example, consider the ambiguity in the following phrase.

28. When Madonna sings the song...

The NP *the song* could be attached as the object of *sings* in the dependent clause, or it may become the subject of the matrix clause, whose verb has not yet been encountered.

Let us assume that the intonational structure of both English and Spanish consists, at the level of the utterance, of an intonation phrase (IntP) which may contain at least one (but possibly more) intermediate phrases (iP), each

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composed of prosodic words (PWds).[47] This structure is assumed for English by Pierrehumbert (1980) and proposed by Nibert (1999) for Spanish.[48]

The phrase in (28) above could have either one of the following prosodic analyses:

29. a. [[When Madonna sings the song]$_{iP}$ ...]$_{IntP}$
    b. [[When Madonna sings]]$_{iP}$ [the song ...]$_{iP}$]$_{IntP}$

The first analysis, in (28a) disambiguates the attachment of *the song*, such that a continuation such as *is always a hit* is actually ungrammatical. Exactly the opposite is true for (28b), where the prosodic analysis in fact makes very difficult a direct object attachment of *the song*, and all but forces it to become the subject of the upcoming matrix clause.

We are concerned here with the extent to which the presentation of experimental stimuli has effects similar to those of the prosody in the preceding example. In other words, the worry is whether a presentation such as the one in (30a) will affect the attachment of *the song* in a different way, if at all, from a presentation such as the one in (30b):

30. a. When Madonna sings the song / ...
    b. When Madonna sings / the song ...

---

[47] We use the notion of the PWd to distinguish among the different senses of the term *word*. PWds have to do with the sound form of a word, itself different from morphosyntactic units and lexical units (see, e.g., Aronoff, 1994, p. 9). A PWd includes the bare lexeme and whatever affixes surround it, as one maximally syllabified unit. For extensive discussion on the PWd- (W-) level in phonological derivations, see Goldsmith (1990).

[48] The intonational structure corresponds to the prosodic hierarchy of prosodic phonology. For extensive discussion, see Nespor & Vogel (1986) and Goldsmith (1990).

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The reason these segmentations are of interest is because they might trigger a particular syntactic analysis (with or without mediation from the prosody), though not necessarily in the sense of the first parse.

Let us then turn to alternative ways of segmenting sentences containing the RC attachment ambiguity. Sentence (1) is repeated below, with one minor change: *was standing* has been changed to *stood* in the English sentence, so that the Spanish and English sentences are more similar in terms of total number of PWds (the labels are aligned with the nuclei of the stress-bearing syllables in the PWds).

1. Someone shot the maid of the actress who stood on the balcony.
   PWd1 PWd2 N1 N2 RC1 RC2

1.′ Alguien disparó contra la criada de la actriz que estaba en el balcón.
   PWd1 PWd2 N1 N2 RC1 RC2

A whole-sentence presentation of these sentences does not introduce any explicit (experimenter-determined) cues for one or another prosodic analysis. The prosodic analysis of that segmentation is provided below.

31. [[PWd1 PWd2 N1 N2 RC1 RC2]$_{iP}$]$_{IntP}$

In this and several upcoming examples, we shall make the assumption that segmentation breaks could induce prosodic breaks at the iP level. Whole-sentence presentations, such as those used in eyetracking experiments by Carreiras & Clifton (1999), Henstra (1996), and Brysbaert & Mitchell (1996) leave

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the reader free to impose breaks or not in implicit prosody. However, a presentation without visual breaks does not ensure that the reader will not make prosodic breaks in the implicit prosodic analysis, especially if the sentence is long.

Another unbiased rendition of (1) is a PWd-by-PWd presentation, such as the one illustrated below:

32. [[PWd1]$_{iP}$ [PWd2]$_{iP}$ [N1]$_{iP}$ [N2]$_{iP}$ [RC1]$_{iP}$ [RC2]$_{iP}$]$_{IntP}$

It is unlikely that the implicit prosodic segmentation that readers superimpose on input would take the form indicated in (32). However, a word-by-word presentation (e.g., Deevy, 1999; Miyamoto, 1998) may induce subjects to project a prosodic structure like the one in (32). It is unclear what biasing effect this structure might have on attachment.

Between these two extreme segmentation patterns and their prosodic correlates lie a number of other patterns. What is critical is whether certain segmentation patterns carry certain contrasts. Consider, for instance, the following possible prosodic analyses of the target construction:

33. a. [[PWd1 PWd2]$_{iP}$ [N1]$_{iP}$ [N2]$_{iP}$ [RC1]$_{iP}$ [RC2]$_{iP}$]$_{IntP}$

b. [[PWd1 PWd2 N1 N2]$_{iP}$ [RC1 RC2]$_{iP}$]$_{IntP}$

c. [[PWd1 PWd2]$_{iP}$ [N1 N2 RC1 RC2]$_{iP}$]$_{IntP}$

d. [[PWd1 PWd2]$_{iP}$ [N1]$_{iP}$ [N2 RC1 RC2]$_{iP}$]$_{IntP}$

e. [[PWd 1 PWd2]$_{iP}$ [N1 N2]$_{iP}$ [RC1]$_{iP}$ [RC2]$_{iP}$]$_{IntP}$

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Of the intonational segmentations listed above (only a handful of all possible parses), the intuition for both English and Spanish is that a distinct break before the RC constituent (as in (33a) and (33b) above) tends to increase the preference for high attachment. Independent evidence of this, using explicit prosody, for English is provided by Maynell (1999); Gilboy & Sopena (1996) discuss something along these lines for Spanish, but do not provide evidence; Carreiras (1992) shows that the presence of a comma between N2 and the RC greatly increases the likelihood that an RC will be attached high. This effect might have to do with the fact that a prosodic break after N2 makes the RC its own independent prosodic unit, and hence freer to float to a higher site (see discussion in §2.2.4, above).[49]

No break between N2 and RC1, however, (as in (33c) and (33d) above) intuitively seems to induce a low attachment preference.[50] A break between N1 and N2 (as in (33a) and (33d)) might also have the same effect: low attachment preference. These prosodic phrasings achieve the low attachment preference in two different ways. On the one hand, no break between N2 and RC1 decreases the likelihood that the RC will be an independent prosodic unit. On the other hand, a break between N1 and N2 (with or without a break after N2) places N2 in

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[49] Intuitively, non-restrictive RCs in English preferentially attach to N1, as do non-restrictive RCs in Spanish, if introduced by *que* (see §2.2.3, for discussion of non-restrictive RCs introduced by *quien*). In both languages, non-restrictive RCs are preceded by an obligatory break (which usually manifests itself as a comma in writing). Quilis (1988) cites the following example for Spanish: *Los alumnos, que viven lejos, llegan tarde* ("the students, who live far away, arrive late"). Without the breaks (indicated here by the commas around the RC), the RC has a restrictive interpretation (Quilis, 1988, pp. 422-423).

[50] The prosodic pattern in (33c) has the same segmentation used by Clifton (1988) in a self-paced reading experiment discussed earlier. In his experiment, Clifton found faster reading times with sentences disambiguated (using gender marked reflexives) for low attachment.

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a position where it is likely to receive a pitch accent and be the head of an intermediate or an intonational phrase. (We know from Schafer, Carter, Clifton & Frazier, 1996, that a pitch accent on one of the nouns in the complex NP makes it a more attractive host for the RC.)

If segmentation in fact promotes its correlate prosodic analysis, and certain prosodic analyses bias one or another structural alternative, then the way materials are segmented in a perceptual task could therefore have a critical impact on the outcome of the experiment.[51] If the sentence is presented in two frames, and there is a break between the complex NP and RC1, as in (33b), the task may be inducing a bias toward the higher site by keeping N1 and N2 together. However, if there is a break between N1 and N2, as in (33a) and (33d), the bias might instead be toward the lower site. The low attachment preference found by De Vincenzi & Job (1993) is therefore not all that surprising, where the segmentation was as in (33a). At the same time, the high attachment preference found by both Cuetos & Mitchell (1988) and Carreiras & Clifton (1993), both of which segmented their materials approximately as in (33b), might be the result of segmentation artifacts. Is there, then, a segmentation that is *less* biasing than all the others?

Cuetos, Mitchell & Corley (1996) have argued that the less biasing presentation is the one where N1 and N2 are kept in the same frame, and hence that a high attachment preference is the more trustworthy finding. However, De

[51] We have used the prosodic analysis as a mediator between the segmentation and the syntax in the examples above, but it is feasible that segmentation affects the syntax directly. How to distinguish between the two alternatives is at the moment unclear.

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Vincenzi & Job (1995) have also presented evidence of an N2 preference in Italian even in presentations where N1 and N2 are kept together, as in (33e). However, De Vincenzi & Job placed a segmentation break before N1, while in the contrasting studies there was no such break. Indeed, it is unclear to what extent segmentation could be fully responsible for the discrepancies between the experimental findings. Also, given this discussion, it is unclear why there is such a heavy reliance, in studies on RC attachment, on self-paced reading methodology.

It has been suggested that the ideal way to present the material is in one frame only, and to measure eye-movements (Mitchell & Brysbaert, 1998; Carreiras & Clifton, 1999; Henstra, 1996). This seems like the least biasing method, but there are some caveats. The literature on the RC attachment ambiguity has not demonstrated empirically that eyetracking data represent initial (on-line) preferences more accurately. In eyetracking studies of RC attachment, the cross-linguistic differences that have been observed using questionnaire tasks are also found, while self-paced reading tasks have yielded results that do not always match the off-line pattern. It thus is not readily explained why eyetracking data are to be considered superior, especially since they do not provide a clearer picture of the self-paced reading on-line results, but rather they only replicate off-line questionnaire results. It may be relevant that self-paced reading paradigms typically urge the subject to read on, quickly and accurately, while eyetracking methods, since they present the whole sentence at once, might allow the reader to wander, and to explore aspects of the sentence not purely

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syntactic in nature, which might be reflected in the eye-movement profiles in different ways (and picked up differently, depending on the analysis technique used).

Clearly, an on-line task must choose the segmentation that is least likely to bias attachment one way or another, and the segmentation that will most efficiently present the stimuli containing the phenomenon being examined, while allowing for isolation of data for that region of the sentence where effects are likely to arise. From the above discussion, it appears that word-by-word presentations could provoke readers to project relatively unnatural prosodic structure, while whole sentence presentations might introduce the least amount of artificial prosody.[52]

For in-between segmentations, the conclusion to be drawn is that they could in fact have biasing effects, which leads to the methodological question: what is in fact the best way to present the RC attachment ambiguity? It might be that the larger the frames are, the better (so as to avoid the relatively unnatural feel of word-by-word segmentation), maintaining N1 and N2 in the same frame (in case a break between the two might place N2 in focus somehow). One possibility suggests itself: starting from the assumption that the null hypothesis states that N2 is the preferred host (because of the locality preference prevalent in a number of languages and constructions), the way to proceed should be to stack the cards *against* N2 attachment. This procedure has two consequences.

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[52] It is odd (and possibly improper) to think of prosody generated by the presentation method to be artificial. However, we use this modifier here to imply that the default prosodic contour has been altered experimentally.

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For one, it limits the type of methodologies to those in which the sentence is segmented somehow, to induce the bias against N2 attachment. Secondly, it limits the segmentation to be used in the materials to one which keeps N1 and N2 in the same frame.

The evidence on RC attachment indicates that a number of variables affect attachment preferences. Deciding among the explanations for the observed differences among the ultimate preferences therefore involves determining whether the initial preferences of speakers of contrasting languages differ (e.g., English speakers have an initial low preference, Spanish speakers an initial high preference), as their ultimate preferences differ. It is therefore critical to compare results using unspeeded measures (indicative of ultimate preferences) and speeded measures (tapping earlier processes). To choose among existing speeded measures, we must consider the limitations of each. Eyetracking has the advantage that the material may be presented all at once on one line, insofar as the material is not too long. Considering the typical length of sentences containing the RC attachment ambiguity, it does not seem a viable method (unless one were only interested in testing short RCs). On the other hand, self-paced reading can be used to present material of any length, especially if the material is presented non-cumulatively on the center of the screen. However, self-paced reading methods face the ultimate difficulty of deciding where to place the visual breaks in the material.

Ultimately, a rigorous comparison of speeded measures (as in Carreiras & Clifton, 1993, 1999) is required. The most reasonable starting point (when

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testing new materials and new subjects) is to compare "off-line" (questionnaire) data to "on-line" data using the prevailing methodology, with the most common segmentation, namely, self-paced reading, with a segmentation such as that illustrated in (33b). (Some of these considerations affected the decisions taken in the design of the experiments reported in Chapters 5 and 6, below.)

2.4.2 Disambiguation in On-Line Tasks and Relative Clause Attachment

Let us assume that a given speeded task for presenting linguistic stimuli might, in principle, tap only the earliest phases of sentence processing routines. However, even the ideal task that taps exclusively early decisions in sentence processing, will be less sensitive if the linguistic manipulation disambiguating the attachment relies on information available only in later stages of processing. In general, the speeded tasks we have discussed in this chapter reflect RC attachment preferences indirectly, by comparing reading times in a given attachment condition, say, forced high attachment, to reading times in a contrasting condition, say, forced low attachment. A strictly serial model of sentence processing requires that the disambiguation used to force attachment to be syntactic, if it is to reflect the operation of early parsing decisions only, without the influence of post-syntactic effects.

Many studies on RC attachment have used semantic/pragmatic disambiguation. For example, Cuetos & Mitchell (1988) relied on real world knowledge to disambiguate attachment. In the Spanish equivalent of a sentence

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like (2a), repeated below, the attachment is forced to the higher site, because it is maids and not actors who have husbands:[53]

2. a. Someone shot the maid of the actor who was on the balcony with her husband. (Forced High)

In comparing English and Spanish directly, Carreiras & Clifton (1993, 1999) used a means of disambiguation that exploited gender roles:

14. b. The police arrested $\left\{\begin{array}{l}\text{the sister of the handyman}\\ \text{the brother of the nursemaid}\end{array}\right\}$ who recently gave birth to twins.

A problem with using disambiguation that relies on "general world knowledge" is that since participants sometimes have different backgrounds, they do not always make the same gender role assumptions assumed by the experimenters. A real danger lies in the possibility that two different communities (say, Spanish speakers in Spain and English speakers in the US) make different assumptions about the pragmatic elements being exploited.[54]

Other studies have used morphosyntactic features to force the attachment of the relative clause. For example, many studies have used morphological gender for disambiguation (e.g., Clifton, 1988; De Vincenzi & Job, 1993, 1995;

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[53] As pointed out above (fn. 1 and fn. 34), this particular sentence is not fully disambiguated. This problem is set aside in the current discussion, and we assume, following Cuetos & Mitchell (1988), that the sentence is disambiguated.

[54] This is discussed further in Chapter 4, §4.3.2, where evidence is presented that the plausibility ratings for a given attachment may differ from language to language (or, more precisely, from speakers of one language to speakers of another language). This problem could be addressed in one of two ways: by abandoning such means for disambiguation or by testing bilinguals who speak the two contrasting languages (see Chapter 3).

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Carreiras & Clifton, 1993, 1999). This eliminates the problem related to possible differences in the backgrounds of participants. Morphological gender, however, does not entirely eliminate the problem related to the influence of post-syntactic factors. In Spanish, French, and Italian, for example, morphological gender correlates almost perfectly with natural (real world) gender, such that morphologically feminine nouns usually refer to females (e.g., *niña* [fem], "girl"). This makes it impossible to determine whether the gender information is accessed strictly through the morphology or through its semantic/pragmatic correlates. Distinguishing between these alternatives is only possible by comparing gender contrasts that do and do not have such semantic/pragmatic reflex (e.g., nouns like Spanish *persona* [fem], "person", morphologically feminine but referring either to a male or to a female), or by examining morphologically neuter nouns in languages like German and Dutch.[55]

An additional problem has to do with the fact that different languages mark gender in different ways. Consider the contrasting languages of central interest here, English and Spanish, both of which have some form of morphological gender. All Spanish nouns have either masculine or feminine gender, which may be overtly marked (e.g., *criado* [masc], *criada* [fem], "servant"; *autor* [masc], *autora* [fem], "author") or not marked (e.g., (*el*) *mártir* [masc], (*la*) *mártir* [fem], "martyr"; *mal* [masc], "evil", *sal* [fem], "salt"). In contrast, while some English nouns are used with masculine and others with feminine pronouns (e.g., *wife*, *husband*; *bride*, *bridegroom*; *mother*, *father*; *boy*, *girl*; *butler*, *maid*), there is

[55] Brysbaert & Mitchell's (1996) materials (discussed above, §2.3.3) exploit such morphological gender for disambiguating the attachment of the relative.

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essentially no productive morphology distinguishing one gender from the other, except in the set of pronouns used to refer to humans and to some animals, e.g., *he*, *she*; *his*, *hers*. More important for our purposes is how gender agreement operates in each language, and it is there that these two languages differ. In English, but not in Spanish, gender-marked pronouns must agree in gender with their antecedents, as in the following examples (the subscripted *i* indicates coindexation between the pronoun and its antecedent, to exclude readings of these sentences where the possessive refers to someone not mentioned within the sentence, e.g., *The butler closed her [the maid's] book*).

34. $\left\{ \begin{array}{l} \text{The maid}_i \\ *\text{The butler}_i \end{array} \right\}$ closed her$_i$ book.

35. $\left\{ \begin{array}{l} \text{La criada}_i \\ \text{El criado}_i \end{array} \right\}$ cerró su$_i$ libro.

$\left\{ \begin{array}{l} \text{the servant [fem]}_i \\ \text{the servant [masc]}_i \end{array} \right\}$ closed[3rd sg] [poss pron]$_i$ book.

In contrast, in Spanish, but not in English, gender-marked adjectives and participles must agree in gender with the nouns they modify:

36. $\left\{ \begin{array}{l} \text{The maid} \\ \text{The butler} \end{array} \right\}$ was seated on the balcony.

37. $\left\{ \begin{array}{l} \text{La criada} \\ *\text{El criado} \end{array} \right\}$ estaba sentada en el balcón.

$\left\{ \begin{array}{l} \text{the servant [fem]} \\ *\text{the servant [masc]} \end{array} \right\}$ was [3rd sg] seated [fem] on the balcony

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This means that a fair comparison of English and Spanish, where the manipulation forcing the attachment one way or the other is equivalent in both languages, is not possible using gender morphology.

Number features have been used for disambiguation in a handful of experiments on RC attachment preferences (in Brazilian Portuguese: Miyamoto, 1998; in English: Deevy, 1999; Henstra, 1996; in French: Colonna, Pynte & Mitchell, 2000; in Spanish: Gibson, Pearlmutter & Torrens, 1999). As it turns out, Spanish and English mark number on nouns in very similar ways. In both languages, the plural is constructed by adding *–s/-es* (*criado+s*, *autor+es*; *butler+s*, *hostess+es*). Crucially, in both languages there exists productive subject-verb agreement for number:[56]

38. $\left\{\begin{array}{l}\text{The maid} \\ *\text{The maids}\end{array}\right\}$ of the actresses was on the balcony.

39. $\left\{\begin{array}{l}\text{La criada} \\ *\text{Las criadas}\end{array}\right\}$ de las actrices estaba en el balcón.

Furthermore, in both languages, plural nouns are marked with respect to number, while singular nouns are unmarked.

Nevertheless, while it appears that number agreement operates in similar ways in English and Spanish, Spanish morphology marks number on the verb with great regularity, while English does not. The minimal verbal morphology of English overtly marks number consistently only in present third person singulars and in the present and past forms of *be*. Additionally, while in Spanish the plural

[56] We return to some problems with subject-verb agreement in Chapter 4, §4.5.

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inflections are considered marked, and the singular unmarked, in English the distribution of marked features in the *was/were* forms is not as straightforward. In English, generally, the third singular form in the present (*-s*) is marked as singular, [+sg], while the rest of the verbal paradigm uses unmarked forms. Kayne (1989) proposes that with the past forms of *be*, it is *were* which is marked [+plu], while *was* is the "elsewhere" (unmarked) form. This analysis, in fact, makes the distribution of marked features in this construction practically identical in English and Spanish. However, a different analysis might take *was* to be marked [+sg] for number (Den Dikken, personal communication). Under this alternative analysis, *were* is the "elsewhere" form, used even with *you*, which in fact is not a [+sg] form, since it is identical with the second person plural. (*You* came to be used as a polite form of address—cf. French *vous*—eventually replacing [+sg] *thou*.) Analyzed thus, Spanish and English differ in their specification of number features at the singular verb: the only English verb forms marked for number are the singular ones, this in contrast to Spanish, where it is the plural ones that are marked for number.

With respect to the number features in these sentences, differences between English and Spanish are minimal and have to do with grammatical features that are not necessarily overt, and that do not in principle disrupt the otherwise normal processes involved in RC attachment. However, there is little that is known about whether marked features do in fact cause disruptions in attachment processes. For example, using a marked feature for disambiguation might disrupt the processes differently, or to a different degree than using an

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unmarked feature. Some of the available results suggest that agreement feature processing and RC attachment processing interact (for gender features, see Carreiras & Clifton, 1999; for number features, see Deevy, 1999).

Supposing that one had found an optimal set of methods (say, a self-paced reading procedure and an unspeeded questionnaire task) for testing RC attachment preferences in early and later phases of processing, in English and Spanish; given the above considerations, one might reasonably conclude that the only way of manipulating ambiguity in approximately equivalent ways across these two languages would be to capitalize on number agreement. Despite shortcomings, it is the only morphosyntactic feature sufficiently comparable in the two languages to serve these purposes. To date, the existing comparisons of Spanish and English RC attachment do not use grammatical number agreement for disambiguation. The experiments in Chapters 5 and 6 do just that.

2.5 Conclusion: Cross-Linguistic Differences in Relative Clause Attachment?

The mounting evidence on cross-linguistic differences in sentence processing seems to indicate that speakers of two classes of languages process relative clause ambiguities in different ways. Spanish and a number of other languages exhibit an ultimate preference for high attachment, while English and a number of other languages exhibit an ultimate preference for low attachment. Evidence from unspeeded questionnaire studies has recently expanded the list of high attaching languages, as well as the list of low attaching languages. There is rough consensus about which languages belong to which category. At the same

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time, there is a degree of item-based variability, modulated by characteristics of particular items, internal to the complex NP, or having to do with the aspects of the relative (such as its length), or resulting from the interaction of the relative and its possible antecedents. This evidence seems to suggest that the ultimate attachment of RCs is multiply determined.

Compared to what we know about off-line behavior, as the discussion above has described, the on-line data are not at all straightforward. Assuming a theory of RC attachment in which ultimate preferences are the result of initial attachments, it follows that if a language attaches, say, high in unspeeded tasks, it should also attach high in a speeded task. In many cases the evidence seems to support this model. Spanish and some other languages have been shown to have early high preferences, and English has been shown to have early low preferences. But this is not always the outcome, and the on-line behavior of speakers of some languages sometimes favors the high site, others the low site, and yet other times neither site. The empirical evidence, therefore, has not yet provided enough information to generate a real consensus on what the initial parsing decisions are for each of the languages—and comparing the existing studies proves to be a difficult exercise, given critical differences in methods and design.

Given the above discussion, there is, as of yet, not enough evidence to discard the original idea from the Garden Path model of sentence processing that initial attachments of RCs are made based on a locality principle such as LC. In fact, a great deal of the data presented above support a model of RC attachment

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tin which the initial low preference is subsequently adjusted in the context of additional (post-syntactic) considerations. A small point to bear in mind is that to date no language has been shown to have an early preference for high attachment and a late preference for low attachment. If this turned out to be an impossible sequence, it would place critical limitations on possible models on RC attachment, in particular on any models proposing time-course differences in attachment decisions.

The experimental research reported this thesis (in particular, in Chapters 5 and 6) has two primary objectives. First, the monolingual evidence is investigated independently in a series of experiments with monolingual speakers of Spanish and of English (Chapter 5). The monolingual experiments provide a direct comparison of the two languages and the two types of task. Such a two-way comparison has not been reported in the literature; many studies concentrate on one or another language, or on one or another method. The baseline data from monolinguals will provide new evidence on RC attachment in English and Spanish, to supplement and perhaps clarify the data reported in this chapter.

Second, the monolingual behavior will be employed as a baseline for a comparison of the behavior of different types of Spanish/English bilinguals, to examine the degree to which sentence processing in bilinguals is language dependent (see Chapter 3). The study of language dependency in bilinguals is only feasible, as we shall see, in the case that monolinguals of two languages

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exhibit language-specific behavior. This is the topic of discussion in Chapter 3, to which we now turn.

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CHAPTER 3

LANGUAGE DEPENDENCY AND SENTENCE PROCESSING IN BILINGUALS

3.1 Introduction

Recent studies of bilingualism have provided a general framework through which to understand the nature of bilingualism as it pertains to societal factors (see, among others, Romaine, 1995; Zentella, 1997) and psychological factors (Brysbaert, 1998; De Groot & Kroll, 1997; Grosjean, 1982; Hakuta, 1985; Hamers & Blanc, 1989). This dissertation is concerned with the nature of bilingualism at the level of the psychology of the individual (a notion which has elsewhere been termed *bilinguality*; Hamers & Blanc, 1989).[57] The focus in this chapter is on describing current knowledge about the nature of bilingual sentence processing, and on developing a working model through which to formulate hypotheses about the system or systems that bilinguals use to process each of their languages.

Any psycholinguistically-based model of bilingualism must provide an account of the following three general domains of bilingual linguistic development and behavior:

[57] The distinction between bilinguality and bilingualism will not be made here, as this investigation is not directly concerned with contrasting societal factors (with respect to bilingualism) and psychological factors (with respect to bilinguality). Hamers & Blanc (1989) distinguish between bilingualism (societal) and bilinguality (individual) for precisely that purpose. The term *bilingualism* will henceforth be used interchangeably with *bilinguality*.

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1. How are the two languages of the bilingual acquired? This domain includes studying distinctions between simultaneous and sequential acquisition (among others, De Houwer, 1995; Schaerlaekens, 1998; Zentella, 1997), the effect of formal instruction (among others, Ellis & Laporte, 1997), and the effect of age of acquisition (among others, Harley & Wang, 1997).
2. How is knowledge of the two languages (bilingual competence) maintained? This area encompasses the study of how and to what extent two grammatical systems, coexisting in one person, can affect each other (transfer phenomena—among others, Odlin, 1989), and how two such systems are accessed when the input or output contains lexical material either in only one or in both languages (among others, Bhatia & Ritchie, 1998; Grosjean, 1997; Ritchie & Bhatia, 1998; Woolford, 1983).
3. How do the perceptual and production systems of the two languages (bilingual performance) operate separately and together?

It is with this last aspect of bilingualism that this investigation is concerned, and in particular, the evidence presented in this background chapter and in an upcoming experimental chapter (Chapter 6) predominantly focuses on the perceptual performance of bilinguals.[58] But although we will focus on this issue separately, it is not the case that bilingual performance exists isolated from the bilingual's competence or acquisition history. In fact, the argument could be

[58] For the most part, this discussion focuses on bilingual performance in the unilingual mode, that is, when there is only one language in the discourse. For a review of bilingual performance in the bilingual mode, see Grosjean (1997).

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made that the architecture of a given aspect of a person's bilingualism very much depends on other aspects of the individual's development or behavior. For example, a bilingual's acquisition history might affect the composition of and interaction between the competence and performance mechanisms, as well as the overall design of the lexical store.[59] One of the challenges of this type of research is the isolation of the specifically perceptual system of a given bilingual population from the other variables that might affect task performance, in order to gain a deeper understanding of the processes underlying the ways bilinguals assign syntactic structure to input in each of their two languages.

This chapter surveys evidence regarding the extent to which *bilinguals*[60] process linguistic input using different sets of strategies, depending on which language is being processed, or the same set of strategies, no matter which language is being processed. The descriptive terminology we adopt for this notion is *language dependence* versus *language independence*, after Fernández (1998). If parsing is language dependent, and the case is one in which cross-linguistic differences in sentence processing exist (see Chapter 2), bilinguals will use the strategies associated with monolingual speakers of the language of the input and will exhibit a shift between sets of strategies when the language of the

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[59] For example, the interpretation provided by Ervin & Osgood (1954) of Weinreich's coordinate/compound distinction (1953) incorporated the idea that acquisition history (whether each language is learned in the same or in different contexts) determined whether the bilingual was to be compound or coordinate.

[60] Henceforth, the term "bilingual" will be used to refer both to balanced speakers of two languages, and to speakers with a definitively dominant language. Recent experimental studies (e.g., Cutler, Mehler, Norris & Segui, 1992) have shown that even speakers with native-like competence in each of their two languages otherwise exhibit language-dominant behavior in circumstances with a sufficiently sensitive focus. Hence, a more traditional restriction on the use of the term "bilingual" (e.g., Bloomfield, 1933) is no longer appropriate.

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input changes. If parsing is language independent, on the other hand, bilinguals will process input in either language using the same strategies—those of L1, those of L2, or a compromise set of L1 and L2 (or yet other) strategies.[61]

In addition to being informative of the architecture of the bilingual's linguistic systems, whether or not bilingual sentence processing is language dependent also has some interesting implications for the study of sentence processing in general. Examining language dependency in bilinguals may in fact prove to be an alternative means of refining knowledge of cross-linguistic differences in sentence processing, with the advantage that the data in two languages can be elicited from the same set of subjects.[62] This avoids some of the problems encountered in monolingual cross-linguistic research, particularly those arising from the fact that the backgrounds of speakers of two different languages cannot always be closely matched.

This chapter is organized as follows. We will first briefly survey general issues related to language representation in bilinguals (§3.2), where we will also outline with more specificity the domains in which the questions associated with language dependency are feasibly addressed. Performance differences between monolinguals and bilinguals already established in the literature will then be reviewed (§3.3). A survey of existing research on the perceptual routines of

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[61] Note that the difference between language dependence and language independence will be detectable in experiments only if cross-linguistic differences in sentence processing exist (see Chapter 2). Where evidence suggests that monolinguals share processing routines, across languages, divergence in the data patterns of bilinguals and monolinguals cannot be interpreted in terms of language dependency.

[62] This is only feasible if cross-linguistic differences in sentence processing (among monolingual populations) have been already established; see fn. 61.

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bilinguals follows, including work carried out under the Competition Model (§3.4), and on how bilinguals process the relative clause attachment ambiguity discussed in Chapter 2 (§3.5). In §3.6, the language-dependency model is assessed.

3.2 Representation of Language in the Bilingual

Understanding the way bilinguals represent their two linguistic systems is far too broad a topic to be fully covered here (for some discussion, see De Bot, 1992; Dufour, 1997; Poulisse, 1997), but some general comments are helpful in bringing the ensuing discussion into focus. We know that the bilingual's two languages must be somehow interrelated. Bilinguals know how to alternate fluently between their two codes when conversing with other bilinguals (Bhatia & Ritchie, 1998; Grosjean, 1997; Myers-Scotton, 1993a, 1993b; Ritchie & Bhatia, 1998).[63] They are also adept at translating experiences lived in one language into the other and at transferring knowledge (e.g., mathematical, literacy, or problem-solving abilities) developed in one language into their other language (Francis, 1999; Hakuta, 1986; Javier, 1989; Javier, Barroso & Muñoz, 1991; Pérez, 1994; Verhoeven, 1994). But bilinguals can also willingly restrict themselves to what at least on the surface can appear to be monolingual behavior, as evidenced by the fact that bilinguals can communicate quite

[63] Code-switching is grammatical both inter- and intra-sententially. Generally, the extent to which a bilingual engages in code-switching, and whether it occurs intra-sententially, has to do with the speaker's personal speech style, and is obviously affected by the sociolinguistic norms of the bilingual's community, including the community's (and the individual's) perception of the acceptability of code-switching.

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effectively with monolingual interlocutors, without necessarily revealing their bilinguality. Speaking in a unilingual mode is for the most part an effortless process for bilinguals (Green, 1998; Grosjean, 1982), requiring no conscious suppression of the other language. This indicates that a bilingual's two languages must, at some level, be represented as separate systems, and be accessed independently.

Given the above, we might propose that a bilingual linguistic system represents the very efficient co-existence of two unilingual codes which operate separately in the unilingual mode, when only one language is required, and jointly in the bilingual mode, when both languages are active in the conversation. Such a dual system would presuppose separate lexical and grammatical components for Lx and Ly,[64] and possibly also separate routines for production and perception processes in Lx and Ly, the use of which would be determined by the language active at the moment of the production or perception act.

As noted above, separate representation of the bilingual's two language-specific grammars seems to be self-evident.[65] The bilingual lexicon also appears to have discrete sections for storing items in one or the other language (Kroll & de Groot, 1997; García-Albea, Sánchez-Casas & Igoa, 1998). However, even though the languages are separate, they are interlinked at both the grammatical

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[64] Throughout, Lx and Ly refer to the bilinguals' two languages, without reference to which one was learned first. This is in contrast to the use of L1 and L2, which specifically make reference to the order of acquisition.

[65] It is sometimes claimed (e.g., Marslen-Wilson & Tyler, 1987) that there is no separately represented mental competence grammar—grammatical competence is stored as part and parcel of processing algorithms. Essentially this position is also taken in the very different framework of Bates & MacWhinney's Competition Model (see §3.4). This *requires* duplicate processing systems for two languages, even if all strategies are identical. However, the arguments for this view are not sufficiently compelling as to make moot the discussion that follows.

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and lexical level. These connections across the two languages might be the primary causes of interlingual interference phenomena, as well as possibly being triggers for code-switching (see, e.g., Clyne, 1987; Grosjean, 1997).

Having made some general comments on the components of the bilingual's linguistic system, let us now turn to issues involved in bilingual perception, and particularly in bilingual sentence processing. The study of language dependency in bilingual sentence processing, as discussed above (p. 95), depends entirely upon whether there exist domains of processing in which speakers of different languages employ different processing routines, the topic of Chapter 2. In other words, cross-linguistic differences or similarities in monolingual sentence processing need to be documented *a priori*. On the one hand, monolingual speakers of all languages may use the same set of processing strategies regardless of the language they speak. On the other hand, monolingual speakers of different languages have language-specific processing strategies. We will consider these two scenarios in turn with respect to the implications each has for the study of bilingual sentence processing.

In the case where monolingual speakers of Lx and Ly do all their perception and production following the same set of strategies, there is a question as to whether it is necessary to claim that bilinguals have two such systems which are in effect identical (except that each accesses a distinct grammatical component). This would mean that bilinguals waste resources (in some sense), by having two copies of the universal processing mechanism in each of their specific languages. Such a proposal, however, might be favored

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under a view of bilingualism in which the bilingual's two languages are hermetically sealed off from one another.[66]

If the first scenario turns out to be correct, we are left with the need to discover whether bilinguals have one copy or two of the universal device used to assign syntactic structure to linguistic input. Distinguishing empirically between these might be difficult, or best seen as a question about neurolinguistic organization for which there is usually no consequence at the level of linguistic function.[67] Nevertheless, it is possible that deciding between one- and two-copy versions might be achieved by considering the speed of processing in bilinguals as evidenced in experimental tasks, compared to that of their monolingual counterparts who necessarily have only one copy of the sentence processing machinery. If the bilingual system distributes its available resources to two separate processing mechanisms, the result could be a slow-down in processing. There are, however, two problems with this idea. The first has to do with the fact that exactly the opposite argument could be made: separate copies of identical routines, each plugged into its appropriate language-specific grammar and lexicon, could as readily have the effect of enhancing performance speed. Secondly, processing either or both languages at a slower rate (comparing speed rates in one language to that in the other, or to the speed of monolinguals of each language) need not necessarily reflect the operation of different devices in

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[66] A view that processing mechanisms in the bilingual are rigidly segregated by language makes the explanation of language-contact phenomena (code-switching, borrowing, calquing, naïve translation, and so on) difficult if not impossible to formulate.

[67] Whether the bilingual system has one copy or two of the universal parser might have consequences for speaker/hearers with focal brain damage.

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the assignment of syntactic structure. Instead, this might have to do with different speeds in processing steps apart from those of the syntax—orthographic or phonetic recognition, prelexical segmentation, lexical retrieval, integration into discourse, and so on. Moreover, slower processing may be the result of additional steps taken by the processor in decoding the input. For example, the "normal" processor may come to a decision about the attachment of an incoming constituent based only on structural grounds (e.g., using principles such as Late Closure, described in Chapter 2), while a slower processor (whether bilingual or monolingual) might incorporate additional information (e.g., pragmatics or discourse considerations) before issuing its decision.

An alternative possible scenario is one in which monolingual routines differ between Lx and Ly. Given such cross-linguistic differences, bilinguals will either process input using two language-dependent sets of processing strategies (one for each of Lx and Ly input), or one language independent set of processing strategies, possibly the one associated with the dominant language, or with the more frequently used language, or with the language first learned.

Henceforth we shall focus only on perceptual routines, but it should be borne in mind that this discussion could easily be adapted to include also the processes involved in production. This discussion is also relevant to bilingual perceptual strategies involved in domains other than sentence processing.

To summarize, it is only in the special case that cross-linguistic differences exist in sentence processing, that we should be able to determine whether bilinguals have one processing system or two. In fact, the RC attachment

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ambiguity discussed in Chapter 2, which has been observed to have different preferred interpretations in different languages, is an ideal testing ground for examining the question of language dependency in bilingual sentence processing. On the other hand, if it turns out that all languages are processed alike by monolinguals, the language dependency question would be difficult to explore, since language-independent behavior would be indistinguishable from language-dependent behavior.

3.3 Bilingual Processing: The "Performance Deficit"

In exploring to what extent bilingual processing resembles or diverges from the behavior of monolinguals, one issue to consider is a characteristic of bilingual performance that is already well documented, and which is very much linked to language dominance: a "performance deficit" associated with bilingualism (for a review of the extensive literature related to this, see Cook, 1997; see also Green, 1998, for discussion of cognitive effects associated with bilingualism, and Noël & Fias, 1998, for discussion of numerical cognition in bilinguals). In experimental tasks, generally, bilinguals are slightly slower than monolinguals, and depending on the task, not as accurate, when the stimulus is linguistic. The deficit increases if the input is in the non-dominant language (usually also the bilingual's L2), but is sometimes also present in the bilingual's dominant language. The reasons for this could be various. Perhaps bilinguals are less efficient in lexical access, because they have more items to sort through in the lexical store. Possibly the routines employed by bilinguals in each of their

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languages are not as automatized as they are in monolinguals, who have more opportunities to "practice" their linguistic performance in Lx, since it is the only one they use.[68] Or perhaps the sets of linguistic constraints for the two languages of a bilingual are activated at the same time, even when the bilingual is performing in a unilingual mode (Altenberg & Cairns, 1983); in this case, sorting among all the possibly relevant data and routines takes longer.

The most interesting aspect of studies on the performance deficit associated with bilingualism is the fact that none of the proposals require the assumption that the processes involved in bilingual perception are different from those involved in monolingual perception. That is, the default assumption to make is that the general routines employed in assigning structure to linguistic input are identical for both monolingual and bilingual listeners or readers, but that bilinguals take a little longer to employ them, with speed and accuracy being related to levels of dominance.[69] This is a reasonable assumption, but it requires confirmation.

Some evidence is available supporting the idea that bilingual and monolingual perceptual routines are similar. For example, Frenck-Mestre & Pynte (1997; see also Frenck-Mestre, 1997) carried out two eyetracking studies

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[68] Notice that a remark about different degrees of automaticity in a bilingual's processing routines for each language assumes a dual system model.

[69] Thus described, the performance deficit is not that much of a deficit after all, but rather only involves slightly decreased reading speed (imperceptible, and possibly an asset, since it could allow for better comprehension), and in some cases, slightly increased error rates (probably not in the bilinguals' dominant language). Nevertheless, to the extent that it has important implications at least in the area of pedagogy, it is crucial to develop a clearer understanding of exactly what components in the bilingual's cognitive architecture are responsible for the deficit. Such an investigation would in turn serve the purpose of enabling distinctions between normal and impaired bilingual performance.

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comparing native speakers of French to L2 learners of French who were native English speakers, reading material in French that contained different syntactic ambiguities. The first experiment examined PP attachment ambiguities (e.g., *They accused the ambassador [of espionage/of Indonesia] but nothing came of it*; the PP either attaches to the VP, *accused... of espionage*, or to the NP, *the ambassador of Indonesia*). The second experiment examined the temporary ambiguity encountered in sentences where an NP following a verb in a subordinate clause may be either the object of the subordinate verb or the subject of the matrix clause (e.g., *Whenever the dog [obeyed/barked] the little girl smiled*). The evidence from these studies led the authors to claim that the way monolinguals and bilinguals process syntactic ambiguities is similar: although overall native and non-native performance differed in second pass reading times, with bilinguals spending more time re-reading sentences than monolinguals, the performance deficit did not at all change the pattern of responses in second pass reading times. For both bilinguals and monolinguals, in the first experiment, reading times were slower when the PP was forced to attach inside the NP (*the ambassador of Indonesia*) than when it was forced to attach inside the VP (*accused... of espionage*).[70] In the second experiment, subjects spent more time re-reading sentences with optionally transitive verbs in the subordinate clause (*obeyed*) than sentences with intransitive verbs (*barked*).

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[70] This example contains a ditransitive verb, *accused*. The experiment additionally tested sentences containing monotransitive verbs (e.g., *He rejected the manuscript [on purpose/on horses] because he hated the author*). With monotransitive verbs, the more difficult condition, as evidenced in slower reading times, was the one in which the PP attached to the VP (*rejected... on purpose*). This evidence suggests to the authors that lexical information exerts a localized influence in processing very rapidly.

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Frenck-Mestre & Pynte explored constructions for which monolinguals of two languages have similar behavior patterns. However, the question of language dependency arises in the case that monolinguals of two languages have different behavior patterns. As part of a growing body of literature on pre-lexical encoding routines, the language dependency question has been addressed in two studies which compare the behavior of bilinguals to that of monolinguals: Cutler, Mehler, Norris & Segui (1992) and Bradley, Sánchez-Casas & García-Albea (1993). Cutler et al. (1992) found asymmetric behavior among almost perfectly balanced French/English bilinguals, with respect to syllabification routines, based on the bilinguals' language dominance. However, Bradley et al. (1993) provided evidence that language dominance alone does not determine behavior in tasks that tap pre-lexical encoding routines, but that additional factors such as the primary language of the environment and the nature of the two languages involved also have an effect. This type of work can serve as paradigmatic regarding the design of psycholinguistic tests of bilinguals, because it raises interesting questions regarding the variables that affect performance in experimental tasks. The methodological challenge involves isolating the critical variables that determine the nature of bilingual performance.

The design and implementation of studies such as these, even though they deal with processing strategies somewhat removed from syntactic processing, can be informative for the development of studies on a new phenomenon (like the RC attachment ambiguity) which has been studied less extensively in bilinguals. For example, Cutler et al. (1992) determined language

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dominance using an entirely non-standard, albeit highly specific procedure: the determination was based on how subjects answered a question about which language they would choose to keep if they had to undergo a life-saving brain operation which would have the unfortunate side effect of removing one of their languages. In fact, the guidelines to be followed in investigating bilinguals, to determine critical aspects of the language history of the subjects, their proficiency in each language, and other relevant biographical data, must not only be reasonable but preferably also standard and sufficiently detailed to permit comparison across the findings of different teams of researchers. There is a question as to what extent existing procedures are sensitive enough to extract the relevant information yet focused enough to disregard information that is extraneous. In this respect, Grosjean (1997, 1998) makes a number of comments regarding numerous existing studies on bilinguals, and sets up useful recommendations which may go some way to unifying practices across the diverse community of researchers.[71]

We will now review two types of literature on bilingual sentence processing, both of which launch from the idea that monolinguals of two languages have different ways of processing linguistic input. We begin with a review of the Competition Model, which is the most widely cited body of work in sentence processing in bilinguals, but which we shall show does not necessarily provide the type of background we need to explore the language dependency issue in bilingual sentence processing.

[71] In Chapter 6 will be discussed a series of criteria, used in the experiments presented there, to determine language dominance in bilinguals.

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3.4 The Competition Model

The Competition model (CM), developed by Elizabeth Bates and Brian MacWhinney (for an overview, see MacWhinney, 1997) and further researched in numerous studies (among others, Bates & MacWhinney, 1981; Hernández, Bates & Avila, 1994; Liu, Bates & Li, 1992; Sasaki, 1994; see MacWhinney, 1997 for further references on both bilingual and monolingual studies), explicitly deals with the question of whether bilinguals process input with one set of language-independent strategies or two sets of language-dependent strategies, with the language of the input determining the set of strategies to be used. Under CM, both L1 and L2 acquisition are data-driven processes relying on universals of cognitive structure, rather than universals of linguistic structure (MacWhinney, 1997). CM requires addressing the question of language dependency in processing because it further proposes that sentence processing is language-specific. As discussed earlier, the model is then faced with the task of explaining the nature of bilingual processing, since it proposes language-specific processing strategies, whereas parsing models proposing a universal parser have the option of taking bilingual processing to be identical to monolingual processing.

According to CM, considerable transfer will be experienced by the L2 learner, in the early stages of acquisition, especially, since the developing network of cognitive structures for the L2 will initially be deeply interconnected with the structures already existing for the L1; this transfer takes place at all levels of linguistic representation (phonological, lexical, syntactic). The

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transferred grammar and lexicon for L2 gradually become more independent of L1, such that learners—i.e., incipient bilinguals—are eventually able to build a "firewall" to block interference between L1 and L2 by strengthening within-language links at the expense of between-language links (MacWhinney, 1997). This process achieves "a certain limited form of emergent linguistic modularity" (p. 120). In other words, balanced bilingualism is viewed as a state in which within-language links are strong, while some between-language links remain, to provide the connections that allow bilinguals the ability to translate from one language to the other and to experience something in one language and recall or retell it in the other. But no matter how strong the within-language links and how weak the between-language links, the language system can still be seen as fundamentally unitary. It is therefore plausible and totally within the framework of CM for there to be overt transfer (and thus language independence in processing) between the two languages of a bilingual. The model predicts high degrees of variability—based on factors like age of acquisition, proficiency in L1 and L2, use of L1 and L2, and so on—as far as processing strategies are concerned.

Research in the CM framework gathers its empirical base through observation of speakers as they read or listen to sentences constructed so that *cues* (e.g., agreement or gender morphology, word order, etc.) compete with each other for the attention of the processing device. The idea here requires explicit illustration, for which Spanish and English serve very well. Spanish has a rich agreement morphology but relatively free word order, while English has a

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rather impoverished agreement morphology but strict word order. In the two sentences in (1) below (word-by-word equivalents in English and Spanish), neither word order nor agreement are anomalous. In (2), however, because there is no plural noun to agree with the plural verb, agreement is anomalous, while in (3) word order is anomalous because VNN is a non-canonical word order in both Spanish and English. (The symbols below indicate the grammaticality [✓] or ungrammaticality [✗] of the examples. In (3), we additionally distinguish ungrammatical from marginally-grammatical [☹] sentences. Although not standardly taken into consideration under CM, the Spanish sentence in (3b) is grammatical, but marginally so, given its non-canonical word order.)

1. a.	The elephant breaks the pencils.	word order ✓	agreement ✓
b.	El elefante rompe los lápices.		
2. a.	The elephant break the pencil.	word order ✓	agreement ✗
b.	El elefante rompen el lápiz.		
3. a.	Breaks the elephant the pencils.	word order ✗	agreement ✓
b.	Rompe el elefante los lápices.	word order ☹	agreement ✓

Of the English sentences in the three examples above, the easiest to process seems to be (1) and the hardest (3), with (2) somewhere in the middle. With the Spanish sentences, the intuition is slightly different: (1) is easiest (like in English), but (3) seems to be less problematic than (2). There is thus a contrast with the English preferences.[72] Under CM, this is taken to mean that strategies for processing input used in the two languages place differing importance on the two

[72] It is not altogether clear what effect the grammaticality status of these sentences should have on their processing difficulty: In English, (2) and (3) are ungrammatical, whereas in Spanish only (2) is ungrammatical.

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kinds of cues. Word order matters more in English than in Spanish, whereas agreement is a cue lent more attention in Spanish than in English.[73]

3.4.1 Differences Between Monolinguals and Bilinguals in the Competition Model Framework

In a study examining the processing costs associated with different cue combinations, Hernández, Bates & Avila (1994) provide empirical support for the intuitive ranking just discussed. In their study, Hernández et al. analyzed the interaction, in both Spanish and English, of not only word order and agreement, but also animacy. They established a rank-order of the three cues as shown in (4), based on the performance of Spanish and English monolinguals in a timed comprehension task.[74] In (4), ">" indicates order of importance of the cues.

4. a. English: word order > agreement > animacy
   b. Spanish: agreement > animacy > word order

Given these facts about English and Spanish monolingual processing, we would expect that if bilinguals process linguistic input as the respective monolinguals do, then Spanish/English bilinguals should have the Spanish

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[73] That attention to cues differs between speakers of Spanish and speakers of English is a conclusion that must be taken with caution. The comparison being made is between elements that do not necessarily match, because in one case (Spanish) the sentence type providing the critical evidence is grammatical, while in the other (English) it is ungrammatical.

[74] The data analyzed by Hernández et al. (1994) to establish the ranking in (4) were the reaction times to visual stimuli of monolingual Spanish and English speakers. The task in which the subjects participated involved showing the subjects the following: first, two words (e.g., *elephant* and *pencils*); then a sentence like the ones in (1)-(3) above; and finally pictures corresponding to the two words (e.g., an elephant and some pencils), side by side. The subjects were asked to push a button (e.g., on the right corresponding to the pencils, on the left corresponding to the elephant) to indicate which of the two pictures was the referent carrying out the action of the sentence.

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ranking shown in (4b) when processing input in Spanish, and the English ranking in (4a) when processing input in English. However, such a *differentiation* (Hernández et al., 1994, p. 421) of strategies (language-dependent processing) is not the only possible alternative for bilingual processing. Bilinguals may transfer their L1 strategies into L2 (*forward transfer*; Hernández et al., 1994, p. 421) or their L2 strategies into L1 (*backward transfer*; Hernández et al., p. 421). In both of the transfer cases, bilinguals use only one set of strategies, independent of the language of the input, so that they behave like monolinguals of only one of their two languages. The fourth (and final) possibility is *amalgamation* (Hernández et al., p. 421), i.e., the case where the bilingual also uses one set of strategies when processing both L1 and L2 input, but this set consists of a blend of L1 and L2 strategies. The four possible types of bilingual language processing are summarized in Table 3-1, and classified into two supergroups: language-dependent and language-independent, using the terminology we have adopted in this chapter.

There are some constraints that perhaps need to be placed on the set of patterns of strategy use in bilinguals, because not all combinations possible in Table 3-1 are in fact feasible. For example, we must exclude cases in which cross-over transfer occurs, e.g., strategies associated with L1 used with L2 input, and strategies associated with L2 used with L1 input. To the extent that such patterns are in fact impossible, any further development of this framework must state the constraints which allow for the right set of combinations, and exclude the impossible ones.

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Table 3-1: Language-Dependent and Language-Independent Patterns of Strategy Use in Bilinguals

Differentiation	Separate strategies for each language S1→L1, S2→L2 S1→L1, SA→L2 SA→L1, S2→L2	Language Dependent
Forward Transfer	Strategies for L1 used also in L2 S1→L1, L2	Language Independent
Backward Transfer	Strategies for L2 used also in L1 S2→L1, L2	Language Independent
Amalgamation	Amalgamated set of strategies used for both languages SA→L1, L2	Language Independent

Note: S1 = strategies associated with monolingual speakers of L1; S2 = strategies associated with monolingual speakers of L2; SA = amalgamated strategies, different from those used by monolingual speakers of either L1 or L2. Statements such as "Sx→Ly" indicate that "Sx applies to Ly".

In this framework, the L1/L2 distinction is called upon to distinguish two directions of transfer, which provides adequate terminology for the phenomenon, but which is clearly too simplistic. The cause of a transfer of strategies from one language to another might actually be language dominance, or frequency of (recent) language use, or any other such language history variable, rather than only order of acquisition. The nature of the two languages involved might also be an influence.

In addition to testing Spanish and English monolinguals, Hernández et al. (1994) analyzed the strategies used by a sizeable sample of Spanish/English bilinguals from Southern California. For these subjects, usage and proficiency in the two languages (as reported by the subjects themselves in self-rating scales) were both very balanced. Hernández et al. found that their Spanish/English

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bilinguals "fell in between" the monolinguals of both languages they tested, apparently having developed a "compromised", or *amalgamated*, set of strategies (Hernández et al., 1994). The bilinguals, with stimulus materials in both languages, exhibited greatest reliance on agreement cues, least reliance on word order cues, with animacy cues in the middle. This pattern matches neither of the patterns exhibited by the monolinguals (in (4), above).

As noted above, CM does not make any predictions regarding the type of processing bilinguals use in their two languages. This is reflected in the CM literature, where many different patterns of results have been obtained, depending on a number of different variables. Even the bilinguals studied by Hernández et al. showed evidence of differentiation (there were slightly flatter effects of word order in Spanish than in English, and slightly flatter effects of agreement in English than in Spanish). Other studies have looked at bilinguals less proficient in one of their languages, and the overwhelming finding is evidence of forward transfer, typically related to greater dominance for or more extensive use of L1.

Liu, Bates & Li (1992) compared the processing strategies used by different speakers of Chinese and English: monolinguals of each language, "late" bilinguals (those who learned their L2 after age 20), and "early" bilinguals (those who learned their L2 before age 16). In the late bilingual group, half were speakers whose L1 was English. In the early bilingual group, all subjects spoke Chinese as an L1, some learning English as infants, others as children or as teenagers. In this experiment, word order cues were contrasted with animacy

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cues, the first cue type being stronger in English and the second, in Chinese. The data were collected, as in Hernández et al. (1994), using an agent identification task. Liu et al. found very little evidence of amalgamation in either of their bilingual subgroups. They report some evidence of differentiation in the child and teen learners, and of backward transfer in the infant learners. In contrast, the results for late bilinguals overall showed evidence of forward transfer, but the sub-group whose L1 was English exhibited some differentiation of strategies not exhibited by the late bilinguals whose L1 was Chinese.

Using a slightly different methodology,[75] Sasaki (1994) found differences between Japanese/English and English/Japanese bilinguals responding to English and Japanese stimuli. In the materials for this experiment, three contrastive cues—word order, animacy, and case-marking—were manipulated. The experiment tested subjects in each of the following three language history categories: (i) native speakers of English beginning to learn Japanese as a second language (students at mid-semester in a beginning Japanese class), (ii) native speakers of English with intermediate knowledge of Japanese, and (iii) native speakers of Japanese with advanced knowledge of English. Under the CM analysis, case-marking is an important cue in both English and Japanese, while word order is less important in Japanese than in English. Sasaki's results point to divergent use of strategies: the Japanese learners of English relied on Japanese-like case-based strategies in both languages, while native English speakers learning Japanese adjusted their cue reliance differently for each

[75] Sasaki (1994) presented spoken sentences, and subjects were instructed to indicate the subject of the sentence.

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language, paying closer attention to word order cues in English than in Japanese. Thus, while the native Japanese speakers learning English transferred their L1 strategies into L2, the native English speakers learning Japanese differentiated between strategies used to process input in L1 and L2.

These results are somewhat surprising, in that they run against the predictions of the model, that there should be greater amounts of transfer during the early stages of L2 acquisition. Sasaki interprets her findings by proposing that learners of Japanese as an L2 rely heavily on case-based strategies, which eventually could lead to misinterpretations. This forces the learners of Japanese to learn to rely on case markers relatively early in their learning process, in order to make semantic sense of input in Japanese. The same process does not take place in the learners of English as an L2, who use case-based strategies even when processing English, since it does not lead to misinterpretations.[76]

3.4.2 Summary

Research under the CM framework has to date produced a vast literature covering a variety of language combinations (as both L1s and L2s), and has been the standardly cited style of work in many discussions of bilingual sentence processing. Arguably, its most important contribution to our current understanding of the architecture of the language faculty in bilinguals is one pitched at a quite general level of description. That is, in addressing the

[76] Contrary to Sasaki's proposal, this outcome might be attributable to (uninteresting) differences between the two groups. For example, native English speakers may not be as adept at recognizing the sentential subject as native Japanese speakers.

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weighting overall of different "cue types", CM research provides an index of performance best suited for capturing broad shifts in L1/L2 influence as bilingualism becomes increasingly mature (or as it approaches greater degrees of balance). In this respect, the CM model makes a series of predictions regarding the type of transfer that may take place, and the directions in which it will happen, though we raised the possibility that the model does not necessarily exclude implausible transfer profiles (see discussion beginning on p. 112).

However, it is not yet clear how findings in the CM framework would interarticulate with linguistically-based models of sentence processing (and language acquisition; see Gibson, 1992, for further discussion), for which evidence at a finer grain is required. Outcomes in the typical CM experiments sketched above could chiefly reflect a *global* (post-syntactic) style of processing, as the linguistic system (now construed with maximum scope) seeks its best resolution of ill-formed inputs. (Research in the CM framework crucially turns on subjects' responses to *ungrammatical* sentences. See Gibson, 1992, for explicit discussion on whether grammatical and ungrammatical stimuli are processed the same way.)

Processing of this kind could well vary cross-linguistically; that is, speakers may have the option to pay attention to this or that aspect of sentential structure *after* they have carried out a syntactic analysis of the sentence, and the earlier (but not the later) processes could turn out to have a universal basis.[77]

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[77] MacWhinney (1997) cites evidence from recent on-line studies under the CM framework which suggests that the predictions of CM break down in genuinely on-line tasks: "...under conditions of speeded on-line judgments, full cue integration does not occur" (p. 132). Clearly, this calls for either a revised version of the model, or for an admission that the model's domain of application

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Potential differences across languages in sentence processing, like the preference for alternative attachments of RCs (the focus of the current research) would have their initial expression too early in the stream of processing to be captured by research in the CM framework.

For the reasons outlined above, CM appears not to be a useful model under which to study syntactic parsing in bilinguals in any detailed way. In the following section, we sketch an area of research in the literature more concerned with the details of parsing, specifically, which is likely to prove to be quite promising.

3.5 Relative Clause Attachment in Bilinguals

In this section, we review a small but growing body of evidence on bilingual sentence processing grounded in the general model of sentence processing outlined in Chapter 2. We have already encountered, in the review of the RC attachment literature in Chapter 2, the work of researchers whose subjects were bilingual, and possibly even polyglot: the subjects of Brysbaert & Mitchell (1996) were native speakers of Dutch, who also spoke French and in all likelihood English as well (Brysbaert, personal communication), while those of Gibson, Pearlmutter, Canseco-González & Hickok (1996) and Gibson, Pearlmutter & Torrens (1999) were native speakers of Spanish who also spoke English. These studies were not deliberate attempts to obtain data from bilinguals; rather, the fact that the subjects spoke languages other than the one

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is post-syntactic.

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of the experiment was considered coincidental and unimportant. As such, the experimental reports of these two studies do not provide any details on the subjects' bilinguality (degree of proficiency in their languages, age of acquisition, and so on).

As discussed in Fernández (1998), a common feature of these studies is the extent to which individual variation is present in the data. That variation may be attributable to the phenomenon of RC attachment in general (especially under a Tuning account, which predicts such variability in populations; see Corley, 1995; this is also discussed in Chapter 2, §2.3.2). However, as speculated in Fernández (1998), it might relate more to the subjects' language histories as speakers of other languages (with relatively different proficiencies in each, and with different ages of acquisition and possibly different frequencies of use).

Monolingual populations can be assumed to reach homogeneous levels of grammatical competence, while in bilingual populations such grammatical competence may be a great deal more variable, especially in the non-native language (Coppieters, 1987), but also in the native language (Seliger & Vago, 1991), and may depend on any of a number of language history factors (for a review of variability in the language of L2 learners, see Ellis, 1994, and Tarone, 1988). One might imagine that at the level of linguistic performance there is also less individual variation in monolingual than in bilingual populations. Thus, as pointed out in Fernández (1998), individual variation in sentence processing can itself become the target of study in bilingual research, with the aim of isolating the determining factors.

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In an investigation of RC attachment preferences comparing native and non-native speakers of English (Fernández, 1995; see also Fernández, 1999), different distributions of data were found in each of the populations studied. The subjects tested fell into three major groups: monolingual English speakers, native Spanish speakers who learned English early in life (before the age of 10, "early learners" so-called), and native Spanish speakers who learned English later in life (after the age of 10, "late learners"). The subjects were tested with identical English materials, by means of an off-line questionnaire with ambiguous targets in two conditions, one in which the preposition *of* in the complex NP introduced an argument of N1 (e.g., *the review of the play*), and the other in which a lexical preposition (e.g., *with*, *from*, and so on) introduced an adjunct to N1 (e.g., *the singer with the guitarist*). The study revealed that the monolinguals had the strongest preference to attach low (mean low attachment rate, 75%), and the late learners the weakest (mean low attachment rate, 37%). The early learners fell in between the other two groups (mean low attachment rate, 49%), but exhibited a great deal of individual variation (with low attachment rates ranging from 20% to 100%).

To account for this variation, not present in the late learner or in the monolingual samples, correlations were carried out on the behavioral data with language history data collected from the subjects, to ascertain whether a particular variable (e.g., age of acquisition, frequency of use of each language, and so on) was more obviously linked to determining RC attachment preferences. The language history variable that best manifested itself as playing

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such a role was the differential score computed from subjects' self-rated proficiencies in English and in Spanish.[78] The subject-based correlation between the differential score of self-rated proficiency and RC attachment preference was significant, $r = 0.400$. The early learners who considered themselves to be more proficient in English than in Spanish were more likely to have an overall preference for the lower site, while those who considered themselves to be more proficient in Spanish than in English or equally proficient in both languages were more likely to have an overall preference for the higher site.

The finding that the native language can affect RC attachment preference in a subject's L2 has been replicated. Fernández & Hirose (1997) presented the same questionnaire used in the Fernández (1995, 1999) study with Spanish L2 learners of English, to a group of native speakers of Japanese who had learned English as a second language, either early or late (for details see Fernández, 1998). Japanese monolinguals have been shown to have a preference for attaching to the higher noun given constructions with an ambiguity similar to that in English (Kamide & Mitchell, 1997).[79] With English materials, the RC attachment preferences for the Japanese/English speakers in the Fernández & Hirose (1997) study did not differ significantly between the early and late learner

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[78] The determination of bilinguals' relative proficiency in their two languages by using a differential, calculated from proficiency self-ratings in each language, has been shown to correlate with independent measures of proficiency (for further discussion and references, see Grosjean, 1982; see also §6.2.1 in Chapter 6).

[79] The ambiguity in Japanese is only similar in that it consists an RC that could refer to either one of two nouns in a complex NP. However, in Japanese (as opposed to Spanish or English) the RC is encountered first, and the initial preference is to attach to N1, which is encountered next, with an ultimate preference for N2 attachment. Attaching one of two nouns to an RC encountered earlier (Japanese) is altogether different from attaching a later encountered RC to one of two nouns which have already been incorporated into the phrase marker (English), if processing is strictly incremental in the first-pass parse (Fodor & Inoue, 2000).

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groups (44% and 48% low attachment, respectively). The two groups of Japanese native speakers did however differ from the English monolinguals tested by Fernández (1995) (mean low attachment preference, 75%, as noted above).

Age of L2 acquisition did not seem to make a difference with the native Japanese speakers as it did with the native Spanish speakers tested in these two studies, but a possible explanation of this result lies, again, in the way proficiency interacts with attachment preferences. As it turned out, the native Japanese speakers were more likely to be Japanese-dominant than the native Spanish speakers (of the 30 Japanese speakers tested, only two claimed their English was better than their Japanese, compared to nine of 30 Spanish speakers whose English was better than their Spanish). The RC attachment behavior in the Japanese speaker group was more homogeneous overall (in both early and late learners) than in the native Spanish speaker group, with most of the native Japanese speakers having an overall preference for high attachment. An obvious difference between the two groups of bilinguals in these studies is the fact that the Japanese group mostly learned English in school in Japan, rather than in an English-based environment, like the Spanish group. Comparison of the two groups is therefore difficult, because of the confounding factor of context of acquisition.

Frenck-Mestre (1997) presents results from two experiments examining the eye movements of bilingual subjects while reading sentences containing the RC attachment ambiguity, where the attachment was disambiguated by means of

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number agreement. Both experiments tested bilinguals with beginner proficiency in their L2, French,[80] but whose L1s were different: the first experiment tested native English speakers, and the second, native Spanish speakers.[81] The results for the bilinguals were compared to results from a control group of French monolinguals, who overall exhibited more difficulty (longer reading times) reading sentences that forced the RC to attach low. The native Spanish speakers had a performance profile reading French similar to that of the French monolinguals (the reading times were also slower with RCs forced to attach low). However, the native English speakers did not exhibit a reliable preference for N1 or N2; in fact, the results point to a pattern in the opposite direction than for the monolinguals and the Spanish/French bilinguals: English/French bilinguals were slightly slower reading the RCs forced to attach high. Frenck-Mestre interprets these results as indicative of the fact that the native language affects L2 processing.

Dussias (in press) provides evidence of the role of sequence of acquisition. She presents data from Spanish/English bilinguals who were "early" bilinguals, having learned both languages before age 6 (though not necessarily simultaneous bilinguals), or "late bilinguals", having learned either English or Spanish as a second language in adulthood. Dussias provides data from both an

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[80] Frenck-Mestre provides no further details on her subjects' language profiles.

[81] According to Frenck-Mestre, the native Spanish speakers share an initial high attachment preference in their L1 with the French-speaking monolingual controls, while the native English speakers have a low attachment preference in their L1. As discussed above in Chapter 2 (and below again in Chapter 5), an initial high attachment preference for French (and Spanish) is not always obtained (see Baccino, De Vincenzi & Job, 2000).

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unspeeded (questionnaire) and a speeded (self-paced reading) measure (with different bilinguals participating in each type of task).

For the unspeeded questionnaire, Dussias presented subjects with sentences such as those in (5) below, followed by questions asking directly about the attachment of the RC.

5. Peter fell in love with the sister of the psychologist who studied in California.
   Who studied in California? the sister the psychologist

5.' Pedro se enamoró de la hermana del psicólogo que estudió en California.
   ¿Quién estudió en California? la hermana el psicólogo

Subjects were asked to circle the noun which they thought best answered the question. Two control groups of English and Spanish monolinguals had preferences in line with the standard finding for RC attachment: English speakers overwhelmingly preferred the low site (low attachment rate, 86%), while Spanish speakers preferred the high site (low attachment rate, 26%). The bilinguals, on the other hand, exhibited a slightly different pattern from the monolinguals in the two languages. The early bilinguals had a low attachment rate of 56% in English and 44% in Spanish, indicating that they are sensitive to neither the language difference nor the attachment distinction (since their responses in both languages center around 50%). The late L2 Spanish bilinguals exhibited very little differentiation between their two languages, although their responses exhibited a low attachment preference with both languages (low attachment preference, 72% in English and 72% in Spanish). Finally, the late L2 English bilinguals appeared to distinguish between English and Spanish input, with an overall rate of 71% low

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attachment in English (very similar to the other late learner group) and 44% in Spanish (approaching similarity to the Spanish monolingual group).

Dussias reports the results of a self-paced reading experiment, run in Spanish only, in which bilingual subjects were asked to read sentences such as the following, segmented as indicated in the example.

6. a. El perro mordió la cuñada del maestro / que vivió en Chile / con su esposo. (Forced High)
   The dog bit the sister-in-law of the teacher[masc] who lived in Chile with [poss. pron.] husband.

   b. El perro mordió al cuñado de la maestra / que vivió en Chile / con su esposo. (Forced Low)
   The dog bit the brother-in-law of the teacher[fem] who lived in Chile with [poss pron] husband.

   c. El perro mordió a la cuñada de la maestra / que vivió en Chile / con su esposo. (Ambiguous)
   The dog bit the sister-in-law of the teacher[fem] who lived in Chile with [poss pron] husband.

Overall, the third frames of the disambiguated sentences took longer to read than that of the ambiguous sentences. As for the disambiguation contrast, the late learners took longer to read RCs forced to attach high than RCs forced to attach low, regardless of their L1. (The difference was significant for L2 English bilinguals, only a trend for L2 Spanish bilinguals.) However, the early learners exhibited no disadvantage associated with either forced low or forced high attachments.

This evidence is difficult to interpret, as two additional comparison data sets are needed. To determine to what extent bilingual behavior in this speeded task diverges from monolingual behavior, data from a Spanish monolingual control group are required (Dussias is currently conducting additional

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experiments; Dussias, personal communication). Finally, the language dependency question cannot be addressed without data in English for the same set of bilinguals. Nonetheless, these studies are an important stepping stone in the study of the question of language dependency in bilingual sentence processing.

We have seen some evidence of forward transfer (from L1 to L2) in the data reported in the discussion above. The evidence, however, is inconclusive because it is for the most part based on the assumption that the L1 strategies of the subjects tested are of a particular type. However, of the studies reviewed in this section, only Dussias (in press) provides any such evidence, and she does so only for her off-line task.

3.6 Assessing the Language Dependency Model

The study of language dependency in bilingualism rests crucially on the question of whether cross-linguistic differences exist in sentence processing. A first possibility is that the language processing mechanisms of both bilingual and monolingual speakers are necessarily language independent because they have a universal basis, and thus apply to all linguistic input, regardless of the specific language the input is in. A second and a third possibility arise for bilingual sentence processing if the language processing mechanisms of monolinguals are language-specific. In the second case, the mechanism used by bilinguals may be language independent, that is, bilinguals will rely on the same set of routines for both their languages (the routines possibly associated with, say, their

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first, dominant, or more frequently used language, or else an amalgamated set of routines). As a third and final alternative, the language processing mechanism of bilinguals may contain language-dependent modules so that different routines are used for different-language input. Recognition of the language of the input, in this case, will trigger selecting the language-appropriate processing mechanisms in addition to selecting the language-specific grammar and lexicon. These three different possibilities for bilingual sentence processing profiles, and their correlates to monolingual behavior, are summarized in Figure 3-1.

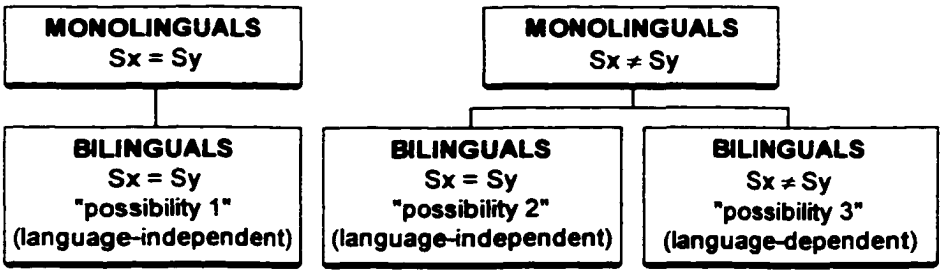

Figure 3-1: Correspondences between bilingual and monolingual behavior in sentence processing, categorized as language-independent and language-dependent. *Sx* indicates set of strategies associated with Lx.

As a preliminary to determining which of these possibilities actually holds, the discussion above explored research programs of two very different kinds. The Competition Model (§3.4) aims to investigate how processing outcomes that are assumed to be language-specific play out in bilingual populations. Research under CM seems to suggest that the weighting afforded certain types of cues can transfer forward from L1 to L2. This result would be indicative of language independence, where the cue weightings employed may be those of the bilingual's L1, or of his or her dominant language. However, we saw that this

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model, or perhaps its standard evidence-base, does not easily fit into current models of parsing (particularly the model explored in Chapter 2 and its related theoretical proposals).

Research specifically examining RC attachment preferences in bilinguals (§3.5) has proven to be more useful in investigating their perceptual mechanisms in real detail. It is research carried out under a view of sentence processing that closely relates to a mainstream literature, in which the focus has largely been on monolingual speakers. More importantly, it provides an appropriate scenario in which to test the language dependency question directly. The evidence to date is suggestive of language-independent processing for late L2 learners or for non-dominant L2 speakers. With early L2 learners (and simultaneous acquirers of two languages), the evidence is scant, but indicative of an important influence of language dominance. That is, the strategies associated with monolingual speakers of a bilingual's dominant language seem to be used by the bilingual to process both the dominant and the non-dominant language. However, none of the studies cited has been sufficiently large-scale to examine language dominance, using materials in both of the bilinguals' two languages, and comparing such results to results with monolingual speakers. To make comparable assessments fairly between the two languages, entirely translation-equivalent materials are called for, constructed (and evaluated with monolinguals) in parallel in the two languages. Finally, the phenomenon of RC attachment has been shown to illustrate time-course differences in attachment

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decisions. This fact requires the use of different methods tapping different phases of processing.

3.7 Summary

We can conclude from the discussion above (including material in both Chapter 2 and the present chapter) that there are cross-linguistic differences in relative clause attachment preferences by monolinguals. Some languages (including English) exhibit a tendency for low attachment, while others (including Spanish) prefer high attachment. This observation has been confirmed in several off-line studies that used slightly different methodologies and materials. This evidence from monolinguals provides the required framework in which to study language dependency in bilingual sentence processing. RC attachment is a phenomenon in which monolinguals of different languages diverge, and in which we should be able to observe either language-dependent or language-independent strategy use in bilinguals.

However, languages that attach high off-line do not always exhibit such a preference in on-line studies (see §2.2.1). Likewise, low attachment preferences observed off-line have not always been replicated in on-line experiments (see §2.2.2). Critical differences among the existing studies, particularly in how materials are segmented and disambiguated, make comparison across sets of on-line data, in particular, almost impossible. Presenting the complex NP in two frames could bias attachment away from N1 (§2.4.1); disambiguating the attachment of the relative by relying exclusively on semantic/pragmatic

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information, without syntactic reflex, might tap post-syntactic strategies (§2.4.2). Further making the existing results difficult to interpret are materials that feel unnatural in one or the other language, as well as materials that are not clearly ambiguous or disambiguated as intended by the experimenters.

The first set of experiments to be presented (see Chapter 5) addresses precisely these issues, by testing monolingual speakers of Spanish and of English in entirely parallel experiments, implemented with both off-line and on-line procedures. The latter feature is an important one: although the phenomenon of cross-linguistic differences in sentence processing is undeniable with respect to later phases of processing (tapped by questionnaire procedures), what is still unclear is whether these differences originate in the earliest decisions made by the parser, or whether instead they are the result of the interface of syntax with extra-syntactic principles, be they pragmatic/discourse principles, or principles related to prosodic segmentation, or any other such extra-syntactic principles. On-line studies in which extra-syntactic sources of influence are minimized are therefore crucial in building the case.

The second set of experiments to be presented (see Chapter 6) proceeds against the background established in this chapter, to seek evidence about the nature of bilingual sentence processing. Testing bilinguals in each of their languages will provide a window of opportunity for distinguishing language-dependent from language-independent behavior. The design of the experiments reported in Chapter 6 is very close to the type of design (procedurally, in particular) that one would expect under the CM framework. However, the

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methodology for eliciting data from subjects is less problematic, particularly in that it does not compare materials with different grammaticality status across languages, and in that the tasks require minimal metalinguistic ability.

The experiments in Chapter 6 focus specifically on the language dominance of the subjects, and divide the sample into Spanish-dominant and English-dominant bilinguals, whose behavior will be compared. In addition to this language history factor, relevant aspects of the bilinguals' acquisition history, and current and past use of each language will additionally be explored as possible factors determining performance, or at least, as factors that determine dominance.

Before we turn to the experimental evidence, Chapter 4 introduces the experimental materials and their critical characteristics. Chapter 4 also describes the basic design of the experimental instruments, a pen-and-paper questionnaire and a self-paced reading task.

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CHAPTER 4

MATERIALS EVALUATION: QUALITY CONTROL FOR EXPERIMENTAL SENTENCES

4.1 Introduction

This chapter discusses considerations in constructing the experimental materials and in designing the experimental tasks used in the studies to be presented in Chapters 5 and 6. As Chapter 2 has made clear, weaknesses in several previous studies seem to lie in flaws in the experimental materials. For example, the ambiguity status of some sentences in some tests was found to be questionable; certain translation equivalent items had an unnatural feel in one or the other language; the Norman genitive construction, *N1 of N2*, seemed noticeably awkward in some cases; and so on.

The discussion in Chapter 2 emphasized the importance of comparable materials across languages, and described how less than optimal materials may negatively affect the outcome of an experiment, either by blurring intended contrasts or by inducing extraneous effects not related to the contrasts being tested (see discussion in Chapter 2, §2.2.2.2). Given that existing materials sets contain items with potentially problematic characteristics, it seemed that the risks associated with re-using those materials far outweighed any possible benefits (e.g., the advantage of being able to compare new data directly with those from

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previous studies sampling from different populations or using different methodology).

Ensuring that materials are comparable across languages is also important in the context of collecting data from bilinguals, as noted in Chapter 3. Any difference in the behavior of bilinguals from one of their languages to the other must be attributable either to the linguistic manipulation under consideration or to the nature of the bilingual's linguistic profile. Therefore, in the ideal, the materials in both languages should differ only as intended. The materials evaluation procedure addresses this worry as well.

Additionally, the materials for the experiments reported in Chapters 5 and 6 needed to be custom-tailored for the purposes of the experimental design. For example, so that the on-line experiment might primarily tap syntactic parsing strategies, the means for establishing disambiguation should be purely morphosyntactic, with no semantic or pragmatic reflex. For the purposes of the study of RC attachment, the only phenomenon comparable in English and Spanish is subject-verb agreement (see §2.4.2 in Chapter 2). The design exploits similarities in the specification of number in past tense *be* in English (*was*, *were*), and in the approximately equivalent imperfect forms of *estar* in Spanish (*estaba*, *estaban*). Since no previous experiments testing English and Spanish in parallel have used this form of disambiguation, existing materials could not be utilized.[82]

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[82] In studies on the RC attachment ambiguity, number has been used for disambiguation with English materials by Henstra (1996) and Deevy (1999), and using Spanish materials by Gibson, Pearlmutter & Torrens (1999). None of these studies compares English and Spanish directly, and the materials in each would require some adaptation for translation into the other language.

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A secondary aspect of RC attachment that the experiments in Chapters 5 and 6 seek to evaluate is the effect of the length of the attaching RC. We have seen in Chapter 2 that item-based variability in existing experiments is attributable to a number of variables. These may be internal to the complex NP (e.g., a referential noun is a more attractive host for the RC), or to the (anaphoric) relationship between the RC and its possible hosts (e.g., an RC containing a relative pronoun with agreement features might seek a more salient antecedent), or to the attaching RC (e.g., an RC which is an independent prosodic unit is freer to seek a higher host). The design of the experiments in this dissertation includes a length manipulation by which long RCs are tested alongside short RCs. As discussed in §2.2.4, Fodor (1998) has proposed that the prosodic weight of an attaching constituent may make it more or less prone to attaching to the higher host. In particular, the anti-gravity principle predicts that heavier (i.e., longer) constituents are more likely to rise and attach non-locally, because heavier constituents are more likely to be independent prosodic units. To date, such a manipulation of the length of the attaching RC has not been carried out in Spanish, and has only been explored in questionnaire studies in English (see Quinn, in progress; Quinn, Abdelghany & Fodor, 2000; Walter, Clifton, Frazier, Hemforth, Koniecnzy & Seelig, 1999; Walter, Hemforth, Konieczny & Seelig, 1999).[83]

The experiments to be reported examine, in parallel, RC attachment preferences using Spanish and English materials, using speeded and unspeeded

[83] RC length effects have been documented in languages other than English and Spanish. For discussion and references, see §2.2.4 in Chapter 2.

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measures, and using monolingual and bilingual subjects. We discuss the on-line and off-line experiments carried out with monolingual subjects in Chapter 5 and those with the bilingual subjects in Chapter 6. The next section (§4.2) describes how the target items were constructed, and discusses the intended similarities as well as some coincidental differences between the English and the Spanish materials. In the following section (§4.3) the target materials are evaluated according to three criteria: plausibility of each reading of the ambiguity, acceptability of the Norman genitive construction, and naturalness in both languages. The next two sections provide expanded descriptions of the length manipulation (§4.4) and the number manipulation (§4.5).

4.2 Development of the Experimental Materials

The experiments in Chapters 5 and 6 report data collected using two instruments, an unspeeded questionnaire with ambiguous materials and a speeded self-paced reading task with disambiguated materials. Except for the number manipulations that disambiguated the attachments in the target materials in the on-line study, all test sentences (fillers and targets) were identical in both tasks. Furthermore, the materials were constructed in parallel in the two languages, as translation equivalent sentences, felicitous in both languages. (Target items are listed in Appendix A-1; filler items are listed in Appendix A-2)

The construction we are interested in, the RC attachment ambiguity, consists of a complex NP followed by a relative clause (RC) modifying either N1 or N2:

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1. Andrew had dinner yesterday with the [nephew]$_{N1}$ of the [teacher]$_{N2}$ [that was in the communist party]$_{RC}$.

The target materials were ambiguous in the off-line questionnaire, and were disambiguated for either high or low attachment in the on-line task. The ambiguous materials contained uniform number in the complex NP: in exactly half of the experimental sentences, N1 and N2 were both singular, and in the other half they were plural (the verb in the RC was either unambiguously singular or unambiguously plural). The on-line materials were disambiguated by changing the number of one of the two nouns in the complex NP, so that it would mismatch the number of the verb in the RC. Thus identical content is maintained in the RCs in each of the attachment conditions, since that is where the critical comparison is going to be made.

Since the materials in the two tasks are identical (except for the disambiguation carried out by mismatching number features), the distribution of number in the on-line target materials has consequences for the off-line study as well. In the materials of both the questionnaire and the self-paced reading task, exactly one half of the targets contained an unambiguously singular verb, the other half an unambiguously plural verb. This distribution of number was included in the overall design to avoid a possible (undesired) strategy in which the subjects could engage in the on-line study, where the number of the nouns in the complex NP is mismatched. When reading disambiguated materials in the self-paced reading task, if the RC always had a singular verb, subjects might learn to only attend to whichever of N1 or N2 is singular, a strategy which would

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introduce artefactual effects into the results. Examples illustrating the distribution of number features in the off-line and on-line materials are provided in (2) and (3) (the nouns with number features matching the number of the subject of the RC are underlined; there were 12 items like (2) and 12 items like (3)):

2.	a.	...the nephew of the teacher that was...	(Off-Line, Ambiguous)
	b.	...the nephew of the teachers that was...	(On-Line, Forced High)
	c.	...the nephews of the teacher that was...	(On-Line, Forced Low)
2.′	a.	...el sobrino del maestro que estaba...	(Off-Line, Ambiguous)
	b.	...el sobrino de los maestros que estaba...	(On-Line, Forced High)
	c.	...los sobrinos del maestro que estaba...	(On-Line, Forced Low)
3.	a.	...the daughters of the hostages that were...	(Off-Line, Ambiguous)
	b.	...the daughters of the hostage that were...	(On-Line, Forced High)
	c.	...the daughter of the hostages that were...	(On-Line, Forced Low)
3.′	a.	...las hijas de los rehenes que estaban...	(Off-Line, Ambiguous)
	b.	...las hijas del rehén que estaba...	(On-Line, Forced High)
	c.	...la hija de los rehenes que estaban...	(On-Line, Forced Low)

We return to some implications of this design in §4.5 below.

To approximate the characteristics of the materials used in previous experiments, the matrix verbs and the verbs in the RCs of the target materials were all in the past tense. The past forms of *be* in English (*was* and *were*) were chosen, as they are the only number-marked verb forms in the past. Spanish has two copulas equivalent to English *be*, *ser* and *estar*, with slightly different distributions. Generally, *ser* is used to express permanent, inherent attributes while *estar* is used for more temporary, circumstantial characteristics. The copula *estar* was chosen for the Spanish materials, rather than its alternative, *ser*, for a number of reasons. For one, *estar* is used in a far wider range of

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contexts (see Silva-Corvalán, 1994, for discussion and references). Furthermore, choosing *estar* over *ser* avoids the possible confusion, in the short relative conditions, of active and passive constructions. For example, the expression *el maestro que era divorciado* ("the teacher who was being [*ser*] divorced"), refers to either a teacher in a divorced state or a teacher in the process of being divorced. The alternative, *el maestro que estaba divorciado*, unequivocally refers to a divorced teacher.

Finally, choosing *estar* over *ser* avoids an additional possible problem with Spanish short relatives. Consider the following:

4. a. ...el sobrino del maestro que estaba divorciado.
   b. ...el sobrino del maestro que era divorciado.

5. a. ...el sobrino divorciado del maestro.
   b. ...el sobrino del maestro divorciado.

In (4a), the RC describes the temporary state (of being divorced), ambiguously of either the *sobrino* or the *maestro*. In (4b), as noted above, there is ambiguity as to whether what is being described by the RC is the act of being divorced (passive) or the more permanent characteristic of being a divorced person. Additionally problematic about (4b) is the fact that it might not be ambiguous at the level required (that the RC be *equally likely* to describe either N1 or N2). The ambiguous phrase in (4b) might actually be biased for high attachment, while the ambiguous phrase in (4a) does not exhibit such a bias. To speak about the (permanently) divorced nephew of the teacher, one is more likely to use (4b) (and the intended meaning is stronger with a non-restrictive interpretation of the

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RC) than a phrase like (5a), since (5a) is ambiguous in yet another way—it can also mean "the nephew divorced from the teacher". To speak about the nephew of the divorced teacher, on the other hand, (5b) is available as a simpler and (almost) unambiguous way to express the idea.[84] Using *estar* (and describing temporary states) rather than *ser* (and describing permanent states) avoids these complications altogether.

The materials also contained a length manipulation, to evaluate the observation that shorter constituents (e.g., the RCs in (6a) and (7a), below) are likely to attach low, locally, while longer constituents (e.g., the RCs in (6b) and (7b)) have a tendency to seek a higher host.

6. a. ...that was divorced.
   b. ...that was in the communist party.

6.′ a. ...que estaba divorciado.
   b. ...que estaba en el partido comunista.

7. a. ...that were waiting.
   b. ...that were about to exit the airplane.

7.′ a. ...que estaban esperando.
   b. ...que estaban a punto de salir del avión.

The aim of the length manipulation was to establish whether the anti-gravity effect (Fodor, 1998; see §2.2.4) plays a role in determining RC attachment preferences in the same way in English and in Spanish. The length of the relatives was secondary to the structural criterion that all relatives contain *be* in English and *estar* in Spanish, which meant that all the Spanish relatives were

[84] The low attachment preference in (5b) is comparable to the low attachment preference reported in Chapter 2 (§2.2.3) above for German PPs (example (19b), p. 45).

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slightly longer (by at least one PWd) than the English relatives. Nevertheless, in each language, the long relatives were longer than the short ones, by an average of two PWds. (More details on the length manipulation are provided in §4.4.)

The ideal test of length would contrast two length conditions with identical content (up to the point of the end of the short RC). In this investigation, however, it was not the case that the long RC was a lengthened version of the short one (e.g., ...*who smokes* $]_{SHORT}$ *a pack of filterless cigarettes a day*$]_{LONG}$; *see* Quinn, Abdelghany & Fodor, 2000). Rather, the long and short RCs had different content, as the examples above indicate. This was one of the compromises made, given other critical aspects of the overall design, with the aim of minimizing repetition effects for the bilingual participants, who were administered two versions of the same task, one in each of their languages. The monolinguals each saw only one version of the relative clause for a given sentence, but the bilinguals saw the long version when they were tested in one of their languages and the short version in the other. See Chapter 6 for details on the testing procedure with bilingual subjects.

The target sentences always contained a complex NP of the form *the N of the N* (or *el/la N del/de la N* in Spanish), followed by an RC always beginning with *that was* (*que estaba*) or *that were* (*que estaban*). The nouns in the complex NP were either both animate (for 13 sentences, e.g., *the aide of the detective*) or both inanimate (for 11 sentences, e.g., *the pages of the magazines*). Both noun types were included for variety in the item set, and to allow the results to be generalized over a larger set of item types. In Spanish, the nouns were either

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both masculine or both feminine, except in three items (which were nevertheless ambiguous).[85]

In psycholinguistic testing, the inclusion of filler items is an intrinsic part of the experimental design. Fillers are used to distract subjects' attention away from the target structures being tested. They also provide a baseline for evaluation of subjects' overall performance in the task. In both the off-line and the on-line experiments, the task was to read sentences and answer questions about them. All distractor items in the experiments reported in Chapters 5 and 6 had questions with a correct and an incorrect response. As will be discussed in Chapter 6 (§6.3), these questions were also designed to provide an independent measure of bilingual subjects' proficiency in the language of the test. The monolingual subjects (Chapter 5) were assumed to be proficient in their native language. Nonetheless, error rates on the questions in the filler items were used as a mixed indicator of reading skill and subjects' attention to the task, and were treated as criterial in determining subjects' inclusion in the final analysis.

In both experimental tasks, the ratio of fillers to targets was 2:1. The fillers in the off-line questionnaire and the on-line self-paced reading task were identical, with the exception of the question and answer format, and some concomitant differences in question content; the sentences themselves were not at all altered between tasks. The questions, however, were binary choice in the

[85] Keeping number and gender identical in both nouns in the complex NP allows the use of adjectives in the relative clause while maintaining the structure morphosyntactically ambiguous. Three sentences violated this requirement ((4), (12) and (13) in Appendix A-1); however, the RCs in these three sentences were free of gender markings which would have otherwise disambiguated the RC attachment.

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questionnaire and YES/NO in the on-line test.[86] Below is a sample filler item with its corresponding question:

8. Boris detested the jazz music that his girlfriend always played while she prepared dinner.

   a. Who played jazz music while making dinner? Boris Boris' girlfriend (Off-Line)

   b. Did Boris' girlfriend play jazz music often? YES NO (On-Line)

8.′ Boris detestaba la música de jazz que su novia siempre ponía cuando ella hacía la cena.

   a. ¿Quién ponía música de jazz mientras hacía la cena? Boris la novia de Boris (Off-Line)

   b. ¿La novia de Boris ponía música de jazz a menudo? YES NO (On-Line)

In the off-line questionnaire, half of the filler questions had the correct answer located on the right, and the other half had the correct answer located on the left. The fillers and their corresponding off-line and on-line questions are included in Appendix A-2.

In the off-line task, subjects' answers to the questions in the target items provided the data indicating subjects' attachment preferences. The off-line target items were ambiguous, and were followed by a question asking directly about the attachment of the relative to which either answer is "correct" (an example is provided below, in (9)). In the on-line reading task, in contrast, the target items

[86] In the on-line procedure, subjects answered NO by pressing a red button on a response pad using their non-dominant hand. To answer YES, subjects pressed a green button using their dominant hand. For further details, see discussion in §5.3.3 (*Procedure*).

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were followed by an unambiguous question asking for confirmation that the subject had understood the intended disambiguation of the attachment. All questions in target items in the on-line experiment therefore asked about N (N1 in the forced high attachment versions of the sentences, N2 in the forced low attachment versions) and the content of the RC, as illustrated by the examples below ((10) and (11)). The correct answer to the 24 target item questions was therefore always YES. So that there would be an equal number of YES and NO answers throughout the test, 36 filler items had NO answers and only 12 had YES answers.

Off-Line, Ambiguous:

9. Andrew had dinner yesterday with the nephew of the teacher who was divorced.
   Who was divorced? the nephew the teacher

9.′ Andrés cenó ayer con el sobrino del maestro que estaba divorciado.
   ¿Quién estaba divorciado? el sobrino el maestro

Off-Line, Forced High:

10. Andrew had dinner yesterday with the nephew of the teachers who was divorced.
   Was the nephew divorced? YES NO

10.′ Andrés cenó ayer con el sobrino de los maestros que estaba divorciado.
   ¿Estaba divorciado el sobrino? SÍ NO

Off-Line, Forced Low:

11. Andrew had dinner yesterday with the nephews of the teacher who was divorced.
   Was the teacher divorced? YES NO

11.′ Andrés cenó ayer con los sobrinos del maestro que estaba divorciado.
   ¿Estaba divorciado el maestro? SÍ NO

As called for in the overall design of the study, bilingual subjects were tested in both of their languages. To minimize materials repetition effects

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between the two testing sessions for the bilinguals, there were two sets of fillers, similar in structure and distribution of correct and incorrect answers, but different in content. The two filler sets were distributed between the two versions of the off-line instrument and between the four versions of the on-line instrument. (In the off-line task, subjects assigned to each of the two different versions read a different set of fillers. In the on-line task, subjects assigned to the first or second version read the same set of fillers, which was different from the set of fillers read by subjects assigned to the third or fourth versions.)

The fillers contained constructions unrelated to the target *N-Prep-N-RC* construction, although some contained relative clauses and/or *N-Prep-N* phrases. In both fillers and targets, the fixed-form relativizer *que* was always used in Spanish,[87] and, rather than using the relative pronoun *who*, *that* was always used in English, a very close correlate to Spanish *que*. Using *that* is acceptable in American English even in constructions where the antecedent is animate (all of the animate nouns in the target complex NPs were also human).

A sub-set of the fillers (12 in each version of the off-line and on-line experiment) constituted the experimental items to an unrelated experiment, testing the double-clause ambiguity (discussed above, in Chapter 2, §2.2.2.1), and contained the structural ambiguity shown below:

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[87] Spanish has a variable-form correlate to *who*, *quien* [sg] / *quienes* [pl] (see §2.2.3 in Chapter 2). This relative pronoun is only grammatical with human antecedents, unlike *que*, which does not place any semantic restriction on its antecedents. *Que* was chosen as the relativizer for the Spanish materials not only because it is the relativizer used in all other studies on RC attachment preferences in Spanish, but also because it would allow for the inclusion of non-human (in this case, inanimate) antecedents in the complex NP.

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12. a. Rita sold the book that she had published to her friend.
    b. Rita published the book that she had sold to her friend.

12.′ a. Rita vendió el libro que había publicado a su amigo.
    b. Rita publicó el libro que había vendido a su amigo.

This experiment will not be discussed here; in the experimental chapters to come, the double-clause ambiguity items will be treated as regular filler items.

4.3 Evaluation of the Target Materials

Having described the general design of the testing instruments, we now focus on some aspects of the target materials that do not necessarily result from their structural characteristics. The target materials were constructed to be reliably ambiguous (in the absence of a deliberately introduced number disambiguation) and similarly acceptable, equivalent and felicitous in the two languages, in addition to fitting the specified structural description. Ambiguity here means that there is nothing about the content of the RC or the complex NP that of itself biases the attachment preference.

This section evaluates the materials in terms of how well they fulfill these three general requirements. (Assuming that the number manipulations will not in and of themselves introduce non-syntactic bias, the materials will be assessed in the (number-matched) form that the sentences took in the questionnaire.) First, the attachment ambiguity must not be disambiguated or biased toward one or the other attachment by means other than those intended through the morphosyntactic manipulations. Second, the Norman genitive must not arouse the sensation of unacceptability in either language. Especially in English, there is

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some danger that it may. Finally, the target materials must be equally natural in both languages.

It is additionally desirable that the manipulations in the materials test only the contrast in question. Therefore, comparing the long-RC against the short-RC materials is critical, as well as comparing the subset of materials with unambiguously singular verbs in the RC against those with unambiguously plural verbs. Ideally, neither of those manipulations should induce additional contrasts.

A preliminary set of materials fulfilling the structural and design requirements was created by the experimenter, a balanced Spanish/English bilingual. These preliminary materials were pre-tested and altered, based on how well each item fulfilled the requirements of the tasks, and taking into account additional aspects of the experimental design, including the following. A panel of Spanish linguists (speakers of Spanish from different regions) was consulted, and their feedback was used to eliminate most (if not all) dialect-specific terminology from the Spanish materials. Furthermore, all nouns intervening between the matrix verb and the complex NP were eliminated (e.g., *Linda wrote a letter to the [manager]$_{N1}$ of the [assistant]$_{N2}$...*), to avoid any possibility of the triple-NP-like sequence making N1 less accessible (see §2.3.1). Finally, the complex NPs in the mixed number conditions (in the on-line task) were constructed such that they made sense in all of the different complex NP configurations. It is not always the case that both the many-to-one and the one-to-many configuration in the complex NP is acceptable (e.g., *the wife of the*

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hostages is not acceptable, while *the daughters of the hostage* suffers no such problem).

The results of a set of norming tests on the preliminary materials set will not be presented here, as they were performed on materials that changed substantially after the revisions. Instead the following sections focus on the final set of items used in the experiments reported in Chapters 5 and 6. Below are presented the results of the evaluation post-tests (identical in form to the pre-tests used to refine the preliminary materials) performed on the final materials set.

Throughout the discussion of the results of the materials evaluation tests, wherever possible, the analysis will take into account the manipulations of RC Length and Complex NP Number in the materials, in addition to Language of the Materials. The objective is for none of these factors to give rise to main effects or to interact with each other. In the analyses reported in the sections that follow, both RC Length and Complex NP Number were considered non-repeated factors, while Language of the Materials was taken to be repeated in the items-based analyses (since the materials were translation equivalents), and non-repeated in the subject-based analyses (different monolingual judges in each language).

4.3.1 Participants and Procedure

Given the delicate nature of the judgments called for in the evaluation of the materials, *expert judges* (rather than naïve subjects) were recruited to complete the materials evaluation questionnaires. An expert judge was deemed

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to be a person familiar with linguistics and linguistic theory—graduate students and other professionals in linguistics, or professionals in related fields. Expert intuitions about notions such as grammaticality, plausibility and naturalness were assumed to be more accurate and less noisy than those of naïve subjects not trained in linguistic analysis; the number of judges consulted could therefore also be kept relatively small. Furthermore, the nature of the evaluation tasks called for very patient participants with an eye for detail, a characteristic of expert judges but not necessarily of naïve subjects. The evaluation tasks included a great deal of repetition, which a naïve subject may not deal with easily, but which a trained expert on language can overcome; the assumption is that an expert will know how to avoid becoming "saturated".

The expert judges completed a series of evaluation questionnaires discussed separately in the sections below. The expert judges fall into three categories, with four judges per group: Spanish monolinguals (test of plausibility, acceptability of the Norman construction, in Spanish), English monolinguals (test of plausibility, acceptability of the Norman construction, Norman/Saxon acceptability comparison, in English), and Spanish/English bilinguals (bilingual test of naturalness).

The expert judges were asked to complete the materials evaluation questionnaires based on their initial intuitions upon reading the sentences. They were requested to undertake the separate tasks on different days (except in the case of the bilingual judges, who completed only one questionnaire), and to take as many breaks as necessary with one particular task, to avoid saturation, given

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the repetitive nature of the materials. Most commented on the overall difficulty associated with the tasks, rather than with the repetitive nature of the materials.

4.3.2 Test of Plausibility

We first address the requirement that both attachments of the RC be equally plausible in the experimental items. One straightforward way to assess this is to collect plausibility ratings on simplex sentences (NP-VP) created from the ambiguous construction in each target. As an example, the two simplex versions generated from the ambiguous target item in (13) are shown in (14a) and (14b).

13. Andrew had dinner yesterday with the nephew of the teacher that was in the communist party.

14. a. The nephew was in the communist party.
    b. The teacher was in the communist party.

In the plausibility questionnaire, the expert judges (four English monolinguals, four Spanish monolinguals) were asked to rate the plausibility of each of the two alternative interpretations of the RC, in both the long (24 pairs) and short (24 pairs) conditions, in both English and Spanish. (In the sample target sentence in (13), for instance, it is desirable that it be just as plausible for the nephew as for the teacher to be in the communist party.) The target pairs were presented in pseudo-random order, interspersed among 52 simplex pairs created from sentences also containing the RC attachment ambiguity (many of them used in some of the experiments reviewed in Chapter 2; the fillers used in this questionnaire are listed in Appendix A-3 and are discussed further below).

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The two simplex versions created from each target and filler sentence were always presented together; the original complex sentence was not presented. The simplex sentence with N1 as the subject was first, while the one with N2 as the subject was second.

For each simplex sentence, separately, plausibility judgments were made on a five-point scale, where 1 indicated the sentence was very plausible, 5 that it was very implausible. The judges were instructed to base their judgments on real-world plausibility, and were informed that in the sentence pairs one of the two sentences was not necessarily more plausible than the other. (The complete instructions and some sample items are provided in Appendix B-1.) Of the sentences used to generate the 52 filler simplex pairs, 21 contained one deliberately implausible host (in either N1 or N2 position), and the remaining 31 contained plausible hosts in both positions (though each with possibly different degrees of plausibility). Of the 21 pairs generated from sentences containing one deliberately implausible host, 7 were generated from materials borrowed from Cuetos & Mitchell (1988) and 14 from materials borrowed from Carreiras & Clifton (1993).

The results of the test of plausibility for the target materials are provided in Table 4-1. The columns labeled *Short-RC* and *Long-RC* list plausibility ratings for simplex sentences constructed from complex sentences with short and long relative clauses, respectively. The rows labeled *Singular* and *Plural* list plausibility ratings for simplex sentences constructed respectively from items with two singular hosts and from items with two plural hosts in the complex NP.

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Table 4-1: Mean Rated Plausibility of N1 and N2 Hosts as a Function of Language and Complex NP Number for Short-RC and Long-RC Experimental Items

		Short-RC		*Long-RC*	
		N1	*N2*	*N1*	*N2*
English Materials	*Singular*	1.04	1.00	1.27	1.08
	Plural	1.02	1.13	1.04	1.06
Spanish Materials	*Singular*	1.50	1.50	1.58	1.54
	Plural	1.77	1.67	1.75	1.19

Note: On the 5-point scale, 1 = "very plausible", 5 = "very implausible".

A four-way analysis of variance was performed on the subject- and item-based plausibility ratings, to evaluate the effects and interaction of Language of the Materials (English versus Spanish), RC Length (short versus long), Complex NP Number (singular N1, N2 versus plural N1, N2), and Host (N1 versus N2). (The analyses of variance reported in this section are provided in Appendix E-1.)

The results of this evaluation confirmed that, as intended, the target materials are appropriately ambiguous at levels beyond the structural ambiguity under scrutiny. The overall plausibility rating for simplex sentences with N1 as subject was 1.37, not different from the overall plausibility rating for simplex sentences with N2 as subject, 1.27, $F_1 < 1$, $F_2(1,88) = 1.95$, $p > .10$. (There was no interaction of host with language, length, or number, and host did not enter into any higher-order interactions; all values of $p > .10$.)[88] There was also no difference between the overall plausibility ratings for short-RC materials (1.33)

[88] The three-way interaction of language, number and host was significant in the item-based analysis ($F_2(1,88) = 4.17$, $p < .05$), but not in the subject-based analysis ($F_1 < 1$).

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and long-RC materials (1.32), F_1, $F_2 < 1$. The only significant difference in the analysis of the plausibility ratings is between the two groups of judges, with the English-speaking judges providing, overall, plausibility ratings closer to 1 (mean plausibility rating: 1.08) than the Spanish-speaking judges (mean plausibility rating: 1.56), $F_1(1,48) = 9.98$, $p < .005$, $F2(1,88) = 64.56$, $p < .001$. This result should not be taken to mean that the Spanish versions of the materials are less plausible, overall, than the English. It merely indicates that the Spanish judges were centered around a slightly higher mean than the English judges, reflecting differences in the make-up of the judges groups beyond the control of the experimenter, or differences in the interpretation of the instructions by the two groups.

As mentioned, a number of the fillers for this task were based on borrowed items, from previous experiments on the RC attachment ambiguity. Of the 52 filler pairs, 14 pairs were generated from novel sentences, but 17 pairs were created based on ambiguous materials used by Gilboy et al. (1995), and 21 pairs based on materials disambiguated pragmatically used by Cuetos & Mitchell (1988; 7 pairs), and Carreiras & Clifton (1993; 14 pairs). Leaving aside the fillers generated from intentionally ambiguous sentences (where both hosts were plausible),[89] it is interesting to consider briefly the results with sentences intentionally disambiguated pragmatically.

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[89] For fillers generated from intentionally ambiguous sentences (which included 17 simplex pairs generated from items borrowed from Gilboy et al., 1995, and 14 simplex pairs generated from novel sentences), the mean plausibility rating with English materials was 1.12, compared to 1.46 with Spanish materials. The language difference (0.33) is in the same direction as with the experimental materials discussed above, with a slightly higher mean for the Spanish judges than for the English judges. (As with the target materials, the difference in plausibility ratings between sentences with N1 as subject (1.31) and sentences with N2 as subject (1.27) was negligible.)

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Items from the Cuetos & Mitchell (1988) and the Carreiras & Clifton (1993) studies were included for the judges to perform with less difficulty in the plausibility task. However, these items were not chosen at random from the lists of experimental materials in the studies cited but were hand-picked from each set of materials as being those in which the plausibility manipulation did not seem altogether effective. (This concern about the materials in these two studies is discussed in Chapter 2, §2.2.2.2 and §2.4.2.) It is important to emphasize, therefore, that the comments below are based only on a subset of the materials from the original studies.

Mean plausibility ratings for the intentionally disambiguated (borrowed) materials are summarized in Table 4-2. The items borrowed from the Cuetos & Mitchell (1988) and Carreiras & Clifton (1993) materials were disambiguated by semantic/pragmatic devices. Rather than provide attachments to N1 or N2 in the table below, the means provided are for attachments to the implausible host and to the plausible host.[90]

[90] The implausible host is always in the N1 position in the Cuetos & Mitchell (1988) items. The implausible host is in the N1 position in half of the Carreiras & Clifton (1993) items, and in the N2 position in the other half. Whether the plausible host is in the N1 or N2 position is irrelevant for this task other than the fact that the simplex pairs were always presented such that the sentence generated from the N1 attachment was followed by the sentence generated from the N2 attachment.

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Table 4-2: Mean Rated Plausibility of Implausible and Plausible Hosts as a Function of Language for Borrowed Materials with One Implausible Host

	Implausible Host	*Plausible Host*
English Materials	2.37	1.15
Spanish Materials	3.60	1.33

Note: On the 5-point scale, 1 = "very plausible", 5 = "very implausible".

As we have already discussed, with the target materials, the English judges overall have plausibility ratings closer to 1 than the Spanish judges. We assumed this has to do with uncontrollable differences between the two groups of monolingual judges. As Table 4-2 indicates, this difference is also present in the ratings for the items borrowed from existing materials sets. The overall rating for the "borrowed materials" subset of the fillers by the Spanish judges was 2.47, while for the English judges it was 1.76. In a two-way analysis of variance (with Language of the Materials and Plausibility of Host as factors), the main effect of language was significant, $F_1(1,12) = 7.40$, $p < .025$, $F_2(1,40) = 39.46$, $p < .001$.

What is striking about Table 4-2 has to do with the differences, within each language, between the sentences generated from attachments to the plausible and to the implausible hosts. These items were designed by those authors to be unambiguous, so that one would expect the responses to the implausible variants to be relatively high (approximating 5, "definitely implausible"). However, the presumably implausible attachments, according to our judges, are more plausible overall than would be expected, and more plausible in English than in Spanish. The mean difference between the implausible and plausible hosts in

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the Cuetos & Mitchell and Carreiras & Clifton borrowed materials taken together was 1.21 in English, but 2.26 in Spanish. (Examining the difference between rated plausibility for plausible and implausible hosts abstracts away from the fact that Spanish-speaking judges were generally more reluctant than the English-speaking judges to accept a given scenario as plausible.) In the analysis of variance, there was a significant main effect of plausibility of the host, $F_1(1,12) = 45.25$, $p < .001$, $F_2(1,40) = 63.44$, $p < .001$, which interacted with language of the materials marginally in the subject-based analysis, $F_1(1,12) = 4.13$, $p < .10$, and significantly in the item-based analysis, $F_2(1,40) = 21.94$, $p < .001$.[91]

This informal evaluation indicates that the disambiguation device used in these particular borrowed sentences is notably less effective in English than it is in Spanish, suggesting that semantic/pragmatic disambiguation cues may have language- or culture-specific characteristics.[92]

4.3.3 Acceptability of the Norman Form

In this section, we consider the extent to which the Norman construction is similarly acceptable in English and Spanish, in the target materials. The concern here is not so much with the Spanish materials as with the materials in English. Spanish, after all, has no alternative way for expressing a genitive other than the *N1-de-N2* sequence. English, on the other hand, has the alternative Saxon

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[91] The marginal significance of the subject-based analysis is possibly due to the fact that the subject pool (of expert judges) is very small.

[92] We stress that the finding reported here is not for the complete set of the materials in each of the studies. The 7 sentences borrowed from Cuetos & Mitchell (1988) constituted 29% of their materials, while the 14 sentences borrowed from Carreiras & Clifton (1993) made up 44% of their materials.

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construction, *N2's N1*, for which (as discussed earlier in Chapter 2, §2.2.1), a following RC may only grammatically attach to N1 (cf. **the actor's children that was...*).

A reduced acceptability in English of the Norman genitive would make the comparison between English and Spanish less direct, as we would be comparing two structures (the Norman in English versus the Norman in Spanish) that are not identical at levels beyond their surface similarity. This is important in terms of comparing both the behavior of monolingual speakers of two languages and the behavior of bilingual speakers in each of their languages. Lower acceptability of the Norman construction in English might also have consequences for how the behavioral data on RC attachment preferences are to be interpreted. Suppose that with a given set of experimental materials, a low attachment preference was observed in English, in contrast to a high attachment preference in Spanish (with translation-equivalent materials sets). A valid interpretation of this pattern of results might be as proposed by Frazier (1990; see also Frazier & Clifton, 1996; Frazier & Vonk, 1997): that the low attachment preference is obtained in English because the Norman construction, *N1 of N2*, is used to focus N2, the possessor; the alternative Saxon construction, *N2's N1*, could and therefore should be used to focus N1.

To determine whether the English materials were biased in such a way, two tests regarding the acceptability of the Norman construction were run. The first was an absolute grammaticality judgment on both the English and Spanish target materials, with the RC omitted ("bare matrix" sentences). The second was

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a relative acceptability judgment, only in English, of the complex NP in its Norman versus its Saxon form.

Neither of these tests probes the Gricean argument directly, but the results of each test speak to the acceptability of the construction used in the target materials, in English. If an unmodified Norman form is unacceptable, then the construction might be biased for low attachment, following Gricean reasoning (e.g., the interlocutor must be focusing N2 somehow, because otherwise the preferred construction might have been a Saxon genitive). The bare matrix grammaticality test is informative in terms of how awkward a sentence-final Norman genitive may be. The assumption is that an awkward or unacceptable bare matrix sentence might be so because the alternative sentence with a Saxon genitive is preferred, or because the Norman genitive requires further modification for N2 (if N2 is focused by virtue of its being inside a PP, rather than being in a prenominal genitive position, it might require further modification).[93] The Norman/Saxon relative acceptability test elicits comparable data, but asking the expert judges to compare the two forms directly.

The grammaticality judgments were performed by the same four Spanish monolingual and four English monolingual judges who provided the plausibility judgments discussed in the preceding section; the same four English monolingual judges also provided the relative acceptability judgments.

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[93] An additional concern is that a complex NP of the form *the N of the N* (*el N del N*, in Spanish) is biased for low attachment because of the presence of a definite article on N2. A definite article needs an identifying modifier. For N1, this modifier is *of the N2*, but for N2 there is no available modifier if the RC attaches high. The following phrases illustrates this quite well: *the sweater of the cotton that Mary wore yesterday* (awkward, because the relative is forced to attach high) compared to *the sweater of the cotton that was imported from Egypt* (intuitively better, given that the RC may attach low). (The same preferences hold for Spanish.)

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In the grammaticality judgment questionnaire, the 24 target sentences, in their bare matrix form, were presented on one line, as in the following example:

15. Andrew had dinner yesterday with the nephew of the teacher.

For each item, the judges used a five-point scale for their responses, where 1 indicated "grammatical" and 5 indicated "ungrammatical" (the full instructions and sample items are provided in Appendix B-2). The judges were not instructed explicitly on the nature of the judgments required, since they were linguistics professionals and were familiar with the notion of grammaticality. The 24 targets were interspersed among 48 fillers (containing simplex versions of the double clause ambiguity discussed in Chapter 5, §2.2.2.1).[94]

In the Norman/Saxon relative acceptability questionnaire, 24 genitive pairs (one Norman, one Saxon) were generated from the 24 basic sentences. The genitives were presented side by side, as in the following examples (for plurals, a possessive apostrophe was used, rather than *–'s*; the Norman genitive always appeared to the left of the Saxon genitive):

16. a. the nephew of the teacher b. the teacher's nephew

17. a. the daughters of the hostages b. the hostages' daughters

The 24 target pairs were interspersed among 40 filler pairs generated from materials used in existing studies on RC attachment, for a total of 64 items in the

[94] These filler sentences were constructed based on the items listed in the final section of Appendix A-2 (p. 331), and were part of an investigation not discussed here. Half of the fillers were ungrammatical (e.g., *Rita published the book to her friend*, and the other half were grammatical (e.g., *Rita sold the book to her friend*).

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questionnaire. The judges were asked to indicate, on a five-point scale, which of the two complex NPs was more acceptable, with 1 indicating that the Norman form (a) was "definitely better", 5 indicating that the Saxon form (b) was "definitely better", and 3 indicating that both were OK. The full instructions together with sample items are provided in Appendix B-3.

The results of these two questionnaires on the acceptability of the Norman construction are provided in Table 4-3. The analyses of variance reported in this section are provided in Appendix E-2.

Table 4-3: Mean Rated Grammaticality of Bare Matrix and Relative Acceptability of Norman versus Saxon Construction as a Function of Language and Complex NP Number

		Grammaticality of Bare Matrix*	*Relative Acceptability** Norman versus Saxon*
English Materials	*Singular*	1.73	2.81
	Plural	1.48	3.15
Spanish Materials	*Singular*	1.10	—
	Plural	1.33	—

* On the 5-point grammaticality scale, 1 = Norman construction "definitely better", 5 = Saxon construction "definitely better".

** On the 5-point relative acceptability scale, 1 = "grammatical", 5 = "ungrammatical".

The first result we will consider is the difference between English and Spanish materials in the grammaticality task. Here, the Spanish judges (the same participants as in the test of plausibility) provided grammaticality judgments closer to 1 ("grammatical") than the English judges (also the same participants as in the test of plausibility): the overall mean was 1.22 in Spanish, 1.60 in English. A two-way analysis of variance was performed on the grammaticality responses,

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including as factors Language of the Materials (English versus Spanish) and Complex NP Number (N1, N2 singular versus plural). This analysis indicated that the difference between the grammaticality ratings of the bare matrix sentences in English and in Spanish was significant, $F_1(1,6) = 7.28$, $p < .05$, $F2(1,44) = 6.17$, $p < .025$. This effect did not interact with the effect of complex NP number, which itself was not significant (interaction: $F_1(1,6) = 2.88$, $p > .10$, $F_2(1,44) = 2.38$, $p > .10$; main effect of number: F_1, $F_2 < 1$).

On the other hand, the English judges did not consider the complex phrase in its Saxon form to be better than the Norman form: the mean relative acceptability judgment was 2.98, not significantly different from 3.00, the central "both OK" rating, $t_1(3) = 0.11$, $p > .20$, $t_2(11) = 0.16$, $p > .20$ (t-test for single mean). The difference between the mean relative acceptability for singular versus plural materials is also not significant, $t_1(2) = 0.87$, $p > .25$, $t_2(10) = 1.35$, $p > .15$ (two sample t-test).

This set of tests provides insight regarding the Norman construction. On the one hand, we have some evidence that the construction has a slightly more marginal grammaticality in Spanish and in English (though it is clearly grammatical in both). On the other hand, we have some indication that the Norman form does not have a reduced acceptability when compared directly with the Saxon form.

4.3.4 Test of Naturalness

The final questionnaire in the procedure of materials evaluation was a cross-linguistic test of naturalness, administered to Spanish/English bilingual

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expert judges. The aim of this questionnaire was to ensure that the sentences, originally constructed as translation equivalents of each other, did not sound like unnatural translations in either of the languages. The judges, fluent and balanced Spanish/English bilinguals, were asked (in English) to indicate directly whether they thought each sentence equally natural in English and Spanish. They rated the relative naturalness of complete target sentences (including the *N1-Prep-N2-RC* sequence in its entirety) in English and Spanish, using a five-point scale where 1 indicated that the sentence was "more natural in Spanish", 5 that it was "more natural in English", and 3 that it was "equally natural in both languages". (The complete instructions and some sample items are included in Appendix B-4.)

This test capitalizes on the judges' bilingualism, which allows them to make relative judgments on materials in two different languages. This is certainly superior to asking monolingual judges of each language to provide absolute judgments on individual sentences, since a direct comparison of the materials in the two languages is precisely what is required. Yet while judges' responses indicate comparative naturalness between related English and Spanish items, there is no mechanism built into the task to distinguish equally natural from equally unnatural items. This means that a particular item which has "passed" the equal-naturalness test may nevertheless be odd—equally so in the two languages involved.[95]

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[95] If we were interested in conducting an extensive study of Spanish (independent of English) or English (independent of Spanish), it would not be satisfactory to include sentences which were odd (due to factors not controlled for). However, in a cross-linguistic comparison as this, inclusion of "odd" or "unnatural" sentences is not altogether misconceived, as including slightly

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The test of naturalness on the final target items set included the 24 long-RC targets and the 24 short-RC targets. For each item, the English sentence was presented directly above its Spanish equivalent, as shown below:

18. Andrew had dinner yesterday with the nephew of the teacher that was in the communist party.
    Andrés cenó ayer con el sobrino del maestro que estaba en el partido comunista.

These 48 items were interspersed among 48 fillers containing the double-clause ambiguity construction (discussed previously in Chapter 2, §2.2.2.1; the items were also used in the off-line and on-line experimental studies, and are therefore listed in Appendix A-2) and 4 additional fillers (listed in Appendix A-3). The target pairs and filler pairs were presented in a pseudo-random order.

The mean ratings on relative naturalness for the target items are presented in Table 4-4.

Table 4-4: Mean Relative Naturalness of Short and Long Versions of Experimental Items as a Function of Complex NP Number

	Short	*Long*
Singular	3.10	3.33
Plural	3.33	3.21

Note: On the 5-point relative naturalness scale, 1 = more natural in English, 3 = equally natural in both languages, 5 = more natural in Spanish.

While the materials are approximately equally natural in the two languages, the overall mean of 3.25 indicates that the Spanish versions of the items are slightly

unnatural stimuli might be one of the compromises made in the process of designing the experiment, as long as the oddness or unnaturalness is *relatively* similar in both languages.

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more natural than the English versions. Separate *t*-tests for a single mean were calculated on the subject- and item-based naturalness ratings provided by the bilingual expert judges for short, long, singular and plural materials, to determine whether each of the four means differed significantly from 3 ("equally natural in both languages"). These *t*-tests confirm that in each of the length conditions of the materials, the Spanish version is preferred (albeit slightly) over the English version: for long-RC materials, mean 3.27, $t_1(3) = 2.93$, $p < .10$, $t_2(23) = 3.47$, $p < .01$; for short-RC materials, mean 3.22, $t_1(3) = 3.18$, $p < .05$, $t_2(23) = 2.83$, $p < .01$. The mean of 3.22 for singular materials was only significantly different from 3 in the item-based analysis, $t_1(3) = 1.48$, $p > .20$, $t_2(23) = 2.32$, $p < .05$; the mean of 3.27 for plural materials was, however, significantly different from 3, $t_1(3) = 3.22$, $p < .05$, $t_2(23) = 4.82$, $p < .001$

The most straightforward explanation of the bilingual judges' indication, that the Spanish form of these sentences is more natural than the English form, hinges on an expected feature of the materials, which was pursued in the tests in the preceding section, but was not found. According to the bilingual expert judges, the Norman construction, *N1 of N2*, followed by an RC, seems to be more natural in Spanish than in English, in a direct comparison. This is quite possibly related to the existence in English, and not in Spanish, of the unambiguous alternative, the Saxon construction, *N2's of N1*. The extent to which this fact makes a difference in RC attachment preferences in perceptual tasks is debatable (see, e.g., Mitchell, Brysbaert, Grondelaers & Swanepoel, 2000, for arguments that it does not play a key role). However, this difference in

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the repertoires of alternative constructions in the two languages under comparison does seem to affect choice in production (see, e.g., Oria-Merino, Costantino, Heydel & Sainz, 2000; Costantino, Oria-Merino, Heydel, & Sainz, 1999).

4.4 The Length Manipulation

The qualitative length difference that was stipulated when the items were constructed needs quantitative support. For the two languages, both a length maximum for short RCs and a (relative) length minimum for long RCs were set. The length maximum in the short-RC condition was one PWd[96] in English, two PWds in Spanish;[97] the long-RC condition was required to be longer by at least one PWd than the short-RC condition. These length criteria, cast at the level of PWd, may or may not turn out to be adequate for determining the relative weight of an RC vis-à-vis the constituent it is attaching to. We leave this issue for future investigation, and provide alternative measures of heaviness for purposes of comparison.

In Table 4-5 are listed means of the number of PWds, number of syllables, and number of characters in the final materials. The row labeled *Sentence Beginning* contains average measurements for the early region of the sentences,

[96] For a definition of PWd, see §2.4.1 in Chapter 2.

[97] Unlike its equivalent in English, we are assuming that the Spanish copula *estar* should be treated as a PWd which may contribute a pitch accent. Reducing Spanish short RCs to the length of one PWd would have meant abandoning the requirement that materials be disambiguated by similar means in both languages (i.e., using copulas marked or unmarked for number), a requirement which took precedence over the maximum length requirement.

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excluding the complex NP and the relative clause. In the *N1* and *N2* rows are provided measurements for each of the nouns in the complex NP, including determiners, but excluding prepositions, measurements of which are listed in the row labeled *Prep*.

Table 4-5: Length of the Target Materials in English and Spanish Materials by Region, Measured in Prosodic Words, Syllables and Characters

	Prosodic Words		Syllables		Characters	
	English	Spanish	English	Spanish	English	Spanish
Sentence Beginning	2.42	2.38	6.04	7.33	20.58	21.13
N1	1.00	1.00	3.13	4.08	10.92	11.33
Prep	0.00	0.00	1.00	0.63	2.00	1.63
N2	1.00	1.00	3.46	4.79	12.71	12.38
N1-Prep-N2	2.00	2.00	7.59	9.50	25.63	25.34
RC Long	2.96	3.83	10.63	14.08	39.58	43.29
RC Short	1.00	2.00	4.00	6.38	16.42	20.21
Total Long	7.38	8.21	24.25	30.92	85.79	89.75
Total Short	5.42	6.38	17.63	23.21	62.63	66.67
△ Long–Short	1.96	1.83	6.63	7.71	23.17	23.08

The preposition measurements were taken separately because in Spanish the preposition and determiner merge when the determiner is masculine singular (*de el* becomes *del*). For these sentences, the preposition count was 0 PWds, 0 syllables, and 1 character. The same process applies to the preposition *a* followed by a masculine singular definite determiner (*a el* becomes *al*). This process applied in some sentences where the accusative marker for animate nouns, *a*, preceded the complex NP (e.g., *conoció al ayudante*, "met the aide").

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In these cases, the preposition did not contribute at all to the counts in either the matrix or the N1 region, since it was absorbed by the determiner (counted in N1).

The next row, *N1-Prep-N2*, provides the sum of the counts in the *N1*, *Prep* and *N2* rows. RC length measurements are provided in the *RC Long* and *RC Short* rows. The rows *Total Long* and *Total Short* list sums of all regions for each of the two conditions. Finally, the difference between the totals for the two length conditions is provided in the column labeled Δ *Long–Short*.

The length difference we are interested in appears to be definitive and similar in both languages. On average, collapsing over languages, long RCs were 1.9 PWds, 7.2 syllables, and 23.1 characters longer than short RCs.

Examination of Table 4-5 reveals an intrinsic RC length difference between RCs in the two languages, associated with the fact that the Spanish copula adds more weight to the RC than the English copula. Overall, short RCs in English were 1.0 PWd, while in Spanish they were 2.0 PWds; long RCs in English were an average 3.0 PWds, while in Spanish they were 3.8 PWds. This length difference between the languages could have consequences in terms of inducing a length effect of the type predicted by Fodor (1998) differently in each of the languages. How exactly the length sensitivity will distribute itself is unclear, and there are two possible alternatives, which depend on whether the length of the RC must be balanced against the whole of the complex NP, or only against N2.

On the one hand, if the critical balance is between the RC and the complete complex NP, it is reasonable to expect that the English materials will

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cause readers to be more sensitive to the length manipulation than the Spanish materials. In the short-RC condition there exists, in English, imbalance between the length of the RC (1.0 PWds) and the length of the complex NP constituent (2.0 PWds), while in Spanish, no such imbalance is present with short relatives (both average 2.0 PWds). On the other hand, the critical imbalance may be between N2 and the RC, in which case the imbalance exists *not* in English (where both regions are 1.0 PWd long), but in Spanish, and in the direction where the attaching constituent exceeds the length of the constituent it is attaching to (N2 is 1.0 PWd, but the short RC is 2.0 PWds). In this case, we might expect a low attachment preference with English short RCs, and a high attachment preference in Spanish, even with short RCs.

4.5 The Number Manipulation

We now consider how number disambiguation will operate in the on-line self-paced reading task. As the examples provided earlier indicate, the ambiguous materials of the off-line task contain uniform number in the complex NP: N1 and N2 are either both singular or both plural (see (2a) and (3a), repeated below). To disambiguate attachment morphosyntactically, the uniform complex NPs were changed into number hybrids (see (2b)-(2c) and (3b)-(3c)), by changing the number of one or the other of the subconstituents. (In the examples, the underlined nouns agree in number with the verb in the relative clause.)

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2. a. ...the nephew of the teacher that was... (Off-Line, Ambiguous)
   b. ...the nephew of the teachers that was... (On-Line, Forced High)
   c. ...the nephews of the teacher that was... (On-Line, Forced Low)

3. a. ...the daughters of the hostages that were... (Off-Line, Ambiguous)
   b. ...the daughters of the hostage that were... (On-Line, Forced High)
   c. ...the daughter of the hostages that were... (On-Line, Forced Low)

This use of number agreement for disambiguation in our materials may carry a special computational burden in some circumstances. It is inescapable that the different number configurations resulting from forcing the attachment of the RC bear a heavy resemblance to the constructions studied by Bock and colleagues (Bock & Miller, 1991; among others, see also Bock & Cutting, 1992; Bock, Nicol & Cutting, 1999; Eberhard, 1997; Oria-Merino & Sainz, 1998, 1999; Vigliocco, Butterworth & Garrett, 1996; Vigliocco, Butterworth & Semenza, 1995; Vigliocco, Hartsuiker, Jarema & Kolk, 1996; Vigliocco & Nicol, 1998). Bock & Miller's (1991) experiments focused on constructions in which the subject noun and a noun in a modifying phrase intervening between subject and verb either matched or mismatched in number:

19. a. The key to the cabinets (Mismatch)
    b. The keys to the cabinet (Mismatch)
    c. The key to the cabinet (Match)
    d. The keys to the cabinets (Match)

In these experiments, subjects listened to pre-recorded sentence preambles similar to those shown in (19),[98] one at a time, and were asked to repeat the

[98] The experiments in Bock & Miller and in the other investigations also cited above have tested a variety of preambles manipulating both aspects of the intervening noun (animacy, concreteness, and so on) and the relationship of the intervening phrase to the subject (prepositional phrase as in *the key to the cabinets*, relative clause as in *the editor who rejected the books*, and so forth).

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preamble, as rapidly as possible, adding a completion. The sentence completions were categorized into correct responses (in which subjects repeated the preamble correctly, with an inflected verb), agreement errors (in which the verb form did not agree with the subject of the sentence), uninflected-verb responses (in which the verb form did not differentiate between singular and plural), and miscellaneous errors (in which the subject failed to repeat the preamble correctly). The critical category, for the purposes of these studies, is that of agreement errors. Compared to the frequency of responses in the other three categories (the exact distribution of which varies to a lesser or greater degree from experiment to experiment), the number of agreement errors produced is generally low. (In Bock & Miller's experiments, for example, the proportion of agreement errors ranges from 2% to 5% of all responses.)

Bock & Miller's (1991) critical finding, which has since been confirmed by other studies, was that agreement errors were approximately ten times more likely in the mismatch condition where the intervening (local) noun was plural, as in (19a), than in any of the other conditions. Similar results have been reported for Dutch and French (Vigliocco, Hartsuiker, Jarema & Kolk, 1996), and Spanish (Oria-Merino & Sainz, 1998, 1999; Vigliocco, Butterworth & Garrett, 1996). While these experiments are primarily concerned with the production component, a handful of studies have investigated the processes of subject-verb agreement in comprehension (Deevy, 1999; Nicol, Forster & Veres, 1997; Pearlmutter, submitted; Pearlmutter, Garnsey & Bock, in press), and generally the findings of the perception studies correlate with those in the production studies: an

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intervening plural noun between a singular subject and verb disrupts processing, as reflected in increased reading times when the local noun is plural.

The critical concern in the literature on subject-verb agreement has been to determine whether the "local plural" effect arises through structural aspects of the implementation of agreement in production and perception, or if this effect originates elsewhere (for a proposal analyzing the local plural effects in terms of LF movement, see Den Dikken, 2000). The "structural proximity" account has been compared to an account by which the "linear proximity" of the local plural plays the critical role (for discussion and references, see Vigliocco & Nicol, 1998; Pearlmutter, submitted).

Bock & Miller discuss some of the possible causes of these errors, and while conceding that their answer is not definitive, suggest that an operation of affix checking (p. 87) drives the errors. The overt plural feature on the second noun in (19a), *cabinets*, suppresses producing a singular verb by percolating to the higher (head) noun and "tingeing" it, in a sense, as plural.

In the on-line experiments in Chapters 5 and 6, we will not be investigating the effects of subject-verb agreement specifically. Instead, the design exploits the agreement between a subject trace (created by WH-movement of the relative pronoun) and the verb in a relative clause, with the number of the trace being overtly expressed on the head noun in the matrix clause that the relative pronoun is linked to. Nonetheless, we must bear in mind that exactly half of the target items in the on-line task contain the potentially problematic "local plural" sequence. In the items where N1 is singular and N2 plural, to whatever extent

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the marked plural feature in N2 overshadows the unmarked singular in N1, the entire complex NP might be taken to be plural. Such a process would render the disambiguation in some items less reliable. In other words, for the items in the materials subset with a singular verb in the RC (see (20) below) the process of feature percolation would result in no legal attachment for the RC (neither of the two nouns in the complex NP would be compatible with the singular verb in the RC), while for the items with a plural verb in the RC (see (21)) the process of feature percolation would render the attachment ambiguous (both nouns would be compatible with the plural verb in the RC). In the examples below, the local plural noun is in boldface, and the status of the RC, if feature percolation has taken place, is italicized.

20. a. ...the nephew of the **teachers** that was... (Forced High; *Ungrammatical?*)
    b. ...the nephews of the teacher that was... (Forced Low)

21. a. ...the daughters of the hostage that were... (Forced High)
    b. ...the daughter of the **hostages** that were... (Forced Low; *Ambiguous?*)

The effect of these number agreement facts in the on-line experiment should be observable by comparing the pattern of results between items with the number configuration N1-sg Prep N2-pl ((20a) and (21b)) and items with the number configuration N1-pl Prep N2-sg ((20b) and (21a)). Particularly worrisome will be the emergence of a large difference between these two types of items in the reading times for the relative clause, because this is the region where the attachment of the RC will be disambiguated. Ideally, no difference between local plural and local singular items should be observed in the RC reading times.

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What is expected, on the other hand, is increased reading times in the first frame, which contains the complex NP, with items with the local plural configuration ((20a) and (21b)), compared to items with local singulars ((20b) and (21a)), since we know that there is a processing cost associated with this number sequence (see especially the perception studies of Nicol et al., 1997; Pearlmutter, submitted; Pearlmutter et al., in press). This disadvantage with the local plural versions of the sentences should not, however, interact with the factor of attachment site.

4.6 Summary

The preceding discussion has outlined in detail certain critical features of the materials that will be used in the experiments reported in the following two experimental chapters. The materials have been designed so that they fit the structural description required for the study, and at the same time fulfill some additional non-structural requirements, such as plausibility and naturalness, which were discussed and evaluated above. Finally, the two manipulations, RC length and number, were addressed separately to discuss characteristics of each that might have implications for how the results should be analyzed and interpreted.

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CHAPTER 5

MONOLINGUAL EXPERIMENTAL DATA ON RELATIVE CLAUSE ATTACHMENT PREFERENCES

5.1 Introduction

This chapter describes the design, implementation, and results of the diagnostic and experimental tasks that will provide the baseline monolingual data against which the bilingual data presented in Chapter 6 are to be interpreted. In the next section (§5.2), the language history questionnaires used in each of the experiments are described, discussing in particular how the criteria for subject selection were determined. In the section that follows (§5.3), experimental data on the relative clause ambiguity are presented, analyzed and discussed for each of the populations studied, Spanish and English monolinguals.

5.2 Language Histories of the Monolingual Samples

Standard psycholinguistic studies generally do not filter subjects from their samples based on their linguistic background, a clear contrast to studies on bilingualism and second language acquisition, where subjects' language histories are carefully considered. It is quite common for such studies of speakers of more than one language to report independent measures of subjects' proficiency in one or all of their languages. On the other hand, studies of presumably

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monolingual subjects generally assume homogeneity in monolingual populations and typically do not ask subjects to provide information on their linguistic background.

Given that the main thrust of the present research is to develop a clearer understanding of the differences between monolingual and bilingual populations, great care was taken in determining the monolinguality or bilinguality of the participants. It was with this purpose in mind that *all* subjects participating in the experiments reported in this chapter and in Chapter 6 completed language history questionnaires which provided detailed information on their linguistic backgrounds.[99]

The questionnaires given to participants who claimed to speak only one language (English or Spanish) or two (English and Spanish) were not identical, though the questions shared by the two types of questionnaire were presented in the same general format. Speakers of two languages provided far more detailed information on their language histories than did speakers of one language. (The monolingual language history questionnaires are provided in Appendix C-1. The bilingual language history questionnaires, discussed in Chapter 6, are provided in Appendix C-2.)

The monolingual questionnaires were generated in two versions: one in English (USENG), administered to American English speakers at a public university in New York City, and one in Spanish (CSPA), administered to Castillian Spanish speakers at a public university in Madrid. The two

[99] As discussed below, the same questionnaires also provided general information on the subjects and their backgrounds.

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monolingual language history questionnaires differed in their references to specific parts of the world (e.g., United States, Spain), and in terms of language-specific connotations (e.g., *high school*, *instituto*). The American subjects were asked in general whether they spoke any languages other than English. The Spaniards, however, since they were more likely to have been exposed to English as well as to an additional foreign language, were asked specifically if they spoke English and if they were familiar with any additional languages.

Through these questionnaires subjects also provided information about their age, sex, place of origin, profession and handedness. Subjects reported on the languages spoken by their parents and on the languages they themselves speak, as well as on how well they speak these languages, on whether they have spent any significant amount of time living in a region where their native language is not the majority language, and on whether they have been schooled in a language other than their native language. The monolingual questionnaires also included three brief questions designed to probe subjects' preference for visual versus auditory encoding of information (Ehrlich, Fernández, Fodor, Stenshoel & Vinereanu, 1999; Fodor, 2000), which would be indicative of subjects' sensitivity to the prominence of specifically acoustic working memory representations.[100] A summary of all subjects' background information is provided in Table 5-1. Data reported are only for those subjects for whom performance profiles were accepted in the analyses in the off-line and on-line

[100] A person who prefers to encode information auditorily is presumably more sensitive to acoustic representations in the working memory store, and thereby might be more likely to be sensitive to (implicit or explicit) prosodic features of the stimulus (Ehrlich et al., 1999).

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studies (for each language history group, N=24 and N=40, respectively), and excluded are subjects who were rejected on the basis of language history or performance on the fillers.

Table 5-1: General Demographics, Language History and Encoding Preferences for USENG and CSPA Monolinguals

General Demographics	***USENG (N = 64)***		***CSPA (N = 64)***	
Mean Age (Years)	23.3		19.6	
	N	**%**	**N**	**%**
Full-Time Students	35	54.7	60	93.8
Sex Ratio, F	43	67.2	58	90.6
Handedness Ratio, R	53	82.8	60	93.8
Language History				
Monolingual Mother	42	65.6	59	92.2
Monolingual Father	42	65.6	56	87.5
Never Lived in Non-L1 Environment	55	85.9	59	92.2
Born in L1 Environment	57	89.1	61	95.3
Elementary Education	64	100.0	63	98.4
Secondary Education	64	100.0	64	100.0
College, University	63	98.4	64	100.0
Graduate School	—	0.0	3	4.7
Other (Vocational School, etc.)	4	6.3	5	7.8
Encoding Preferences				
Inner Voice (Self)	39	60.9	49	76.6
Inner Voice (Others)	32	50.0	40	62.5
Preference for Words over Images	15	23.4	4	6.3

The upper panel (General Demographics) in Table 5-1 shows that the subjects from the two different populations differ slightly, though in probably unimportant ways. The New Yorkers are a little older than the Madrilènes. Probably as a consequence, almost all of the Madrilènes, but only slightly over

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half of the New Yorkers, are full-time students (those who are not, work either part- or full-time to support their studies). These differences largely arise from differences in the enrollment of students at the two different universities and/or from differences in government policies on the funding of higher education in the two countries. It is also the case that the Spanish-speaking sample contains a far higher proportion of females to males than the English-speaking sample, and the English-speaking group has almost three times as many left-handed individuals as does the Spanish-speaking group (though a clear minority in both cases).

Answers to the questions on mental encoding preferences are distributed similarly in the two groups (lower panel, Table 5-1). In both groups, more individuals affirm that they sometimes hear an inner voice when reading silently than that they sometimes hear the voice of their correspondents when reading letters. Additionally, relatively few individuals claim they would memorize words rather than form visual images in order to remember a list of random objects.[101]

The primary requirement for participation in the study was monolinguality, a characteristic which was defined based on a number of specific language history criteria (center panel, Table 5-1). Monolinguals had to be native speakers of American English or Castillian Spanish. In the ideal, they would have lived in a place where their native language was the majority language, and have been

[101] Answers to this final question are possibly not an accurate indicator of encoding preferences. The question was phrased misleadingly, as it asked subjects to distinguish between visualizing objects and visualizing the words for the objects. (A less misleading phrasing might have been to ask subjects to choose between visualizing the objects and memorizing the words for the objects.)

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schooled primarily in their native language, though they may have taken classes in a foreign language. Most subjects included in the analysis have monolingual parents,[102] were born and have always lived in a place where their native language is the majority language, and were educated predominantly in their native language.

Table 5-2: Monolingual Subjects' L2s

USENG (N = 64)

Language	*N*	*%*	*Language*	*N*	*%*	*Language*	*N*	*%*
Spanish	24	37.5	Italian	2	3.1	Japanese	1	1.6
Hebrew	7	10.9	Mandarin	2	3.1	Korean	1	1.6
French	6	9.4	Yiddish	2	3.1	Malayam	1	1.6
Punjabi	3	4.7	Croatian	1	1.6	Portuguese	1	1.6
Urdu	3	4.7	German	1	1.6	Thai	1	1.6
Arabic	2	3.1	Hindi	1	1.6			

CSPA (N = 64)

Language	*N*	*%*	*Language*	*N*	*%*	*Language*	*N*	*%*
English	62	96.9	German	1	1.6	Valenciano	1	1.6
French	15	23.4	Polish	1	1.6			

Those who indicated that they speak other languages (see Table 5-2) also reported they are for the most part not fluent speakers of these languages (see Table 5-3). For the English speakers, the most common foreign languages were Spanish (spoken, not fluently, by a little over one-third of the subjects), followed

[102] The Madrilènes were very unlikely to have parents who speak a language other than Spanish. About one-third of the New Yorkers, on the other hand, reported that their parents speak languages other than English, which suggests that they are second or third generation descendants of immigrants. This datum reflects the make-up of New York City, which contrasts with the population in Madrid, a city where immigration from areas where Spanish is not the dominant language is not at all common, at least in the generations spanned by the students tested and their families (parents and grandparents).

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by Hebrew and French. For the Castillian Spanish speakers the most common foreign language was English (spoken, not fluently, by almost all of the subjects); roughly one-quarter of the Castillian subjects reported they were familiar with French.

Table 5-3: Monolingual Subjects' Fluency in L2s[103]

	USENG (N=64)		*CSPA (N=64)*	
Spanish (USENG), English (CSPA)	*N*	*%*	*N*	*%*
None	40	62.5	2	3.1
Beginner	24	37.5	43	67.2
Advanced	0	0.0	19	29.7
Fluent	0	0.0	0	0.0
L2s Other than Spanish (USENG), English (CSPA)	*N*	*%*	*N*	*%*
None	36	56.3	46	71.9
Beginner	17	26.6	15	23.4
Advanced	4	6.3	3	4.7
Fluent	7	10.9	0	0.0

[103] The figures in the table represent the number of subjects who answered regarding their fluency as follows. *None* indicates subjects who reported no experience with an L2. Subjects listed in the *Beginner* category claimed they had some limited experience with an L2. Subjects in the next category, *Advanced*, noted they had considerable experience with an L2, and possibly had also studied it formally, and therefore were able to read and write it to some extent. Finally, subjects who claimed they were close to native-like in an L2 are listed in the last category, *Fluent*. This last category distinguishes the two groups considerably. None of the Madrilènes claimed to be native-like speakers of any language other than Spanish, while about 10% of the New Yorkers claimed to be native-like speakers of languages other than English. (These languages were Croatian, Hebrew, Hindi, Korean, Mandarin, Punjabi and Urdu. Croatian is a language for which a high attachment preference has been found; Lovrić & Fodor, 2000. No published data on RC attachment preferences exist to date on speakers of the other languages.) This fact is again related to the differing immigrant profiles of the two cities (see fn. 102, above). However, none of the seven native-like speakers of languages other than English were ever schooled in those languages, and when asked by the experimenter about their literacy in their other language, all reported they were either poor readers of or illiterate in their other language.

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Overall, the two populations are comparable with respect to the details we take to be important in their backgrounds. In particular, their levels of monolinguality are roughly equivalent, as are limits to their proficiencies as L2 speakers of each other's L1. While the New York group is more mixed than the very homogeneous Madrid group, reflecting the different demographics of the two cities (particularly regarding immigration patterns), this is not of itself problematic for the purposes of this study. What is more crucial is that none of the subjects was fluent in both of the languages being contrasted in the experiments (or in languages so similar to them as to create some danger of contamination in the experiment, e.g., Italian for the USENG group).

5.3 Monolingual Experimental Data on the Relative Clause Attachment Ambiguity

5.3.1 Experiment 1: Off-Line Questionnaire, Monolinguals

The off-line questionnaire was designed to test subjects' preferences in RC attachment, under the assumption that subjects' off-line choices when faced with ambiguous sentences are representative of their attachment preferences, although these preferences may be influenced post-syntactically by, among other things, prosodic, pragmatic/semantic and discourse processing. Additionally, a subject in providing an unspeeded response always has the opportunity to re-read a sentence and revise an answer to the accompanying question, invoking considerations well beyond the normal operation of sentence processing routines. With this in mind, several features of the off-line instrument were

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devised to minimize such behavior, and the data analysis additionally paid attention to overt revision of responses. First, subjects were instructed very carefully about how they should answer questions, quickly but accurately (see below, *Procedure*). Second, the task itself was not presented as a test about ambiguity (unlike many questionnaires studying the RC attachment ambiguity, e.g., Cuetos & Mitchell, 1988), but instead as a test of reading comprehension. Thus, subjects were never told (and possibly were never aware) that any sentences in the questionnaire were ambiguous and that both answers were possible. Finally, answers that had been altered ostensibly by the subjects were excluded in the final analysis.

Method

Materials. The materials used in this experiment are described in greater detail in Chapter 4 (particularly in §4.2). The testing instrument is described below, along with a summary of critical aspects of the materials. The materials, in English and Spanish, are provided in Appendix A.

Each of two versions of the off-line questionnaire consisted of 80 sentence-and-question items (8 practice items, 48 unambiguous fillers, and 24 ambiguous targets), arranged on a single line with the question immediately below the sentence. Briefly, the ambiguous target items (see Appendix A-1) manipulated length in a within-items design (short, as in (1a) and (2a), and long, as in (1b) and (2b)), and number in a between-items design (singular, as in (1a) and (1b), and plural, as in (2a) and (2b)):

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1. a. ...the nephew of the teacher that was divorced.
   b. ...the nephew of the teacher that was in the communist party.

2. a. ...the daughters of the hostages that were waiting.
   b. ...the daughters of the hostages that were about to exit the airplane.

Practice and filler item sentences were followed by questions about some aspect of the meaning of the sentence (see (3)), while the targets were followed by questions about the attachment of the RC (see (4)):

3. Boris detested the jazz music that his girlfriend always played while she prepared dinner.
   Who played jazz music while making dinner? Boris Boris' girlfriend

4. Andrew had dinner yesterday with the nephew of the teacher that was divorced.
   Who was divorced? the nephew the teacher

The materials were arranged in a fixed pseudo-randomization and presented in two separate versions of the questionnaire such that no subject would see more than one of the two versions of each experimental item. For fillers, questions were constructed so that the choice on the left always preceded, inside the sentence itself, the choice on the right, as in the example in (3); at the same time, the number of correct answers on the right was equal to that of answers on the left. For experimental items, choices were also presented in the order of their occurrence in the sentence (N1 always on the left, N2 on the right).

As discussed in Chapter 4 (§4.2), the fillers each of the two versions of the questionnaire were different, to minimize repetition effects when the bilinguals were tested in their two languages (see Chapter 6 for more details and discussion). Appendix A-2 lists all filler items and their corresponding questions.

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Procedure. Subjects first completed the language history questionnaire (Appendix C-1), and were then administered the off-line test. The first page of the test packet they received was a sheet of instructions (see Appendix D-1) which provided two example items and two practice items about which the subjects were encouraged to query the experimenter, if necessary, as well as guidelines on how to complete the questionnaire (read at a natural pace, do not change answers, do the test without interruptions, and so forth). The subjects were tested in a quiet room where other subjects were occasionally participating in the same or other experiments. Ballpoint pens with indelible ink were made available, though not all subjects used the writing utensils provided. The experimenter remained in the room for the 20 to 30 minutes it took subjects to complete the questionnaires, but did not overtly observe subjects.

Subjects. The Castillian Spanish (CSPA) data reported are from 24 subjects (12 in each of the versions of the questionnaire) who received credit in a psychology course for their participation. The subjects were all first year students at the Universidad Complutense de Madrid (Somosaguas Campus), and their mean age was 19.8 years. Of the 33 subjects who participated in the study, those selected had language backgrounds meeting the criteria for monolinguality (see above, §5.2), and incurred fewer than 5% errors in responses to filler items (mean error rate, 2.7%). Four participants were excluded based on their self-reported language histories, and five on the filler-accuracy criterion.

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The US English (USENG) data reported are from 24 subjects who received $5 or credit in a psychology course for their participation. The mean age of subjects was 23.1 years and all were undergraduate students at Queens College in the City University of New York. Of the 68 subjects who participated in the study, 24 were selected whose linguistic background best met the criteria for monolinguality (see above, §5.2), and who incurred fewer than 5% errors in responses to filler items (mean error rate, 1.7%). Nine participants were excluded because they were native speakers of varieties of English other than American English, as were 32 participants who did not meet the criteria for monolinguality, and 3 participants whose error rates on fillers exceeded 5%.

Data Treatment. Responses to target items were coded in terms of the attachment site (high or low) implied by the choice of noun; responses which had self-evidently been altered were excluded and treated as missing data. These, along with any items left blank, constituted 2.6% of the total Spanish data set, 4.2% of the total English data set. The response-coding supported subject- and item-based calculations of summary values which were cast in terms of the proportion of responses indicating *low attachment*, for each of the cells of a design factorially combining RC Length (short versus long) and Complex NP Number (N1 and N2 singular versus plural). The analyses also included as an independent variable the factor Language of the Materials (English versus Spanish). An additional dummy factor, Design Groups (subject groups in the subject-based analysis, item groups in the item-based analysis) takes into

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account the assignment of subjects and items to the two versions of the questionnaire over which materials were counterbalanced. This factor is included in the analyses of variance design to extract irrelevant variance, but is not reported in what follows. All analyses of variance reported for Experiment 1 are provided in Appendix E-3.

Results

Summary data for Castillian Spanish and US English speakers in the off-line questionnaire are presented in Figure 5-1 (singular materials) and Figure 5-2 (plural materials). In these two figures and in the remaining figures in this section, the scale in the vertical axis is reversed, to make the figures "read" more intuitively: high attachment is above the 50% horizontal gridline, low attachment is below the 50% horizontal gridline.[104]

The analysis of the results indicates that two separate phenomena need explanation, one relating to the effect of length, the other to the effect of complex NP number. We will consider each in turn. In the omnibus analysis of variance, length and number did not interact, F_1, $F_2 < 1$, and did not engage in the higher order interaction with language of the materials, $F_1(1,44) = 2.09$, $p > .15$, $F_2(1,10) = 1.18$, $p > .30$, hence it is possible to consider these aspects of the data pattern independently.

[104] We prefer a casting of the data in terms of low attachment, because the phenomenon of high attachment is understood here as being a departure from the parser's general preference, all other things being equal, for local (low) attachments.

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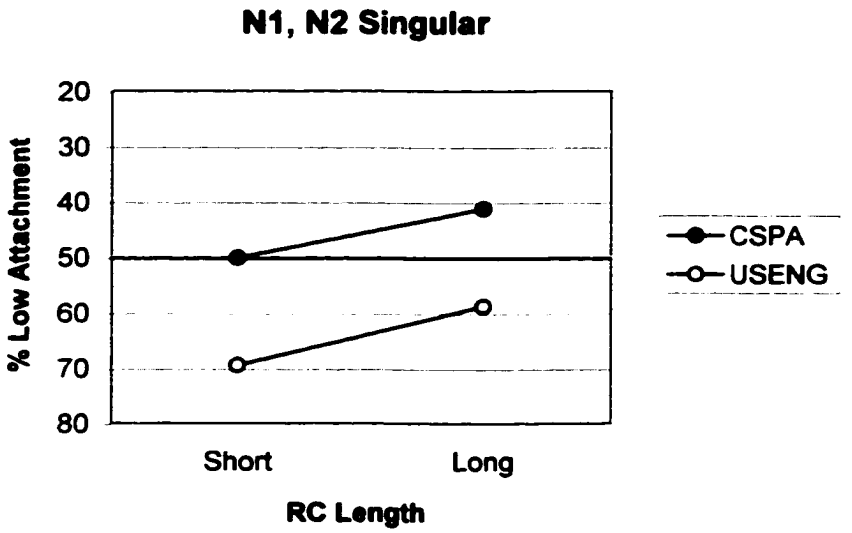

Figure 5-1: Mean percentage low attachment as a function of RC length, for two language groups. (Materials are sentences containing two singular nouns in the complex NP.)

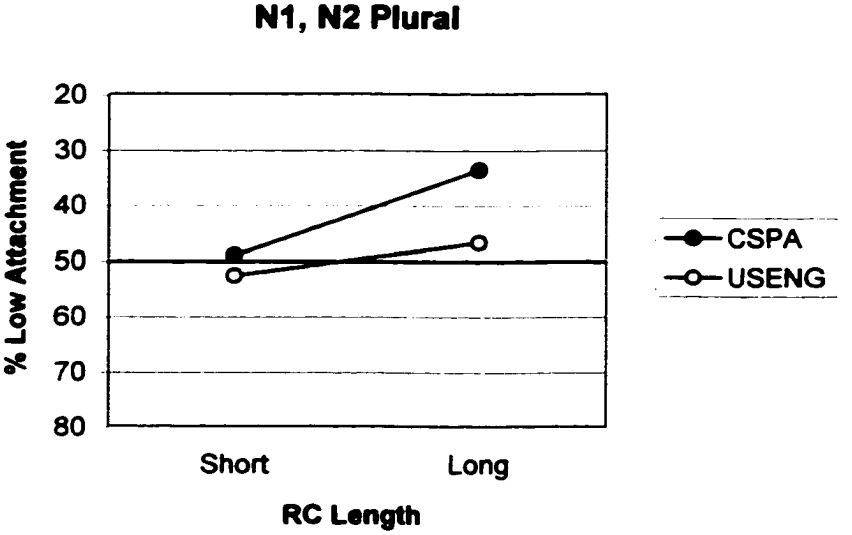

Figure 5-2: Mean percentage low attachment as a function of RC length, for two language groups. (Materials are sentences containing two plural nouns in the complex NP.)

Consider first the effect of the RC length manipulation, evident in both figures above: the slope rises in both charts. As predicted by Fodor (1998), the longer the relative, the less likely it is to be interpreted as a modifier of N2,

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because of the greater likelihood that it is an independent prosodic unit. There was an overall low attachment preference of 55.2% with short relatives, and of 45.4% with long relatives; this length difference was significant in the subject-based analysis, $F_1(1,44) = 15.64$, $p < .001$, but fell short of significance in the item-based analysis, $F_2(1,10) = 2.63$, $p > .10$.[105]

The data from the off-line questionnaire also replicate another standard finding: English speakers have a stronger preference to attach low (56.7% mean attachment to N2) than do Spanish speakers (43.3% mean attachment to N2). The main effect of language was significant, $F_1(1,44) = 5.48$, $p < .025$; $F_2(1,10) = 56.05$, $p < .001$, and did not interact with length, F_1, $F_2 < 1$. However, there are two unsettling facts related to this apparently strong difference. The first is related to the length effect.

As we have discussed in Chapter 2, the anti-gravity behavior of long relatives is not directly linked to their length. According to Fodor's prosody account, described in §2.2.4, the length of an attaching constituent controls how the input can be "chunked" or segmented prosodically. If a constituent is longer, it is more likely to be an independent prosodic unit, and therefore, may be freer to attach to N1.

From the quantitative description of the length of the materials in English and Spanish in Chapter 4 (§4.4), we know that the Spanish RCs were

[105] The lack of significance of the main effect of length in the items-based analysis could be related to the fact that the different length conditions had different content in the RC. The long and the short versions of each sentence were identical up until the verb in the RC, and because of this, RC Length was taken to be a repeated measure. However, it is possible that the different RC content introduced contrasts (not controlled for) in addition to the length contrast, resulting in a weakened effect of length.

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consistently longer than the English RCs, by one prosodic word. To illustrate the impact of that difference implicit in the language of the materials, the right panel of Figure 5-3 re-plots the data, against length in PWds (for mean PWd values, see Chapter 4, §4.4). This is to be compared with a categorical interpretation of the length manipulation, depicted in the two figures above, and in the left panel of Figure 5-3. In the figure below, the data are collapsed over number.

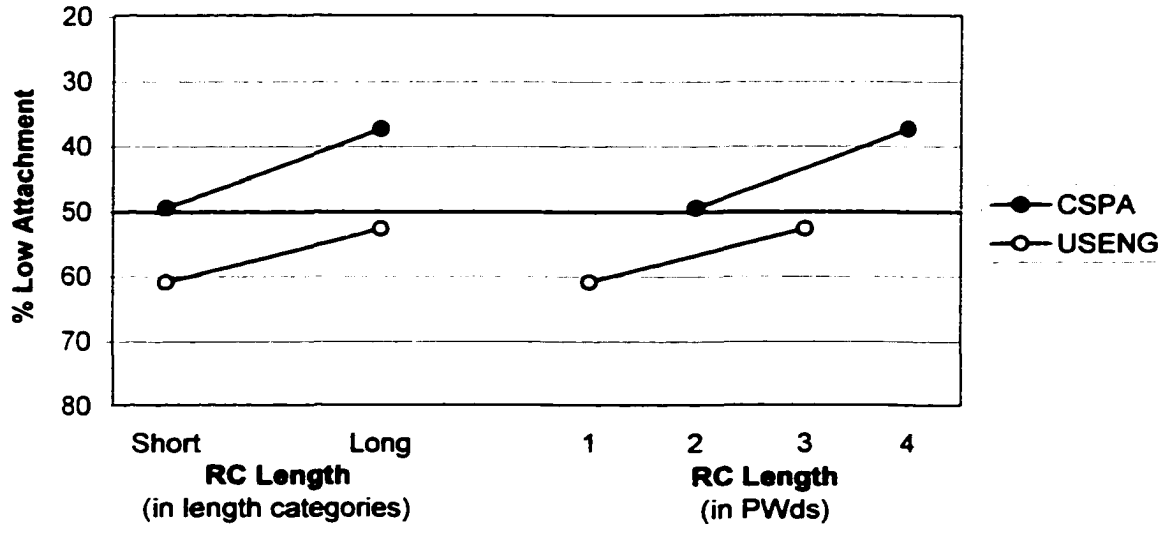

Figure 5-3: Mean percentage low attachment, as a function of language group and RC length. Length is plotted categorically (Short/Long) in the left panel, and parametrically (by PWds) in the right panel. The data are averaged over complex NP number.

The plots in Figure 5-3 indicate that when the length difference between English and Spanish is taken into account, the cross-linguistic differences are more modest than when the length variable is considered categorically. The

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length effect is still evident (the slope rises in both charts), but the cross-linguistic differences are less striking in the panel on the right.

A second effect found in the overall analysis warrants discussion, a cross-linguistic difference that was, in fact, not at all expected. The materials included items in which N1 and N2 (and, consequently, the verb in the RC) were singular, and items in which N1 and N2 (and the verb in the RC) were plural. The two types of items were included to maintain parallelism between the materials in this experiment and in Experiment 2, as discussed in Chapter 4 (§4.2). Figure 5-4 plots the data by language as a function of number, collapsing over length. In the omnibus analysis, the interaction of language and number was significant in the subject-based data, $F_1(1,44) = 4.74$, $p < .05$, and approached significance in the item-based data, $F_2(1,10) = 4.37$, $p = .063$.

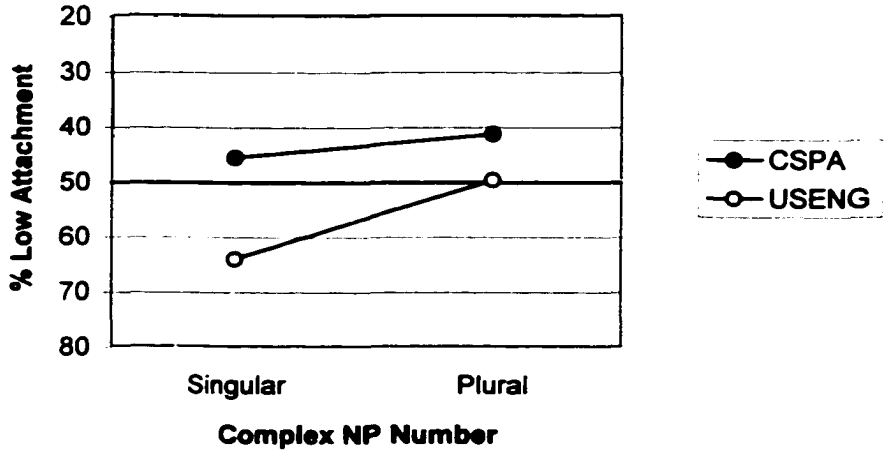

Figure 5-4: Mean percentage low attachment, as a function of language group and complex NP number, collapsing over RC length.

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Independent subanalyses of length and number were carried out for the data in each language separately. In Spanish the main effect of complex NP number was not significant, F_1, $F_2 < 1$; the 45.4% rate of low attachment observed with singular hosts did not differ from the 41.2% observed with plural hosts. In English, however, the number of the complex NP did produce a reliable difference, with low attachment rates of 63.9% and 49.6% for singular and plural hosts, respectively, $F_1(1,22) = 16.54$, $p < .001$, $F_2(1,20) = 5.80$, $p < .05$. That is, in English, the preference to attach low with singular hosts disappears with plural hosts. (As in the omnibus analysis, the interaction of length and complex NP number was not significant in both of the subanalyses; all values of $p > .25$.)

The source (or sources) of this difference between English and Spanish is (are) not possible to explain given the evidence available in this experiment. Future investigation of the effect of number features in RC attachment preferences should be able to identify whether the plural feature shifting the English preferences is the one in N1, the one in N2, or the combination of the two, or perhaps the critical feature is the one specified at the verb. Perhaps there is no reversal in Spanish because the general preference is already for high attachment. However, a more plausible explanation would posit differences between English and Spanish in the way number is processed. These differences might be rooted in the small but possibly critical difference in the way number is marked on the verb in English and in Spanish, discussed in Chapter 2, §2.4.2. Briefly, in Spanish the marked form of the verb is the plural, while in

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English it is arguably the singular. (Evidence supporting such an account in which English number is processed differently will be presented in Chapter 6.)

Discussion

The results of Experiment 1 confirm the existence of cross-linguistic differences in RC attachment preferences between English and Spanish speakers. Specifically, the preferences of Spanish speakers are higher than those of English speakers. However, the results of Experiment 1 also indicate that these differences are modest, particularly when considering implicit length differences in each language.

The results finally yielded a puzzling interaction of language and number, which is difficult to interpret with the available data. However, we speculated on the result that English exhibits sensitivity to number features in the complex NP while Spanish does not. This effect might have to do with a general shift toward high attachment in both languages when the processor is confronted with two plural nouns. However, the result could instead be related to differences in the way number is processed, or to the way number is specified morpho-syntactically, in English and Spanish. Since this experiment was not designed to probe number processing in English and Spanish, the available data are not enough to explain this result (but see Chapter 6, where evidence will be presented supporting an explanation under which English number is processed differently from Spanish number).

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5.3.2 Exploration of the Off-Line Monolingual Data

The results of this experiment suggest that the ultimate preferences of speakers of both Spanish and English depart from low attachment, particularly when the attaching constituent is long. This departure from low attachment is multiply determined, by a number of item-based and subject-based factors. RC length and complex NP number are two such item-based factors. In this section we explore some subject-based factors also affecting ultimate RC attachment preferences, including subjects' self-reported preferences for encoding information. (We shall see in Chapter 6 that language dominance in bilinguals is also a subject-based factor determining attachment preferences.) We will close the discussion of this off-line experiment with another aspect of the off-line data, namely, the alterations subjects made to their answers in the course of completing the questionnaire.

5.3.2.1 Correlational Exploration

In Chapter 2 we discussed that RC attachment preferences are multiply determined by factors internal to both the complex NP and the RC, as well as by factors having to do with the relationship between the RC and its possible hosts. Multiple factors determining preferences might result in item-based variability. The variability over items, however, might be expected to be stable across languages. For example, a given RC might be biased for attachment to, say, N2, because N2 is a more plausible or more frequent or more salient host than N1.

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This bias is likely to transcend the language of the materials (assuming translation equivalence between the materials in the languages being compared).

To examine the stability across English and Spanish of the properties of individual items that determine RC attachment preferences, item-based means in English were correlated with item-based means in Spanish. The result of this correlation, plotted in Figure 5-5, strongly support this discussion. The RCs in certain items were more likely to prefer the higher host (those plotted in the upper right quadrant of Figure 5-5), others the lower host (lower left quadrant), and yet others exhibit no bias for either N1 or N2. Abstracting away from the linguistic expression of item content, there was stability in the item-based data. Statistically, this stability can be expressed as the significant correlation between the item-based means in English and the item-based means in Spanish, $r(46) = 0.738$, $p < .01$.

The correlation does not intersect the *x* and *y* axes precisely at 50%; rather, the intersection is below the horizontal 50% axis and to the right of the vertical 50% axis. This is the result of the language difference found overall in this experiment. The preference in English was for low attachment (depicted here as the area below the horizontal axis), while the preference in Spanish was for high attachment (here, to the right of the vertical axis).

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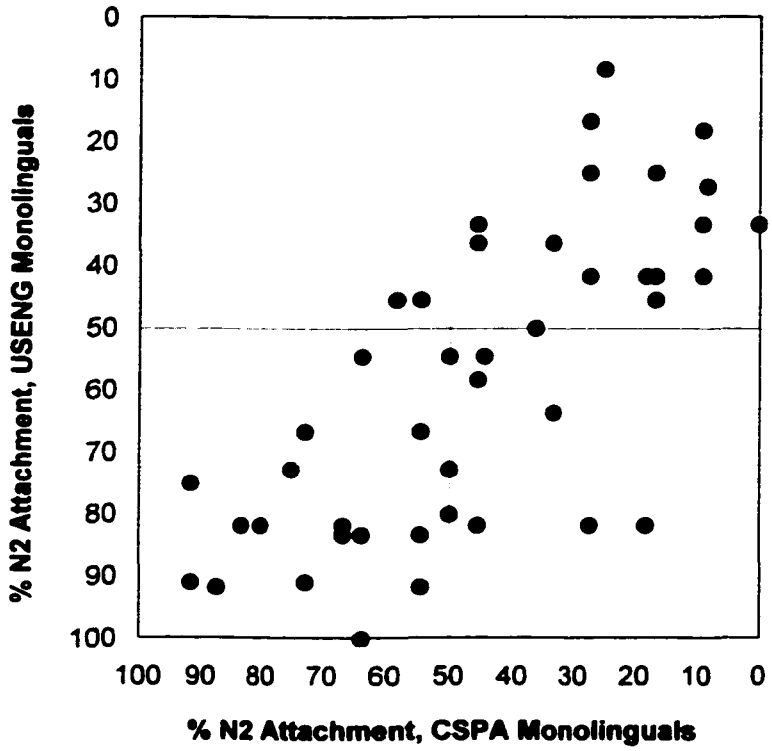

Figure 5-5: Item-based means for Spanish materials against item-based means for English materials. The means are expressed as % attachment preference to N2.

As also noted above, and as discussed to some extent in Chapter 3, attachment preferences might be additionally modulated by characteristics of the participants. Given that the data in this chapter come from monolingual subjects, with very similar backgrounds (they are all students, they are all fluent in their mother tongue and do not speak other languages fluently, and so on), it is an uninteresting (and relatively fruitless) exercise to explore subject-based variability.

One aspect of subject-based variability that is worth commenting on, however, is related to the three questions on information encoding preferences that were asked of the subjects. As mentioned above (§5.2), a person with a

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preference to encode information auditorily should be more sensitive to variations in the prosodic characteristics of the input. Increased sensitivity to prosody might translate into a greater likelihood to depart from low attachment when the attaching constituent is heavy (or long).

Table 5-4, below, focuses on the monolingual subjects' responses in the category "Inner Voice (Letters)".[106] For the subjects who answered NO and those who answered YES, the table lists a mean rate of low attachment and a mean difference between the rate of low attachment with short versus long RCs. Individuals who answered YES to this question should have been more likely to exhibit a departure from the low attachment preference (because they place greater emphasis on prosodic considerations in RC attachment in general), and (for the same reason) perhaps also to exhibit a greater sensitivity to the length manipulation (reflected in a greater differential score between the two length conditions).

Table 5-4: Distribution of N2 Attachment Rates and Difference Between Short-RC and Long-RC Rates as a Function of Subjects' Responses to "Inner Voice (Letters)" for USENG and CSPA Monolinguals

	USENG (N=24)		*CSPA (N=24)*	
	"NO"	*"YES"*	*"NO"*	*"YES"*
N	17	7	12	12
% Low Attachment	55.39	51.19	48.26	38.54
Δ Short – Long	+14.71	–2.38	+9.03	+11.81

[106] We focus on this category because it is the one for which the question was most favorably phrased (see fn. 101).

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The figures listed in Table 5-4[107] indicate that this speculation holds for Spanish. The 12 CSPA subjects who answered YES to this question exhibited a marked preference for high attachment and a sizeable sensitivity to the length manipulation. For these 12 subjects, the mean N2 attachment rate of 38.5% was significantly different from 50%, $t_1(11) = 3.62$, $p < .01$, and the +11.8 difference between N2 attachment rates with short and long RCs was marginally different from 0, $t_1(11) = 2.20$, $.05 < p < .10$. In contrast, the 12 CSPA subjects who answered NO showed no preference for either high or low attachment, and little sensitivity to the length manipulation. The 48.3% N2 attachment rate was not significantly different from 50%, $t_1 < 1$, and despite appearances, the +9.0 differential score was only marginally significant, $t_1(11) = 1.82$, $p < .10$.

For the USENG subjects, the results of this inquiry are less informative, partly because of the relatively small number of subjects (N=7) who answered YES. For this group, the overall 51.2% rate of N2 attachment was not significantly different from 50%, $t_1 < 1$, and the differential score of –2.38 was not significantly different from 0, $t_1 < 1$. For the 17 USENG subjects who answered NO, however, while their overall low attachment rate of 55.4% was not significantly different from 50%, $t_1(16) = 1.12$, $p > .20$, their differential score of +14.71 was significantly different from 0, $t_1(16) = 4.78$, $p < .001$.

[107] Because of data excluded from the analyses, the subject-based and item-based means do not match perfectly. The figures reported earlier are based on item-based calculations, while the figures in this table are based on subject-based calculations, hence the slight discrepancy between the means here and those reported above for CSPA and USENG off-line results.

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This exploration links the sensitivity to length, in the Spanish speaker group, to a self-reported preference for encoding information auditorily. This finding is also in line with Fodor's (1998) proposal, by which a greater sensitivity to prosodic aspects of the stimulus could be the result of greater reliance on acoustic representations of stimuli temporarily stored in short-term memory. The finding with the English speakers, however, is less clear.

5.3.2.2 Missing and Altered Responses

As reported above, items which had been left blank or which had been visibly altered by the subjects were treated as errors and were excluded from the analysis. These errors totaled 2.6% of the Spanish monolingual data and 4.2% of the English monolingual data. Of these, 0.0% of the CSPA data and 0.2% of the USENG data were missing data points, and the remaining data excluded from the analyses were altered responses.

Table 5-5 summarizes the distribution of the altered responses into two categories: those in which the response was altered from N2 to N1, and those in which the response was altered from N1 to N2. The proportion of missing responses is negligible and will not be discussed further.

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Table 5-5: Distribution of Altered Responses in the Off-Line Monolingual Data

	N2 to N1		*N1 to N2*		*Total*	
	N	*%*	*N*	*%*	*N*	*%*
USENG	12	2.78	3	1.22		
CSPA	16	2.08	7	0.52		
Mean	14	2.43	5	0.87	19	3.30

Note: The percentages are calculated based on total target responses.

The distribution of altered responses is clearly not random. Alterations from N2 to N1 were far more frequent (2.4%) than the other way around (0.9%), in *both* the English and the Spanish sample. The difference between the two alteration types was found to be significant, $\chi^2(1) = 8.53$, $p < .005$.

This pattern of responses is not unexpected if the RC attachment phenomenon is understood as an initial low attachment preference (driven by a locality strategy such as Late Closure) that eventually shifts to high attachment when post-syntactic strategies have had a chance to come into play. If the alteration of initial responses is related to the process of reanalysis of the initial attachment based on post-syntactic information, these data support such an interpretation. These error data additionally emphasize similarities, rather than differences, in the behavior of speakers of the two languages tested here.

The data for Experiment 1 document the departure from low attachment characteristic of unspeeded judgment tasks. However, while such an interpretation of the findings assumes an initial preference for low attachment, we have not yet provided evidence for it. For this purpose, a second experiment

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was run in parallel to Experiment 1, using self-paced reading methodology. Self-paced reading measures presumably tap earlier processes in sentence processing, and the results for Experiment 2 should be more indicative of subjects' initial attachment decisions.

5.3.3 Experiment 2: On-Line Self-Paced Reading, Monolinguals

The on-line test was designed to determine whether the different effects of length in the off-line results are also evident in the behavior of subjects in a task that may reflect their first-pass parsing preferences more accurately than the off-line questionnaire. In this speeded task, subjects have no time to re-read the sentence (and no opportunity to go back to the beginning); in fact, they are instructed to read as quickly and accurately as possible, and the task is designed to encourage this behavior. If a subject takes too long (over 9000 msec) to read a frame, the next frame is presented. Question reading-and-answering times are also provided for subjects alongside accuracy feedback on the answers, to keep them informed on their reading speed. Additionally, subjects are informed, before they begin the test, of the speed-accuracy trade-off and are asked to slow down only if they feel they are making too many errors.

Subjects' reaction times in reading the disambiguated RCs in this task should reflect difficulties encountered in the earliest phases of processing. On the other hand, difficulties in answering the comprehension questions may reflect difficulties related to post-syntactic processing or to strategies the subjects may develop to answer questions within the task itself.

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Method

Materials. The testing instrument and the materials used in this experiment (including the English and Spanish equivalent examples) are described in detail in Chapter 4 (§4.2). Critical aspects are summarized below. A full list of the materials, in English and Spanish, is provided in Appendix A.

The 24 ambiguous targets used in the off-line study (listed in Appendix A-1) were disambiguated for high or low attachment by changing the number of either the high or the low NP in the complex NP, as shown below (the slash separates the two presentation frames; the underlined nouns have number features compatible with the subject of the RC):

5. a. ...the nephew of the teachers / that was...
   b. ...the nephews of the teacher / that was...

6. a. ...the daughters of the hostage / that were...
   b. ...daughter of the hostages / that were...

Half of the materials were disambiguated by the unambiguously singular verb *was* (*estaba* in Spanish), the other half at the unambiguously plural verb *were* (*estaban*). The two variables, length of RC and site of attachment, were fully crossed in a Latin square design and presented in four different versions of the on-line reading task such that no subject saw more than one version of each sentence. The verb variable was a replication variable and not fully crossed; sentences of both types were included to increase variety in the experimental materials. The target sentences were interleaved with fillers and all sentences were separately pseudorandomized for each subject.

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The questions to all targets used in the off-line questionnaire were converted into YES/NO questions about the attachment of the RC, where the correct answer would always be YES, as shown in the following example.

7. Andrew had dinner yesterday with the nephews of the teacher that was in the communist party.
   Was the teacher in the communist party?

The questions for the fillers used in the off-line test were also converted into YES/NO questions, as in the following example.

8. Boris detested the jazz music that his girlfriend always played while she prepared dinner.
   Did Boris' girlfriend play jazz music often?

In each version of the reading task there was an equal number of YES and NO answers, including answers to both fillers and targets. As already mentioned, the fillers in two of the versions of the experiment were identical, but different from the fillers in the other two versions, which were also identical (for details on the fillers, see Chapter 4, §4.2; a full list of the fillers and their corresponding questions is provided in Appendix A-2).

The target sentence questions were designed to provide an "off-line" judgment on subjects' attachment preferences.[108] In the off-line questionnaire, subjects had two options, each choice representing one of the two possible attachment types. Subjects' answers (either N1 or N2) represented which of the

[108] Similar questions, designed to tap subjects' off-line (post-syntactic) preferences, are used by De Vincenzi & Job (1993, 1995) and Baccino, De Vincenzi & Job (2000) in their studies of RC attachment in Italian and French.

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two readings for the sentence came to them first, or which reading they preferred overall. The YES/NO question in the on-line task taps subjects' preferred attachment in a slightly different and somewhat more indirect way. A YES answer indicates that the subject most likely processed the attachment without difficulty on the first pass. A NO answer, however, reflects two possible, and perhaps not mutually exclusive events. On the one hand, a NO answer could indicate that the subject experienced (perhaps temporarily) processing difficulty because the sentence was incompatible with the preferred attachment. On the other hand, the subject might have read the sentence inadequately, perhaps overlooking the host noun entirely, or (more likely) the number of either the host noun or the RC verb. In either case, the subject may have made the ungrammatical attachment choice due to an attachment preference. That there are multiple sources of NO responses means that two forces potentially work against the subjects, which might result in inflated error rates.

Procedure. The self-paced reading paradigm was designed and presented using version 2.6 of the DMASTR software for mental chronometry (developed at Monash University and the University of Arizona by K.I. Forster and J.C. Forster). The particular implementation of the self-paced reading paradigm used here was similar to that in previous experiments on RC attachment (e.g., Cuetos & Mitchell, 1988; Carreiras & Clifton, 1993). Upon the subject's request (by pressing a foot-switch), the first frame of the sentence appeared, centered on the screen; for the targets, this frame included the first part of the sentence up until

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the end of the complex NP.[109] The subject's second request (by pressing a green button on the response pad with the dominant hand) extinguished the first frame and prompted the second frame, which contained the RC in its entirety. A third request by the subject prompted the YES/NO comprehension question. This procedure is illustrated below, with a sample target item:

Frame 1 (bare matrix)	Andrew had dinner yesterday with the nephews of the teacher
Frame 2 (RC)	that was in the communist party.
Frame 3 (question)	Was the teacher in the communist party?

To answer YES, subjects pressed the green button on the response pad with the index finger or thumb of their dominant hand, and to answer NO, subjects pressed the red button on the response pad with the index finger or thumb of their non-dominant hand. (The response pad is configured in such a way that it can be flipped so that left-handed participants may use their dominant hand for green button presses.)

The fillers were also divided into two frames, followed by a question in a third frame (the segmentation for the fillers is shown in Appendix A-2). No frame exceeded one line on the computer screen. Each frame was presented for no longer than 9000 msec, after which time, if the subject had not responded, the

[109] In developing the procedure for this series of experiments, it was determined that using large segmentation would be the method most comparable to the majority of existing studies on the RC attachment ambiguity. In large segmentation paradigms, the target sentences are presented using two large frames, keeping the entire complex NP in the same frame, rather than using a series of smaller frames and splitting the complex NP between two frames. For discussion of segmentation effects, see Chapter 2, particularly §2.4.1; see also De Vincenzi & Job (1995), Gilboy & Sopena (1996), and Mitchell & Brysbaert (1996).

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frame would extinguish and the next frame would appear (for a given frame, time-out responses were recorded as errors and were not included in the analysis). The 9000 msec time-out was implemented to prompt subjects to read quickly.

Subjects received feedback on their answers to questions. If an answer was correct, the message "CORRECT" was shown in English or "CORRECTO" in Spanish, along with the time (in msec) it took the subject to read and answer the question. If an answer was incorrect, the feedback display was "INCORRECT" in English, "INCORRECTO" in Spanish, and no reaction time was shown. If the subject timed out (took longer than 9000 msec) while reading and answering the question, the feedback display was "TOO LONG" in English, "DEMASIADO LARGO" in Spanish. Including feedback messages after responses to questions provided subjects a means for self-evaluation of both their accuracy and their pace as they were doing the test.

Subjects first filled out a language history questionnaire. They were then asked to study a sheet of instructions about the reading task. The instructions were reviewed orally by the experimenter with each subject, and were repeated at the beginning of the on-screen presentation. It took subjects between 15 and 20 minutes to complete the on-line reading task.

Subjects. The CSPA data reported are from 40 subjects who received credit in a psychology course for their participation. The mean age of subjects was 19.4 and all were first year students at the Universidad Complutense de Madrid,

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Somosaguas Campus. Of the 49 subjects who participated, the 40 whose data are reported here were selected following the same set of criteria for monolinguality as in the off-line study, and the criterion that responses to the fillers were more than 80% accurate.[110] The CSPA group made an average 5.9% errors on questions to filler items.

The USENG data reported are from 40 subjects who received $5 or credit in a psychology course for their participation. The mean age of subjects was 25 and all were undergraduate students at Queens College in the City University of New York. Of the 75 subjects who participated, the 40 whose data are reported here were selected following the same set of criteria for monolinguality as in the off-line study, and the criterion that responses to the fillers were more than 80% accurate.[111] The USENG group made an average 12.1% errors on questions to filler items.[112]

Data Treatment. Among all the data points from the 80 subjects (40 per language), reading times less than 500 msec were rejected as outliers; this trimming procedure affected 0.3% of the data. (Because of the pre-set "time out"

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[110] All nine subjects excluded from the analysis were rejected on the basis of criteria for monolinguality.

[111] Of the USENG participants, 7 were excluded because they were not native speakers of American English, 23 because they did not meet the criteria for monolinguality, and 5 because their accuracy in answering filler questions was below 80%.

[112] The English monolingual subjects who participated in the on-line task stand out as being less accurate than the Spanish monolinguals (12.1% versus 5.9% errors on fillers). While this might be suggestive of a greater degree of literacy for the latter group, we suspect this is not the case. Instead, it is possible that the Spanish monolingual subjects tested were more experienced in psycholinguistic tests similar to the on-line task in this investigation, or the English speakers more naïve. (Recall that no such imbalance was found in responses to filler items in the off-line questionnaire, where the error rate for English monolinguals was 1.7%, compared to 2.7% with the Spanish monolinguals.)

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limit per frame, no responses exceeded 9000 msec.) Additionally, values falling beyond cutoffs established for each subject at mean plus-or-minus two standard deviations were replaced with those cutoff values, in order to limit the extent to which occasional extreme values might distort the mean. This procedure affected 3.7% of the data. Within the analysis of a given frame, incorrect responses were treated as missing data points and were excluded from the analysis.

Subject- and item-based calculations of summary values were cast in terms of reaction times (in msec) for Frame 2, and percent errors for Frame 3, for each of the cells of a design factorially combining Attachment Site (low versus high) and RC Length (short versus long). The analyses also included as an independent variable the factor Language of the Materials (English versus Spanish). An additional dummy factor, Design Groups (subject groups in the subject-based analysis, item groups in the item-based analysis) takes into account the assignment of subjects to four versions of the task over which materials were counterbalanced. This factor was included in the analyses of variance design to extract irrelevant variance, but is not reported in what follows. All analyses of variance reported in the section below are provided in Appendix E-4.

Results and Discussion

The chart in Figure 5-6 plots the mean difference in reaction times between the forced low and forced high conditions, for the English monolingual

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and the Spanish monolingual subjects. The differences were calculated by subtracting mean RTs in the forced high attachment conditions from mean RTs in the forced low attachment conditions, such that a mean difference below zero would indicate a low attachment preference, while a mean difference above zero would indicate a high attachment preference. (This way of plotting the data is intuitively easier to read, since a low attachment preference is represented below zero, and a high attachment preference above zero.)

As evident from inspection of Figure 5-6, the subjects' behavior, in both languages, was strikingly uniform. There was no main effect of language in the analysis, $F_1 < 1$; $F_2(1,20) = 7.62$, $p < .025$, and language did not interact with length, F_1, $F_2 < 1$, or site, F_1, $F_2 < 1$. The three-way interaction (Language of the Materials × RC Length × Attachment Site) was also not significant, F_1, $F_2 < 1$. The preferred site for attaching the RC, in both languages, tended to be N2, the lower site (the mean response time for RCs forced to attach low was 2477 msec, which was significantly different from that for RCs forced to attach high, an average of 2563 msec, $F_1(1,72) = 7.77$, $p < .01$, $F_2(1,20) = 6.15$, $p < .05$.

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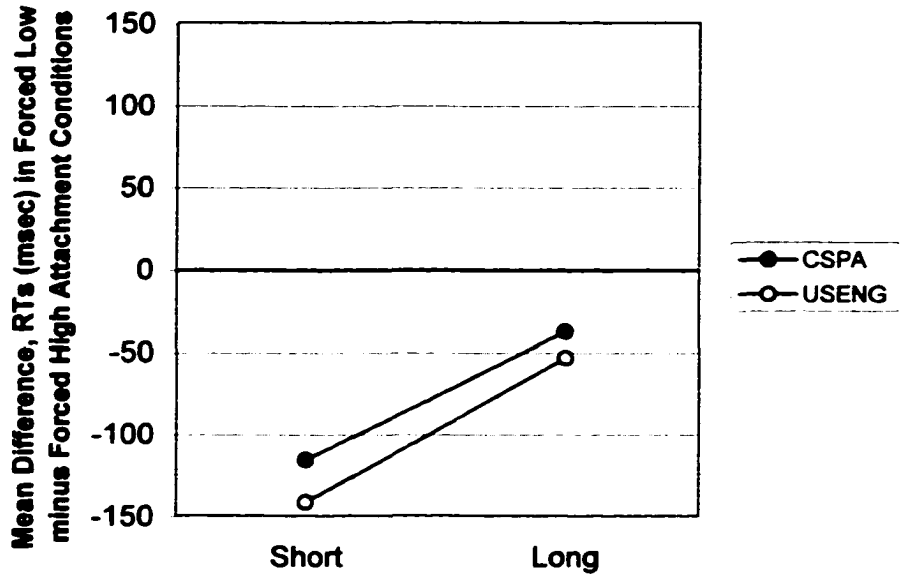

Figure 5-6: Mean difference between RTs (in msec) for Frame 2, in forced low and forced high attachment conditions, as a function of language group and RC length.

The overall low attachment preference was modulated by the length of the attaching RC, as indicated by the rising slope in the chart in Figure 5-6. While the interaction of length and attachment site was not significant, $F_1(1,72) = 1.06$, $p > .25$, $F_2 < 1$, separate independent subanalyses of the long-RC and the short-RC materials were carried out on the data. When the RC was long, the difference between the two attachment site conditions was not significant (2899 msec for forced low, compared to 2945 msec for forced high; $F_1 < 1$, $F_2(1,20) = 2.56$, $p > .10$). In contrast, when the RC was short the effect of attachment site was reliable, 2055 msec for forced low, compared to 2182 msec for forced high, an average difference of 127 msec, $F_1(1,72) = 8.18$, $p < .01$, $F_2(1,20) = 5.60$, $p < .05$.

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The omnibus analysis of variance indicated that there was a highly significant, but uninteresting main effect of length, $F_1(1,72) = 357.42$, $p < .001$, $F_2(1,20) = 76.15$, $p < .001$. The average reading time for long RCs was 2922 msec, compared to 2118 msec for short RCs, a fact which reflects the effectiveness of the length manipulation.

The data indicate, overall, that the early decisions on the attachment of the RC made by English and Spanish speakers are quite parallel, a result different from the off-line finding in Experiment 1 reported above, that Spanish and English speakers have different preferences.

For Spanish in particular, this overall picture is rather different from the one painted by earlier self-paced reading studies in both Spanish (Cuetos & Mitchell, 1988; Carreiras & Clifton, 1993) and other languages, such as French (Zagar, Pynte & Rativeau, 1997) and Dutch (Brysbaert & Mitchell, 1996). This study fails to replicate the strong high attachment bias for Spanish and other languages found by Brysbaert & Mitchell (1996), Carreiras & Clifton (1993), Cuetos & Mitchell (1988), and Zagar et al. (1997). However, the finding of low attachment is in line with the experimental evidence on RC attachment preferences in Italian and French provided by De Vincenzi and colleagues (De Vincenzi & Job, 1993, 1995; Baccino, De Vincenzi & Job, 2000).

Methodologically, this study is closer in design to the Spanish studies by Cuetos & Mitchell (1988) and Carreiras & Clifton (1993)—the presentation frames are large—but the method of disambiguation (morphosyntactic, rather than semantic/pragmatic) is arguably closer to that used in the Italian and French

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studies by De Vincenzi and colleagues (De Vincenzi & Job, 1993, 1995; Baccino et al., 2000). Subjects also answered questions after every sentence (unlike subjects in Cuetos & Mitchell's studies, like subjects in De Vincenzi and colleagues' studies). Finally, there was no preposition other than *of/de* (unlike in the studies by De Vincenzi and colleagues).

A possible problem with the results has to do with the inclusion of short as well as long sentences in each of the versions. It is possible that the subjects were biased for low attachment in the long condition because of the short items presented side-by-side.[113] This problem is similar to the one Pynte & Frenck-Mestre (1996) have brought up regarding the Italian data by De Vincenzi & Job (1993, 1995); see discussion in §2.2.1, Chapter 2. If inclusion of a short condition within a given version actually biases subjects for low attachment, this effect might have also been obtained in the Spanish off-line data in Experiment 1, but no such effect was present there. We cannot entirely discard this problem, but we leave it to future investigation to establish empirically the possibility of such an effect in on-line self-paced reading tasks such as this one.

We now turn to the analyses of error rates in the third frame, where the question was presented and answered. In studies that have collected data of this type, the assumption has been that asking such a post-on-line-reading question is another way of examining the influence of later processing. As such this task should resemble the attachment preferences found in standard off-line questionnaires. To the contrary, we have speculated (see pp. 200-ff.) that the

[113] We thank Don Mitchell for suggesting this possible interpretation.

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subjects' behavior in this part of the task may not be affected exclusively by (early or late) strategies responsible for ultimate RC attachment choices in questionnaires, but may be influenced by other strategies developed by the subjects to deal with the task at hand.

The reading times for this third frame are unreliable, because almost a quarter of the data (24.9%) are missing due to question-answering errors (subjects were notably inaccurate in answering these questions, compared to the overall error rate of 9.0% with the fillers). Additionally, the high/low contrast in Frame 3 reading times is confounded with a difference in the topic of the question, which also introduces noise in the reaction time data. For example, for forced high attachments, the question was about N1, while for forced low attachments the question was about N2. For these reasons, reaction time data for Frame 3 will be omitted from the discussion below, which focuses on the error rates in the question-answering task.

The chart in Figure 5-7 plots the difference between errors made in the forced low attachment conditions and the forced high attachment conditions. As in Figure 5-6, above, the mean differences were calculated by subtracting mean errors in the forced high attachment conditions from mean errors in the forced low attachment conditions, such that a mean difference above zero represents less errors with forced high attachments, and a mean difference below zero represents less errors with forced low attachments.

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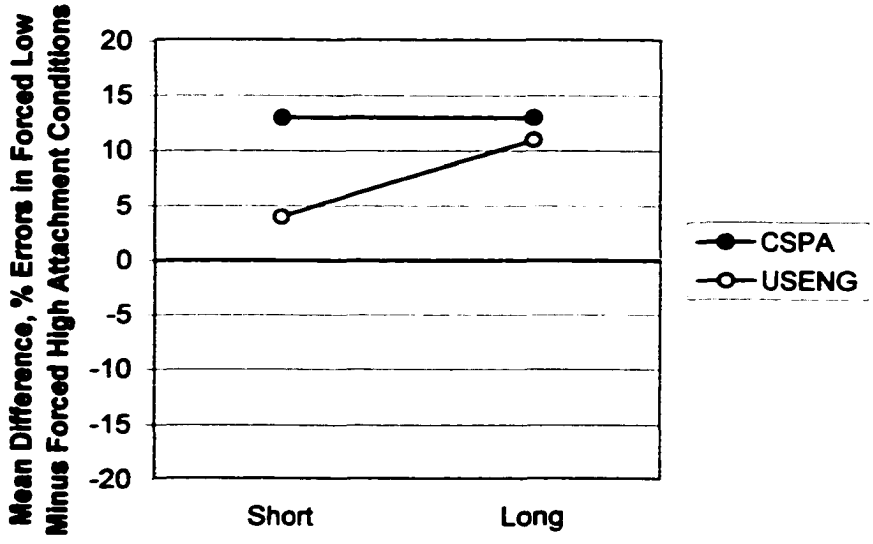

Figure 5-7: Mean difference between % errors at Frame 3, in the forced low and the forced high attachment conditions, as a function of language group and RC length.

The question answering error data reveal a different picture altogether from the one in the reaction time data for Frame 2. Rather than a preference for low attachments, the preference is now for questions about RCs that were forced to attach high (overall, the error rate in the forced low attachment condition was 33%, compared to 23% in the forced high attachment condition, $F_1(1,72) = 20.90$, $p < .001$, $F_2(1,20) = 6.38$, $p < .05$). Striking again is the lack of systematic differences in the behavior of English and Spanish speakers (despite appearances in Figure 5-7, the interaction of language and site is not significant, $F_1(1,72) = 1.42$, $p > .20$, $F_2(1,20) = 1.22$, $p > .25$).

There is a problem with interpreting these error rates as reflecting the effects of post-syntactic processing affecting ultimate RC attachment choices. In particular, it is difficult to establish why a sentence in which the RC was forced low, to the site which was the immediate choice of the parser in the earlier

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phases of processing, should cause difficulty at later phases. This interpretation implies that the parser's early choice is reanalyzed based on post-syntactic principles (e.g., pragmatic principles such as Relativized Relevance), to an attachment site which is ungrammatical, even though a grammatical alternative is present (the forced low attachment). Under familiar assumptions, pragmatic principles should only apply given a situation where everything else is equal, including that all possible interpretations are grammatical (see discussion of Relativized Relevance in Chapter 2, §2.2.2).

We propose instead that this behavior corresponds to difficulties the subjects encounter when a comprehension question is not about something central to the meaning of the sentence. N1 is the object of the matrix verb, and is thereby a more salient element in the sentence (at least more salient than N2, which is a noun embedded inside N1).

In the analysis of Frame 3 error rates, the main effect of length was not significant, F_1, $F_2 < 1$, while the main effect of language was indeed significant, $F_1(1,72) = 6.55$, $p < .025$, $F_2(1,20) = 7.55$, $p < .025$. However, these main effects may be misleading, because the interaction (RC Length × Language of the Materials) was significant, $F_1(1,72) = 14.97$, $p < .001$, $F_2(1,20) = 18.38$, $p < .001$. This interaction is clearly appreciable in Figure 5-8, where the data are re-plotted collapsing over attachment site.

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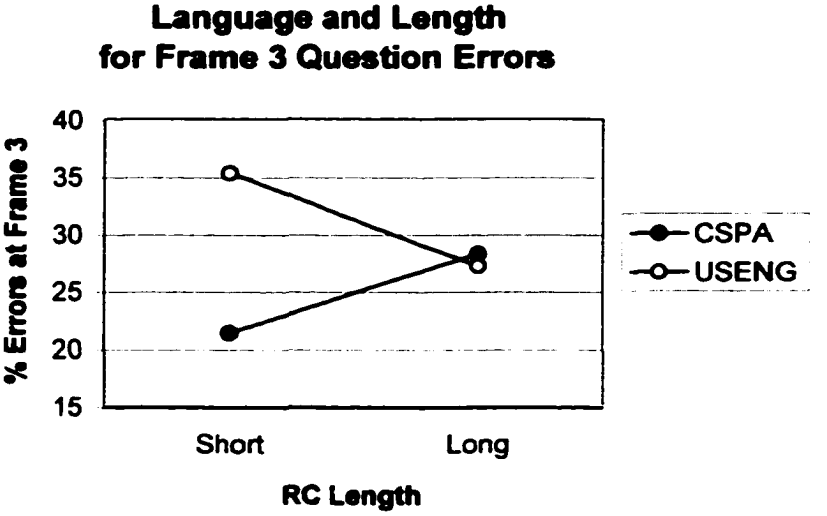

Figure 5-8: Mean percentage errors in answering target item questions at Frame 3, for two language groups, as a function of RC length. The data are averaged over attachment site.

To explore this interaction, subanalyses by language group were carried out on the subject- and item-based results. In English, the main effect of length, with short-RC questions incurring an average 8.1% more errors than long-RC questions, was significant in the subanalysis, $F_1(1,36) = 13.39$, $p < .001$, $F_2(1,20) = 13.27$, $p < .005$, and critically, this effect did not interact with site, $F_1(1,36) = 2.91$, $p < .10$, $F_2(1,20) = 1.27$, $p > .25$. In Spanish, on the other hand, short-RC questions had an average error rate 6.7% lower than long-RC questions; this difference was significant in the subject-based analysis and marginal in the item-based analysis, $F_1(1,36) = 4.68$, $p < .05$, $F_2(1,20) = 2.95$, $p < .10$. (In the subanalysis with Spanish results only, the interaction of length and site was not significant, F_1, $F_2 < 1$.)

One important aspect of the interaction of length and language, depicted in Figure 5-8, in the errors incurred at Frame 3 is the fact that it does not involve

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site (recall that, from the omnibus analysis, the related three-way interaction was not significant, $F_1(1,72) = 1.17$, $p > .25$, $F_2 < 1$). The length effects observed in this question-answering task, then, are purely linked to the difficulty associated with very short materials, and the language difference is merely associated with the intrinsic length difference across the two languages. The English short RCs were extremely short (1 PWd), which may have led the English speakers to read them very quickly, thus trading off accuracy for speed. (The subanalysis of the English data described above indicated that English speakers made far more errors with short than with long RCs.) The Spanish short RCs were slightly longer (1 PWd), and in fact, Spanish speakers made more errors (though only with marginal significance in the analysis) with questions about the attachment of long RCs. It is possible that this trend in the Spanish data has to do with the increase in task difficulty when the RC is much longer (notice that the Spanish long RCs were, on average, 4 PWds long, compared to the English long RCs, which were about 1 PWd shorter; see Table 4-5 in Chapter 4.

The fact that constituent length does not interact with attachment site in the question answering errors lends further support to the interpretation advocated here of the question error data. There were effects of length with respect to attachment preferences in the off-line questionnaire data of Experiment 1, and in the reaction time data reported above, with a tendency for materials with longer RCs to depart from the default low attachment preference of the parser. We took those to mean that length of the attaching RC affects the processes involved in RC attachment. With the question error data, however, the

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length of the attaching constituent does not modulate subjects' behavior with respect to attachment preferences (RC length did not interact with attachment site in the analyses). The most logical interpretation of this outcome is to assume that the behavior subjects engage in when dealing with the question-answering task in the on-line experiment is not controlled by the strategies related to RC attachment, but rather by strategies subjects use to answer questions in this type of task. It is easier to answer questions asked about N1 than about N2, and this is true both in English and in Spanish.

5.3.4 Exploration of the On-Line Monolingual Data: Complex NP Configuration

A final aspect of the on-line data that warrants discussion is whether the different number configurations in the complex NPs affected the outcome of the experiment. The disambiguation was forced by number agreement, where one sub-set of experimental items used unambiguous singular in the RC to force attachment high or low, and a different sub-set of experimental items used unambiguous plural in the RC, as shown in the examples provided earlier, repeated below (see also discussion in Chapter 4, particularly in §4.2).

5. a. ...the nephew of the teachers / that was... (Forced High)
   b. ...the nephews of the teacher / that was... (Forced Low)

6. a. ...the daughters of the hostage / that were... (Forced High)
   b. ...daughter of the hostages / that were... (Forced Low)

The discussion in §4.5 in Chapter 4 pointed out that difficulty with complex NPs containing plural N2s ("local plurals") was to be expected. This would in fact be

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in line with existing perceptual evidence in the subject-verb agreement discussed in §4.5, in which the complex NP configuration with a local plural (as those in (5a) and (6b)) is usually read more slowly than its local singular alternative. The discussion in §4.5 also speculated that this effect might lead to longer readiung times in the first frame of the items for the present experiment, as well as to decreased accuracy with the question errors (since the questions require remembering which one, of the two nouns, was singular or plural). However, it was also proposed that local plural sentences would not necessarily induce longer reading times at the RC region, Frame 2, because while reading the disambiguating region, the processing of the number features in the complex NP (and any difficulty associated therewith) has already taken place.

Table 5-6 shows the results of this exploration of the on-line data, by listing the difference between reading times for Frames 1 and 2 and percent errors for Frame 3, for local singular and local plural items.

Table 5-6: Difference Between RTs and % Errors in Items Containing Plural versus Singular N2s, as a Function of Language Group for Frames 1, 2 and 3

	*Frame 1, Bare Matrix RTs, Δ**	*Frame 2, Relative Clause RTs, Δ**	*Frame 3, Question % Errors, Δ**
USENG	+161	–48	+3.96
CSPA	+218	+46	+9.79
Mean	+189	–1	+6.88

* The differences (Δs) were calculated by subtracting RTs or % errors for items with a singular N2 from items with a plural N2.

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Separate analyses of variance were performed on the reaction time data for Frames 1 and 2 and on the error data for Frame 3, using as factors Language (USENG versus CSPA), Materials Subset (items such as (5), with a singular auxiliary in the RC, versus items such as (6), with a plural auxiliary), and Complex NP Configuration (plural N2 versus singular N2). An additional factor, Design Groups (subject groups in the subject-based analysis, item groups in the item-based analysis) takes into account the assignment of subjects to four versions of the on-line task over which materials were counterbalanced. This factor is included in the analyses of variance to extract irrelevant variance but is not reported here. (The analyses of variance reported in this section are provided in Appendix E-4.)

As Table 5-6 indicates, in Frame 1 the sentences containing the N2-plural number configuration took 189 msec longer to read than the sentences containing the N2-singular number configuration, a difference which was significant in the analysis, $F_1(1,72) = 10.32$, $p < .005$, $F_2(1,40) = 17.78$, $p < .001$. This effect did not interact with language, $F_1 < 1$, $F_2(1,40) = 6.22$, $p < .001$, or with materials subset, $F_1(1,72) = 1.35$, $p > .20$, $F_2(1,40) = 2.58$, $p > .10$, and the three-way interaction was not significant, F_1, $F_2 < 1$.

The N2-plural number configuration also resulted in an average 6.88 more question-answering errors in Frame 3, an effect which was significant in the analysis, $F_1(1,72) = 19.24$, $p < .001$, $F_2(1,40) = 4.57$, $p < .05$. This effect did not interact with language, nor did it engage in the higher-order three-way interaction (all values of $p > .05$), but did interact with materials subset, $F_1(1,72) = 20.90$, $p <$

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.001, $F_2(1,40) = 10.49$, $p < .005$. This puzzling interaction is very likely an artifact of the analysis, and should not be taken to mean that the two materials subsets have different characteristics with respect to the way the two complex NP number configurations cause difficulty for subjects. However, further investigation of this problem, by testing materials fully crossing the complex NP number configuration with attachment site, is necessary to confirm this speculation (see, e.g., Deevy, 1999).

The difficulty associated with the local plural complex NP configuration seems to be limited to the fringe frames, Frames 1 and 3, where the subjects are either reading material with the complex NP itself, or participating in the question-answering task (where, as we have argued, the behavior does not necessarily reflect strategies associated with RC attachment). As Table 5-6 shows, in Frame 2, where the RC was presented and the attachment disambiguated morphosyntactically, there was no difference between the local plural and local singular materials, F_1, $F_2 < 1$, a main effect which did not interact with language, all p's > .20, and which did not engage in the three-way interaction, F_1, $F_2 < 1$. As in Frame 3, the analysis reveals an interaction between complex NP configuration and materials subset, $F_1(1,72) = 7.77$, $p < .01$, $F_2(1,40) = 4.94$, $p < .05$. A full understanding of this interaction, as noted above, will require additional investigation using materials fully crossing the critical variables of number configuration and attachment site.

In sum, the difficulty associated with a configuration in which the lower noun in the complex NP is plural, where feature percolation may have taken

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place, only appears to exert an influence in the frames surrounding the one where the critical measure is taken. This in turn suggests that number was not only an adequate disambiguator, in both languages, but also not the characteristic of the materials driving the overall on-line preference for low attachment in the Frame 2 reaction time data.

5.3.5 Summary and Discussion

The evidence from Experiments 1 and 2 together documents the anti-gravity effect, as it emerged through the length manipulation. Longer constituents rise to N1, in off-line judgments, and seemingly so also in on-line reaction times, and this occurs in similar ways in both English and Spanish. The length effect did not, however, play a role in determining behavior in the different attachment conditions in the post-on-line reading question answering task. This, of itself, suggests that the question-answering errors are governed by question answering strategies that are not necessarily related to the local attachment decisions made in the on-line processing of linguistic material. The subjects' greater accuracy in the forced high conditions is attributable to question-answering strategies favoring questions about arguments of the matrix verb.

A slight reservation should be expressed here about the interpretation that longer constituents led to different attachment preferences than shorter constituents, in the on-line task, particularly because in the analysis, length and site did *not* interact in the reaction time data for Frame 2. This finding might be explainable by Fodor's (1998) anti-gravity proposal. However, it is perhaps more parsimoniously dealt with under a view of RC attachment that proposes on the

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one hand that prosodic considerations lead to a departure from low attachment in the later phases of processing, and on the other that timing considerations can affect the sensitivity of a presumably on-line task. We noted in Chapter 2 (§2.2.4) that prosody does not necessarily affect initial attachments, but rather could be seen as operating in the post-syntactic phase. If this is the case, then the fact that length and site did not interact in the on-line experiment is not at all surprising.

To cope with the finding that, in subanalyses, the site effect disappeared with long RCs, we could propose that there was a loss of sensitivity in the experimental task with long RCs. If there is more material to be read, there are more lexical items to be accessed, which results in longer reading times, and possibly also in a greater likelihood that post-syntactic processes (which generally play the role of biasing attachment toward the higher host) will have a chance to exert their influence on the attachment process. We return to this point in Chapter 6.

Our data paint a picture of RC attachment preferences that is difficult to interpret in the context of a number of existing studies, particularly those which have shown an early N1 advantage (in Spanish). In the reaction time data from Experiment 2, there was an N2, low attachment advantage in both our Spanish and English speakers. This finding contrasts with the off-line questionnaire data from Experiment 1, where the usual cross-linguistic differences were replicated, with Spanish attaching higher, and English attaching lower—at least with the

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standard singular NP materials. (But recall the discussion of the similarities between the speakers of the two languages in those data as well.)

The general finding in both experiments reported above is one in which English and Spanish monolinguals behave in ways more similar than expected, and are more similar than they have been found to be in the past. The results presented above are more in line with those reported by De Vincenzi and colleagues, from experiments in Italian and French, in the respect that they also report an initial low attachment preference; this finding is different from the results for Spanish reported by Mitchell, Cuetos and colleagues, and by Carreiras and Clifton. Together, the studies reported in this chapter suggest that RC attachment preferences are guided by universal principles that operate in similar ways in English and Spanish. While the picture on RC attachment preferences has become more complex, the two experiments reported above have pointed out some promising areas for future research.

5.4 Monolingual RC Attachment Preferences, On-Line and Off-Line

The results of Experiments 1 and 2 indicate that Spanish and English speakers behave in parallel ways, even with the RC attachment construction, which elsewhere in the literature has been cited as one in which cross-linguistic differences are evident. This chapter has provided evidence that the early preferences of speakers of both languages are for the low site, and these preferences are strongest with short relatives, and with "local plural" NPs (where

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N1 is singular and N2 is plural). With longer relatives, in the self-paced reading task we see no tendency for either attachment.

The only behavior that seems to differ between Spanish and English speakers is with off-line judgments on relative clause attachments in fully ambiguous sentences. Here, the cross-linguistic differences that have been reported in the literature (see Chapter 2) were replicated in Experiment 1 using a new set of materials and subjects. Spanish speakers tend to attach high, while English speakers tend to attach low. These preferences are modulated by an influence of RC length which may be attributable to the operation of the anti-gravity law (Fodor, 1998). The anti-gravity law predicts that long relatives may become independent prosodic units, which in turn would allow them to raise to N1. On the other hand, the anti-gravity law predicts that short relatives will stay low.

The experiments reported in this chapter provide the necessary backdrop for the experiments in Chapter 6, which explore bilingual sentence processing. Specifically, in Experiment 1 we have evidence of cross-linguistic differences between monolingual speakers of Spanish and English, with a task which tests off-line RC attachment preferences. In Experiment 2, however, we found that monolingual speakers of Spanish and English exhibit low attachment preferences, with a task which taps earlier phases of processing. This means that the question of language dependency in bilingual sentence processing is only properly addressed by off-line tasks. In on-line tasks, instead, the expectation is for bilingual behavior to resemble that of monolinguals.

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CHAPTER 6

BILINGUAL EXPERIMENTAL DATA ON RELATIVE CLAUSE ATTACHMENT PREFERENCES

6.1 Introduction

This chapter presents off-line and on-line evidence on the parsing routines bilinguals use when processing linguistic input, in each of their languages. As in the preceding chapter on monolingual sentence processing, we begin by describing the backgrounds of the participants (§6.2), where we focus, among other aspects of the bilinguals' backgrounds, on the criteria used to assign subjects into one of two dominance subgroups. We continue with a discussion of how subjects' accuracy on filler items was used as a criterion for inclusion in the analysis (§6.3), following a procedure slightly different from that used with the monolinguals. The bilingual behavioral data are then presented, analyzed and discussed (§6.4). In each of the two experiments, an off-line questionnaire and an on-line self-paced reading task, data were collected from English- and Spanish-dominant bilinguals in each of their two languages, in separate experimental sessions.

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6.2 Bilingual Background Questionnaire

Like their monolingual counterparts, the bilinguals who participated in this series of experiments provided information regarding their backgrounds, but did so with a great deal more detail concerning their language histories. The questionnaires completed by the bilinguals had the primary purpose of determining as accurately as possible the subjects' dominant language, a datum which was used to divide the sample of bilinguals into two groups, English-dominant bilinguals and Spanish-dominant bilinguals.

Two translation-equivalent bilingual background questionnaires were constructed, one in English and one in Spanish (both are provided in Appendix C-2). The subjects were randomly assigned to complete the background questionnaire in one or the other of their two languages,[114] at the beginning of their first experimental session.

The discussion in this section will begin by summarizing the criteria considered to determine language dominance in the bilinguals tested, and will continue by presenting summary data on the bilinguals' general histories and language histories. The data reported are for 80 subjects who, having met the language history and performance criteria, were included in the final analyses in either the off-line or the on-line study (N=24 and N=56, respectively). The information is pooled for the participants undertaking the two different tasks because no important differences existed. (Appendix F presents tables

[114] As discussed in the *Procedure* sections for each of the experiments reported below, the language of the first session was determined by the experimenter. Throughout most of the testing period, English and Spanish were alternated for consecutive subjects.

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corresponding to those in the following sub-sections, separating the biographical data of the participants by task.)

6.2.1 Determining Language Dominance

Before examining the general histories and language histories of the bilinguals, we will address how language dominance was determined. As discussed in Chapter 3, this is a critical variable to examine in a study of bilingual sentence processing, because in the existing studies RC attachment preferences in bilinguals seem to be at least partially determined by the bilinguals' dominant language (see discussion in Chapter 3, §3.5). The experiments carried out for this investigation were designed to examine the processing strategies used by bilinguals with different dominance profiles across their languages. Thus, the dominant language of a bilingual is the primary characteristic used in dividing the samples. We are interested in determining whether this variable affects performance in bilingual sentence processing.

The bilinguals were not asked directly about which language they thought they spoke better. Rather, a series of questions in the background questionnaire was designed to elicit this information indirectly. From these questions, a dominant language was determined (no bilingual participants were absolutely balanced by all of the criteria), and degrees of dominance were quantified as described below.

The bilinguals investigated were Spanish/English speakers recruited from a public university in New York City. It is thus expected that they will not represent an "ideal" bilingual population with fully symmetrical dominance

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patterns: because English was the language of current education, it was likely that Spanish-dominant bilinguals would not be as dominant in Spanish as the English-dominant bilinguals would be in English. This is a fact of the population surveyed, and is beyond experimental control.[115]

An additional concern regarding the particular population of bilinguals surveyed was the fact that the Spanish they spoke was predominantly Pan-American, rather than Castillian, the variety spoken by the monolingual Spanish speakers from the experiments in Chapter 5, to whom the bilinguals are to be compared. Appendix G presents the results of a preliminary study on monolinguals from Puerto Rico, using the same materials and procedure as Experiment 1. The results from this pilot study indicate that monolingual Caribbean Spanish speakers have RC attachment preferences not different from those of monolingual Castillian Spanish speakers.[116] This licenses the comparison between Castillian Spanish speaking monolinguals and Pan-American Spanish speaking bilinguals.

Language dominance was determined by considering subjects' responses to a series of questions about their proficiency in each of their languages; these questions always sought information about English and Spanish separately. To

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[115] We emphasize the importance of future research in bilinguals with different dominance distributions, for example, those residing in a Spanish-speaking community such as San Juan, Puerto Rico.

[116] This is not at all a surprising finding, considering that Spanish speakers from a variety of regions have been shown to have a general ultimate preference for high attachment. For instance, the speakers from Northern Spain tested by Cuetos & Mitchell (1988) have similar behavior patterns to the speakers from the Canary Islands tested by Carreiras & Clifton (1993, 1999)—see fn. 20, in Chapter 2. Additionally, Gibson and colleagues (Gibson, Pearlmutter, Canseco-González & Hickok, 1996; Gibson, Pearlmutter & Torrens, 1999) have worked with speakers from a variety of Latin American countries, residing in the United States at the time of testing, who share the general preference for high attachment reported for speakers from Spain.

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begin with, the bilinguals were asked to rate proficiency in each of the four competencies: oral comprehension, oral production, reading comprehension, and written production; they rated their ability using a five-point scale, where 1 indicated "very good" ("muy buena"), 3 "so-so" ("regular"), and 5 "very poor" ("muy mala"). The bilinguals were also asked if they thought they could pass as monolinguals, in a face-to-face conversation or in speaking on the telephone. (In the latter case, a reduction of contextual cues should mask a non-monolingual background, the notion of monolinguality possibly being interpreted by some subjects as referring to appearance as well as to speech pattern.) In addition to their relevance to issues of dominance, these questions also indirectly address phonetic/phonological proficiency. The primary reason (though by no means the only reason) one might not pass as a monolingual of a given language is because one speaks with a "foreign accent" (Flege, 1987). For each language separately, subjects were asked to use a five-point scale, where 1 indicated they pass as monolinguals "always" ("siempre"), 3 "sometimes" ("a veces"), and 5 "never" ("nunca").

In the analysis of these data, differences between subjects' self-ratings in English and Spanish, rather than the absolute responses for each, were taken to be indicative of dominance in one or the other language.[117] Subjects were assigned to the English-dominant or to the Spanish-dominant group based on a summed difference score. The large majority (95%, 76 of 80) indicated greater

[117] As pointed out in Chapter 3 (see especially fn. 78), difference scores computed from bilinguals' self-ratings in each of their languages have been shown to correlate significantly with independent measures of proficiency.

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proficiency in either Spanish or English in at least one, but usually several, of the levels of proficiency queried; none reported mixed dominance, e.g., better oral proficiency in one language but better literacy in the other; and only two subjects in each dominance group reported themselves to be equally proficient at all levels[118] in their two languages.

The table below summarizes mean differences computed over the self-reported proficiency ratings just described, for the English-dominant (EDOM) and the Spanish-dominant (SDOM) groups.

Table 6-1: Mean Self-Reported Proficiencies for EDOM and SDOM Bilinguals (Primary Language Dominance Criteria)

	EDOM (N=40)	*SDOM (N=40)*
Oral Comprehension	–0.54	+0.55
Oral Production	–0.95	+0.88
Reading Comprehension	–1.00	+0.70
Written Production	–1.33	+0.83
Pass as Monolingual, Face-to-Face	–0.90	+1.53
Pass as Monolingual, Telephone	–0.98	+1.55

Note: Scores represent the difference between English and Spanish; a positive figure indicates Spanish is rated higher than English, and a negative figure that English is rated higher than Spanish.

The figures in Table 6-1 show different degrees of dominance in the two bilingual groups, not necessarily in oral proficiency, but certainly in literacy and at the phonetic/phonological level. In the English-dominant group there is a larger differential in the reading and writing categories than there is in the Spanish-dominant group. This asymmetry between the English-dominant and Spanish-

[118] The language dominance for these four subjects was determined using the secondary criteria discussed below.

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dominant bilinguals is reliable in both categories; *t*-tests on *unsigned* scores produce significant outcomes for reading proficiency ($t_1(78) = 2.13$, $p < .05$) and for writing proficiency ($t_1(78) = 2.31$, $p < .025$). In contrast, there is no such asymmetry in the degree of dominance in the categories of oral comprehension ($t_1 < 1$) and oral production ($t_1 < 1$).

On the other hand, the Spanish-dominant differential for questions about passing as a monolingual is larger than that for the English-dominant bilinguals; this difference is, however, only marginally reliable for the "face-to-face" question, $t_1(78) = 1.92$, $.05 < p < .10$, and fails to reach significance for the "telephone" question, $t_1(78) = 1.45$, $p > .15$. To the extent that responses here reflect facts about foreign accent in the two groups, it appears that the Spanish-dominant bilinguals are more likely to think their English has a Spanish accent than the English-dominant bilinguals are to think their Spanish has an American English accent. This pattern may, however, be confounded with the fact that some of the English-dominant bilinguals speak a non-standard variety of English (African American Vernacular), which they perceive as diverging from the American English monolingual norm.

The bilinguals were additionally asked to indicate which language they felt more comfortable speaking, and which language they were most likely to use when very tired, very angry, and very happy, or when doing simple arithmetic. Plausibly, bilinguals are more likely to choose to use their dominant language under such special circumstances. Finally, for purposes of comparison, the "neurosurgery" question used by Cutler, Mehler, Norris & Segui (1992) to

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determine language dominance was included in the questionnaire, using similar though not exact wording. As in the Cutler et al. study, this question asked the bilinguals to indicate which language they would choose to keep if they were to have a serious operation with the unfortunate side effect of removing one of their languages; they were also asked to give reasons for that choice (see discussion in Chapter 3, §3.3). According to Cutler et al., bilinguals will choose to keep the language in which they are more dominant (but see Grosjean, 1998, for a critique of this procedure for determining dominance).

This additional information on language dominance (summary data for which are reported in Tables 6-2 and 6-3, below) was sought in the background questionnaire and was examined in the case that dominance could not be determined using self-rated proficiency. As noted earlier, only two subjects in each of the dominance groups did not exhibit dominance by the primary criteria.

Table 6-2: Preferred Language for Special Circumstances for EDOM and SDOM Bilinguals (Secondary Language Dominance Criteria)

	EDOM (N=40)						*SDOM (N=40)*					
	English		*Spanish*		*Either*		*English*		*Spanish*		*Either*	
	N	*%**	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Comfortable to Use	33	84.6	4	10.3	2	5.1	1	2.5	33	82.5	6	15.0
Tired	25	65.8	4	10.5	9	23.7	4	10.3	16	41.0	19	48.7
Angry	23	59.0	9	23.1	7	17.9	4	10.0	22	55.0	14	35.0
Happy	27	69.2	2	5.1	10	25.6	6	15.0	13	32.5	21	52.5
Arithmetic	35	87.5	2	5.0	3	7.5	6	15.0	23	57.5	11	27.5
MEAN (%)		73.2		10.8		16.0		10.6		53.7		35.7

Note: The percentages are computed in terms of subjects responding, per dominance group. Occasionally subjects recorded no response to a question; this applied to 2.5% of the data for the EDOM sample, 0.5% for the SDOM sample.

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Table 6-2 exhibits once more the patterns seen in Table 6-1, i.e., it shows that the Spanish-dominant bilinguals are more nearly balanced speakers of their two languages than the English-dominant bilinguals. Overall, some three-quarters of the English-dominant bilinguals report that they are more likely to use English for the special circumstances queried. In contrast, only about half of the Spanish-dominant bilinguals claim they are more likely to use Spanish, and roughly one-third report they use both languages for these circumstances, many claiming that the language they prefer to use depends on the situation or the interlocutor (so that dominance is not the determinant of language choice).[119] The language that bilinguals use for doing simple arithmetic is generally more associated with their primary language of education than with their language dominance (Noël & Fias, 1998; see also fn. 121, below).

As a potential ternary criterion for determining language dominance, Cutler et al.'s (1992) "neurosurgery" question provided interesting insights about the bilinguals in our sample (though not necessarily about their language dominance), and about the validity of asking such a question to determine language dominance. Informal inspection of subjects' responses revealed that it was not likely to be an accurate indicator of language dominance, since the reasons cited for choosing English or Spanish as the language they would prefer

[119] One reason that the "special circumstance" questions did not return a sharp differentiation between English- and Spanish-dominant bilinguals might lie, rather than in the character of the questions themselves, in the fact that the choice was not binary (English versus Spanish). Allowing subjects to write in their preference, and including in the count answers such as "both" or "either", blurred the outcome. In fact, if subjects responding "either" are excluded, approximately 85% of responses agree with the dominance distribution determined by self-rated proficiency.

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to keep ranged beyond issues plausibly bearing on dominance. (Answers to this question were in fact not used to determine assignment to groups for any of the bilingual subjects; the primary and secondary criteria sufficed.)

In the table below, summary statistics are provided on the subjects' choice of language given the neurosurgery scenario, along with their reasons for choosing that language. These reasons (compiled from subjects' written comments about the question) fall into three general categories: (i) reasons related to proficiency, and order or ease of acquisition (dominant language, language learned first, language with which acquisition difficulty is associated); (ii) utilitarian reasons (majority language, language essential for finance or required for gainful employment); and (iii) familial or heritage reasons (common language among family members, language associated with cultural heritage; affective and aesthetic reasons are also included in this category).

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Table 6-3: Preferred Language for "Neurosurgery" Question for EDOM and SDOM Bilinguals (Ternary Language Dominance Criterion)

	EDOM				*SDOM*			
	Keep English		*Keep Spanish*		*Keep English*		*Keep Spanish*	
Responses	*N*	*% (N=39*)*	*N*	*% (N=39*)*	*N*	*% (N=38*)*	*N*	*% (N=38*)*
	29	74.4	10	25.6	11	28.9	27	71.1
Reasons for Choice	*N*	*% (N=29)*	*N*	*% (N=10)*	*N*	*% (N=11)*	*N*	*% (N=27)*
Dominant Language	12	41.4	—	0.0	—	0.0	5	18.5
Harder Language	—	0.0	—	0.0	1	9.1	1	3.7
First Language	—	0.0	1	10.0	—	0.0	5	18.5
Majority Language	12	44.8	—	0.0	6	54.5	—	0.0
Language of Finance	2	6.9	—	0.0	1	9.1	—	0.0
Family Language	1	3.4	3	30.0	2	18.2	7	25.9
Heritage Language	1	3.4	4	40.0	—	0.0	5	18.5
Emotional Reasons	1	3.4	2	20.0	1	9.1	4	14.8

* One English-dominant and two Spanish-dominant bilinguals did not record an answer for this question.

Inspection of Table 6-3 reveals that language dominance is offered as the primary reason for choosing a language to keep only by a sub-group of the bilinguals (34% of reasons), while reasons bearing on economics and heritage make up the rest (24% and 42% of reasons, respectively). The bilinguals citing reasons in the language dominance category choose their language-to-keep in a way that concords with assignment to dominance groups 92% of the time. Those citing utilitarian reasons, on the other hand, always choose English, which is almost exclusively the language of employment and finance in New York City. Conversely, those citing heritage reasons choose Spanish most of the time (approximately 81%), reflecting the fact that Spanish/English bilinguals in New

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York are concerned with maintaining their non-majority (Spanish-language) heritage live in an English-majority city.

Given the preceding, it is reasonable to conclude that the most straightforward way to determine language dominance, for purposes like those of the current research, is to rely on differences between a bilingual's self-reported proficiency in each of his or her languages. Questions having to do with the language a bilingual is likely to use under special circumstances also appear to be indicative of language dominance, though not as sharply as the proficiency-differential scores (but see fn. 119, above). Finally, the neurosurgery question is not always an accurate indicator of language dominance.

Having determined the assignment of subjects in the sample to the groups we have dubbed EDOM and SDOM, we continue by examining to what extent the language histories of the bilinguals in this sample correlate with their presumed language dominance. As the following sections will show, perhaps not surprisingly, the data make it clear that language history is indeed a very important determinant of language dominance.

6.2.2 General Demographics

We turn first to the background information provided by the bilinguals. The questions used to elicit this information were essentially identical in the bilingual and the monolingual history questionnaires. Table 6-4 summarizes the general demographics information for the bilinguals.

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Table 6-4: Bilinguals' General Demographics				
	EDOM (N = 40)		*SDOM (N = 40)*	
Mean Age (yrs)	25.4		25.9	
	N	*%*	*N*	*%*
Sex Ratio, F	30	75.0	32	80.0
Handedness Ratio, R	36	90.0	36	90.0
Full-Time Students	23	57.5	24	60.0

As the above table indicates, the two bilingual sub-groups are not very different from one another. The picture here is also similar to that of the monolinguals reported in Table 5-1 (Chapter 5, §5.2).

6.2.3 Language History

This section describes language history data for the bilinguals, an exercise requiring a finer grain of analysis than it did for the monolinguals. We begin by considering aspects of the bilinguals' backgrounds, including their parents' language(s), the majority language of the place where they were born and the places in which they have resided, and the language(s) of their education. This information is summarized in Table 6-5 for the EDOM group, and in Table 6-6 for the SDOM group.[120]

[120] In Table 6-5 and Table 6-6, the categories labeled *Both* are multi-valued. They include subjects who were schooled in bilingual education programs and who spent part of their time in each of two monolingual programs, or in a combination of monolingual and bilingual programs. The *Spanish-Dominant Environment* subjects were either born in or had spent a significant time (over six consecutive months) residing in the following regions of the Americas: Argentina, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Panama, Peru, Puerto Rico, Uruguay and Venezuela.

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Table 6-5: Language History of the EDOM Bilinguals

	Only English		*Only Spanish*		*Both*		*English and LOTE/LOTS**	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Monolingual Mother	5	12.5	19	47.5	14	35.0	2	5.0
Monolingual Father	3	7.5	17	42.5	17	42.5	3	7.5

	In English-Majority Environment Only		*In Spanish-Majority Environment Only*		*In Both*		*In LOTE/LOTS*-Majority Environment*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Elementary Ed.	29	72.5	6	15.0	5	12.5	—	0.0
Secondary Ed.	33	82.5	2	5.0	5	12.5	—	0.0
College, University	39	97.5	—	0.0	1	2.5	—	0.0
Graduate School	4	10.0	—	0.0	—	0.0	—	0.0
Other (Vocational School, etc.)	1	2.5	—	0.0	—	0.0	—	0.0
Place of Birth	28	70.0	10	25.0	—	0.0	—	0.0
Domicile History	18	45.0	—	0.0	22	55.0	—	0.0

* LOTE = languages other than English; LOTS = languages other than Spanish. For parental languages, these included German and Italian (N=2), German (N=1), French (N=1) and Chinese (N=1).

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Table 6-6: Language History of the SDOM Bilinguals

	Only English		*Only Spanish*		*Both*		*Spanish and LOTE/LOTS**	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Monolingual Mother	1	2.5	32	80.0	6	15.0	1	2.5
Monolingual Father	1	2.5	32	80.0	5	12.5	2	5.0

	In English-Majority Environment Only		*In Spanish-Majority Environment Only*		*In Both*		*In LOTE/LOTS-Majority Environment*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Elementary Ed.	4	10.0	28	70.0	8	20.0	—	0.0
Secondary Ed.	15	37.5	17	42.5	8	20.0	—	0.0
College, University	35	87.5	—	0.0	5	12.5	—	0.0
Graduate School	7	17.5	—	0.0	1	2.5	—	0.0
Other (Vocational School, etc.)	1	2.5	1	2.5	1	2.5	1	2.5
Place of Birth	4	10.0	36	90.0	—	0.0	—	0.0
Domicile History	—	0.0	—	0.0	40	100.0	—	0.0

* LOTE = languages other than English; LOTS = languages other than Spanish. For parental languages, these included Italian (N=2) and Catalan (N=1). For languages of the environment, this included Italian (N=1).

The aspects of language history listed in the two tables above appear to be strong determinants of language dominance, at least with the groups being surveyed here. The English-dominant bilinguals were more likely than the Spanish-dominant to have bilingual parents, and conversely the Spanish-dominant bilinguals were more likely than the English-dominant to have parents who only spoke Spanish. While this does not necessarily have direct consequences for the language dominance of the subjects, it is likely to be indicative of the amount of input received early in life in each of the languages.

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Secondly, while the two dominance groups resemble each other in terms of where the bilinguals attended college, all of them having been recruited from an English-speaking university in New York City, the primary language of their education in the earlier grades differed considerably. The English-dominant group was predominantly schooled in English, in the US, with a few individuals either having spent some time abroad or having attended bilingual education programs in the US. On the other hand, the Spanish-dominant group had a more mixed education background, reflecting the fact that not all of them had resided in the US in the early parts of their lives. Crucially, most of the latter had had formal education in Spanish at some point, even the few born in the US (who had spent time living and studying abroad). This contrasts with the English-dominant bilinguals, most of whom had never had Spanish as the primary language at any academic setting.[121]

Finally, the English-dominant bilinguals were more likely to have been born in the US and less likely to have spent time residing in a Spanish-dominant environment. On the other hand, the Spanish-dominant bilinguals were almost all born in Spanish-dominant areas, and even those born in the US had spent a significant amount of time residing in a Spanish-dominant environment.

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[121] It is interesting to compare this finding to the finding regarding bilinguals' preferred language for performing simple arithmetic, reported in Table 6-2 above (p. 230). The preferred language for simple mathematical operations tends to be the primary language of one's education (see Noël & Fias, 1998, for discussion and references). Since the English-dominant bilinguals had most of their education in English, it is not surprising that most of them (88%) chose English as the preferred language for arithmetic. On the other hand, only 58% of the Spanish-dominant bilinguals chose Spanish as the preferred language for arithmetic, with 15% choosing English, and 28% claiming they have no preference. This correlates quite well with the fact that many of the Spanish-dominant bilinguals have had a mixed education background.

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6.2.4 Frequency of Language Use

A bilingual's more frequently used language is a characteristic we are interested in documenting for the bilinguals used in this study, particularly as it may bear on whether the perceptual strategies used in sentence processing are language dependent. If frequency of language use were shown to play a role, it could also be argued that the mechanism responsible for setting the preferences in a speaker of a language (or a set of languages) is *exposure*-based, as proposed by the Tuning Hypothesis (see discussion in Chapter 2, §2.3.2). We do not pursue this question in detail here, but future research might take frequency of language use as a primary independent measure, comparing groups of bilinguals whose exposure to English and Spanish differs systematically (in a way parallel to the way language dominance is used here as a primary independent measure).

The bilinguals in this study were asked about the language in which they speak and are spoken to more frequently in a number of different sociolinguistic contexts, as well as at different times in their lives. The language frequency data generated from these questions are summarized in Table 6-7. The bilinguals provided this information by indicating on a five-point scale which language they used more often in given *Time Periods* (past and present), and in given *Contexts*; on the scale, 1 indicated "always Spanish" ("siempre español"), 3 indicated "Spanish as much as English" ("tanto español como inglés"), and 5 indicated "always English" ("siempre inglés").

Each subject was asked to report the relative frequency of language use as a *Child*, as an *Adolescent* and now (as an *Adult*). Within those categories,

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subjects further indicated which language they use more frequently with their immediate *Family* (grandparents, parents, siblings, spouses and children), in *Private* contexts (relatives other than the immediate family, friends and acquaintances), and in *Public* contexts (teachers, peers at school and at work, and the cover category "others", which includes people that they might come into contact with in their daily activities, such as bus-drivers, shopkeepers, telephone operators, and so forth). For each category, the participants were asked to report on the language they used more to address people (*Output*) versus the language in which they were more often addressed (*Input*). (The scales are shown in full in the background questionnaires provided in Appendix C-2.)

Table 6-7: Mean Rated Frequency of Language Use for EDOM and SDOM Bilinguals, in Different Time Periods and Contexts

Time Period			*Context*		
	EDOM	***SDOM***		***EDOM***	***SDOM***
Child Output	3.19	1.37	*Family Output*	3.12	1.63
Input	3.15	1.40	*Input*	3.23	1.68
Adolescent Output	3.52	1.75	*Private Output*	3.47	1.91
Input	3.68	1.84	*Input*	3.77	2.11
Adult Output	3.95	3.14	*Public Output*	4.28	2.99
Input	3.97	3.17	*Input*	4.23	3.02

Note 1: Data shown for Time Periods collapse over contexts, and for Contexts, over Time Periods.

Note 2: Mean values above 3 indicate that English is more frequent, and below 3, that Spanish is more frequent.

The figures in the left panel of Table 6-7 (Time Period) suggest that the two bilingual groups differ notably in their reported frequency of use in earlier time

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periods but approach each other in their language use for the present. The data in the right panel of the table (Context) also reveal a similar trend, in that the two dominance groups differ more in their interactions in family and private contexts than in public contexts. An interesting detail emerges if we consider how the bilinguals reported they interacted with immediate family members prior to adulthood. The relevant data are summarized in Table 6-8. In the English-dominant group, there is a very strong tendency to use English more with siblings than with parents.

Table 6-8: Mean Rated Frequency of Language Use with Immediate Family During Childhood and Adolescence, for EDOM and SDOM Bilinguals

	EDOM			*SDOM*	
	Parents	*Siblings*		*Parents*	*Siblings*
Output	2.56	4.07	*Output*	1.26	1.47
Input	2.88	4.03	*Input*	1.20	1.62

The data reported in this section show that language dominance partially correlates with language frequency of use, though not for all time periods or for all contexts. In general, the language used more frequently in childhood and adolescence, as well as the language used more frequently in family and private contexts, is also the dominant language. To the extent that fraternal input is critical in the early linguistic development of a child, these data point to a sharp difference between the two groups in interaction with siblings. However, the two

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groups approximate each other in terms of the more frequently used language in adulthood and in public contexts.

6.2.5 Age of Acquisition

A final variable to be considered in describing the nature of the bilinguals studied is age of L2 acquisition. This variable might be held to be important in determining the extent to which age of L2 acquisition affects language dominance (see, e.g., discussion in Harley & Wang, 1997). Furthermore, we know that RC attachment preferences in the second language, as estimated in off-line studies, are subject to age of acquisition effects, with different patterns in the behavior of bilinguals who learned their second language late versus those who learned their second language early (see discussion in Chapter 3, §3.5; see also Fernández, 1999; Dussias, in press). Specifically, late L2 learners have been shown to make up a homogeneous group which uses L1 strategies even with L2 input. This stands in contrast to early L2 learners, who appear to be more heterogeneous and use strategies associated with either L1 or L2, variously.

Table 6-9 summarizes the acquisition history of the bilinguals tested, distinguishing between simultaneous acquirers and two possible sub-types of sequential acquirers, those for whom L2 was Spanish and those for whom L2 was English. (For discussion of the simultaneous/sequential distinction in the acquisition of two languages, see De Houwer, 1993, Schaerlaekens, 1997, and references cited therein.)

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Table 6-9: EDOM and SDOM Bilinguals in Three Acquisition History Categories

	EDOM (N=40)			*SDOM (N=40)*		
	N	*%*	*Age L2*	*N*	*%*	*Age L2*
Simultaneous	11	27.5	—	2	5.0	—
L2 Spanish	8	20.0	9.6	1	2.5	7.0
< Age 15	7	17.5	8.1	1	2.5	7.0
≥ Age 15	1	2.5	21.0	—	0.0	—
L2 English	21	52.5	6.0	37	92.5	13.0
< Age 15	21	52.5	6.0	26	65.0	9.8
≥ Age 15	—	0.0	—	11	27.5	20.6

The table shows that there are broadly symmetrical patterns across the two dominance groups accompanied by differences of detail, which may have been important contributors to language dominance. For both groups, sequential acquisition of English and Spanish was much more common than simultaneous acquisition—but this holds more strongly of the Spanish-dominant than of the English-dominant bilinguals. For both groups, the majority of the subjects were exposed to Spanish first and learned English as a second language—however, in the case of the English-dominant group, this is a bare majority, slightly over 50%, to be compared with a majority surpassing 90% in the Spanish-dominant group. And for both groups, the L2 was more often learned early in life, with only a fraction of the bilinguals (overall, 15%) being late L2 learners, all but one of the late learners falling in the Spanish-dominant group.[122]

[122] It is unfortunate that 92% of the late learners belong to the Spanish-dominant group, but this is possibly an inevitable outcome with a sample of bilinguals recruited in an English-majority environment. This fact underscores the need to conduct similar research with samples of bilinguals living in environments where the majority language is different (see also fn. 120 above).

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A handful of the bilingual subjects indicated they were speakers of other languages, including Italian (N=3), Cantonese (N=1) and Greek (N=1) in the SDOM group, and French (N=5), Italian (N=2), Haitian Creole (N=1), Hebrew (N=1) and Persian (N=1) in the EDOM group. None of these subjects claimed to be dominant in these other languages, though some claimed to be advanced speakers of their L3s.

6.2.6 Encoding Preferences

The bilinguals were asked to report on their preferences for encoding information (as were the monolinguals in the studies reported in Chapter 5, and the monolinguals tested by Ehrlich, Fernández, Fodor, Stenshoel & Vinereanu, 1999). However, the questions on encoding preferences were slightly altered for the bilinguals, to determine—if they claimed a preference for encoding information in words, as opposed to images—whether they preferred to use one or the other language. Such preferences should also reflect language dominance; it seems implausible that bilinguals would claim to prefer encoding information in their non-dominant language.

The bilinguals were asked to indicate, separately for each language, if they heard an inner voice when reading. This question generated confusion among some subjects, who interpreted it as inquiring whether they translate into Spanish when reading English (and consequently hear an inner voice in Spanish), and vice-versa when reading Spanish; consequently, the data reported below for this question are noisy. Less problematic was the question about hearing the correspondent's voice when reading a letter, again posed separately

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for English and Spanish. Finally, for the question regarding using visual images versus words to memorize a set of random objects, the bilinguals were asked to indicate, if their preference was for choosing words, whether they would use English words, or Spanish words, or a combination of English and Spanish depending on the nature of the items (e.g., English for kitchen utensils, Spanish for children's toys). The table below summarizes the distribution of the encoding preferences for the two bilingual dominance groups.

Table 6-10: Encoding Preferences for EDOM and SDOM Bilinguals

	EDOM		*SDOM*	
	N	*%*	*N*	*%*
Inner Voice (Self) in English	31	77.5	27	67.5
Inner Voice (Self) in Spanish	22	55.0	28	70.0
Inner Voice (Others) in English	28	70.0	24	60.0
Inner Voice (Others) in Spanish	22	55.0	30	75.0
Preference for Words over Images	23	57.5	15	37.5
Words in English	7	30.4	1	6.7
Words in Spanish	—	0.0	3	20.0
Words in English or Spanish, Depending on Object Type	16	69.6	11	73.3

Note: In the breakdowns of subjects preferring words over images, the denominators used for EDOM and SDOM were N=23 and N=15, respectively.

Table 6-10 reveals a slightly greater likelihood for hearing an inner voice in the subjects' dominant language. The prevailing preference to use words over images to memorize a set of objects is striking (especially in comparison to the figures reported in §5.2 of Chapter 5 for the monolinguals—23% USENG, 6%

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CSPA). This might reflect greater sensitivity to verbal encoding in bilinguals, or might instead be related to the way the question was phrased, with four possible answers (rather than two), three of which comprise the *preference for words* category. Even more striking is the fact that no EDOM bilingual and only one SDOM bilingual chose words in the non-dominant language as the preferred vehicle for memorizing objects.[123] Questions such as these could in the future be developed as an alternative means for determining language dominance.

6.2.7 Summary: Bilinguals' Background

The preceding sections have described the nature of the bilinguals who participated in the experiments, via evaluations along a series of variables. We began by discussing how language dominance was determined, and found that, comparing the two dominance groups to each other, the Spanish-dominant bilinguals are relatively less Spanish-dominant (and therefore approach being balanced speakers of their two languages), while the English-dominant bilinguals are relatively more English-dominant (and are imbalanced bilinguals). The language histories of the two groups illustrated the fact that the English-dominant bilinguals were primarily raised and educated in a society where English is the majority language, while the Spanish-dominant bilinguals had a more mixed background, with all of them having spent some time living and studying in areas where Spanish is the majority language. We also saw that the bilingual subjects

[123] Although the numbers are very small, that the dominant language is consistently chosen by the bilinguals to memorize a set of objects seems no accident. A χ^2 test confirms that the distribution of 10 versus 1 is significant, $\chi^2(1)= 7.36$, $p < .001$.

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have usage frequencies for the two languages which diverge only modestly in adulthood and in public contexts, but were markedly different in earlier periods of their lives and in family or private contexts, with the Spanish-dominant group using much Spanish more often than English, and the English-dominant group using English somewhat more frequently than Spanish. The acquisition history of the two groups was shown to be broadly symmetrical, with most subjects having learned either Spanish as a first and English as a second language, or both languages concurrently from birth. Finally, we saw that language-based encoding preferences for the bilinguals are related to their language dominance, with subjects reporting a preference for encoding information in the language in which they are more proficient.

6.3 Accuracy with Fillers

In the monolingual experiments presented in Chapter 5, a criterion for inclusion in the analysis was subjects' accuracy with filler items, the comprehension questions for which were entirely unambiguous and had unarguably correct and incorrect answers. Subjects making too many errors (more than 5% in the off-line study, more than 20% in the on-line study) were excluded from further data analysis, on the assumption that high error rates on these materials were indicative of a lack of attention to the task.

With the bilingual samples, accuracy on fillers depends not only on adequate attention to the task, but also on proficiency in the language of the test. Thus determining the threshold for inclusion in the analysis is a more

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complicated issue for the bilingual subjects than for the monolinguals. Decreased accuracy as well as increased reaction times (what we have referred to earlier as a "performance deficit") in tasks examining linguistic behavior in bilingual populations is a well-documented phenomenon (see discussion in §3.3, Chapter 3). Bilinguals take longer to respond to linguistic stimuli, and do so less accurately for certain tasks, not only in their non-dominant language but also in their dominant language. The reasons for this are unclear, as we have seen in Chapter 3, but researchers usually cite the very fact of two coexistent codes as the culprit (Cook, 1997). Also contributing to the performance deficit might be the fact that the combined lexical store is larger in bilinguals than in monolinguals (thus lengthening lexical search times), or that a bilingual's processing routines may not be as automatic as those of a monolingual (less time using any one language possibly impeding the development of automaticity in that language). Finally, interlingual interference arising because of parallel activation of the two grammatical components (even when a bilingual is apparently performing in unilingual mode) may be another cause of increased reaction times and decreased accuracy. Interestingly, none of these explanations requires that the bilingual's linguistic components operate differently (or are structured differently) from those of the monolingual. In the discussion of the results for Experiment 4 we will return to this important point.

If a performance deficit is a fact of bilingual populations (albeit not yet fully understood), it follows that the filler accuracy threshold employed to exclude subjects from the analysis in the monolingual experiments might be too strict for

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a bilingual population: it would be inappropriate to exclude a portion of the sample for exhibiting behavior that is normal for the sample itself. At issue, then, is ascertaining how much leeway should reasonably be allowed for the bilinguals. Any leeway granted must be carefully judged to still exclude subjects who truly are not attentive in the task, and yet include those who are attentive, but suffering some degree of performance deficit.

The permissible error rates for the bilinguals were set at 15% for the off-line task and 30% for the on-line task. In both cases, the errors allowed for bilinguals were 10 percentage points more than for the monolinguals. The calculation of error rates for the purpose of subject selection was averaged over performance in the two languages. Participants who exceeded the cut-off in their combined error rate were rejected and replaced.

For confirmation that the error rate cut-offs operate in similar ways in the monolingual and bilingual experiments, we can compare the rates of exclusion with the two different groups. Of the 150 monolingual participants,[124] 13 were excluded based on filler inaccuracy—for an exclusion rate of 9%. Of the 92 bilingual participants,[125] 12 were excluded based on filler inaccuracy—for an exclusion rate of 13%, not markedly different from that in the monolingual sample.

Table 6-11 summarizes the error rates for the bilinguals included in the data analyses, and for comparison provides the parallel error rates for

[124] This figure omits subjects rejected on language history criteria.

[125] This figure omits subjects rejected on other criteria (language history, incomplete participation).

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monolinguals (already reported in Chapter 5). Since the cut-off rates for errors differ in the two experimental tasks, the table distinguishes between these.

Table 6-11: Percent Error Rates for Filler Questions in Questionnaire and Self-Paced Reading Tasks, for EDOM and SDOM Bilinguals, and USENG and CSPA Monolinguals

	Questionnaire		*Self-Paced Reading*	
Language of the Materials	*English*	*Spanish*	*English*	*Spanish*
EDOM Bilinguals	2.4	8.0	13.0	24.7
SDOM Bilinguals	4.7	6.5	19.0	19.6
*Monolinguals**	1.7	2.7	12.1	5.9

* The subjects providing data for monolingual English (USENG) and Spanish (CSPA) are different between the languages; see Experiments 1 and 2 in Chapter 5.

Beyond establishing the bilingual/monolingual difference in accuracy, which will temper our consideration of the experimental outcomes, Table 6-11 also provides information which adds to the picture of dominance asymmetries between the two groups of bilinguals. We focus on the error rates for the self-paced reading task, because the error rates in the questionnaire task are low enough to compress differences between the groups.

In the self-paced reading task, the English-dominant group performed better with the English fillers than with the Spanish fillers. In this group, 25 of 28 subjects were more accurate in English than they were in Spanish (an average difference of 14 percentage points), 2 subjects were equally accurate in English and in Spanish, and only 1 subject performed better in Spanish than in English. However, the Spanish-dominant group has the interesting characteristic of being

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more mixed in terms of individual participants' performance in English versus Spanish. Of the 28 Spanish-dominant bilinguals, 13 performed more accurately in Spanish (average difference between English and Spanish, 9 percentage points), but 15 (surprisingly) performed more accurately in English (average difference between Spanish and English, 9 percentage points).

Interestingly, the self-reported reading ability differential scores are not good predictors of accuracy with filler questions in the self-paced reading task. Recall that the Spanish-dominant group reported overall a better ability reading Spanish than English (a score of +0.70 in Table 6-1 for participants from both tasks; see also Table F-1, which lists a reading ability score of +0.64 for the 28 on-line participants). The 13 Spanish-dominant bilinguals who performed more accurately in Spanish had an average reading ability differential score of +0.62, very similar to the average reading ability differential score of +0.67 for the 15 who performed more accurately in English.

The finding that the Spanish-dominant bilinguals should exhibit a deficit in both the non-dominant and the dominant language has a straightforward explanation. Consider the fact that all the bilinguals tested were residing in a city where English is the majority language and were attending a university where they were expected to be fluent readers of English but did not necessarily have regular exposure to Spanish printed material in the course of their studies. Automaticity in reading (with its correlates, speed and accuracy) in reading increases with exposure and practice (see, e.g., discussion in Van Wijnendaele, 1998). Informally, we could say that extensive exposure to reading in a given

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language generally results in enhanced reading performance. If one is able to read in two languages, reading performance in each will be more directly related to reading exposure rather than to spoken language proficiency (beyond some threshold of proficiency) (see, e.g., Perfetti, 1988).[126]

6.4 Bilingual Experimental Data on the Relative Clause Attachment Ambiguity

The monolingual evidence on the RC attachment ambiguity reported in Chapter 5 pointed to differences between speakers of English and Spanish only in their ultimate attachment choices, as shown in the off-line questionnaire data. The on-line evidence, on the other hand, indicated similarities rather than differences between the two language groups, with both English and Spanish monolinguals exhibiting an early preference for RCs forced to attach low. We have evidence from two task domains: the off-line questionnaire, in which monolinguals exhibit *different* behavior patterns across languages, and the self-paced reading task, in which monolinguals exhibit *similar* behavior patterns across languages. The question of language dependency in bilingual sentence processing is therefore only properly addressed by the off-line (questionnaire) data. Here we may see either language dependent or language independent

[126] A typical complaint among the bilinguals, after completing the task in both languages, was that they sensed they had "done worse" in Spanish than in English, which surprised those who (presumably) knew themselves to be Spanish-dominant. When asked why they thought this might have happened, they generally remarked that their day-to-day activities in a society where English is the majority language prevented them from keeping up their fluency in their native language.

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processing with the bilinguals. Language dependent processing would involve the bilinguals' using separate strategies for each of their languages (e.g., high attachment with Spanish stimuli, low attachment with English stimuli). Language independent processing, on the other hand, would manifest itself as bilinguals' using one set of strategies with stimulus materials in either language—the one associated with their dominant language, or their first language, or the language they use more frequently. For example, English-dominant bilinguals would plausibly be more likely to attach low, no matter which language, while Spanish-dominant bilinguals would plausibly be more likely to attach high, in both of their languages.

In the on-line study, on the other hand, the evidence presented in Chapter 5 suggests that monolinguals share processing routines across languages. In this case, divergence in the data patterns of bilinguals and monolinguals will not be interpretable using the model of language dependency. However, we do expect to find more evidence of the performance deficit discussed above (§6.3). In particular, we expect to find speed and accuracy differences among the bilinguals, for which the pattern would be related to language dominance. Given the design of the analysis, these differences should manifest themselves as interactions of dominance and language of the materials. Importantly, the findings for monolinguals lead us to expect that neither dominance nor language of the materials would interact with RC attachment preferences. On the contrary, the expectation must be for the bilinguals to exhibit a low attachment preference in the self-paced reading experiment, particularly with short-RC materials.

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Finally, there should be uniform behavior across the bilingual groups in the question-answering task that is part of the self-paced reading procedure. Recall that monolinguals of both English and Spanish exhibited greater accuracy answering questions about forced high attachments. In the discussion of Experiment 2 data, we interpreted this finding as being reflective, not of RC attachment strategies but of question-answering strategies specific to the task itself. Bilinguals should also follow this pattern of behavior, and are expected to exhibit greater accuracy in answering questions about forced high attachments.

6.4.1 Experiment 3: Off-Line Questionnaire, Bilinguals

This experiment is the bilingual version of Experiment 1, reported in Chapter 5 (§5.3.1). It is an unspeeded questionnaire investigating the RC attachment preferences of bilingual speakers of English and Spanish. The questionnaire asks subjects to report directly on the preferred attachment of an attachment-ambiguous RC. Since it is an unspeeded measure, the strategies used by the subjects to answer the questions may not be exclusively structural, and the results not necessarily indicative of initial syntactic preferences.

Method

Materials. The testing instrument and the materials used in this experiment were identical to those used in Experiment 1 (Chapter 5, §5.3.1). Minor changes were made to the written instructions and to some of the filler items, to remove dialect-specific terminology in the Spanish language materials (e.g., *gafas* versus *lentes*

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for "glasses", *coche* versus *carro* for "car").[127] The alterations were minimal, particularly in the case of the target materials; crucially, none of the complex NPs was altered in any way between the Castillian Spanish version (Experiment 1) and the Pan-American Spanish version (this experiment). All materials changes are listed in Appendix A-1 (for the targets) and in Appendix A-2 (for the fillers).

To recap, the materials consisted of 8 practice items, 48 unambiguous fillers, and 24 ambiguous targets. The ambiguous target items manipulated length within items (short and long) and number between items (singular and plural), as indicated in the examples below.

1. Andrew had dinner yesterday with the nephew of the teacher...	(Sing N1, N2)
a. that was divorced.	(Short)
b. that was in the communist party.	(Long)
2. The journalist interviewed the daughters of the hostages...	(Plu N1, N2)
a. that were waiting.	(Short)
c. that were about to exit the airplane.	(Long)

Each practice and filler item was followed by an unambiguous question about the meaning of the sentence, while the targets were followed by questions about the ambiguous attachment of the RC.

Since each of the subjects would be reading two versions of the questionnaire, one in each of their languages, certain features had been built into the original materials construction to minimize the amount of repetition in the content of the questionnaires. The fillers were different in each of the two

[127] As noted above, the bilinguals did not speak Castillian Spanish, but rather spoke some variety of Pan-American Spanish; see fns. 115 and 120.

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versions of the test, and subjects completed one version in English, and the alternate version in Spanish. Additionally, the length manipulation in the target sentences was not based on identical RC content over the two length conditions (e.g., *...who smokes]$_{SHORT}$ a pack of filterless cigarettes a day]$_{LONG}$*; Quinn, in progress; Quinn, Abdelghany & Fodor, 2000), but rather on different RC content (e.g., *...that was divorced* for the short RC, *...that was in the communist party* for the long RC). With this design, each bilingual provides data for both versions of each target item. The language of each version was different, as was the RC content. For example, a given subject read sentence (1a) in English and (1b) in Spanish, while another read (1a) in Spanish and (1b) in English. The cross-linguistic lexical differences among the translation-equivalent items (even in the case of proper names, e.g., *Andrew* versus *Andrés*) should additionally have helped to minimize any repetition effects from the first session to the second.

Procedure. The bilingual subjects were tested in each of their two languages in separate experimental sessions which occurred a minimum of two weeks apart. Generally, the experimenter assigned subjects to one or the other language as they arrived for their first session, alternating language between subjects.[128] Approximately half of the subjects were first tested in English, and the other half in Spanish.

[128] The exceptions to this general rule were as follows: (i) when two bilingual subjects arrived together for testing, the same language was used with both subjects, to minimize codeswitching; and (ii) as the testing drew to a close, bilingual subjects were assigned to one or the other language based on what cells of the design required filling.

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The experimenter made every effort to maintain an English-only or a Spanish-only atmosphere in the testing area. However, this was not always possible for a number of reasons, including the fact that the experimenter was known to the subjects to be a Spanish/English bilingual (and therefore some chose to use their dominant language with her). Also, the testing was done at a university where English is the majority language, and (English) monolinguals and other bilinguals were being tested concurrently in the testing area, not always in the same language.[129]

To prompt subjects into a unilingual mode during the experiment, preliminary tasks were conducted in the language of the test. The background questionnaire that the subjects filled out in the first session was in the language of the test, as were the written instructions that the subjects were asked to read before they began the experimental portion of their session. Oral review of the instructions with the experimenter also took place in the language of the session.

The rest of the procedure followed was identical to that for Experiment 1, as reported in Chapter 5. The subjects were given a test packet with a sheet of instructions (see Appendix D-1), followed by the test in full which they were asked to complete without interruption. They were tested semi-individually in a quiet room where other subjects were participating in the same or other experiments. The experimenter remained in the room while subjects completed the questionnaires, but did not overtly observe subjects. It took subjects between

[129] Spanish and English were not the only languages heard in the laboratory. Many of the English-speaking participants for the monolingual version of this experiment (who were later excluded on language history grounds) spoke other languages to each other while in the testing area, most typically, Russian, Greek and Haitian Creole.

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20 and 30 minutes to complete the off-line questionnaire. (The bilinguals required considerably more time than did monolinguals to complete the separate background questionnaire seeking language histories and other biographic detail. This was, as noted earlier, in §6.2, more extensive for bilingual subjects than for monolingual subjects.)

Subjects. The bilingual data reported are from 24 subjects (12 in each of the versions of the questionnaire, half of these in each language dominance group) who received $10 ($5 per session) or two credits (one per session) in a psychology course for their participation in the two testing sessions required. The mean age of subjects was 28 and all were students at the City University of New York. Of the 25 subjects who actually participated in the study, the 24 selected were those whose linguistic background best met the language history criteria, and whose error rates in responses to filler items were less than 15%. The mean error rate on filler items for the bilinguals in the off-line study was 5.4%. Only 1 participant was excluded whose error rate on fillers (combined over the Spanish and English tests) exceeded 15%.

Data Treatment. Following a procedure identical to that used in Experiment 1 (Chapter 5), responses to target items were coded in terms of the attachment site (high or low) implied by the choice of noun; responses which had self-evidently been altered were excluded and treated as missing data. These, along with any items left blank, constituted 5.3% of the total data set. The responses were

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coded to generate subject- and item-based calculations of summary values which were cast in terms of the proportion of responses indicating *low attachment*, for each of the cells of a design factorially combining RC Length (short versus long) and Complex NP Number (N1 and N2 singular versus plural). Like in the data analysis of Experiment 1, in this experiment an additional dummy factor, Design Groups (subject groups in the subject-based analysis, item groups in the item-based analysis) takes into account the assignment of subjects and items to two versions of the questionnaire over which materials were counterbalanced (but will not reported in the discussion that follows; see remarks in §5.3.1). Finally, the analyses included as factors the independent variables Language Dominance (English- versus Spanish-dominant) and Language of the Materials (English versus Spanish). The factors for this analysis are therefore identical to those for the analysis of Experiment 1, with the exception that English and Spanish variants of the experiment (Language of the Materials factor) were encountered by the same subjects, and with the addition to the design of the Language Dominance factor. Summary tables for all analyses reported for Experiment 3 in the sections below are provided in Appendix E-5.

Results

We first summarize briefly the results from the parallel Experiment 1 (reported in Chapter 5, §5.3.1), an off-line questionnaire study carried out with monolingual subjects. Critically for the investigation of language dependency in bilingual sentence processing, English and Spanish monolingual speakers differed in terms of attachment preferences, and the difference was in the

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direction expected: English speakers overall had a higher rate of low attachment (57%) than the Spanish speakers (43%). Secondly, the length effect (higher rates of low attachment with short than with long RCs) was significant in the subject-based but not in the item-based analysis. Finally, and unexpectedly, the interaction of language and number was significant. The preference for low attachment in English disappeared when the two hosts in the complex NP were plural, while no such effect of number was present in Spanish.

Summary data for Spanish- and English-dominant bilinguals in the off-line questionnaire are presented in Figure 6-1 (for singular materials) and Figure 6-2 (for plural materials).

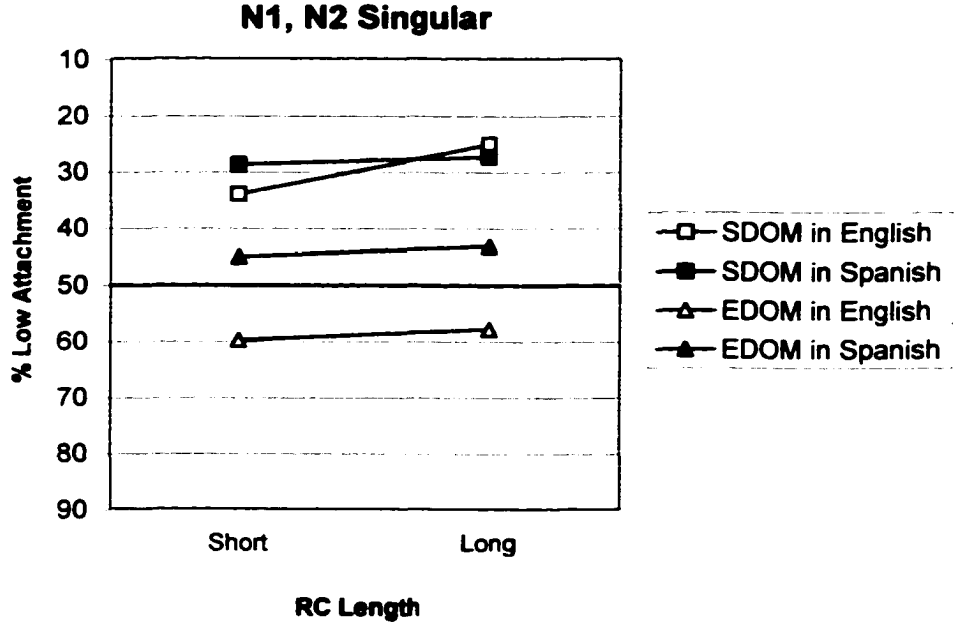

Figure 6-1: Mean percentage low attachment, in English (empty symbols) and Spanish (filled symbols), as a function of RC length, for two dominance groups. (Materials are sentences containing two singular nouns in the complex NP.)

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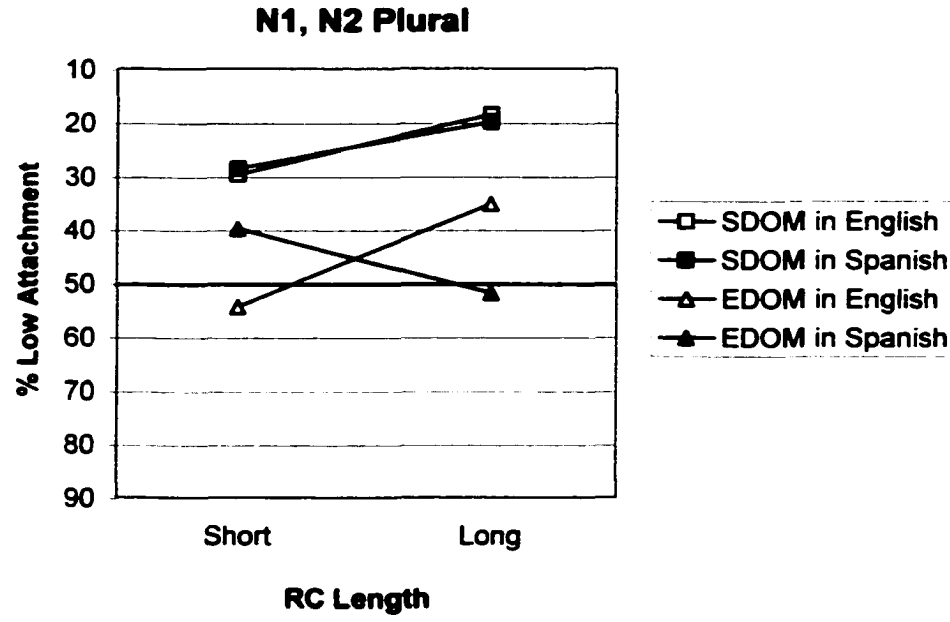

Figure 6-2: Mean percentage low attachment, in English (empty symbols) and Spanish (filled symbols), as a function of RC length, for two dominance groups. (Materials are sentences containing two plural nouns in the complex NP.)

The first clear finding for these off-line data is that the two dominance groups have different RC attachment preferences. Overall, Spanish-dominant bilinguals had a low attachment rate of 26%, compared to a rate of 48% for English-dominant bilinguals; the Spanish-dominant group exhibited a preference for *high* attachment, while the English-dominant group exhibited no overall preference either way. The main effect of dominance was significant, $F_1(1,40) = 9.04$, $p < .005$, $F_2(1,20) = 59.36$, $p < .001$, and dominance did not engage in any two- or three-way interactions, for all, $p > .10$. The four-way interaction (RC Length × Complex NP Number × Language of the Materials × Language Dominance) was not significant, $F_1(1,40) = 2.04$, $p > .15$; $F_2(1,20) = 3.53$, $p < .10$.

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Importantly for the question of language (in)dependency, there is no interaction of dominance with language of the materials, $F_1 < 1$, $F_2(1,20) = 1.39$, $p > .25$.

This unmodified effect of language dominance constitutes strong evidence of language *independent* processing in bilinguals. Regardless of the language, the length of the attaching RC, and the number features in the complex NP, the Spanish-dominant bilinguals tested were more likely to attach high than were the English-dominant bilinguals. And independently of the language of the materials, the bilinguals in this experiment used strategies remarkably like those of monolinguals of their dominant language. (It is unclear, however, why the low attachment rate is lower in this experiment, where the overall mean was 37%, than in Experiment 1, where the overall mean was 50%, even though the materials were identical. We tentatively suggest that bilinguals engage in more post-syntactic deliberations than monolinguals, thus more frequently opting for the high attachment interpretation of the ambiguity.)

Two additional patterns of effect emerging in the omnibus analysis warrant discussion; these are effects of length, and number, both of which are modulated by language of the materials.[130]

We focus first on the effects of the length manipulation. Following the findings of Experiment 1 for monolinguals, we expect to find sensitivity to the length of the attaching relative in the bilingual data. As in Experiment 1, in the

[130] In the following discussion of the effects of length and number, we will refer to independent subanalyses of the data based on language of the materials. The primary motivation for analyzing the data separately for English- and Spanish-language materials was the fact that, in the omnibus analysis, language of the materials was involved in interactions with both length and with number, as reported below.

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present experiment the main effect of length was significant by subjects, $F_1(1,40) = 5.56$, $p < .025$, and failed to reach significance by items, $F_2(1,20) = 1.51$, $p > .20$. However, length interacted with language of the materials, $F_1(1,40) = 6.35$, $p < .025$; $F_2(1,20) = 5.17$, $p < .05$. (The associated three-way interaction, Dominance × Language of the Materials × RC Length, was not significant, all values of $p > .20$. As noted above, length also did not interact with language dominance, $F_1 < 1$, $F_2(1,20) = 1.00$, $p > .25$.) Figure 6-3, below, plots the data for RC length (collapsing over complex NP number), for the two languages of the materials involved.

The figure illustrates that the bilingual subjects were sensitive to the length manipulation with English-language materials, where short RCs were overall attached lower (44.3% low attachment) than long RCs (34.0% low attachment). In a subanalysis of the English-language data independently, the effect of length was significant by subjects, $F_1(1,20) = 8.90$, $p < .01$, and was evident as a strong trend by items, $F_2(1,20) = 3.29$, $.05 < p < .10$. (Length did not engage in any interactions in the English-language data, all values of $p > .20$).

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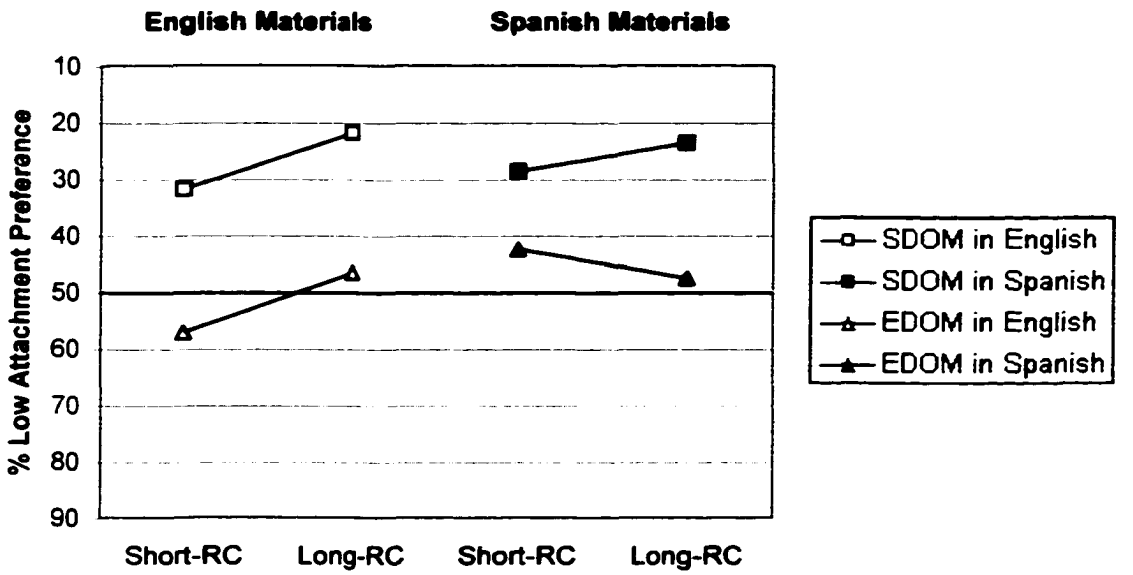

Figure 6-3: Mean percentage low attachment, in English (left panel) and Spanish (right panel), as a function of RC length, for two dominance groups. The data are averaged over complex NP number.

With Spanish-language materials, however, the sensitivity to length disappeared; the bilinguals showed an overall low attachment rate of 35.4% with both long and short RCs; for the length effect, $F < 1$ in both item- and subject-based subanalyses of the Spanish-language data. (Length did not engage in any interactions, all values of $p > .05$; the apparent interaction of length and dominance with Spanish materials was a trend in the subject-based analysis, $F_1(1,20) = 3.37$, $.05 < p < .10$, and failed to reach significance in the item-based analysis, $F_2(1,20) = 2.35$, $p > .10$.)

The finding that Spanish-dominant bilinguals, in particular, should fail to exhibit a length effect in Spanish, their dominant language, is difficult to interpret. However, an account might be possible with an assumption that sensitivity to

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length emerges most clearly in the language one reads more frequently. In the case of this bilingual sample, all subjects were more frequent readers of English, regardless of the dominant language. This tentative account is more compelling viewed from a slightly different perspective. The English-dominant bilinguals are not very fluent readers of Spanish (or at least, they are less fluent readers of their weaker language than are the Spanish-dominant bilinguals; see discussion of asymmetries in the dominance patterns of the bilinguals discussed in §6.2.1, and their consequences for overall bilingual performance in §6.3). This might explain the lack of a length effect for this group with Spanish materials.

The findings for length—sensitivity in English materials, non-sensitivity in Spanish—appear to contradict the claim made earlier of language-independent processing in bilinguals. In fact, the interaction of the length effect with language of the materials might directly suggest language-dependent processing for the bilinguals in this study. However, this same fact can be interpreted within the model of multiply-determined RC attachment developed in Chapter 5. RC length is one of several item characteristics which ultimately determine attachment preference. The extent to which there is reliance on RC length as a determinant of attachment may be modulated on a subject-by-subject basis, varying with dominance in the language *being read*. (Crucially, RC length did not interact with language dominance, which was the variable associated with the finding of language independence reported above.) We will return to this point in the discussion below, after a consideration of the effects of number in the bilingual data for this experiment.

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In Experiment 1 an effect of number emerged in the data for English (but not Spanish) monolinguals. We proposed that the finding might have to do with differently specified features at the English auxiliaries, where singular *was* might be taken to be the marked verb, compared to the Spanish auxiliaries, where the marked form is plural *estaban*. Based on this, we would expect an effect of number to emerge in this experiment with English (but not with Spanish) materials. In the omnibus analysis of the bilingual data for this experiment, the main effect of number was not significant, $F_1(1,40) = 3.50$, $.05 < p < .10$, $F_2(1,20) = 1.20$, $p > .25$, and as already noted (in the discussion of the unmodified main effect of dominance), number did not interact with dominance, F_1, $F_2 < 1$. However, as expected based on the monolingual data, in the bilingual data the interaction of language and complex NP number existed as a trend, $F_1(1,40) = 3.04$, $.05 < p < .10$; $F_2(1,20) = 3.76$, $.05 < p < .10$. (Number did not interact with length, or engage in higher order interactions, all p's > .15.) Figure 6-4 re-plots the bilingual off-line data, collapsing over RC length.

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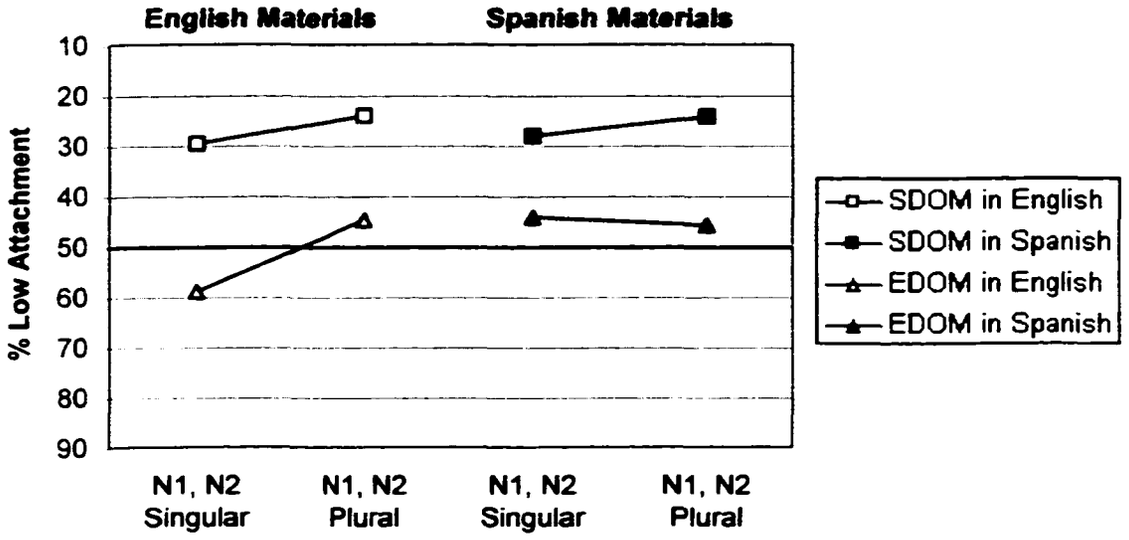

Figure 6-4: Mean percentage low attachment, in English (left panel) and Spanish (right panel), as a function of complex NP number, for two dominance groups. The data are averaged over RC length.

With English-language materials, the number of the two hosts in the complex NP seems to make a difference. Sentences with singular complex NPs induce outcomes closer to the standardly reported picture of low attachment preference for English (44.1% low attachment, overall), while those with plural complex NPs depart more drastically from it (34.2% low attachment, overall). In the independent subanalysis of data for English materials, the effect of number was significant by subjects, $F_1(1,20) = 6.74$, $p < .025$, and was a trend by items, $F_2(1,20) = 3.22$, $.05 < p < .10$, and number did not engage in any interactions, all p's > .20. This pattern stands in contrast to that for Spanish-language materials, where the independent subanalysis showed that there was no effect of number,

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F_1, F_2 < 1. (With Spanish-language materials, number did not engage in any interactions, all p's > .10.)

This result may be informative with respect to an issue left open in Chapter 5: Does the sensitivity to the number manipulation in English have to do with number processing in general (plurals go higher, whatever the language) or with number processing in English in particular? The answer to this question must await further experimentation focusing on number features exclusively. (Differing number configurations were included in this experiment as a consequence of the experimental design of the on-line task; see discussion in Chapter 4.) However, we speculated in the discussion of Experiment 1 that the possibly different specifications of number at the auxiliary in English versus Spanish (see discussion in §2.4.2, Chapter 2) might affect the way these features are processed. In particular, although both languages specify number on nouns in a similar way (plural is marked), in Spanish the plural auxiliary is marked for number (and the singular unmarked), while in English it could be argued that it is instead the singular auxiliary which is marked (and the plural unmarked).

The bilinguals exhibit a language-dependent sensitivity to the number configuration in the stimulus sentences, modulated by the language of the materials, rather than by language dominance (the factor determining the overall rate of attachment). Like the English monolingual subjects reading English sentences in Experiment 1, the bilingual subjects are more likely to attach low with singular materials than with plural materials, when reading in English. The bilingual data indicate that this does not have to do with the languages subjects

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speak and the dominance patterns they exhibit for those languages. Otherwise, we would have likely witnessed a sensitivity to number in the English-dominant group (English-dominant bilinguals behaving like their monolingual English counterparts), but not in the Spanish-dominant group. Instead, the sensitivity to number seems to be driven by the language of the stimulus materials. What exactly drives these processes in English is still somewhat unclear. We return to this in Chapter 7, where future paths for exploring this problem are outlined.

Discussion

The data for Experiment 3 are relevant to the question of language dependency in bilingual sentence processing, particularly because they arise in a domain where monolinguals of the two languages have been shown to exhibit language-specific behavior. The overall difference between the two dominance groups indicates that language dominance determines RC attachment preferences in bilinguals. The findings of this factorial experiment are also compatible with those of Fernández (1995; see discussion in Chapter 3, §3.5), in which correlational analyses of bilingual RC attachment preferences indicated that language dominance played a key role.

Beyond this apparently simple difference is a rather more complex divergence between the two dominance groups, arising from the different effects that the language of the materials has with certain item classes. The language of

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the materials determined varying degrees of sensitivity to both RC length and complex NP number, in both English- and Spanish-dominant bilinguals.

While bilinguals exhibit language-independent behavior regarding their overall attachment preference, they have language-specific sensitivities to two characteristics of the items that, as the data from Experiment 1 showed, modulate RC attachment preferences in monolinguals. The sensitivity to both RC length and complex NP number modulated bilinguals' behavior with English but not with Spanish materials. These findings add to the idea that RC attachment preferences are determined by multiple factors. Such factors may be generalized across languages, as was RC length in the monolingual results presented in Chapter 5, which had a uniform effect across English and Spanish. We have argued, furthermore, that the length effect might also be more likely to be present in the language more commonly read by bilinguals, since the sensitivity to length was present in the data for this experiment with English but not with Spanish materials. The factors determining RC attachment may be additionally related to formal features of the language being read, as the effect that the plurality of the hosts has with English-language materials in the English monolingual group and in both of the bilingual groups (English- and Spanish-dominant).

While the data presented above are informative regarding ultimate choices in RC attachment, we still need to establish what the early preferences are for bilinguals. This is the issue explored in the next and final experiment presented in this thesis. However, before we come to Experiment 4, we turn to a final

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aspect of the off-line bilingual data, namely, the nature of the data excluded from the analysis because the response either was missing or had been visibly altered by the subject.

6.4.2 Missing and Altered Responses

As noted earlier (see §6.4.1, *Data Treatment*), questionnaire items which were left unanswered or which had visibly been altered were treated as errors and excluded from the analysis. This procedure affected 5.3% of the off-line bilingual data. Of these, 2.4% of the EDOM data and 0.5% of the SDOM data were missing responses. As in Experiment 1, with data for monolinguals, missing responses will not be discussed, as they represent a very small proportion of the data. However, the distribution of the altered responses is again of interest. Table 6-12 shows the distribution of altered responses, sub-categorized into those where the alteration was from an N2 to an N1 response, and those where the alteration was from an N1 to an N2 response.

Table 6-12: Distribution of Altered Responses in the Off-Line Bilingual Data

		N2 to N1		*N1 to N2*		*Total*	
		N	*%*	*N*	*%*	*N*	*%*
English Materials	*EDOM*	6	2.08	0	0.00		
	SDOM	4	1.39	0	0.00		
Spanish Materials	*EDOM*	8	2.78	2	0.69		
	SDOM	6	2.08	2	0.69		
	Mean	24	2.08	4	0.35	28	2.43

Note: The percentages are calculated based on total target responses.

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In the discussion of alterations in the monolingual error data (§5.3.2.2), we showed that the distribution was unbalanced, and that monolingual speakers of both Spanish and English made more changes from N2 to N1 than from N1 to N2, a pattern which was significant in the analysis. A similar distribution of altered responses is present in the bilingual data. Following the pattern in the monolingual data, alterations from N2 to N1 in the bilingual data were also more frequent (2.1%) than alterations from N1 to N2 (0.4%). A χ^2 test confirms that the difference in the distribution is significant, $\chi^2(1) = 14.29$, $p < .001$.

The general explanation for the phenomenon of RC attachment that was put forward in Chapter 5 is one in which RC attachment is understood as an initial low attachment preference (driven by a locality strategy such as Late Closure) that can subsequently shift to high attachment when post-syntactic strategies come into play. The bilingual response alteration data from the off-line experiment (albeit a small portion of the data) provide strong additional support for this idea. Subjects are more likely to alter initial low attachment responses to high attachment responses. To the extent that altering a response has to do with an initial attachment decision revoked by later considerations, even this off-line questionnaire is suggestive that the initial attachment preference is for the low site, a preference which may shift as later processes begin to take effect.

The fact that the alterations pattern in similar ways with both monolingual (Experiment 1) and bilingual (Experiment 3) subjects is interesting from a theoretical point of view, but it has more crucial methodological implications. Had the altered responses been included in the analyses of the data, they would have

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shifted the grand means in slightly different directions, depending on whether initial or final responses were taken as the data. More critically, this exploration of altered responses emphasizes the importance of developing instructions stressing "first impression" rather than "considered judgment" in questionnaire tasks of this type.

6.4.3 Experiment 4: On-Line Self-Paced Reading, Bilinguals

This section reports the results of the bilingual version of Experiment 2 (Chapter 5, §5.3.3): the self-paced reading experiment is now run with English-dominant and Spanish-dominant bilinguals reading materials in each of their languages. Given Experiment 1's finding of cross-linguistic differences (off-line) for monolinguals, in the off-line questionnaire of Experiment 3 we were licensed to explore the question of language dependency in bilingual sentence processing. However, given Experiment 2's finding of consistent behavior across languages (on-line) for monolinguals, in the present experiment we are unable to consider the language dependency question; where monolinguals of two languages do not differ, the language dependency question cannot be raised. Instead, in this experiment the focus shifts to more general issues of the character of reading performance in bilinguals, compared to monolinguals.

The reading time data of Experiment 2 showed low attachment for English and Spanish. The results of the present experiment, rather than replicating those of the monolinguals, indicate that bilinguals have a different pattern of behavior with the RC attachment ambiguity. That pattern not only sheds light on the

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efficiency with which bilinguals process linguistic input in each of their languages but also suggests interesting possibilities for investigating alternative hypotheses about the existing (and conflicting) data on monolingual RC attachment preferences.

To set a background, we begin by summarizing briefly the monolingual results for the comparison Experiment 2 (presented in Chapter 5, §5.3.3). Frame 2 reading times, an indirect measure of RC attachment preference, indicated that both English and Spanish monolinguals had a low attachment preference: the monolinguals' response times were longer in the forced high attachment conditions than in the forced low attachment conditions. Independent subanalyses showed that the reading time cost for RCs with forced high attachment was significant with short RCs and not significant with long RCs. Error rates for answering the questions presented in Frame 3 (uniformly asking for confirmation of the disambiguated attachment of the RC) indicated a consistently greater accuracy on the part of both English and Spanish monolinguals in answering questions about forced high attachments. Rather than interpreting this as behavior related to processing the RC attachment ambiguity, we interpreted the result as indicative of strategies specific to the question-answering task.

Method

Materials. The materials used in this experiment are identical to those of Experiment 2 (Chapter 5), with minimal lexical changes in the Spanish version, to

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accommodate dialectal differences between the Castillian Spanish speakers of the monolingual experiment and the Pan-American Spanish speaking bilinguals of the present experiment (for example, the Castillian Spanish term for "glasses", *gafas*, was replaced by *lentes*, which is more common throughout the Spanish of the Americas). The changes are as indicated in Appendices A-1 and A-2. Critical aspects of the materials design are sketched below in summary form, for the reader's convenience.

The twenty-four (ambiguous) targets containing the RC attachment ambiguity that were used in Experiments 1 and 3 were disambiguated using number agreement, as shown in the examples below.

3. Andrew had dinner yesterday with...
   a. the nephew of the teachers / that was... (Forced High)
   b. the nephews of the teacher / that was... (Forced Low)

4. The journalist interviewed...
   a. the daughters of the hostage / that were... (Forced High)
   b. daughter of the hostages / that were... (Forced Low)

Two variables, RC length (short, long) and site of attachment (high, low), were fully crossed to produce a materials set that was distributed over four versions of the on-line reading experiment, in each language. Consequently, a subject saw only one version of each sentence in English, and one version in Spanish. The two versions of the experiment encountered by any particular subject, one in English and the other in Spanish, were selected from the prepared design to minimize the overlap of translation-equivalent materials. Thus, a target sentence encountered in, say, long-RC form in Spanish was encountered in English in its

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short-RC form. RC content was different in the short and long versions (rather than being two variants of the same idea), an aspect of the design included to minimize subjects' remembering items from one session (in Lx) to the next (in Ly).

Target sentences were followed by a question directly asking about the attachment of the RC in which the correct answer would always be YES, as in the following example:

5. Andrew had dinner yesterday with the nephews of the teacher that was in the communist party.
   Was the teacher in the communist party?

The questions for the fillers were also YES/NO questions, and balanced the number of YES and NO answers in each version of the task. To limit the extent to which the bilingual subjects would remember items from one session to the other, the 48 fillers and 8 practice items in two of the versions of the experiment were identical, but different from the 48 filler and 8 practice items in the other two versions.

Procedure. Each of the bilingual participants was tested in each of his or her two languages, in different experimental sessions separated by a minimum of two weeks. As in Experiment 3, subjects were assigned to one or the other language as they arrived for their first session. Approximately half of the subjects were tested first in English, and the other half in Spanish.

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As with Experiment 3, efforts were made to maintain a unilingual atmosphere in the testing area, although this was not always possible. The bilinguals were asked to carry out preliminary tasks in a given session in the language of the test; these tasks included filling out the background questionnaire at the beginning of the first session, and reading the procedural instructions in each of the first and second sessions.

The procedure in the self-paced reading task was identical to that in Experiment 2. Using the DMASTR software for mental chronometry, subjects paced their own reading of the experimental stimuli, which were presented in three frames. The first frame included the beginning of the sentence through the end of the complex NP; the second frame presented the RC in its entirety; and the third frame was a YES/NO reading comprehension question. Subjects received feedback on their answers to questions.

For each session, subjects were asked to study a sheet of instructions about the reading task (see Appendix D). The instructions were reviewed orally by the experimenter with each subject, and were repeated at the beginning of the on-screen presentation. The written, oral, and on-screen instructions for each task were either completely in English or completely in Spanish, as was the feedback provided by the on-screen presentation, following comprehension questions. It took subjects between 15 and 25 minutes to complete the on-line reading task.

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Subjects. The data reported are from 56 subjects who received $10 ($5 per session) or two credits (one per session) in a psychology course for their participation in each of the two required testing sessions; half of these were Spanish-dominant and the other half, English-dominant. (The 28 subjects of each dominance group were evenly distributed over 4 versions of the experiment.) The mean age of subjects was 25 and all were undergraduate students at Queens College in the City University of New York. Of the 82 subjects who participated, the 56 whose data are reported here were selected following the criteria for bilinguality as specified in Experiment 3, and additionally, a criterion that the combined error rate for the tasks completed in the two languages should be below 30%.[131] The mean error rate with fillers was 19.1%. In their dominant language, the bilinguals' mean error rate with fillers was 16.3%, compared to 21.9% in their non-dominant language.

Data Treatment. For the analyses of reading times, values less than 500 msec were rejected as outliers; this trimming procedure affected 0.7% of the data for the final set of 56 subjects. (Because of the pre-set "time-out" limit per frame, no reading time responses exceeded 9000 msec.) Additionally, values falling beyond cutoffs established for each subject at mean plus-or-minus two standard deviations were replaced with those cutoff values, in order to limit the extent to

[131] Three participants were excluded because their language history profiles departed significantly from those of the rest of the bilinguals. Eleven participants were excluded because their accuracy in answering filler questions was inadequate. Twelve participants were excluded because they did not return for a second session.

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which occasional extreme values might distort the mean. This procedure affected 3.9% of the data.

Subject- and item-based calculations of summary values were cast in terms of reading times (in msec) for Frame 2, and percent errors for Frame 3, for each of the cells of a design factorially combining Attachment Site (low versus high) and RC Length (short versus long).[132] The analyses also included as factors Language Dominance (English- versus Spanish-dominant) and Language of the Materials (English versus Spanish). An additional dummy factor, Design Groups (subject groups in the subject-based analysis, item groups in the item-based analysis) took into account the assignment of subjects and items to four versions of the experiment over which materials were counterbalanced. The factorial design for this experiment is identical to that for Experiment 2, with the exceptions that English and Spanish variants of the experiment (Language of the Materials factor) were encountered by the same subjects, and that a Language Dominance factor has been added.

Results

For the two bilingual groups, the results for reading times in Frame 2 are shown in Figure 6-5, where the difference between the forced low and forced high attachment conditions is plotted as a function of RC length. Here (as in Figure 5-6, which displays the corresponding monolingual results), the chart displays differences calculated by subtracting the mean reaction times in the

[132] As in Experiment 2, in Chapter 5, reaction times for Frame 3 will not be reported, because of their unreliability given the high error rates in this frame.

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forced high conditions from the mean reaction times in the forced low conditions; thus, a high attachment preference would result in a positive figure (upper half of the chart), and a low attachment preference in a negative figure (lower half of the chart).

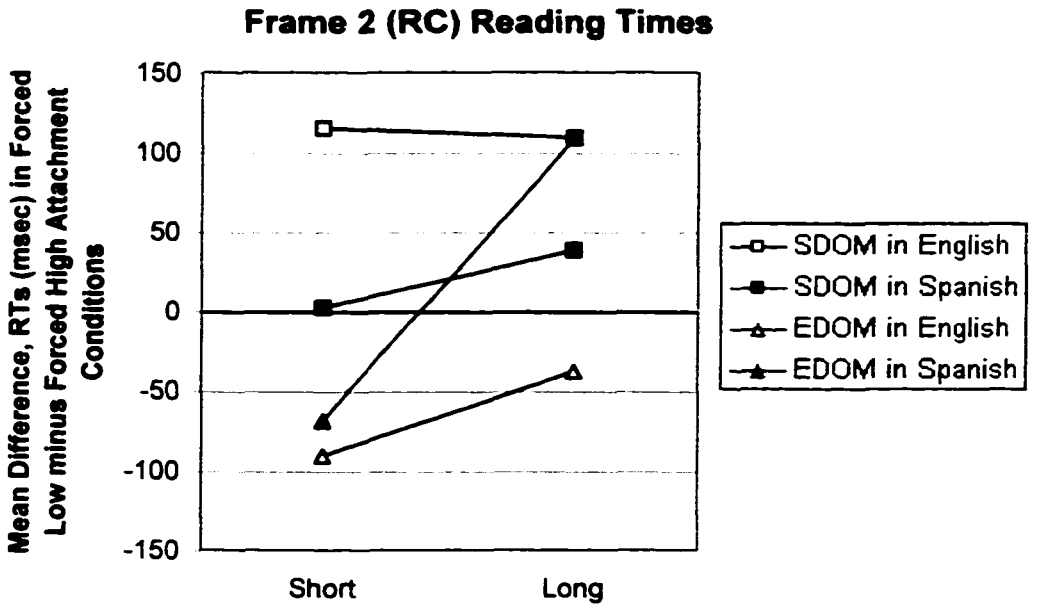

Figure 6-5: Mean difference, in English (empty symbols) and Spanish (filled symbols), between RTs (in msec) for Frame 2, in forced low and forced high attachment conditions, as a function of RC length, for two dominance groups.

Certainly we do *not* see, in these reading time data for bilingual speakers, the consistent pattern of low attachment preference exhibited by monolingual speakers. Notwithstanding the differences of outcome apparently suggested by Figure 6-5, the analysis of variance gave no indication that the high/low contrast played any critical role. The main effect of attachment site was not significant, F_1, $F_2 < 1$, and attachment site did not engage in any interactions with other factors, all values of $p > .15$.

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These null findings with respect to attachment site are difficult to interpret as indicative of first parse preferences for Spanish/English bilinguals. Interestingly, the lack of preference for either attachment site observed in this experiment is similar to the results of a self-paced reading study of the same ambiguity conducted (in Spanish only) by Dussias (in press) with Spanish/English bilinguals (see Chapter 3, §3.5). In Dussias' study, early bilinguals (those most comparable to the subjects in this experiment) showed no reliable attachment preference.

That bilinguals do not exhibit a sensitivity to one attachment site or another cannot be interpreted as indicative of an absence of syntactic parsing strategies in bilinguals, since such a proposal has the implausible implication that bilinguals do not follow procedures which distinguish between alternative syntactic structures. (As we saw in Experiment 3, bilinguals do exhibit off-line preferences for high or low attachment.) An alternative explanation (proposed by Dussias) to account for the null finding is that bilinguals develop an amalgamated set of strategies, which compromise over conflicting preferences in the two languages. This explanation, however, is necessarily ruled out by the monolingual findings of Experiment 2, where both English and Spanish speakers exhibited a consistent preference for low attachment.

In the absence of evidence to the contrary, we might assume identical processing for bilinguals and monolinguals reading stimulus materials containing the RC attachment ambiguity. The monolinguals in both English and Spanish exhibited an initial preference for the low site. The possibility that is to be

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considered is that bilinguals also have this preference, but that it is difficult to capture. On the one hand, the intrinsic variability of bilingual reading performance might have made the data noisy to the extent that RC attachment preferences were masked. On the other hand, we need to contemplate the possibility that the sensitivity of self-paced reading measures to "early syntactic processes" is *not* guaranteed. Keeping the latter possibility in mind, the discussion that follows explores the on-line data taking into consideration aspects of the results for Frame 2 which have to do with overall reading speed.

The analysis of variance indicated that language of the materials engaged in a three-way interaction with dominance and length, $F_1(1,96) = 10.84$, $p < .001$, $F_2(1,20) = 15.18$, $p < .001$; also significant were the related two-way interactions, language and dominance, $F_1(1,96) = 32.67$, $p < .001$, $F_2(1,20) = 28.30$, $p < .001$, and language and length $F_1(1,96) = 13.07$, $p < .001$, $F_2(1,20) = 10.16$, $p < .005$. (The interaction of dominance and length was not significant, F_1, $F_2 < 1$.) All of these interactions have in common the factor of language of the materials, and further examination will therefore proceed considering data subsets for English- and Spanish-language materials, separately.

Figure 6-6 shows the average reading times at Frame 2 for the two bilingual groups, collapsing over site, with short versus long materials, in both English and Spanish. The bars in Figure 6-6 represent the average reading times at Frame 2 for the monolinguals from Experiment 2, for comparison purposes. (The performance deficit discussed in Chapter 3 and earlier in this

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chapter is evident in the figure: the bilinguals took some 400 msec longer, on average, than the monolinguals to read the RCs presented in Frame 2.)

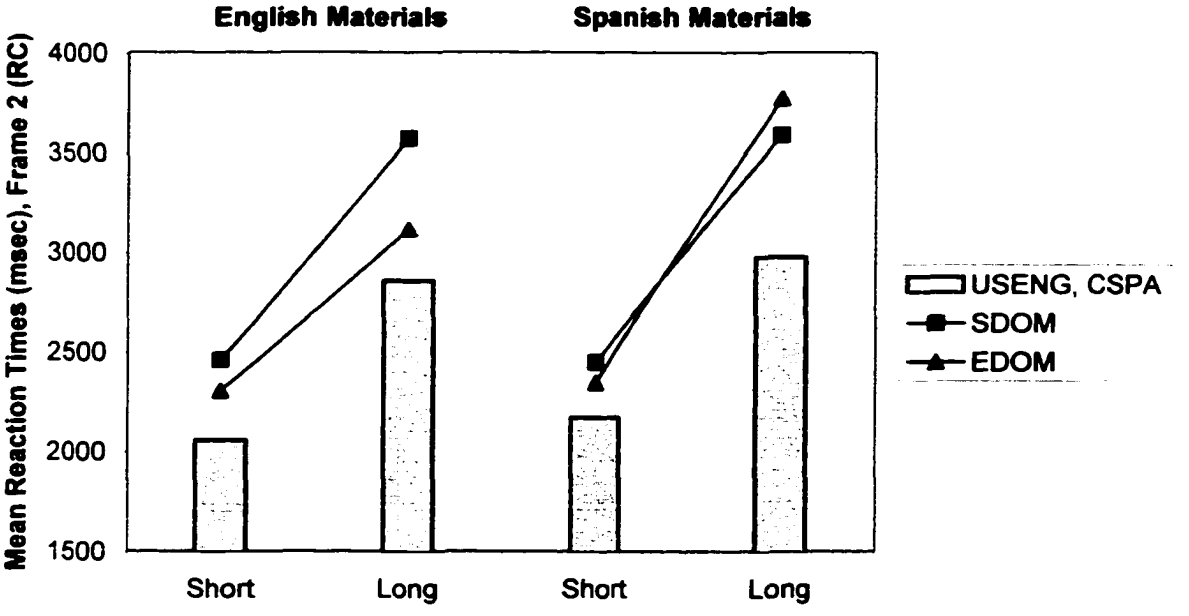

Figure 6-6: Mean reaction times for Frame 2, for monolinguals (data from Experiment 2) and English- and Spanish-dominant bilinguals, as a function RC length, for materials in English (left panel) and Spanish (right panel). The data are averaged over attachment site.

Let us focus first on the independent subanalyses of the data for English-language materials (left panel of Figure 6-6). For the two dominance groups taken together, long RCs in English took 959 msec longer to read than short RCs, $F_1(1,48) = 318.08$, $p < .001$; $F_2(1,20) = 103.08$, $p < .001$, reflecting the (entirely unsurprising) effectiveness of the length manipulation. There was also a main effect of dominance (though one that just failed to reach conventional levels of significance in the subject-based analysis), $F_1(1,48) = 3.95$, $p < .10$, $F_2(1,20) = 43.80$, $p < .001$: overall, English-dominant bilinguals read the English materials

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308 msec faster than Spanish-dominant bilinguals. Moreover, the interaction of length and dominance was significant, $F_1(1,48) = 8.43$, $p < .01$; $F_2(1,20) = 13.92$, $p < .001$.

Further subanalyses of the English-language data, considering the two length conditions separately, indicated that the reading time difference was significant with long RCs (SDOM taking 457 msec longer than EDOM, $F_1(1, 48) = 7.69$, $p < .01$, $F_2(1,20) = 46.24$, $p < .001$), but not with short RCs (the difference of 159 msec, though still favoring English-dominant bilinguals, was non-significant, $F_1 < 1$, $F_2(1,20) = 8.38$, $p < .01$). This pattern is not unexpected: it is entirely reasonable that bilinguals might experience a reading delay in their non-dominant language, and that the delay is more notable when there is more lexical material (as in the case of long RCs).

With Spanish-language materials (right panel of Figure 6-6), on the other hand, the pattern of the performance deficit appears in mirror-image though not perfectly so—we do not find the bilinguals for whom this language is non-dominant experiencing a greater delay *overall* than those for whom it is. Thus, unlike in the English-language subanalysis, the effect of dominance in the subanalysis of the Spanish-language data was not significant, F_1, $F_2 < 1$, with English-dominant bilinguals taking only 40 msec longer on average to read Frame 2 than Spanish-dominant bilinguals. (The effect of RC length in the Spanish-language subanalysis, as expected, was significant, $F_1(1,48) = 358.71$, $p < .001$, $F_2(1,20) = 111.43$, $p < .001$, long RCs taking an average 1285 msec longer to read than short RCs, again reflecting the effectiveness of the length

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manipulation.) However, as before, the interaction of dominance and length was significant (though it failed to reach conventional levels of significance in the subject-based analysis), $F_1(1,48) = 3.58$, $p < .10$, $F2(1,20) = 6.61$, $p < .025$.

Independent sub-analyses by RC length carried out on the Spanish-language data confirmed that the differences between the two dominance groups with Spanish materials were not significant. With long materials, the 182 msec difference in favor of Spanish-dominant bilinguals was not significant, $F_1 < 1$, $F_2(1,20) = 4.60$, $p < .05$. With short materials, the 102 msec difference in favor of English-dominant bilinguals was also not significant, $F_1 < 1$, $F_2(1,20) = 1.86$, $p > .10$.

Figure 6-6 illustrates a uniform pattern between English and Spanish materials: the slope of the length effect is steeper when the language being read is the bilingual's non-dominant language. With English materials, the cost of extra length is greater for Spanish- than for English-dominant bilinguals, and conversely, with Spanish materials, the cost of extra length is greater for English- than for Spanish-dominant bilinguals. The cause of the cross-over interaction in the right panel of Figure 6-6 is somewhat unclear. English-dominant bilinguals do not exhibit a disadvantage reading short-RC materials in their non-dominant, Spanish, resulting in the cross-over pattern when the disadvantage associated with reading long RCs is added in. We tentatively suggest that English-dominant bilinguals, used to reading complex material only in English, have not developed expert reading habits in their non-dominant language, and pace themselves

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inadequately through the material in Spanish (they read the short materials too fast).

The reading time patterns just reported are useful in developing an understanding of the nature of the performance deficit associated with bilingualism. The reading time delay experienced by the bilinguals reading materials in their non-dominant language emerges especially in the context of more lexical material (with longer RCs). The additional lexical material requires not only additional decoding of symbols, but also additional access to the lexicon (without necessarily adding syntactic complexity, other than the fact that there are more constituents, such as PPs, in the RC). It seems likely, then, that the delay arises not so much because of a lack of automaticity in syntactic routines per se, but rather because of additional load on lower-level (lexical) processes.

We now turn to the error rates in answering the questions presented at Frame 3. With monolinguals in Experiment 2, we found greater accuracy in answering questions about forced high attachments, consistently across the two languages. We interpreted this result as reflective of question-answering strategies rather than RC attachment strategies. The expectation for the bilinguals is that they should also have greater accuracy in answering questions about forced high attachments, as this behavior is linked not to specific linguistic processing components but to more general components of the cognitive system.

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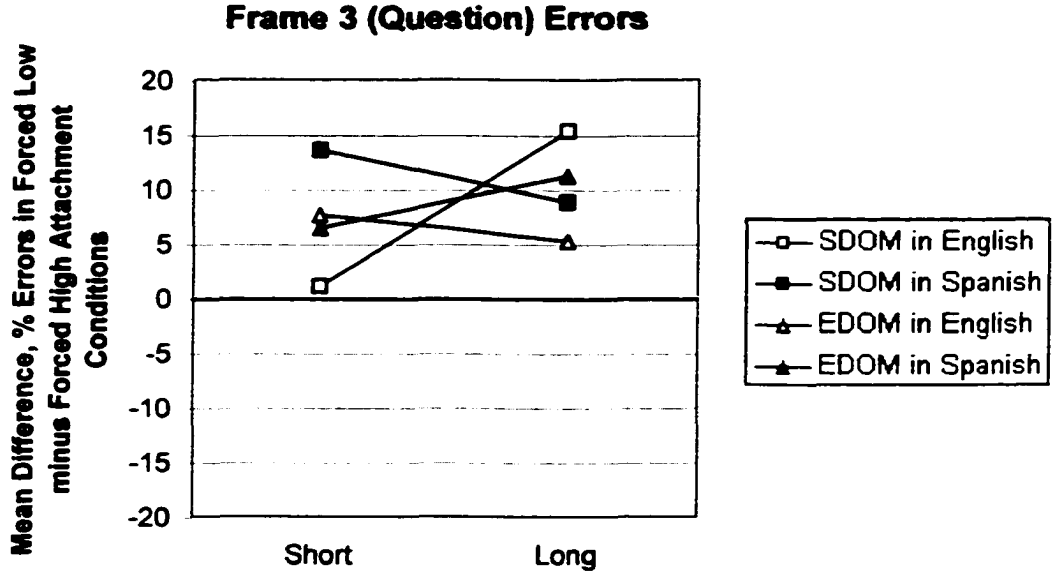

Figure 6-7: Mean difference, in English (empty symbols) and Spanish (filled symbols), between % errors at Frame 3, in forced low and forced high attachment conditions, as a function of RC length, for two dominance groups.

Figure 6-7 plots the question-answering error data for the two bilingual groups, in terms of the difference between errors in the forced low and the forced high attachment conditions, as a function of RC length. As in Figure 5-7 (presenting the corresponding data for monolinguals), positive differences (those falling in the upper panel) reflect fewer errors with forced high attachments.

As with the monolinguals in Chapter 5, we find a main effect of site in the Frame 3 error data for the bilinguals. The bilinguals made more errors overall with questions for items that were forced to attach low (31.9%) than with questions for items that were forced to attach high (23.1%), resulting in a mean difference favoring the latter of 8.8%, $F_1(1,96) = 19.57$, $p < .001$, $F_2(1,20) = 5.33$, $p < .05$. This replication of the earlier finding, now with a population of readers

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with very different characteristics, is a particularly striking one. Its generalization to Spanish/English bilinguals, whose reading time data at Frame 2 gave no indication that attachment site played any important role, therefore adds support to the interpretation proposed in Chapter 5 for the behavior in this speeded question-answering task, namely, that it reflects task-specific question-answering strategies rather than attachment preferences driven by syntactic or post-syntactic mechanisms of the sentence processing machinery.

However, the replication of the finding for monolinguals is not an exact one. The omnibus analysis of Frame 3 error data also revealed that the site effect engaged in a four-way interaction with the other variables tested (i.e., dominance, language and length), $F_1(1,96) = 3.91$, $p < .10$, $F_2(1,20) = 7.62$, $p < .025$. This complex pattern of interaction has no ready interpretation. To support the brief discussion that follows, Figure 6-8 below displays the bilingual question-answering data in a different form. The values depicted now represent mean error rates in each cell of the design directly, cf. Figure 6-7's depiction of site effects via mean differences in error rates.

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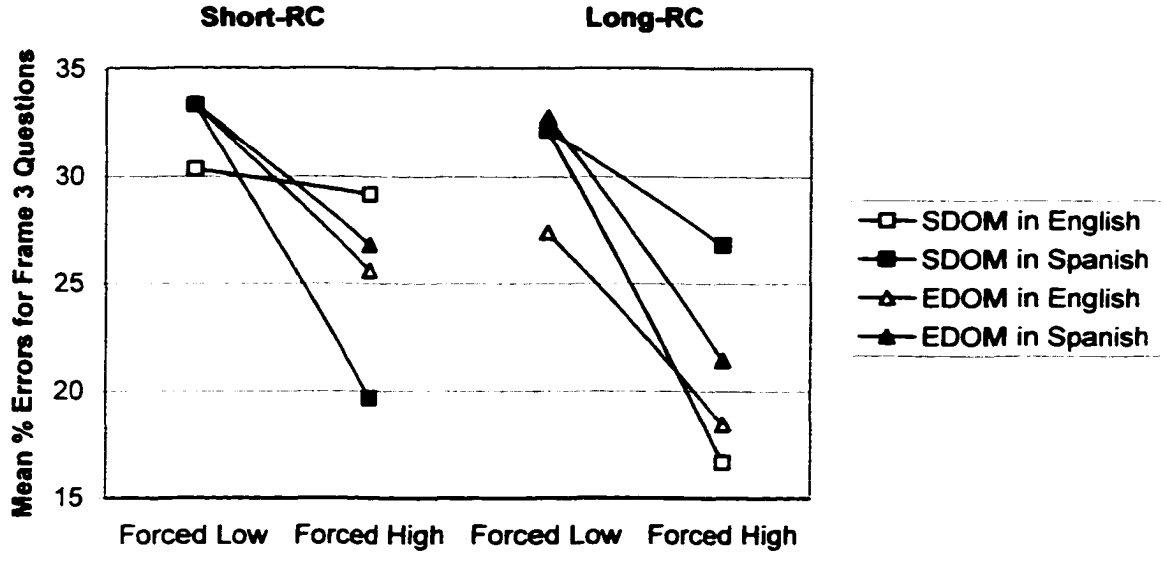

Figure 6-8: Mean error rates for Frame 3, in English (empty symbols) and Spanish (filled symbols), as a function of attachment site with short-RC and long-RC materials, for two dominance groups.

Figure 6-8 makes clear the variability of site effects in these data for bilinguals which has been reflected in the finding of a four-way interaction. While each cell of the Dominance × Language × Length design exhibits numerically fewer errors for items in which RCs attach high rather than low, the magnitude of the site effect ranges cell-to-cell from negligible (a 1.2% difference, in the Spanish-dominant data for short-RC items read in English) to substantial (a 15.5% difference in the Spanish-dominant data for long-RC items read in English), with no evident systematicity. Considerations of power rule out the fine-grained subanalyses that this kind of data scatter usually demands. We can observe, however, that variability in the magnitude of site effects seems to be chiefly driven by variation in the error rates for item types where RC attachment had been forced high, *cf.* relative stability for items with forced low attachment.

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In Chapter 5's discussion of question-answering behavior in monolingual readers, we attributed the finding (of decreased accuracy with items forced to attach low) to difficulties encountered by subjects when a comprehension question is not posed about an element central to the meaning of the sentence. We reiterate this argument, given the findings just reported. What remains to be explained is the variability with forced high items, a puzzle which must await future experimentation focusing on the strategies employed by subjects when performing tasks of this type.

Discussion

The data from Experiment 4 provide important findings regarding two aspects of bilingual performance: RC attachment preferences on the one hand, and the performance deficit associated with bilingualism on the other. The analysis of Frame 2 reaction time results indicated that the attachment site manipulation did not play any important role in determining behavior. Further analysis of the results proved to be informative regarding the delay experienced by bilinguals when reading material in their non-dominant language. The deficit is less notable, however, when there is less lexical material. Finally, Frame 3 error data are indicative of a pattern similar to that of the monolinguals, albeit with more noise: questions about forced low attachments were answered less accurately than questions about forced high attachments.

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That there is no effect of site in the Frame 2 reaction time data could be interpreted as indicative of a lack of systematic use of parsing strategies on the part of bilinguals. However, a more plausible interpretation is that the self-paced reading task is differently sensitive with different types of readers. The difference between the readers considered here has to do with overall speed, decreased in the bilingual group (compared to the monolingual group), an aspect of performance which was expected based on existing knowledge on bilingual performance.

One particularly enigmatic aspect of self-paced reading procedures is understanding what signal it is which tells the reader that enough time has been spent reading a given stretch of material and that it is appropriate to initiate a button press to move on. This problem becomes even more difficult for the final frame (Frame 2), where sentence-final "wrap-up" effects might also be playing a role. It is this signal which in the end determines speed of response in the self-paced reading task. Reasonably, we might propose that the speed of response depends largely on how quickly constituent words are recognized. This would readily explain why bilinguals take longer than monolinguals to respond: they take longer to recognize the words, because they need to sort through more lexical entries. The amount of time a reader takes to access the necessary lexical entries when reading a sentence varies depending on the number of words being read, as well as on the number of competitors in the reader's lexicon. For bilinguals the number of competitors for a given input word may be greater than for monolinguals. Bilinguals may also have less automatized

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routines for decoding symbols, or less automatized lexical access routines, especially in their non-dominant language and/or in the language for which they are less frequent readers.

After a bare minimum of the lexical material has been recognized (say, the relative pronoun and the auxiliary), the parser can begin to run in the background; when the parser has finished its initial routines, the post-syntactic routines may apply in a way that affects (measured) speed of response, if there is still time. If the lexical material takes longer to process, the parser may be done with its routines and the post-syntactic processes may have begun to apply by the time the signal to move on has been made. If, on the other hand, the lexical material is recognized quickly, the button may get pressed before post-syntactic considerations have had a chance to come into play.

Under this view, the signal to move on is based on the achievement of a *lexical* interpretation, rather than on any availability of a fully built phrase marker for the material that has been received. Also implied is that the syntax running in the background makes attachment decisions based on minimal syntactic information, as soon as enough words flagging the presence of an RC have been recognized. Then for short RCs, there is not much time after the fact of the RC is recognized (and an initial low attachment is made) before the signal to move on occurs. For long RCs, on the other hand, there could be quite a delay before the signal to move on takes place, leaving more time for post-syntactic considerations to come into play.[133]

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[133] The lexical proposal outlined in this section is similar to an idea proposed by Pynte (1998; see also Pynte & Colonna, 2000; see also fn. 24, p. 40, above).

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However, under this view, we must abandon the interpretation put forward in Chapter 5, which attributes length effects to the interface between prosody and syntax.[134] There is reason to believe that the lexical account proposed in this chapter provides a more parsimonious account of the data in this thesis, at least the data from the self-paced reading Experiments 2 and 4. The prosody account specifically predicts an interaction between length and attachment site, with short RCs taking less time to read if forced to attach low, and long RCs taking less time to read if forced to attach high. This interaction was not obtained in either the monolingual or the bilingual experiments. Instead, with monolingual readers, we found a low attachment preference with both short and long RCs, a preference which was reliable with short RCs and unreliable with long RCs, in independent subanalyses. If this finding is instead interpreted under the account proposed above, the loss of reliability with long RCs in the Frame 2 reading time data for the monolinguals is related to the amount of lexical processing, increased with the added length of the RC, which impacts on the window of opportunity to catch an initial low attachment preference. The lexical account can thus handle the results in both Experiment 2 and Experiment 4.

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[134] Crucially, to distinguish between prosodic and lexical accounts of the shift from low attachment evident with longer materials, a systematic comparison would need to be made between the prosodic weight (in terms of, say, PWds) versus the lexical weight (in terms of lexical words) of attaching constituents, something which the experiments reported in this thesis were not designed to do. Furthermore, any eventual adoption of the lexical interpretation would also mean setting aside some of the observations made in Chapter 5. In particular, in the report of the findings for Experiment 1, we noted that the differences found between Spanish and English monolingual speakers might be exaggerated if we take into consideration intrinsic differences in the prosodic weight of the attaching constituents between English and Spanish. Such a remark would need to be set aside if the lexical account outlined here turns out to provide a more accurate interpretation of the data.

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6.5 Summary: Relative Clause Attachment in Spanish/English Bilinguals

The language (in)dependency question we set out to answer at the beginning of this dissertation—i.e., whether bilinguals are like two monolinguals in one—must be answered in the negative. Speakers of two languages process their two languages using language-independent sentence processing routines, and the evidence from Experiments 3 and 4, reported above, indicates that those routines are the ones associated with bilinguals' dominant language. However, let us address this finding in detail, considering first the early ("on-line") processing of monolinguals and bilinguals, and second, the later ("off-line") processing.

First, we found no cross-linguistic differences in early monolingual processing: speakers of English and Spanish seem to prefer low attachment in the early phases. Given this lack of cross-linguistic differences, the language dependency question is inapplicable for the bilinguals. In this case, therefore, we would expect bilinguals to behave in very similar ways to the monolinguals. However, we saw this was not entirely true. The bilinguals were slower readers, overall, than the monolinguals, a result which was expected given our discussion of the bilingual performance deficit.

But in addition, the reading time data for bilinguals provided no evidence that they were attaching low, a result which is somewhat unexpected, but not inexplicable. If we compare the behavior of the bilinguals, overall, with the behavior of the monolinguals reading long RCs, we can argue that the bilinguals

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did not *skip* the syntactic processing routines, but rather that the experimental measures failed to capture the event when it happened.

These findings call into question the proposal that length effects are the result of an interplay between prosodic segmentation preferences and syntactic attachment preferences, at least in the determination of initial attachments. The view advanced here is one where low attachment prevails the parser's initial routines, an initial attachment which might be reconsidered in later phases of processing when post-syntactic considerations may play a role. Such reanalysis should, in principle, only be possible in the case where all other things are equal, where all possible interpretations are grammatical, and so on. The multiple post-syntactic factors that shift an initial low attachment preference—whatever they might be—seem likely to have different weights cross-linguistically, and there is nothing in the research reported here to suggest why this should be so. Rather, the position put forward here proposes specifically that whatever cross-linguistic differences exist emerge only in later stages of processing.

Cross-linguistic differences in the monolingual data were indeed obtained in the off-line questionnaire study, where English speakers tended to attach lower than Spanish speakers. In the bilingual off-line questionnaire results we saw a language effect, but *between* rather than *within* the two dominance groups. The English-dominant bilinguals exhibited overall lower attachment preferences (in both of their languages) than the Spanish-dominant bilinguals whose preferences were overall higher (in both of their languages). This result is evidence of language independent processing. Bilinguals process linguistic input using the

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same type of strategies for both of their languages, and the set they use is the one associated with their dominant language. Language-specific stimuli are handled by a quasi-universal device, which has some (post-syntactic) functions that might differ cross-linguistically in monolingual populations. (These functions are the ones responsible for the overall difference found in the off-line questionnaire between monolingual English speakers and monolingual Spanish speakers.) For bilinguals, one set of language-specific functions takes over the entire system. Independent of the stimulus language, bilinguals have ultimate preferences in both of their languages that resemble those of monolingual speakers of their dominant language.

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CHAPTER 7

CONCLUSIONS

The original motivation for the research reported in this dissertation focused on a specific aspect of bilingual performance: the question of language dependency in bilingual sentence processing. The focus was on determining whether bilinguals with proficiencies in each of their languages sufficient to support reasonable fluency process linguistic input by employing the routines that are followed by monolinguals of each of their languages. We recapitulate the central ideas presented in the preceding chapters first by describing the general background considerations of the investigation, and then by briefly restating the important results of the experiments conducted. The final section goes on to suggest possible avenues for future research in this area.

7.1 Background Considerations

In order to study the question of language dependency in bilingual sentence processing, we first needed to find a sentence-processing phenomenon for which cross-linguistic differences existed in some form. Without such a phenomenon bilinguals would be expected to process linguistic material following the same set of (presumably universal) routines—in both of their languages—as

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would be used by monolinguals of either language. This would limit the study of bilingual sentence processing to the investigation of the ways in which bilinguals diverge from the monolingual norm.

Fortunately, one phenomenon exists in sentence processing research for which cross-linguistic differences have been extensively documented: relative clause attachment preferences in languages such as Spanish and English. This body of literature indicates that Spanish and English speakers ultimately have different patterns of preference in attaching relative clauses to complex NPs. English speakers prefer low attachment, while Spanish speakers prefer high attachment. This fact holds if the methodology is unspeeded (e.g., questionnaire tasks),[135] but does not always hold if the methodology is speeded (e.g., self-paced reading tasks). Critical differences among the existing experiments make comparisons very difficult (see Chapter 2 for a review of this literature). The way to proceed, therefore, is to test English and Spanish speakers in parallel, using closely matched materials and identical methodology, and contrasting unspeeded and speeded measures. Experiments 1 and 2 in Chapter 5 were designed and implemented to accomplish precisely this task.

We have argued (particularly in Chapter 3) that the problems to consider in bilingual sentence processing hinge on whether monolingual sentence processing turns out to be the same in all languages, or differs across certain languages. In the first case (i.e., if all languages are processed in the same

[135] It is noteworthy that questionnaire tasks have also shown that attachment preferences, within a given language, can be shifted around by a variety of item-based as well as subject-based manipulations.

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way), bilinguals should exhibit nothing other than a "performance deficit". This deficit should emerge especially in the bilinguals' non-dominant language, and might be related to the coexistence of two codes. Two sets of lexical items and two sets of grammars—one for Lx, the other for Ly—might decrease processing speed or might impact on automaticity in processing, given that there are more lexical entries to sort through, and more syntactic alternatives to consider. In the second case, if monolinguals differ, bilinguals may engage in language dependent or language independent behavior. The preferences of a bilingual are then either the same when processing both languages (language independent processing), or different, depending on the language of the stimulus (language dependent processing). In some preliminary work on relative clause attachment in bilinguals (see discussion in Chapter 3), it was established that age of acquisition played an important role in determining whether L2 speakers of English would transfer Spanish-like strategies into English perceptual routines. This work also showed that language dominance could be a driving force behind patterns of attachment preferences. Experiments 3 and 4 in Chapter 6 address directly the impact of language dominance on the relative clause attachment preferences of bilinguals, while at the same time examining the question of language dependency in bilingual sentence processing, via the relative clause attachment preferences of Spanish/English bilinguals in each of their languages.

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7.2 Summary of Experimental Findings

The set of experiments presented in Chapters 5 and 6 constitute, in effect, a three-way comparison of off-line and on-line measures, English and Spanish materials, and monolingual and bilingual subjects. Within the materials, manipulations of length and number were included (see discussion in Chapter 4). Length was manipulated to test the predictions of the anti-gravity law (Fodor, 1998), which makes reference to the interplay of prosodic segmentation preferences and syntactic preferences. Under the anti-gravity law, short relative clauses prefer low attachment, while longer (and therefore heavier) relative clauses are freer by virtue of their prosodic weight to seek the higher host. Number was manipulated because it was the syntactic device used for disambiguating the on-line materials. In fact, number was chosen as the vehicle for disambiguation because it is the only formal feature shared by English and Spanish which would serve the purpose of disambiguating the attachment of a relative clause syntactically.[136]

The off-line questionnaire data for monolingual speakers of English and Spanish (Experiment 1) indicated that there are cross-linguistic differences between speakers of the two languages in terms of ultimate relative clause attachment preferences. That is, given ambiguous sentences in English such as (1) (or its translation-equivalent in Spanish in (1')), below, English speakers were

[136] In this summary of the experimental findings, we will gloss over the modulation by number that emerged particularly in the off-line experiments. The reader is referred to Chapter 5 (§5.3.1) for further discussion of relevant monolingual off-line evidence, and to Chapter 6 (§6.4.1) for bilingual off-line evidence. An exploration of certain aspects of the number manipulation in the on-line monolingual experiment are also discussed in Chapter 5 (§5.3.4).

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more likely than Spanish speakers to choose an interpretation in which the relative clause, *that was divorced*, referred to the lower noun (*teacher*).

1. Andrew had dinner yesterday with the nephew of the teacher that was divorced.

1.′ Andrés cenó ayer con el sobrino del maestro que estaba divorciado.

However, the differences between the English and Spanish monolingual speakers were shown to be more modest than they otherwise seemed, if intrinsic length (or prosodic weight) differences between the materials in the two languages were taken into account. Furthermore, an unexpected effect of number emerged in the off-line questionnaire monolingual data, with English but not Spanish speakers exhibiting a sensitivity to the configuration of number in the materials.

The corresponding bilingual data from the off-line questionnaire (Experiment 3) provided the key piece of evidence for concluding that bilingual sentence processing is language independent. This evidence was the unmodified main effect of dominance in the relative clause attachment preference data. For materials either in English or Spanish, English-dominant bilinguals showed overall attachment preferences closer to those of English monolinguals, while Spanish-dominant bilinguals showed overall preferences closer to those of Spanish monolinguals. What makes these findings instances of language independence, in the sense intended here, is that these patterns held across the board for each of the dominance groups, regardless of the language of the experimental materials.

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The on-line self-paced reading experiment with speakers of English and speakers of Spanish revealed that the behavior of speakers of each of these two languages was quite consistent. Both monolingual groups showed a preference for low attachment, as indicated by longer reading times with relative clauses forced syntactically to attach high (see (2a), below), compared to reading times with relative clauses forced to attach low (see (2b)).

2. Andrew had dinner yesterday with...
   a. the nephew of the teachers / that was divorced. (Forced High)
   b. the nephews of the teacher / that was divorced. (Forced Low)

This finding, while incompatible with some existing evidence on Spanish monolinguals, is compatible with the work of De Vincenzi and colleagues (De Vincenzi & Job, 1993, 1995; Baccino, De Vincenzi & Job, 2000) in Italian and French. The evidence presented in Chapter 5 for both English and Spanish monolinguals is exactly that predicted by a syntactic principle of locality in the attachment of new constituents, a principle such as Late Closure: a relative clause is initially attached to the local (low) site.

Also consistent in the monolingual on-line data was the behavior of speakers of English and speakers of Spanish with questions posed after every target item, asking subjects for confirmation that they had understood the grammatically licensed attachment of the relative clause. Uniformly, subjects were more accurate when the question was posed about a relative clause forced to attach high, compared to when the question was posed about a relative clause forced to attach low.

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3. a. Was the nephew divorced? (Question for (2a), Forced High)
   b. Was the teacher divorced? (Question for (2b), Forced Low)

This finding was interpreted as indicative of subjects following routines in answering such a question that are quite different from those related to the syntactic and post-syntactic routines employed in relative clause attachment. The questions answered more accurately were those cast about N1 which, as direct object of the matrix verb, is a more salient element of the sentence. Subjects encountered more difficulties answering accurately when the questions were posed about N2, a noun embedded within the direct object.

The consistency in the behavior of monolingual English and Spanish speakers in the on-line task dictated that the focus in analyzing the data for the bilingual on-line task must be on comparing data patterns across monolingual and bilingual populations, rather than on the question of language dependency (see Chapter 6). The expectation that bilingual and monolingual behavior should be similar was only partially fulfilled.

The on-line evidence for bilingual speakers of Spanish and English provided additional confirmation of the interpretation that question-answering behavior reflected the operation of strategies unrelated to those determining relative clause attachment. The bilinguals again exhibited an overall preference for answering questions cast about N1 than for answering questions cast about N2.

However, the on-line evidence for bilinguals did not converge with the on-line evidence from monolinguals in the reading times for the relative clause

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frame. Rather than finding confirmation of a general low attachment preference in early phases of processing (as with the monolingual data), the bilingual data for reading the relative clause in disambiguated sentences (such as (2)) indicated that the manipulation of attachment site did not play any crucial role in determining subjects' behavior. In fact, the bilingual subjects failed to match the patterns in the monolingual data in their on-line reading of disambiguated relative clauses: there was no evident preference for either attachment site.

The investigation of length of the attaching relative clause deserves special attention. As noted above, the length of the attaching relative clause was manipulated to investigate the anti-gravity law proposed by Fodor (1998). Under Fodor's proposal, effects of length in relative clause attachment have to do with conflicting preferences between the syntax and the prosody. While short constituents should uniformly attach low, longer constituents have more prosodic weight, are therefore more likely to be independent prosodic constituents, and are thus able to seek a higher host.

The evidence on the effects of length in relative clause attachment from the experiments in Chapters 5 and 6 does not necessarily negate Fodor's proposal. A length effect in the direction predicted by the anti-gravity law was indeed observed, although the effect did not reach conventional levels of significance in the item-based analysis. Monolinguals English speakers and monolingual Spanish speakers, in the off-line questionnaire (Experiment 1), were more likely to opt for an N1 host when the materials were long, as in (4a), than when they were short, as in (4b).

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4. Andrew had dinner yesterday with the nephew of the teacher...
   a. that was in the communist party. (Long-RC)
   b. that was divorced. (Short-RC)

This effect (long more likely to attach high) was also observed in the bilingual off-line data (Experiment 3), but only in bilinguals' preferences with English-language materials. The length effect was not obtained with Spanish-language materials, in the bilingual experiment.

In the on-line monolingual data (Experiment 2), the interaction of length and attachment site predicted by Fodor's (1998) anti-gravity law was not observed. Length effects were only evident in independent subanalyses of the short-RC and the long-RC data separately: with short-RCs, the preference to attach low was reliable, while with long-RCs a numerically smaller effect lacked statistical significance. Finally, as noted above, the bilingual on-line data did not provide any indication that site plays any significant role, including a role modulated by length.

We argued in Chapter 6 that this evidence on the effects of length is perhaps more parsimoniously explained under an account which attributes length effects not to the interface of prosody and syntax, but rather to an account in which an increased number of lexical entries to be recognized in a given constituent increases reading time, which in turn allows more time for post-syntactic considerations (i.e., considerations which generally lead to a departure from low attachment) to play a role.

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To summarize, the experiments reported in Chapters 5 and 6 indicate that the observed cross-linguistic differences in relative clause attachment preferences are not the result of language-specific processing within the parser proper. Instead, the evidence shows that the departure from the universal locality preference comes from processing associated with post-syntactic components.

The evidence reported in this thesis also points to a major role played by *language-independent* strategy use in bilingual sentence processing, with language dominance playing a critical role in determining the set of strategies used by bilinguals. Bilinguals exhibit ultimate attachment preferences that are similar in both of their languages, and that resemble those of monolingual speakers of their dominant language. This suggests that the sentence processing machinery in bilinguals basically uses one set of routines, not two, no matter what the stimulus language may be.

7.3 Issues for Future Investigation

The evidence presented in this thesis leaves a number of issues open for future investigation. These issues, as with the main thrust of the discussion throughout the preceding chapters, fall under two categories: those having to do with relative clause attachment in particular, and those having to do with bilingual sentence processing more generally. We will address each separately in the discussion that follows.

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7.3.1 Future Studies of Relative Clause Attachment

Regarding the study of the relative clause attachment ambiguity, the findings from this thesis indicate a pressing need for an extensive investigation of formal morphosyntactic features and their role in the determination of relative clause attachment preferences. Such an investigation might proceed by examining number and gender agreement in more detail with the structure under consideration, by testing different number and gender configurations both in the nouns of the complex NP and at the site where the attachment is to be disambiguated (be it a verb, an adjective, a reflexive pronoun, agreeing in number or in gender with an antecedent in the complex NP). The evidence on number from the off-line experiments in Chapters 5 and 6 suggests that number in English is somehow processed differently than number in Spanish, and while we have tentatively proposed that this may have to do with the specification of number at the auxiliary, this idea clearly requires further research. A motivation for the investigation of number features, complemented by a study of gender features, in relative clause attachment would thus be a focus on the role of markedness and the extent to which marked features disrupt (or interact with) otherwise normal attachment processes.

In addition to a more thorough study of formal agreement features and their role in relative clause attachment, future studies might also expand on the role of complementizers (such as *that* and *que*) and relative pronouns (such as *who*, *which*, *quien* and *el/la cual*). Also to be investigated are the differences

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between restrictive and non-restrictive relative clauses and the impact they might have on attachment preferences.

The position of the disambiguating region in relative clause attachment is an issue that has been addressed by very few studies (see in particular Brysbaert & Mitchell, 1996). However, the comparison of early versus late disambiguation might sort some of the puzzles we have discovered. In particular, such an investigation should provide some clues to solve the question as to whether it is prosodic segmentation preferences or lexically-induced delay which causes a shift from low attachment when the attaching constituent is long. With late disambiguation, compared to early disambiguation, the lexical account does not necessarily predict a greater effect of length (i.e., more departure from low attachment as the constituent gets longer. In contrast, under a prosody account, a late disambiguation should induce a greater length effect than an early disambiguation (which is encountered when the attaching constituent is still short).

Distinguishing between the prosodic and lexical accounts might turn out to be a very interesting area for future endeavors. Under a lexical account, more lexical content in the attaching constituent should induce more delay, hence providing a greater opportunity for post-syntactic considerations to play a role. The function of attachment on length, under this account, should therefore be monotonic increasing; in the presence of increasing amounts of lexical material, an asymptotic level of high attachment will be reached. Under a prosodic account of the length effects, however, the function of attachment on length is not

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necessarily monotonic. If prosodic phrasing depends on the number of PWds in the attaching constituent, and if there are constraints on the number of PWds a given prosodic phrase may contain, then the relation of the length of the attaching constituent with respect to, say, the anti-gravity law may not necessarily be linear. A very long attaching constituent may be broken down into two smaller prosodic phrases, so that the attachment preference may flip back to the lower site. This idea is testable, by systematically tracking attachment preferences over increasingly longer relative clauses. A finding of non-linearity would be difficult to explain under a lexical account like the one outlined in Chapter 6.

Finally, a number of methodological issues raised by the experimental evidence reported in this thesis must be addressed. Future investigation must focus on comparing different speeded methodologies and how they reflect the strategies involved in relative clause attachment. After all, it was the consideration that the self-paced reading task might not be sensitive enough to capture early low attachment preferences which motivated the lexical account outlined in Chapter 6. Also necessary is a thorough investigation of the types of strategies employed by subjects in question-answering tasks, such as the post-on-line reading comprehension questions of Experiments 2 and 4.

7.3.2 Future Studies of Bilingual Sentence Processing

In the area of bilingual sentence processing, future studies must examine in greater detail the effect of different degrees of dominance on the type of strategies employed by bilinguals in determining attachment of an ambiguously

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attached relative. In this investigation, bilinguals relatively fluent in both of their languages were tested, and two sub-groups generated, one of which was English-dominant, the other Spanish-dominant. However, evidence from relatively balanced bilinguals, such as those tested here, must be compared to bilinguals who have considerably different levels of proficiency in each of their languages. The level of sophistication in L1 literacy skills might also be a factor to be taken into consideration in future studies of bilingual sentence processing, as well as the effect of the language which is more frequently read. In addition to these dominance-related variables, additional language history variables might be examined to investigate the degree to which they determine the language-independent set of processing routines employed by bilinguals in relative clause attachment. These additional variables include most notably age of L2 acquisition and language frequency of use.

Additional future research in the area of bilingual sentence processing, and more generally, in the area of bilingual cognition, could focus on developing a clearer picture of how language history affects language dominance. The evidence presented in this thesis indicates that a number of factors in the history of a bilingual are strong indicators of the language dominance profile of a bilingual. In addition to providing a better understanding of what it means for a language to be dominant, such investigations would also be in the position of enhancing the tools available for determining language dominance objectively and systematically. In this final respect, developing and disseminating

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streamlined instruments for determining aspects of the background of bilinguals, as well as monolinguals, might prove to be a valuable future undertaking.

The bilingual population studied in this dissertation has its own circumstantial idiosyncrasies, and a more complete picture of bilingual sentence processing will only be developed when these findings are supplemented with evidence from other bilingual populations. For example, comparing the bilinguals studied here, who live in an environment where English is the majority language, to bilinguals living in an environment where Spanish is the dominant language should be especially useful. Such a study would address questions having to do with whether the effects we found here regarding English-language materials are truly related, as we have proposed, to the fact that for these bilinguals English is the language more frequently read in their immediate past.

Finally, continuing the study of the performance deficit associated with bilingualism should generate important knowledge with a number of direct pedagogical applications. In particular, understanding the causes of decreased speed and accuracy in linguistic tasks on the part of bilinguals should be insightful in developing tools to distinguish normal from impaired bilingual behavior.

7.4 Concluding Remarks

The research reported in the preceding chapters addressed the question of language (in)dependency in bilingual sentence processing. Overall, we have

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found that bilinguals process linguistic stimuli in both of their languages by following strategies similar to those of monolinguals of their dominant language. As the discussion in this chapter has shown, we have answered many of the questions we set out to investigate. However, as always, a body of questions remains, making the two areas of relative clause attachment and bilingual sentence processing ripe for future inquiry.

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APPENDICES

Appendix A: Materials

Appendix A-1: Target Items in Experiments 1, 2, 3 and 4

This appendix lists the 24 experimental items, in English and Spanish, evaluated in Chapter 4, and used in the experiments reported in Chapters 5 and 6.

Each item has a short-RC (a) and a long-RC (b) version. Within the 24 items, there are two items subsets, items 1-12 with an unambiguously singular RC verb, and items 13-24 with an unambiguously plural RC verb.

The first item in each of the two item subsets contains the complete paradigm. The first version listed is ambiguous (RC may permissibly refer to either N1 or N2), the second forces the RC to attach high (to N1), and the third forces the RC to attach low (to N2). The first item in each of the two item subsets also provides the question paradigm for the experimental items. For the remaining experimental items, only the ambiguous version is provided. The experimental items were presented in their ambiguous versions in Experiments 1 and 3, and in their disambiguated versions in Experiments 2 and 4. (The underlined nouns are those compatible with the verb in the RC.)

In the Spanish versions of the items, lexical items specific to Castillian Spanish are italicized. They are followed, in brackets, by the corresponding lexical items used in the materials read by the bilingual subjects (who spoke varieties of Spanish from Latin America and the United States).

1a. Andrew had dinner yesterday with the nephew of the teacher that was divorced.
Who was divorced? the nephew the teacher

Andrew had dinner yesterday with the nephew of the teachers / that was divorced.
Was the nephew divorced? YES

Andrew had dinner yesterday with the nephews of the teacher / that was divorced.
Was the teacher divorced? YES

Andrés cenó ayer con el sobrino del maestro que estaba divorciado.
¿Quién estaba divorciado? el sobrino el maestro

Andrés cenó ayer con el sobrino de los maestros / que estaba divorciado.
¿Estaba divorciado el sobrino? SÍ

Andrés cenó ayer con los sobrinos del maestro / que estaba divorciado.
¿Estaba divorciado el maestro? SÍ

1b. Andrew had dinner yesterday with the nephew of the teacher that was in the communist party.
Who was in the communist party? the nephew the teacher

Andrew had dinner yesterday with the nephew of the teachers / that was in the communist party.
Was the nephew in the communist party? YES

Andrew had dinner yesterday with the nephews of the teacher / that was in the communist party.
Was the teacher in the communist party? YES

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Andrés cenó ayer con el sobrino del maestro que estaba en el partido comunista.
¿Quién estaba en el partido comunista? el sobrino el maestro

Andrés cenó ayer con el sobrino de los maestros / que estaba en el partido comunista.
¿Estaba el sobrino en el partido comunista? Sí

Andrés cenó ayer con los sobrinos del maestro / que estaba en el partido comunista.
¿Estaba el maestro en el partido comunista? Sí

2a. The journalist interviewed the coach of the gymnast that was sick.
El periodista entrevistó al entrenador del gimnasta que estaba enfermo.

2b. The journalist interviewed the coach of the gymnast that was signing autographs during the competition.
El periodista entrevistó al entrenador del gimnasta que estaba firmando autógrafos durante la competición.

3a. The personnel manager was observing the secretary of the accountant that was studying.
El gerente observaba al secretario del contable que estaba estudiando.

3b. The personnel manager was observing the secretary of the accountant that was hired temporarily.
El gerente observaba al secretario del contable que estaba contratado temporalmente.

4a. Julia had spoken to the secretary of the lawyer that was on vacation.
Julia había hablado con la secretaria del abogado que estaba de vacaciones.

4b. Julia had spoken to the secretary of the lawyer that was telephoning the office all morning.
Julia había hablado con la secretaria del abogado que estaba telefoneando a la oficina toda la mañana.

5a. My friend met the aide of the detective that was fired.
Mi amigo conoció al ayudante del detective que estaba despedido.

5b. My friend met the aide of the detective that was investigating the assassination case.
Mi amigo conoció al ayudante del detective que estaba investigando el caso del asesinato.

6a. Charlie met the interpreter of the ambassador that was eating.
Carlos conoció al intérprete del embajador que estaba cenando.

6b. Charlie met the interpreter of the ambassador that was hosting the party last night.
Carlos conoció al intérprete del embajador que estaba organizando la fiesta de anoche.

7a. Roxanne read the review of the poem that was unfinished.
Rosa leyó la crítica de la poesía que estaba sin terminar.

7b. Roxanne read the review of the poem that was printed on the last pages of the magazine.
Rosa leyó la crítica de la poesía que estaba impresa en las últimas páginas de la revista.

8a. The plumber adjusted the pipe of the sink that was cracked.
El *fontanero* [plomero] ajustó el tubo del fregadero que estaba agrietado.

8b. The plumber adjusted the pipe of the sink that was installed improperly since last week.
El *fontanero* [plomero] ajustó el tubo del fregadero que estaba instalado malamente desde la semana pasada.

9a. Mary replaced the wire of the amplifier that was damaged.
María reemplazó el cable del amplificador que estaba estropeado.

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9b. Mary replaced the wire of the amplifier that was not working since she moved last summer.
María reemplazó el cable del amplificador que estaba sin funcionar desde la mudanza del verano pasado.

10a. My brother liked listening to the recording of the song that was banned.
A mi hermano le gustaba escuchar la grabación de la canción que estaba prohibida.

10b. My brother liked listening to the recording of the song that was on the first side of the album.
A mi hermano le gustaba escuchar la grabación de la canción que estaba en la primera cara del álbum.

11a. The chef couldn't find the lid of the pan that was clean.
El cocinero no pudo encontrar la tapa de la cacerola que estaba limpia.

11b. The chef couldn't find the lid of the pan that was in the cupboard on the left.
El cocinero no pudo encontrar la tapa de la cacerola que estaba en el aparador de la izquierda.

12a. The thief took the key of the trunk that was outside.
El ladrón se llevó la llave del baúl que estaba afuera.

12b. The thief took the key of the trunk that was in the closet in the hall.
El ladrón se llevó la llave del baúl que estaba en el armario del pasillo.

13a. The journalist was unable to interview the daughters of the hostages that were waiting.
Who was waiting? the daughters the hostages

The journalist was unable to interview the daughters of the hostage that were waiting.
Were the daughters waiting? YES

The journalist was unable to interview the daughter of the hostages that were waiting.
Were the hostages waiting? YES

El periodista no pudo entrevistar a las hijas de los rehenes que estaban esperando.
¿Quién estaba esperando? las hijas los rehenes

El periodista no pudo entrevistar a las hijas del rehén que estaban esperando.
¿Estaban esperando las hijas? SÍ

El periodista no pudo entrevistar a la hija de los rehenes que estaban esperando.
¿Estaban esperando los rehenes? SÍ

13b. The journalist was unable to interview the daughters of the hostages that were about to exit the airplane.
Who was about to exit the airplane? the daughters the hostages

The journalist was unable to interview the daughters of the hostage that were about to exit the airplane.
Were the daughters about to exit the airplane? YES

The journalist was unable to interview the daughter of the hostages that were about to exit the airplane.
Were the hostages about to exit the airplane? YES

El periodista no pudo entrevistar a las hijas de los rehenes que estaban a punto de salir del avión.
¿Quién estaba esperando? las hijas los rehenes

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El periodista no pudo entrevistar a las hijas del rehén que estaban a punto de salir del avión.
¿Estaban esperando las hijas? SÍ

El periodista no pudo entrevistar a la hija de los rehenes que estaban a punto de salir del avión.
¿Estaban esperando los rehenes? SÍ

14a. Patricia saw the teachers of the students that were in class.
Patricia vio a los profesores de los estudiantes que estaban en clase.

14b. Patricia saw the teachers of the students that were in the library the other day.
Patricia vio a los profesores de los estudiantes que estaban en la biblioteca el otro día.

15a. Linda wrote to the managers of the assistants that were late.
Linda escribió a los gerentes de los asistentes que estaban demorados.

15b. Linda wrote to the managers of the assistants that were evaluating her study.
Linda escribió a los gerentes de los asistentes que estaban evaluando su informe.

16a. The hotel director didn't want to see the guides of the tourists that were angry.
El director del hotel no quiso ver a los guías de los turistas que estaban enojados.

16b. The hotel director didn't want to see the guides of the tourists that were waiting at the reception desk.
El director del hotel no quiso ver a los guías de los turistas que estaban esperando en recepción.

17a. The receptionist greeted the clients of the lawyers that were chatting.
La recepcionista saludó a los clientes de los abogados que estaban charlando.

17b. The receptionist greeted the clients of the lawyers that were waiting in the conference room.
La recepcionista saludó a los clientes de los abogados que estaban esperando en la sala de conferencias.

18a. Nobody noticed the bodyguards of the ambassadors that were hiding.
Nadie vio a los guardaespaldas de los embajadores que estaban escondidos.

18b. Nobody noticed the bodyguards of the ambassadors that were talking to the photographer at the party.
Nadie vio a los guardaespaldas de los embajadores que estaban hablando con el fotógrafo en la fiesta.

19a. Ivana met the sons of the delegates that were smoking.
Ivana conoció a los hijos de los delegados que estaban fumando.

19b. Ivana met the sons of the delegates that were watching television in the den.
Ivana conoció a los hijos de los delegados que estaban viendo la televisión en el salón.

20a. Lisa couldn't find the refills of the pens that were on sale.
Lisa no pudo encontrar los recambios de los bolígrafos que estaban de oferta.

20b. Lisa couldn't find the refills of the pens that were in the lower desk drawer.
Lisa no pudo encontrar los recambios de los bolígrafos que estaban en *el cajón* [la gaveta] del escritorio.

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21a. The student read the revisions of the manuscripts that were on the test.
El estudiante leyó las revisiones de los manuscritos que estaban en el examen.

21b. The student read the revisions of the manuscripts that were on the list of readings required for the class.
El estudiante leyó las revisiones de los manuscritos que estaban en la lista de lecturas requeridas para la clase.

22a. The archaeologists finally found the panels of the sarcophagi that were broken.
Los arqueólogos finalmente encontraron los paneles de los sarcófagos que estaban rotos.

22b. The archaeologists finally found the panels of the sarcophagi that were described in the poem.
Los arqueólogos finalmente encontraron los paneles de los sarcófagos que estaban descritos en el poema.

23a. Harry had inspected the printers of the computers that were stolen.
Enrique había inspeccionado las impresoras de las computadoras que estaban robadas.

23b. Harry had inspected the printers of the computers that were on top of the desk.
Enrique había inspeccionado las impresoras de las computadoras que estaban encima del escritorio.

24a. Susan admired the hallways of the apartments that were painted.
Susana admiró los pasillos de los apartamentos que estaban pintados.

24b. Susan admired the hallways of the apartments that were on the upper floor of the building.
Susana admiró los pasillos de los apartamentos que estaban en el piso de arriba del edificio.

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Appendix A-2: Fillers in Experiments 1, 2, 3 and 4

This appendix lists the filler items used in the experiments reported in Chapters 5 and 6. They are distributed into three types: practice fillers, regular fillers (sets A and B), and double-clause ambiguity fillers.

Slashes indicate segmentation into two frames for the on-line presentation of the materials (in Experiments 2 and 4). In the off-line presentation, sentences for each item were formatted to fit on one line.

In the Spanish versions of the items, lexical items specific to Castillian Spanish are italicized. They are followed, in brackets, by the corresponding lexical items used in the materials read by the bilingual subjects (who spoke varieties of Spanish from Latin America and the United States).

PRACTICE FILLERS

Items at the beginning of experimental tasks, not counted toward subjects' score on fillers

Items 1-8 appeared in version A off-line, and in versions A and B on-line, 9-16 in version B off-line, and in versions C and D on-line.

1. The editor didn't publish Linda's letter / about the article on the upcoming Olympic games.
   El editor no publicó la carta de Linda / sobre el artículo de los próximos juegos olímpicos.
   Who had written a letter? the editor Linda
   Did Linda write a letter? YES
   ¿Quién había escrito una carta? el editor Linda
   ¿Había escrito Linda una carta? SÍ

2. After they had their bath / the children sat down to eat dinner.
   Después del baño / los niños se sentaron a cenar.
   What did the children do first? bathe eat
   Did the children eat before they bathed? NO
   ¿Qué hicieron los niños primero? bañarse cenar
   ¿Cenaron los niños antes de bañarse? NO

3. The maid of the duchess sat in the patio / reading a book.
   La criada de la duquesa estaba en el patio / leyendo un libro.
   Who was reading a book? the maid the duchess
   Was the duchess reading a book? NO
   ¿Quién estaba leyendo un libro? la criada la duquesa
   ¿Estaba leyendo un libro la duquesa? NO

4. The seamstress had finished the alterations on the wedding dress, / but the shoes were not ready yet.
   La costurera había terminado de arreglar el vestido de la novia, / pero los zapatos aun no estaban preparados.
   Was the wedding dress ready? no yes
   Was the wedding dress ready? YES
   ¿Estaba preparado el vestido de la novia? no sí
   ¿Estaba preparado el vestido de la novia? SÍ

5. The manager asked the women who had been working all morning / to take a half-hour break.
   El gerente les pidió a las mujeres que habían estado trabajando toda la mañana / que tomaran un descanso de media hora.

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Who was supposed to take a break? the manager the women
Were the women supposed to take a break? YES
¿Quién debía tomar un descanso? el gerente las mujeres
¿Debían tomar un descanso las mujeres? SÍ

6. Yolanda didn't see the lifeguard / running on the beach.
Yolanda no vio al salvavidas / corriendo en la playa.
Who was running on the beach? Yolanda the lifeguard
Did Yolanda see the lifeguard? NO
¿Quién estaba corriendo en la playa? Yolanda el salvavidas
¿Vio Yolanda al salvavidas? NO

7. Martha sent a letter to the gallery / where Phil's paintings had been shown.
Marta envió una carta a la galería / donde habían exhibido las pinturas de Felipe.
Whose paintings were shown in the gallery? Martha's Phil's
Were Phil's paintings shown in the gallery? YES
¿Qué pinturas habían exhibido en la galería? las de Marta las de Felipe
¿Se habían exhibido las pinturas de Felipe en la galería? SÍ

8. Miranda had an ivory box / where she kept the jewelry that her grandmother had left her.
Miranda tenía una caja de marfil / donde ponía las *joyas* [prendas] que su abuela le dejó.
Who put her jewelry in an ivory box? Miranda her grandmother
Did Miranda keep her jewelry in a metal safe? NO
¿Quién ponía sus *joyas* [prendas] en una caja de marfil? Miranda su abuela
¿Miranda guardaba sus *joyas* [prendas] en una caja fuerte de metal? N

9. Boris detested the jazz music / that his girlfriend always played while she prepared dinner.
Boris odiaba la música de jazz / que su novia siempre ponía cuando ella hacía la cena.
Who played jazz music while making dinner? Boris Boris' girlfriend
Did Boris' girlfriend play jazz music often? YES
¿Quién ponía música de jazz mientras hacía la cena? Boris la novia de Boris
¿La novia de Boris ponía música de jazz a menudo? SÍ

10. Alfred expected to receive a letter from his parents / about his sister's wedding.
Alfredo esperaba recibir una carta de sus padres / sobre la boda de su hermana.
Who hadn't written to Alfred yet? his parents his sister
Had Alfred received a letter from his parents? NO
¿Quién no le había escrito a Alfredo? sus padres su hermana
¿Había recibido Alfredo una carta de sus padres? NO

11. Ted never read the book about the Civil War / that he borrowed from a friend of Mark's over a year ago.
Teo nunca se leyó el libro sobre la Guerra Civil / que le prestó un amigo de Marcos hace más de un año.
Who was lent a book? Ted Mark
Did Mark borrow a book? NO
¿A quién se le había prestado un libro? a Teo a Marcos
¿Se le había prestado un libro a Marcos? NO

12. The secretary sent a messenger to the airport / to pick up the package.
La secretaria envió a un mensajero al aeropuerto / para recoger el paquete.
Who was going to pick up the package? the secretary the messenger
Was the messenger going to pick up the package? YES
¿Quién iba a recoger el paquete? la secretaria el mensajero
¿Iba el mensajero a recoger el paquete? SÍ

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13. The only way to exit the building was by the stairs / because the elevators were not working.
La única forma de salir del edificio era por las escaleras / porque los *ascensores* [elevadores] no funcionaban.
How could one exit the building?by the stairs on the elevator
Could one take the elevator to leave the building? NO
¿Cómo se podía salir del edificio? por las escaleras en el *ascensor* [elevador]
¿Se podía salir del edificio bajando en el *ascensor* [elevador]? NO

14. Mike saw his physics professor / walking down the street with his girlfriend.
Miguel vio a su profesor de física / caminando por la calle con su novia.
Who was walking down the street? Mike the professor
Did Mike see his physics professor? YES
¿Quién iba caminando por la calle? Miguel el profesor
¿Vio Miguel a su profesor de física? SÍ

15. The sister of the babysitter who was arrested recently / gave birth to twins.
La hermana de la niñera que arrestó la policía / dio a luz recientemente dos gemelos.
Who recently gave birth to twins? the sister the babysitter
Did the babysitter give birth to twins? NO
¿Quién dio a luz recientemente dos gemelos? la hermana la niñera
¿Dio a luz dos gemelos la niñera? NO

16. The terrorists kidnapped the pilot / that had played rugby at Harvard.
Los terroristas secuestraron al piloto / que había sido jugador de rugby en la universidad.
Who had played rugby at Harvard? the terrorists the pilot
Had the pilot played rugby at Harvard? YES
¿Quién había sido jugador de rugby en la universidad? los terroristas el piloto
¿El piloto había sido jugador de rugby en la universidad? SÍ

FILLER SET A

For off-line questions, the answer on the right is correct. Items 1-18 appeared in version A off-line, and in versions A and B on-line, 19-36 in version B off-line, and in versions C and D on-line

1. The Secretary of State had an interpreter / who spoke perfect Spanish.
El secretario de estado tenía un intérprete / que hablaba perfectamente el español.
Who spoke perfect Spanish? the Secretary of State the interpreter
Did the interpreter speak perfect Spanish? YES
¿Quién hablaba perfectamente el español? el secretario de estado el intérprete
¿Hablaba perfectamente el español el intérprete? SÍ

2. The journalist interviewed the terrorist / that arrived at the airport this morning.
El periodista entrevistó al terrorista / que llegó al aeropuerto esta mañana.
Who arrived at the airport this morning? the journalist the terrorist
Did the terrorist arrive this morning? YES
¿Quién llegó al aeropuerto esta mañana? el periodista el terrorista
¿Llegó el terrorista esta mañana? SÍ

3. The detective interrogated the salesman / that was behind the counter.
El detective interrogó al dependiente / que estaba detrás del mostrador.
Who was behind the counter? the detective the salesman
Was the salesman interrogated?YES

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¿Quién estaba detrás del mostrador? el detective el dependiente
¿Fue interrogado el dependiente? SÍ

4. The dress matched the belt / that Sue got from Linda the other day.
El vestido iba muy bien con el cinturón / que le regaló Linda a Susana el otro día.
What did Sue get from Linda? the dress the belt
Did Linda give Sue a belt? YES
¿Qué le regaló Linda a Susana?el vestido el cinturón
¿Le regaló Linda un cinturón a Susana? SÍ

5. The article described the book / that Thomas published last year.
El artículo describía el libro / que Tomás publicó el año pasado.
What did Thomas publish last year? the article the book
Did Thomas publish an article last year? NO
¿Qué publicó Tomás el año pasado? el artículo el libro
¿Tomás publicó un artículo el año pasado? NO

6. The director of the corporation fired the accountant / that Oscar had worked with since 1985.
El director de la empresa despidió al contable / con quien había trabajado Oscar desde el 1985.
Who had Oscar worked with since 1985? the director the accountant
Had Oscar worked with the director? NO
¿Con quién había trabajado Oscar desde el 1985? con el director con el contable
¿Había trabajado Oscar con el director? NO

7. Anne wrote to the secretary / that Jim had introduced to us.
Ana escribió a la secretaria / que Jaime nos había presentado.
Who had Jim introduced to us? Anne the secretary
Had Jim introduced us to Anne? NO
¿A quién nos había presentado Jaime? a Ana a la secretaria
¿Nos había presentado Jaime a Ana? NO

8. Tony explained that Frank / was coming to the party with Grace.
Tony explicó que Paco / iba a venir a la fiesta con *Gabriela* [Graciela].
Who was coming to the party with Grace? Tony Frank
Was Grace coming to the party with Tony? NO
¿Quién iba a venir a la fiesta con *Gabriela* [Graciela]? Tony Paco
¿*Gabriela* [Graciela] iba a venir a la fiesta con Tony? NO

9. Johnny smoked one of the cigars / that Ernest gave my uncle for his birthday.
Juanito se fumó uno de los cigarros / que Ernesto le regaló a mi tío para su cumpleaños.
Who gave cigars to my uncle? Johnny Ernest
Did Johnny give my uncle cigars? NO
¿Quién le regaló cigarros a mi tío? Juanito Ernesto
¿Le regaló cigarros Juanito a mi tío? NOO

10. Fred lives in a city far from the little town / in the mountains where he was born.
Perico vive en una ciudad lejos del pueblecito / en las montañas donde nació.
Where was Fred born? in a city in the mountains
Was Fred born in a city? NO
¿Dónde nació Perico? en una ciudad en las montañas
¿Nació Perico en una ciudad? NO

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11. The police never found the gun, / but they did have the bullet.
La policía nunca encontró el revólver, / pero sí tenían la bala.
What did the police have? the gun the bullet
Did the police have the gun? NO
¿Qué tenía la policía? el revólver la bala
¿Tenía la policía el revólver? NO

12. The building where Naomi lives / has a white facade and wooden doors.
El edificio donde vive Noemí / tiene la fachada blanca y las puertas de madera.
What are the doors in Naomi's building like? white made of wood
Are the doors in Naomi's building white? NO
¿Cómo son las puertas del edificio de Noemí? blancas de madera
¿Son blancas las puertas del edificio de Noemí? NO

13. The old man never liked telling his children stories, / but now he tells his grandchildren fairy tales every night.
Al viejo nunca le gustó contar historias a sus hijos, / pero ahora les cuenta a sus nietos cuentos de hadas todas las noches.
Who does the old man tell fairy tales to? his children his grandchildren
Did the old man like to tell stories to his children? NO
¿A quién le cuenta cuentos de hadas el viejo? a sus hijos a sus nietos
¿Al viejo le gustaba contar historias a sus hijos? NO

14. When she's studying, Christine never listens to the radio, / but when she's reading a novel she likes listening to Mozart.
Cuando estudia, Cristina nunca escucha la radio, / pero cuando está leyendo una novela le gusta escuchar música de Mozart.
Does Christine listen to music when she reads novels? no, never yes, usually
Does Christine listen to music when she's studying? NO
¿Cristina escucha música cuando lee novelas? no, nunca sí, normalmente
¿Cristina escucha música cuando estudia? NO

15. Paula prefers dancing with Dionysius rather than with Mario, / because Mario always steps on her feet.
Paula prefiere bailar con Dionisio que con Mario, / porque Mario siempre le pisa los pies.
Who doesn't Paula like to dance with? Dionysius Mario
Does Paula like to dance with Mario? NO
¿Con quién no le gusta bailar a Paula? con Dionisio con Mario
¿A Paula le gusta bailar con Mario? NO

16. Bart lost all the money he won this summer in Vegas / when he went to the jai alai last weekend.
Bartolomé perdió todo el dinero que ganó en Las Vegas el verano pasado / cuando fue al *hipódromo* [jai alai] este fin de semana.
Where was Bart last weekend? in Vegas at the jai alai
Did Bart go to Vegas last weekend? NO
¿Dónde estuvo Bartolomé este fin de semana? en Las Vegas en el *hipódromo* [jai alai]
¿Fue a Las Vegas Bartolomé este fin de semana? NO

17. The pirate hid his treasure in a cave on the island / and put the map inside a trunk on the galleon.
El pirata escondió su tesoro en una cueva en la isla / y guardó el mapa dentro de un baúl en el galeón.
Where did the pirate hide the map? in a cave in the galleon
Did the pirate hide the map in a cave? NO

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¿Dónde escondió el mapa el pirata? en una cueva en el galeón
¿Escondió el pirata el mapa en una cueva? NO

18. The saxophonist didn't like the song / that the singer in the band wrote.
Al saxófono no le gustaba la canción / que escribió el cantante del grupo.
Who wrote the song? the saxophonist the singer
Did the singer write a song? YES
¿Quién escribió la canción? el saxófono el cantante
¿Escribió una canción el cantante? SÍ

19. David sent Irene / a postcard from Rome.
David envió una postal / a Irene desde Roma.
Who received a postcard from Rome? David Irene
Did David receive a postcard? YES
¿Quién recibió una postal desde Roma? David Irene
¿Recibió una postal David? SÍ

20. Theresa went to the bank / to exchange Mexican pesos for pounds sterling.
Teresa fue al banco / para cambiar *pesetas* [pesos mexicanos] por libras esterlinas.
What type of currency did Theresa want when she went to the bank? pesos pounds
Did Theresa need pounds? YES
¿Qué moneda quería Teresa cuando fue al banco? *pesetas* [pesos] libras
¿Teresa necesitaba libras? SÍ

21. The secretary filed the photocopies of the documents / and sent the originals to the clients.
La secretaria archivó las fotocopias de los documentos / y envió los originales a los clientes.
What did the secretary send the clients? the photocopies the originals
Did the secretary send the clients the originals? YES
¿Qué envió la secretaria a los clientes? las fotocopias los originales
¿Envió la secretaria los originales a los clientes? SÍ

22. The kids put their gloves in the drawer / and their coats in the closet.
Los niños pusieron los guantes en *el cajón* [la gaveta] / y los abrigos en el armario.
What did the kids put in the closet? their gloves their coats
Did the kids put the gloves in the closet? NO
¿Qué pusieron los niños en el armario? los guantes los abrigos
¿Pusieron los niños los guantes en el armario? NO

23. Isa has a son who is studying English / and a daughter working as an engineer for a petroleum corporation.
Isa tiene un hijo que estudia inglés / y una hija que trabaja de ingeniero con una empresa de petróleo
What does Isa's daughter do? she's a student she's an engineer
Is Isa's daughter an a student? NO
¿Qué hace la hija de Isa? es estudiante es ingeniero
¿Es estudiante la hija de Isa? NO

24. The librarian would let the students take out / only one volume of the encyclopedia at a time.
La bibliotecaria dejaba a los estudiantes sacar / sólo un tomo de la enciclopedia a la vez.
Were the students allowed to take out two volumes of the encyclopedia? yes no
Were the students allowed to take out two volumes of the encyclopedia? NO
¿Podían sacar los estudiantes dos tomos de la enciclopedia? sí no
¿Podían sacar los estudiantes dos tomos de la enciclopedia? NO

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25. The nurse took the syrup of the patient / by the window sitting in the sun.
La enfermera se llevó el jarabe del paciente / junto a la ventana tomando el sol.
Who was sitting in the sun? the nurse the patient
Was the nurse sitting in the sun? NO
¿Quién estaba tomando el sol? la enfermera el paciente
¿Estaba tomando el sol la enfermera? NOO

26. The son of the doctor came to our home / to visit grandfather.
El hijo del médico vino a casa / para visitar al abuelo.
¿Who was going to visit grandfather? the son the doctor
Was the doctor going to visit grandfather? NO
¿Quién iba a visitar al abuelo? el hijo el médico
¿Iba a visitar al abuelo el médico? NO

27. The boys poked fun at the teacher / that was in the park with his wife.
Los *chicos* [muchachos] se burlaron del profesor / que estaba en el parque con su esposa.
Who was in the park with his wife? a boy a teacher
Was the teacher alone in the park? NO
¿Quién estaba en el parque con su esposa? un *chico* [muchacho] un profesor
¿Estaba solo el maestro en el parque? NO

28. Peter went to a concert yesterday with his colleague / that always wears red gloves.
Pedro fue a un concierto ayer con su colega / que siempre lleva unos guantes rojos.
Who always wears red gloves? Peter Peter's colleague
Did Peter go to a concert with his wife? NO
¿Quién lleva siempre unos guantes rojos? Pedro el colega de Pedro
¿Fue Pedro a un concierto con su esposa? NO

29. The prosecutor proved / that the defendant murdered the mechanic.
El fiscal demostró / que el acusado asesinó al mecánico.
Who murdered the mechanic? the prosecutor the defendant
Did the prosecutor murder the mechanic? NO
¿Quién asesinó al mecánico? el fiscal el acusado
¿Asesinó al mecánico el fiscal? NO

30. John's wife explained to her father-in-law / how she fell at the supermarket.
La esposa de Juan le explicó a su suegro / cómo ella se cayó en el supermercado.
Who fell in the supermarket? the wife the father-in-law
Did John's father fall at the supermarket? NO
¿Quién se cayó en el supermercado? la esposa el suegro
¿Se cayó el padre de Juan en el supermercado? NO

31. The employees asked the chief engineer / to replace the faulty machinery.
Los empleados le pidieron al ingeniero jefe / que reemplazara la maquinaria defectuosa.
Who should replace the machinery? the employees the engineer
Should the employees replace the machinery? NO
¿Quién debía reemplazar la maquinaria? los empleados el ingeniero
¿Debían reemplazar la maquinaria los empleados? NO

32. The students had to show the new teacher / where the encyclopedias were.
Los alumnos tuvieron que enseñarle al maestro nuevo / dónde estaban las enciclopedias.
Who didn't know where the encyclopedias were? the students the teacher
Did the teacher know where the encyclopedias were? NO
¿Quién no sabía dónde estaban las enciclopedias? los alumnos el maestro
¿El profesor sabía dónde estaban las enciclopedias? NO

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33. The waiter denied that he had served / the old women their soup cold.
El camarero negó que les había servido / a las ancianas la sopa fría.
Who complained that the soup was cold? the waiter the old women
Did the waiter complain that the soup was cold? NO
¿Quién se quejó que la sopa estaba fría? el camarero las ancianas
¿Se quejó el camarero que la sopa estaba fría? NO

34. Castro ignored the reporters in Havana / that fell asleep during his speech.
Castro ignoró a los periodistas en Habana / que se durmieron durante su discurso.
Who slept during the speech? Castro the reporters
Did Castro care about the sleeping reporters? NO
¿Quién durmió durante el discurso? Castro los periodistas
¿Le importaban a Castro los periodistas que se durmieron? NO

35. Melinda was rude to the cameraman / that was looking at himself in the mirror in the hall.
Melinda fue grosera con el cámara / que se estaba mirando en el espejo del pasillo.
Who was looking in the mirror? Melinda the cameraman
Was Melinda looking at herself in the mirror? NO
¿Quién miraba en el espejo? Melinda el cámara
¿Se estaba mirando Melinda en el espejo? NO

36. Robert was fascinated by the singer / that showed up at the party without an invitation.
A Roberto le fascinaba la cantante / que se presentó en la fiesta sin invitación.
Who came to the party without an invitation? Robert the singer
Did Robert come to the party without an invitation? NO
¿Quién vino a la fiesta sin invitación? Roberto la cantante
¿Roberto vino a la fiesta sin invitación? NO

FILLER SET B

For off-line questions, the answer on the left is correct. Items 1-18 appeared in version A off-line, and in versions A and B on-line, 19-36 in version B off-line, and in versions C and D on-line

1. Although Maurice always takes the bus, / to get to work today he had to take a taxi.
Aunque Mauricio siempre va en autobús, / para venir a la oficina hoy tuvo que tomar un taxi.
How does Maurice generally get to work? on the bus in a taxi
Does Maurice usually go to work on the bus? YES
¿Cómo va Mauricio a trabajar normalmente? en autobús en taxi
¿Mauricio va a trabajar en autobús generalmente? SÍ

2. Floyd read the article in the book / that he took out of the library.
Fernando leyó el artículo en el libro / que sacó de la biblioteca.
What did Floyd read? the article the book
Did Floyd read the article? YES
¿Qué leyó Fernando? el artículo el libro
¿Fernando se leyó el artículo? SÍ

3. When Petra gets home after work, / she always takes a nap before making dinner.
Cuando Petra llega a casa después de trabajar, / siempre se echa la siesta antes de hacer la cena.
What does Petra do immediately when she gets home from work? she takes a nap she makes dinner

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Does Petra nap when she gets home from work? YES
¿Qué hace Petra inmediatamente cuando llega a casa después de trabajar? se echa la siesta se hace la cena
¿Se echa la siesta Petra cuando llega a casa? SÍ

4. The mechanic ordered the parts / that Vinny needed to fix the car.
El mecánico pidió las partes / que Vicente necesitaba para arreglar el *coche* [carro].
What did Vinny need? the parts the car
Did Vinny need some parts for the car? YES
¿Qué necesitaba Vicente? las partes el *coche* [carro]
¿Necesitaba algunas partes Vicente para arreglar el *coche* [carro]? SÍ

5. At the supermarket they never have mangos, / and the apples are always overripe.
En el supermercado nunca tienen *melocotones* [mangos], / y las manzanas siempre están pasadas de maduras.
Are there mangos at the supermarket? no, never yes, always
Are there mangos at the supermarket? NO
¿Hay *melocotones* [mangos] en el supermercado? no, nunca sí, siempre
¿Hay *melocotones* [mangos] en el supermercado? NO

6. Rick bought the apartment next to the store / where his girlfriend works.
Ricardo compró el apartamento de al lado de la tienda / donde trabaja su novia.
What did Rick buy? the apartment the store
Did Rick buy a store? NO
¿Qué compró Ricardo? el apartamento la tienda
¿Ricardo compró una tienda? NO

7. The tables in the dining room / were cleaned this morning.
Las mesas del comedor / se limpiaron esta mañana.
What was cleaned this morning? the tables the dining room
Were the tables cleaned yesterday morning? NO
¿Qué se limpió esta mañana? las mesas el comedor
¿Se limpiaron las mesas ayer por la mañana? NO

8. Rosalie wound up buying the blue sofa / for her new apartment.
Rosalia terminó comprándose el sofá azul / para su apartamento nuevo.
What did Rosalie buy? a sofa an apartment
Did Rosalie buy a green sofa? NO
¿Qué se compró Rosalia? un sofá un apartamento
¿Se compró Rosalia un sofá verde? NO

9. The cook spent an hour preparing the sauce/ that he was going to serve with the steak.
El cocinero estuvo una hora preparando la salsa / que iba a servir con el bistec.
What did the cook spend time preparing? the sauce the steak
Did the cook make the sauce in a few minutes? NO
¿Qué tardó un buen rato en preparar el cocinero? la salsa el bistec
¿El cocinero hizo la salsa en unos minutos? NO

10. The police wanted to know the name of the witness / of the assault of the cab driver.
La policía quería saber el nombre del testigo / del asalto del taxista.
Whose name did the police want to know? the witness' the cab driver's
Did the police know the name of the witness? NO
¿Qué nombre quería saber la policía? el del testigo el del taxista
¿Sabía la policía el nombre del testigo? NO

11. The woman tried on the dress / that the seamstress had fixed for her.

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La mujer se probó el vestido / que le había arreglado la costurera.
Who tried on the dress? the woman the seamstress
Did the seamstress try on the dress? NO
¿Quién se probó el vestido? la mujer la costurera
¿Se probó el vestido la costurera? NO

12. Elizabeth called the journalist / that had offered her sister a job.
Elisa llamó al periodista / que le había ofrecido trabajo a su hermana.
Who did Elizabeth call? the journalist her sister
Did Elizabeth call her sister? NO
¿A quién llamó Elisa? al periodista a su hermana
¿Llamó Elisa a su hermana? NO

13. The secretary photocopied the document / for the clients.
La secretaria les fotocopió el documento / a los clientes.
Who photocopied the document? the secretary the clients
Did the clients photocopy the document? NO
¿Quién fotocopió el documento? la secretaria los clientes
¿Fotocopiaron el documento los clientes? NO

14. The prosecutor interviewed / the defendant's landlord in court.
El fiscal entrevistó / al casero del demandado en el tribunal.
Who interviewed the landlord? the prosecutor the defendant
Did the prosecutor interview the tenants? NO
¿Quién entrevistó al casero? el fiscal el demandado
¿Entrevistó el fiscal a los inquilinos? NO

15. The neighbor's dog barked at our cat / and bit the mailman.
El perro del vecino le ladró al gato / y mordió al cartero.
Who bit the mailman? the dog the cat
Did the dog bite the cat? NO
¿Quién mordió al cartero? el perro el gato
¿Mordió el perro al gato? NO

16. The receptionist asked the tourists / to put their suitcases in the checkroom until the bellboy could come.
La recepcionista les pidió a los turistas / que pusieran su equipaje en la consigna hasta que pudiera venir el botones.
Who was supposed to put the suitcases in the checkroom? the tourists the bellboy
Did the receptionist put the suitcases in the checkroom? NO
¿Quién tenía que poner el equipaje en la consigna? los turistas el botones
¿Puso la recepcionista el equipaje en la consigna? NO

17. Edward invited Gerry's boss / to come to dinner tomorrow.
Eduardo invitó al jefe de Gerardo / a cenar en casa mañana.
Who did Edward invite to dinner? the boss Gerry
Did Edward invite Gerry's boss to lunch? NO
¿A quién invitó Eduardo a cenar? al jefe a Gerardo
¿Invito Eduardo a almorzar al jefe de Gerardo? NO

18. The locksmith fixed the key / and opened the door.
El cerrajero arregló la llave / y abrió la puerta.
What did the locksmith fix? the key the door
Did the locksmith fix the door? NO
¿Qué arregló el cerrajero? la llave la puerta
¿Arregló el cerrajero la puerta? NO

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19. The tourist photographed / the gypsy's donkey by the bridge.
El turista fotografió / el burro del gitano al lado del puente.
Who took a photo of the donkey? the tourist the gypsy
Did the tourist photograph the donkey? YES
¿Quién le hizo una foto al burro? el turista el gitano
¿Le hizo una foto el turista al burro? SÍ

20. The patient was afraid of telling his psychiatrist / about the nightmare he had the night before.
El paciente temía contarle a su psiquiatra / sobre la pesadilla que había tenido la noche anterior.
Who had a nightmare? the patient the psychiatrist
Did the patient have a nightmare? YES
¿Quién tuvo una pesadilla? el paciente el psiquiatra
¿El paciente tuvo una pesadilla? SÍ

21. The tenants demanded that the landlord pay for their piano, / which was damaged by the flood in the house's basement.
Los inquilinos exigieron que el casero pagara por su piano, / que fue dañado por la inundación en el sótano de la casa.
Whose piano was damaged by the flood? the tenants' the landlord's
Was the piano damaged by the flood? YES
¿Qué piano fue dañado por la inundación? el de los inquilinos el del casero
¿Fue dañado el piano durante la inundación? SÍ

22. Helen called her travel agent to find out whether she could fly to Florida / or if it would be better to take a train.
Elena llamó a su agente de viajes para averiguar si podría volar a *Málaga* [la Florida] / o si sería mejor ir en tren.
Who wanted to go to Florida? Helen a travel agent
Did Helen want to go to Florida? YES
¿Quién quería ir a *Málaga* [la Florida]? Elena un agente de viajes
¿Quería ir a *Málaga* [la Florida] Elena? SÍ

23. The orchestra conductor asked the violinist sitting next to the oboe / to tune his instrument.
El director de la orquesta le pidió al violinista que estaba sentado al lado del oboe / que afinara su instrumento.
Which instrument was out of tune? the violin the oboe
Was the oboe out of tune? NO
¿Cuál instrumento estaba desafinado? el violín el oboe
¿Estaba desafinado el oboe? NO

24. Daniel wrote a letter to his aunt in New York City / telling her when he would visit.
Daniel escribió una carta a su tía en Nueva York / diciéndole cuándo la visitaría.
Who was planning on traveling to New York City? Daniel Daniel's aunt
Was Daniel's aunt going to visit him in New York? NO
¿Quién tenía planes de viajar a Nueva York? Daniel la tía de Daniel
¿La tía de Daniel iba a visitarle en Nueva York? NO

25. The teacher that was at the school as technical director / telephoned the dean.
El profesor que estaba en la escuela como director técnico / telefoneó al decano.
Who was at the school as technical director? the teacher the dean
Was the dean also the school's technical director? NO
¿Quién estaba en la escuela como director técnico? el profesor el decano
¿El decano era también director técnico de la escuela? NO

26. The actress bought a silk gown/ and a pair of shoes from the old woman.
La actriz le compró un vestido de seda / y un par de zapatos a la anciana.

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Who bought a silk gown? the actress the old woman
Did the old woman buy a silk gown? NO
¿Quién compró un vestido de seda? la actriz la anciana
¿Compró un vestido de seda la anciana? NO

27. The sister of the doorman / worked in a mission in Senegal.
La hermana del portero / estuvo trabajando en una misión en Senegal.
Who worked in Senegal? the sister the doorman
Did the doorman work in Senegal? NO
¿Quién trabajó en Senegal? la hermana el portero
¿Trabajó en Senegal el portero? NO

28. Rick will telephone his mother / announcing his wedding plans.
Ricardo llamará a su madre / para contarle sobre sus planes de matrimonio.
Who is going to get married? Rick Rick's mother
Is Rick's mother going to get married? NO
¿Quién va a casarse? Ricardo la madre de Ricardo
¿Va a casarse la madre de Ricardo? NO

29. The salesman couldn't convince the customer / to replace the speakers for his stereo.
El dependiente no pudo convencer al cliente / de comprar altavoces nuevos para su equipo de música.
Who wanted to replace the speakers? the salesman the customer
Did the customer want to replace his speakers? NO
¿Quién quería reemplazar los altavoces? el dependiente el cliente
¿Quería reemplazar el cliente sus altavoces? NO

30. The doctor told Alice / that her mother was in intensive care.
La doctora informó / a Alicia que su madre estaba en cuidados intensivos.
Who did the doctor speak to? Alice Alice's mother
Was Alice in intensive care? NO
¿Con quién habló el doctor? Alicia la madre de Alicia
¿Estaba Alicia en cuidados intensivos? NO

31. The landlord lost the certified letter / that came for the tenant who was a sergeant in the reserves.
El casero perdió la carta certificada / que llegó para el inquilino que fue sargento de la legión.
Who lost the letter? the landlord the tenant
¿Did the tenant lose the letter? NO
¿Quién perdió la carta? el casero el inquilino
¿Perdió la carta el inquilino? NO

32. Goodman is the only politician with an interest in public education / that knows the Governor well.
Guzmán es el único político con interés en la educación pública / que conoce bien al gobernador.
Who is interested in public education? Goodman the Governor
Does Goodman ignore issues about public education? NO
¿A quién le interesa la educación pública? a Guzmán al gobernador
¿Ignora Guzmán temas de la educación pública? NO

33. Nancy is the only nurse / that has been working in the clinic for over ten years.
Nuria [Nancy] es la única enfermera / que ha trabajado en la clínica más de diez años.
How many nurses have worked at the clinic for ten years or more? one more than one
Were there many nurses with more than ten years experience? NO
¿Cuántas enfermeras han trabajado en la clínica diez años o más? una más de una
¿Había muchas enfermeras con más de diez años de experiencia en esa clínica? NO

34. Fred had never met the daughter of the fireman / that committed suicide last year.

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Paco nunca había conocido a la hija del bombero / que se suicidó el año pasado.
Who had never met the daughter? Fred the fireman
Had Fred met the daughter? NO
¿Quién no había conocido nunca a la hija? Paco el bombero
Había conocido Paco a la hija? NO

35. The balding restaurant owner motioned to the waitress / that was wearing a very short miniskirt.
El dueño calvo del restaurante le hizo seña a la camarera / que llevaba una minifalda muy corta.
Who was balding? the owner the waitress
Was the owner wearing a miniskirt? NO
¿Quién estaba calvo? el dueño la camarera
¿Llevaba minifalda el dueño? NO

36. Tina couldn't find the mistress of the executive / that got drunk at the party.
Tina no podía encontrar a la querida del ejecutivo / que se emborrachó en la fiesta.
Who was Tina looking for? the mistress the executive
Was Tina looking for the executive? NO
¿A quién buscaba Tina? a la querida al ejecutivo
¿Buscaba Tina al ejecutivo? NO

DOUBLE-CLAUSE FILLERS

These items contain the double-clause ambiguity discussed in §2.2.2.1, in which a PP may attach within the matrix verb (V1) VP or within the embedded verb (V2) VP. In the sentences containing this ambiguity in the experimental tasks, the PP was forced to attach high or low. They comprised the experimental materials for an unrelated experiment, not discussed in this thesis. These fillers are treated as regular fillers in the discussion of the experiments in Chapters 5 and 6.

Odd numbered items 1-11 and even numbered items 12-24 appeared in version A of the off-line task, and in versions A and B of the on-line task. Odd numbered items 13-23 and even numbered items 2-12 appeared in version B of the off-line task, and in versions C and D of the on-line task. The correct answer for the off-line question is underlined.

(In the cases where the forced high and the forced low versions had different questions, both questions are provided.)

These items were also used to generate items in the Test of Naturalness and in the Absolute Grammaticality of Bare Matrix Questionnaire, both of which are discussed in Chapter 4.

1. Rita [sold]$_{V1}$ the book that she [had published]$_{V2}$ / to her friend.
Rita vendió el libro que había publicado / a su amigo.
Rita [published]$_{V1}$ the book that she [had sold]$_{V2}$ / to her friend.
Rita publicó el libro que había vendido / a su amigo.
What did Rita sell? <u>a book</u> a magazine
¿Qué vendió Rita? <u>un libro</u> una revista
Did Rita sell a book? YES
¿Vendió Rita un libro? SÍ

2. The girl returned the book that she had read / to the library.
La niña devolvió el libro que había leído / a la biblioteca.
The girl remembered the book that she had returned / to the library.
La niña recordó el libro que había devuelto / a la biblioteca.
What did the girl do with the book she had read? she sold it <u>she returned it</u>
¿Qué hizo la niña con el libro que había leído? lo vendió <u>lo devolvió</u>

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Did the girl sell the book she had read? NO
¿Vendió la niña el libro que había leído? NO
What did the girl do with the book? she sold it she returned it
¿Qué hizo la niña con el libro? lo vendió lo devolvió
Did the girl sell the book she had remembered? NO
¿Vendió la niña el libro que había recordado? NO

3. Mark recommended the movie that he had seen / to his parents.
Marcos recomendó la película que había visto / a sus padres.
Mark loved the movie that he had recommended / to his parents.
A Marcos le encantó la película que había recomendado / a sus padres.
Who had seen the movie? Mark Mark's parents
¿Quién había visto la película? Marcos los padres de Marcos
Had Mark seen the movie? YES
¿Había visto Marcos la película? SÍ
Who had recommended the movie? Mark Mark's parents
¿Quién había recomendado la película? Marcos los padres de Marcos
¿Did Mark like the movie? YES
¿Le gustó la película a Marcos? SÍ

4. Natalie gave the diamonds that she had examined / to the jeweler.
Natalia dio los diamantes que había examinado / al joyero.
Natalie examined the diamonds that she had given / to the jeweler.
Natalia examinó los diamantes que había dado / al joyero.
Who did Natalie give the diamonds to? a friend the jeweler
¿A quién dio los diamantes Natalia? a un amigo al joyero
Did Natalie give the diamonds to a friend? NO
¿Natalia le dio los diamantes a un amigo? NO

5. The professor recommended the documentary that he had seen / to the students.
El profesor recomendó el documental que había visto / a los estudiantes.
The professor didn't remember the documentary that he had recommended / to the class.
El profesor no recordaba el documental que había recomendado / a la clase.
Who recommended the documentary? the professor the students
¿Quién recomendó el documental? el profesor los estudiantes
Had the professor played the documentary in class? NO
¿Había puesto el profesor el documental en clase? NO
Who had recommended the documentary? the professor the students
¿Quién había recomendado el documental? el profesor la clase
Did the professor remember the documentary? NO
¿Recordaba el profesor el documental? NO

6. Martha sent the gloves that she had found / to her sister.
Marta envió los guantes que había encontrado / a su hermana.
Martha found the gloves that she was going to send / to her sister.
Marta encontró los guantes que iba a enviar / a su abuela.
Who found the gloves? Martha's mother Martha
¿Quién encontró los guantes? la madre de Marta Marta
Had Martha's mother found the gloves? NO
¿Había encontrado los guantes la madre de Marta? NO

7. Rose returned the sweater that she had worn / to her boyfriend.
Rosa devolvió el suéter que se había puesto / a su novio.
Rose wore the sweater that she was going to return / to her boyfriend.
Rosa se puso el suéter que iba a devolver / a su novio.
Who returned the sweater? Rose Rose's boyfriend

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¿Quién devolvió el suéter? Rosa el novio de Rosa
Did Rose give back the sweater? YES
¿Le devolvió el suéter Rosa a su novio? SÍ
Who was going to return the sweater? Rose Rose's boyfriend
¿Quién iba a devolver el suéter? Rosa el novio de Rosa
Did Rose plan on returning the sweater? YES
¿Rosa planeaba devolver el suéter? SÍ

8. The artist sold the painting that she had finished / to the collector.
La pintora vendió el cuadro que había terminado / al coleccionista.
The artist finished the painting that she had sold / to the collector.
La pintora terminó el cuadro que había vendido / al coleccionista.
Who bought the painting? the artist the collector
¿Quién compró el cuadro? la pintora el coleccionista
Did the artist buy the painting? NO
¿Compró la pintora el cuadro? NO

9. Gregory sang the song that he hated / to the children.
Gregorio cantó la canción que detestaba / a los niños.
Gregory hated the song that he had sung / to the children.
Gregorio detestaba la canción que había cantado / a los niños.
Who hated the song? Gregory the children
¿Quién detestaba la canción? Gregorio los niños
Did Gregory dislike the song? YES
¿Gregorio odiaba la canción? SÍ

10. Dolores sent the vase that she had found / to her grandmother.
Dolores envió el jarrón que había encontrado / a su abuela.
Dolores found the vase that she was going to send / to her grandmother.
Dolores encontró el jarrón que iba a enviar / a su abuela.
Who would receive the vase? Dolores Dolores' grandmother
¿Quién iba a recibir el jarrón? Dolores la abuela de Dolores
Did Dolores break the vase? NO
¿Dolores rompió el jarrón? NO

11. The teacher couldn't give the exam that he lost / to the students.
El maestro no pudo dar el examen que perdió / a los estudiantes.
The teacher lost the exam that he was going to give / to the students.
El maestro perdió el examen que iba a dar / a los estudiantes.
Who lost the exam? the teacher the students
¿Quién perdió el examen? el maestro los estudiantes
Did the students lose the exam? NO
¿Perdieron los estudiantes el examen? NO

12. The nurse sent the blood that she hadn't spilled / to the lab.
La enfermera envió la sangre que no había derramado / al laboratorio.
The nurse spilled the blood that she was going to send / to the lab.
La enfermera derramó la sangre que iba a enviar / al laboratorio.
What did the nurse send the lab? the records the blood
¿Qué envió la enfermera al laboratorio? los récords la sangre
Did the nurse spill all the blood? NO
¿Derramó la enfermera toda la sangre? NO
What was the nurse going to send to the lab? the records the blood
¿Qué iba a enviar al laboratorio la enfermera? los récords la sangre
Did the nurse spill the blood? NO
¿Derramó la enfermera medicina? NO

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13. Marilyn showed the blouse that she was going to wear / to her friends.
Marisol *enseñó* [mostró] la blusa que se iba a poner / a sus amigas.
Marilyn didn't wear the blouse that she had shown / to her friends.
Marisol no se puso la blusa que había *enseñado* [mostrado] / a sus amigas.
Who was going to wear a blouse? Marilyn Marilyn's friends
¿Quién se iba a poner una blusa? Marisol las amigas de Marisol
Was Marilyn going to wear a blouse? YES
¿Se iba a poner una blusa Marisol? SÍ
Who didn't wear a blouse? Marilyn Marilyn's friends
¿Quién no se puso una blusa? Marisol las amigas de Marisol
Did Marilyn show a blouse to her friends? YES
¿*Enseñó* [Mostró] Marisol una blusa a sus amigas? SÍ

14. Ellen described the earrings that she had lost / to her daughter.
Elena describió los pendientes que había perdido / a su hija.
Ellen lost the earrings that she had promised / to her daughter.
Elena perdió los pendientes que había prometido / a su hija.
Who lost the earrings? Ellen's niece Ellen
¿Quién perdió los pendientes? la sobrina de Elena Elena
Did Ellen's daughter lose the earrings? NO
¿Perdió los pendientes la hija de Elena? NO

15. The candidate promised the document that he had found / to his opponent.
El candidato prometió el documento que había encontrado / a su adversario.
The candidate found the document that he had promised / to his opponent.
El candidato encontró el documento que había prometido / a su adversario.
Who found the document? the candidate the opponent
¿Quién encontró el documento? el candidato el adversario
Did the candidate find the document? YES
¿Encontró el documento el candidato? SÍ

16. The chauffeur returned the car that he had crashed / to the garage.
El chófer devolvió el *coche* [carro] que había estrellado / al garaje.
The chauffeur crashed the car that he was going to drive / to the garage.
El chófer estrelló el *coche* [carro] que iba a conducir / al garaje.
Who crashed the car? the maid the chauffeur
¿Quién estrelló el *coche* [carro]? la criada el chófer
Did a maid crash the car? NO
¿Estrelló el *coche* [carro] una criada? NO

17. David promised the ring that he had inherited / to his girlfriend.
David prometió el anillo que había heredado / a su novia.
David inherited the ring that he had promised / to his girlfriend.
David heredó el anillo que había prometido / a su novia.
Who had inherited a ring? David David's girlfriend
¿Quién había heredado un anillo? David la novia de David
Did David inherit a house? NO
¿Había heredado una casa David? NO

18. The nanny read the book that she hated / to the children.
La niñera leyó el libro que odiaba / a los niños.
The nanny hated the book that she read / to the children.
La niñera odiaba el libro que leyó / a los niños.
What did the nanny hate? the children a book
¿Qué odiaba la niñera? a los niños un libro

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Did the nanny hate the children?NO
¿La niñera odiaba a los niños? NO

19. Some of the teachers spoke about the rules that the new dean established / to the students.
Algunos de los maestros hablaron sobre las reglas que estableció el decano nuevo / a los estudiantes.
The new dean established rules that some of the teachers spoke about / to the students.
El decano nuevo estableció reglas de las que algunos maestros hablaron / a los estudiantes.
Who established the rules? the dean the teachers
¿Quién estableció las reglas? el decano los maestros
Did the dean establish new rules? YES
¿Estableció reglas nuevas el decano? SÍ

20. The soldiers delivered the food that the UN representatives had collected / to the refugees.
Los soldados entregaron los alimentos que los representantes de la ONU habían juntado / a los refugiados.
The UN representatives collected the food that the soldiers would deliver / to the refugees.
Los representantes de la ONU juntaron los alimentos que los soldados entregarían / a los refugiados.
Who delivered the food? the UN the soldiers
¿Quién entregó los alimentos? la ONU los soldados
Did the UN deliver the food? NO
¿Entregó los alimentos la ONU?NO

21. The violinist refused to show the violin that she had tuned / to the orchestra conductor.
La violinista se negó a *enseñar* [mostrar] el violín que había afinado / al director de la orquesta.
The violinist tuned the violin that she had refused to show / to the orchestra conductor.
La violinista afinó el violín que se había negado a *enseñar* [mostrar] / al director de la orquesta.
Who tuned the violin? the violinist the conductor
¿Quién afinó el violín? la violinista el director
Did the violinist tune the violin? YES
¿Afinó el violín la violinista? SÍ

22. The taxi driver handed over the bag full of money that he found in his cab / to the police.
El taxista entregó la bolsa llena de dinero que encontró en su *coche* [carro] / a la policía.
The taxi driver found in his cab the bag full of money that he handed over / to the police.
El taxista encontró en su *coche* [carro] la bolsa llena de dinero que entregó / a la policía.
What did the taxi driver find? a wallet a bag
¿Qué encontró el taxista? una cartera una bolsa
Did the taxi driver find a wallet? NO
¿Encontró una cartera el taxista? NO

23. The little boy gave the picture that he had drawn at school / to his mother.
El niño regaló el dibujo que había hecho en la escuela / a su madre.
The little boy drew a picture that he was going to give / to his mother.
El niño hizo un dibujo que iba a regalar / a su madre.
Who drew a picture? the boy the boy's mother
¿Quién hizo un dibujo? el niño la madre del niño
Did the boy's mother draw a picture? NO
¿Hizo un dibujo la madre del niño? NO

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24. The gardener sold the flowers that he had cut / to the florist.
El jardinero vendió las flores que había cortado / al florista.
The gardener cut the flowers that he was going to sell / to the florist.
El jardinero cortó las flores que iba a vender / al florista.
Who sold the flowers? the gardener the florist
¿Quién vendió las flores? el jardinero el florista
Did the florist cut the flowers? NO
¿Cortó las flores el florista? NO

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Appendix A-3: Sentences Used to Generate Fillers for the Test of Plausibility and the Norman/Saxon Relative Acceptability Questionnaire

Items borrowed from Cuetos & Mitchell (1988), as originally numbered (N=8), used to generate simplex pairs in the test of plausibility, discussed in Chapter 4.

2. Someone shot the servant of the actress that was on the balcony with her husband.
   Alguien disparó contra el criado de la actriz que estaba en el balcón con su marido.

6. The police arrested the sister of the porter that was in Melilla serving in the army.
   La policía detuvo a la hermana del portero que estuvo en Melilla haciendo la mili.

7. The nurse took the syrup of the patient that was by the window sunning himself.
   La enfermera apartó el jarabe del paciente que estaba junto a la ventana tomando el sol.

8. A student stared at the friend of the teacher that was at the school as technical director.
   Un alumno apedreó a la amiga del profesor que estuvo en el colegio como director técnico.

10. Amelia exchanges letters with the cousin of the singer that was in the church performing a concert.
    Amelia se escribe con el primo del cantante que estuvo en la iglesia dando un concierto.

22. The boys poked fun at the niece of the teacher that was in the park with his wife.
    Los chicos se burlaron de la sobrina del maestro que estaba en el parque con su esposa.

23. My mother argued with the maid of the duchess that was looking out the window.
    Mi madre discutió con la sirvienta del duque que estaba mirando por la ventana.

24. This afternoon I saw the son of the doctor that was at our home treating grandfather.
    Esta tarde he visto al hijo del doctor que estuvo en nuestra casa curando al abuelo.

Items borrowed from Carreiras & Clifton (1993), as originally numbered (N=14), used to generate simplex pairs in the test of plausibility, discussed in Chapter 4. (Note that Carreiras & Clifton's materials, disambiguated pragmatically, fully cross the variable of attachment site (high and low) with gender of host (feminine and masculine). For the purposes of the materials evaluation questionnaires, each Carreiras & Clifton item was taken to be two separate items (with different complex NPs).

4. This afternoon I saw the daughter of the madman that was trying out some new eyeshadow.
   Esta tarde he visto a la hija del loco que estaba probándose una nueva pintura de ojos.
   This afternoon I saw the son of the madwoman that was trying out some new eyeshadow.
   Esta tarde he visto al hijo de la loca que estaba probándose una nueva pintura de ojos.

5. The children followed the grandmother of the boy that was wearing a torn skirt.
   Los niños siguieron a la abuela del niño que tenía la falda rota.
   The children followed the grandfather of the girl that was wearing a torn skirt.
   Los niños siguieron al abuelo de la niña que tenía la falda rota.

6. Peter went to a concert yesterday with the mother of the count that always wears flaming red lipstick.
   Pedro fue ayer al concierto con la madre del conde que siempre se pone una pintura de labios roja brillante.
   Peter went to a concert yesterday with the father of the countess that always wears flaming red lipstick.

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Pedro fue ayer al concierto con el padre de la condesa que siempre se pone una pintura de labios roja brillante.

8. The journalist interviewed the bodyguard of the queen that always sunbathed topless.
   El periodista entrevistó al guardaespaldas de la reina que siempre tomaba el sol en topless.
   The journalist interviewed the mistress of the king that always sunbathed topless.
   El periodista entrevistó a la querida del rey que siempre tomaba el sol en topless.

13. A registered letter came for the landlady of the businessman that was a sergeant in the army reserves.
    Llegó una carta certificada para la casera del ejecutivo que fue sargento de la legión.
    A registered letter came for the landlord of the ballerina that was a sergeant in the army reserves.
    Llegó una carta certificada para el casero de la bailarina que fue sargento de la legión.

14. Amelia photographed the bride of the prince that had been a football player in college.
    Amelia fotografió a la prometida del príncipe que había sido jugador de fútbol en el instituto.
    Amelia photographed the bridegroom of the princess that had been a football player in college.
    Amelia fotografió al prometido de la princesa que había sido jugador de fútbol en el instituto.

15. The terrorists kidnapped the grandson of the stewardess that had played rugby at Harvard.
    Los terroristas secuestraron al nieto de la azafata que había sido jugador de rugby en la universidad.
    The terrorists kidnapped the granddaughter of the steward that had played rugby at Harvard.
    Los terroristas secuestraron a la nieta del administrador que había sido jugador de rugby en la universidad.

Items borrowed from Gilboy, Sopena, Clifton & Frazier (1995), as originally numbered (*N*=17), used to generate simplex pairs in the test of plausibility, discussed in Chapter 4.

A(sub)

1. In the garage we keep the table of wood that John carved this Christmas holiday.
   En el garaje guardamos la mesa de madera que Juan serró estas Navidades.

2. To my sister they gave the lamp of alabaster that they polished until it looked like marble.
   A mi hermana le regalaron la lámpara de alabastro que pulieron hasta que pareciera mármol.

3. Yesterday they gave me the sweater of cotton that was illegally imported.
   Ayer me regalaron el jersey de algodón que importaban de contrabando.

4. In the end Tomas brought the shawl of wool that was very expensive.
   Al final Tomás compró la manta de lana que era muy cara.

5. Maria made the belt of leather that Pedro liked a lot.
   María hizo el cinturón de piel que le gusta a Pedro.

6. Finally they placed the bell of bronze that they brought from the foundry.
   Por fin colocaron la campana de bronce que trajeron de la fundición.

7. Yesterday we ate the cake of rice that they sold us in the oriental shop.
   Ayer nos comimos el pastel de arroz que nos vendieron en la tienda de productos orientales.

8. The young actress admired the gown of silk that was so beautiful.
   La joven actriz admiraba la toga de seda que era muy bonita.

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A(quant)

1. John asked for the glass of water that was on the table.
   Juan pidió el vaso de agua que estaba encima de la mesa.

2. Mary liked the bottle of brandy that we kept in the wine cellar.
   A María le gustaba la botella de coñac que guardábamos en la bodega.

3. Pedro took away the cup of sugar that fell on the floor.
   Pedro se llevó la taza de azúcar que se cayó al suelo.

4. Andres picked up the sack of sand that we brought from the construction site.
   Andrés recogió el saco de arena que trajimos de la obra.

5. The clerk brought us the package of fish that was on the counter.
   El vendedor nos trajo el paquete de pescado que estaba en el mostrador.

6. When we go camping we take the suitcase of clothes that we use in the summer.
   Cuando vamos de cámping llevamos la maleta de ropa que usamos en verano.

7. In the dining room you will find the basket of apples that John gave us.
   En el comedor encontrarás la cesta de manzanas que Juan nos regaló.

8. Julia picked up the can of varnish that was oily.
   Julia recogió el pote de barniz que estaba aceitoso.

9. My mother didn't see the jar of jam that was crawling with ants.
   Mi madre no vio la jarra de mermelada que estaba cubierta de hormigas.

Additional sentences used to generate the remaining simplex pairs in the test of plausibility, discussed in Chapter 4.

1. Someone shot the servant of the actress that was reading.
   Alguien disparó contra el criado de la actriz que estaba leyendo.

2. The police arrested the sister of the porter that was visiting.
   La policía detuvo a la hermana del portero que estaba de visita.

3. The nurse took the syrup of the patient that was here.
   La enfermera apartó el jarabe del paciente que estaba aquí.

4. A student stared at the friend of the teacher that was standing.
   Un alumno apedreó a la amiga del profesor que estaba de pie.

5. Amelia exchanges letters with the cousin of the singer that was praying.
   Amelia se escribe con el primo del cantante que estaba rezando.

6. The boys poked fun at the niece of the teacher that was sleeping.
   Los chicos se burlaron de la sobrina del maestro que estaba durmiendo.

7. My mother argued with the maid of the duchess that left.
   Mi madre discutió con la sirvienta del duque que se marchó.

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8. This afternoon I saw the son of the doctor that was nervous.
   Esta tarde he visto al hijo del doctor que estaba nervioso.

9. An armed robber shot the maid of the actress that was single.
   Un ladrón armado disparó contra la criada de la actriz que estaba soltera.

10. The police arrested the sister of the nursemaid that was pregnant.
    La policía arrestó a la hermana de la niñera que estaba embarazada.

11. The dog barked at the niece of the empress that was crying.
    El perro ladró a la sobrina de la emperatriz que estaba llorando.

12. An armed robber shot the maid of the actress that had just divorced her husband.
    Un ladrón armado disparó contra la criada de la actriz que estaba divorciada de su marido.

13. The police arrested the sister of the nursemaid that recently gave birth to twins.
    La policía arrestó a la hermana de la niñera que dio a luz recientemente dos gemelos.

14. The dog barked at the niece of the empress that was wearing a green dress.
    El perro ladró a la sobrina de la emperatriz que siempre se pone vestidos verdes.

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Appendix B: Materials Evaluation Questionnaires

Appendix B-1: Test of Plausibility

English Version

Regardless of what you think the interpretation of the sentence could be, indicate how plausible you consider the meaning of each of the following sentences by circling the appropriate number. Base your answers on the following scale.

very plausible	somewhat plausible	don't know	somewhat implausible	very implausible
1	2	3	4	5

For example, consider the sentence *The octopus was reading the newspaper.* While the sentence could be meaningfully uttered under certain circumstances (for instance, to describe a picture in a children's book), its meaning is not very plausible in the real world (octopi typically cannot read).

Please note that the sentences below come in pairs (e.g., *The printers were stolen, The computers were stolen*). This does not mean that one of the sentences should be more plausible than the other. In fact, *both* sentences could be very plausible or very implausible.

		✓P		?		×P
1.	The printers were stolen.	1	2	3	4	5
2.	The computers were stolen.	1	2	3	4	5
3.	The panels were broken.	1	2	3	4	5
4.	The sarcophagi were broken.	1	2	3	4	5
5.	The revisions were on the test.	1	2	3	4	5
6.	The manuscripts were on the test.	1	2	3	4	5

Spanish Version

Sin tomar en cuenta la interpretación de las siguientes oraciones, indica la plausibilidad del significado de cada una, marcando el número que corresponda. Basa tus respuestas en la escala a continuación.

definitivamente plausible	posiblemente plausible	no sé	posiblemente no plausible	definitivamente no plausible
1	2	3	4	5

Por ejemplo, aunque la oración *El pulpo estaba leyendo el periódico* puede tener sentido bajo ciertas circunstancias (por ejemplo, si se refiere a un dibujo en un cuento para niños), su significado no es muy plausible, ya que los pulpos típicamente no saben leer.

Observa que las oraciones van en pares (*Los gerentes estaban evaluando su informe* y *Los asistentes estaban evaluando su informe*). Esto no quiere decir que debes comparar las dos oraciones en cada par con respecto a su plausibilidad. Las dos oraciones pueden ser plausibles o no.

		✓P		?		×P
1.	Los gerentes estaban evaluando su informe.	1	2	3	4	5
2.	Los asistentes estaban evaluando su informe.	1	2	3	4	5
3.	Los recambios estaban de oferta.	1	2	3	4	5
4.	Los bolígrafos estaban de oferta.	1	2	3	4	5
5.	Los programas estaban de oferta.	1	2	3	4	5
6.	Los computadores estaban de oferta.	1	2	3	4	5

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Appendix B-2: Absolute Grammaticality of Bare Matrix

English Version

Indicate how grammatical you consider each of the following sentences to be by circling the appropriate number. Base your answers on the following scale.

grammatical	marginally grammatical	don't know	marginally ungrammatical	ungrammatical
1	2	3	4	5

		✓G		?		×G
1.	The chauffeur crashed the car to the garage.	1	2	3	4	5
2.	David inherited the ring to his girlfriend.	1	2	3	4	5
3.	The soldiers delivered the food to the refugees.	1	2	3	4	5
4.	The violinist refused to show the violin to the orchestra conductor.	1	2	3	4	5
5.	Rita sold the book to her friend.	1	2	3	4	5

Spanish Version

Indica la gramaticalidad de cada una de las siguientes oraciones marcando el número que corresponda. Basa tus respuestas en la escala a continuación.

gramatical	marginalmente gramatical	no sé	marginalmente no gramatical	no gramatical
1	2	3	4	5

		✓G		?		×G
1.	Marcos vio la película a sus padres.	1	2	3	4	5
2.	Natalia examinó los diamantes al joyero.	1	2	3	4	5
3.	El director del hotel no quiso ver a los guías de los turistas.	1	2	3	4	5
4.	El niño hizo el dibujo a su madre.	1	2	3	4	5
5.	Susana admiró los pasillos de los apartamentos.	1	2	3	4	5

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Appendix B-3: Relative Acceptability of Norman Versus Saxon Construction

Consider each pair of noun phrases below and indicate whether both are grammatical or one is more grammatical (better) than the other. Circle the appropriate number, basing your answers on the scale below.

(a) definitely better	(a) somewhat better	both OK	(b) somewhat better	(b) definitely better
1	2	3	4	5

				(a)		=		(b)
1.	a. the bodyguard of the queen	b.	the queen's bodyguard	1	2	3	4	5
2.	a. the wives of the hostages	b.	the hostages' wives	1	2	3	4	5
3.	a. the jar of jam	b.	the jam jar	1	2	3	4	5
4.	a. the maid of the duchess	b.	the duchess' maid	1	2	3	4	5
5.	a. the bodyguards of the ambassadors	b.	the ambassadors' bodyguards	1	2	3	4	5

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Appendix B-4: Test of Naturalness

Read each of the following pairs of sentences and indicate whether or not they are both natural in Spanish and English by cirling the appropriate number. Base your answers on the following scale.

English *definitely* more natural 1	English somewhat more natural 2	both equally natural 3	Spanish somewhat more natural 4	Spanish *definitely* more natural 5

		E<		=		S>
1.	Patricia saw the teachers of the students that were in the library the other day. Patricia vio a los profesores de los estudiantes que estaban en la biblioteca el otro día.	1	2	3	4	5
2.	To my sister they gave the lamp of alabaster that they polished until it looked like marble. A mi hermana le regalaron la lámpara de alabastro que pulieron hasta que pareciera mármol.	1	2	3	4	5
3.	The personnel manager was observing the secretary of the accountant that was studying. El gerente observaba al secretario del contable que estaba estudiando.	1	2	3	4	5
4.	The nurse took the syrup of the patient that was by the window sunning himself. La enfermera apartó el jarabe del paciente que estaba junto a la ventana tomando el sol.	1	2	3	4	5
5.	The violinist refused to show the violin that she had tuned to the orchestra conductor. La violinista se negó a mostrar el violín que había afinado al director de la orquesta.	1	2	3	4	5

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Appendix C: Language History (Background) Questionnaires

Appendix C-1: Monolingual Language History Questionnaires

English

BACKGROUND INFORMATION

All personal information you provide will maintained in strict confidentiality. Feel free to use the back of the sheet if you need more room.

Subject No.: .....
Age:..... Sex: ☐ male ☐ female
What language(s) does your mother speak? ..... your father?.....
Have you spent any time longer than two months living in an environment where English is not the dominant language? ☐☐yes ☐☐no
If yes, explain where and when.: .....
.....

Do you speak any languages other than English? .....
(Indicate "fluent" or "only a little".).....

City/Country of origin: ..... Occupation: .....

Have you ever lived outside of the United States? ☐☐yes ☐☐no
If yes, describe briefly where, when, and for how long:.....
.....

Are you right handed or left handed? ☐ right handed ☐ left handed
Do you have any left-handed blood relations? (please list them).....
.....

Education background (check all that apply):

☐ elementary school	☐ in English	☐ in another language
☐ high-school	☐ in English	☐ in another language
☐ college	☐ in English	☐ in another language
☐ graduate school	☐ in English	☐ in another language
☐ other: please explain	☐ in English	☐ in another language

Where did you attend elementary school? ☐ in US ☐ elsewhere (indicate where).....
Where did you attend high-school? ☐ in US ☐ elsewhere.....
Where did you go to college? ☐ in US ☐ elsewhere.....

Do you hear an inner voice when you read? ☐ yes ☐ no

When reading a letter, have you ever experienced the sensation of hearing the voice of the person who wrote it as you read the words? ☐ yes ☐ no

If you were asked to remember twelve items, without being able to write them down, which technique do you think would work better for you? Check only **one**: ☐ Visualizing the objects.
☐ Visualizing the words for the objects.

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Castillian Spanish

INFORMACIÓN GENERAL

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No. de Participante: .....

Edad:..... Sexo: ☐ masculino ☐ femenino

¿Qué idioma(s) habla tu madre? ..... tu padre? .....
¿Has pasado más de dos meses viviendo en algún lugar donde el castellano no sea la lengua mayoritaria?
☐ no.
☐ sí. Explica dónde y cuándo.....
.....

¿Hablas inglés?
☐ con soltura
☐ me defiendo
☐ lo he estudiado. pero no lo hablo bien
☐ lo hablo un poco
☐ no hablo inglés

¿Hablas algún otro idioma? .....
☐ con soltura
☐ me defiendo
☐ lo he estudiado, pero no lo hablo bien
☐ lo hablo un poco
☐ no hablo ningún otro idioma

Ciudad/País de origen: ..... Profesión: .....

¿Has vivido fuera de España? ☐ no ☐ sí
Describe brevemente dónde, cuándo, y por cuánto tiempo: .....
.....

¿Eres zurdo/a o diestro/a? ☐ zurdo/a ☐ diestro/a
¿Tienes algún pariente consanguíneo que sea zurdo/a? ¿De quién se trata? .....
.....

Educación (marca las casillas que correspondan; si se trata de otro idioma, indica cuál):

☐ educación básica	☐ en castellano	☐ en otro idioma.....
☐ escuela secundaria (instituto)	☐ en castellano	☐ en otro idioma.....
☐ universidad	☐ en castellano	☐ en otro idioma.....
☐ estudios universitarios avanzados	☐ en castellano	☐ en otro idioma.....
☐ otro (indica de qué tipo de estudios se trata).....	☐ en castellano	☐ en otro idioma.....

¿Dónde has hecho tus estudios primarios? ☐ en España ☐ en otro lugar (indica dónde) .....
¿Dónde has hecho tus estudios secundarios? ☐ en España ☐ en otro lugar.....
¿Dónde has ido/vas a la universidad? ☐ en España ☐ en otro lugar.....

Cuando lees, ¿oyes una voz interior? ☐ sí ☐ no

¿Alguna vez has tenido la impresión al leer una carta que estás oyendo la voz de la persona que escribió la carta a la vez que vas leyendo las palabras? ☐ sí ☐ no

Si tuvieras que recordar doce objetos, sin poder escribir los nombres de cada uno, ¿cuál de las siguientes técnicas crees que funcionaría mejor para ti? Marca solamente **una** casilla:

☐ Visualizar los objetos.
☐ Visualizar las palabras de cada objeto.

¡MUCHAS GRACIAS POR TU COLABORACIÓN!

Por favor, repasa tus respuestas para asegurarte de haber rellenado todos los espacios en blanco.

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Pan-American Spanish (used with Puerto Rican Spanish monolinguals, Experiment 5, discussed in Appendix G)

Información General

Toda información personal que proporciones se mantendrá en confianza absoluta. Puedes utilizar el dorso de esta página si necesitas más espacio.

No. de Participante: .....
Edad:..... Sexo: ☐ masculino ☐ femenino
¿Qué idioma(s) habla tu madre? ..... tu padre? .....
¿Has pasado más de dos meses viviendo en algún lugar donde el español no sea la lengua mayoritaria?
☐ ☐ no.
☐ ☐ sí. Explica dónde y cuándo.....
.....

¿Hablas algún otro idioma además de español? .....
(Indica si lo hablas "con soltura" o "sólo un poco".).....

Ciudad/País de origen: ..... Profesión: .....

¿Has vivido fuera de Puerto Rico? ☐ ☐ no ☐ ☐ sí
Describe brevemente dónde, cuándo, y por cuánto tiempo: .....
.....

¿Eres zurdo/a o diestro/a? ☐ zurdo/a ☐ diestro/a
¿Tienes algún pariente consanguíneo que sea zurdo/a? ¿De quién se trata? .....
.....

Educación (marca las casillas que correspondan):

☐ educación básica *(elementary school)*	☐ en español	☐ en otro idioma
☐ escuela secundaria *(high school)*	☐ en español	☐ en otro idioma
☐ universidad	☐ en español	☐ en otro idioma
☐ estudios universitarios avanzados	☐ en español	☐ en otro idioma
☐ otro (indica de qué tipo de estudios se trata).....	☐ en español	☐ en otro idioma

¿Dónde hiciste tus estudios primarios? ☐ en PR ☐ en otra parte (indica dónde).....
¿Dónde hiciste tus estudios secundarios? ☐ en PR ☐ en otra parte.....
¿Dónde fuiste a la universidad? ☐ en PR ☐ en otra parte.....

Cuando lees, ¿oyes una voz interior? ☐ sí ☐ no

¿Alguna vez has tenido la impresión al leer una carta que estás oyendo la voz de la persona que escribió la carta a la vez que vas leyendo las palabras? ☐ sí ☐ no

Si tuvieras que recordar doce objetos, sin poder escribir los nombres de cada uno, ¿cuál de las siguientes técnicas crees que funcionaría mejor para ti? Marca solamente **una** casilla:

☐ Visualizar los objetos.
☐ Visualizar las palabras de cada objeto.

¡MUCHAS GRACIAS POR TU COLABORACIÓN!
Por favor, repasa tus respuestas para asegurarte de haber rellenado todos los espacios en blanco.

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Appendix C-2: Bilingual Language History Questionnaires

English

BACKGROUND INFORMATION

All personal information you provide will maintained in strict confidentiality. Feel free to use the back of the sheet if you need more room.

Subject No.: .....

Age:..... Sex: ☐ male ☐ female

Age you were first exposed to Spanish: ..... Age you were first exposed to English: .....

Briefly explain when you began learning each of your languages: .....
.....
.....

Where did you learn each language? Spanish: .....
English: .....

What language(s) does your mother speak? ..... your father?.....

If you've lived outside of the US, describe briefly where, when, and for how long. .....
.....
.....

Age you arrived to US: .....

Do you speak any languages other than Spanish and English? .....
(Indicate "fluent" or "only a little".) .....

City/Country of origin: ..... Occupation: .....

Are you right handed or left handed? ☐ right handed ☐ left handed
Do you have any left-handed blood relations? (please list them).....

Education background (check all that apply):

☐ elementary school	☐ in Spanish	☐ in English
☐ high-school	☐ in Spanish	☐ in English
☐ college	☐ in Spanish	☐ in English
☐ graduate school	☐ in Spanish	☐ in English
☐ other: please explain	☐ in Spanish	☐ in English

.....

Where did you attend elementary school? ☐ in US ☐ elsewhere (indicate where).....
Where did you attend high-school? ☐ in US ☐ elsewhere.....
Where did you go to college? ☐ in US ☐ elsewhere.....

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For the following questions, circle the number that corresponds with the amount of English or Spanish that you generally use. Follow the scale below:

1	2	3	4	5	n/a
Spanish all the time (always)	Spanish usually more than English	Spanish as much as English	English usually more than Spanish	English all the time (always)	does not apply

When you were a child, how much Spanish/English did you speak:	always Spanish				always English	
at home, to your parents?	1	2	3	4	5	n/a
at home, to your brothers or sisters?	1	2	3	4	5	n/a
at home, to your grandparents?	1	2	3	4	5	n/a
at home, to other relatives?	1	2	3	4	5	n/a
to your friends?	1	2	3	4	5	n/a
in other social contexts (to neighbors, people at the supermarket, etc.)?	1	2	3	4	5	n/a

When you were a child, how much Spanish/English did the following people speak to you?	always Spanish				always English	
your parents	1	2	3	4	5	n/a
your brothers or sisters	1	2	3	4	5	n/a
your grandparents	1	2	3	4	5	n/a
other relatives	1	2	3	4	5	n/a
your friends	1	2	3	4	5	n/a
other people	1	2	3	4	5	n/a

When you were a teenager, how much Spanish/English did you speak:	always Spanish				always English	
at home, to your parents?	1	2	3	4	5	n/a
at home, to your brothers or sisters?	1	2	3	4	5	n/a
at home, to your grandparents?	1	2	3	4	5	n/a
at home, to other relatives?	1	2	3	4	5	n/a
to your friends?	1	2	3	4	5	n/a
to your teachers at school?	1	2	3	4	5	n/a
in other social contexts?	1	2	3	4	5	n/a

When you were a teenager, how much Spanish/English did the following people speak to you?	always Spanish				always English	
your parents	1	2	3	4	5	n/a
your brothers or sisters	1	2	3	4	5	n/a
your grandparents	1	2	3	4	5	n/a
other relatives	1	2	3	4	5	n/a
your friends	1	2	3	4	5	n/a
your teachers at school	1	2	3	4	5	n/a
other people	1	2	3	4	5	n/a

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(The scale is repeated here for your reference.)

1	2	3	4	5	n/a
Spanish all the time (always)	Spanish usually more than English	Spanish as much as English	English usually more than Spanish	English all the time (always)	does not apply

How much Spanish/English do you speak now:	always Spanish				always English	
at home, to your spouse, living companion, roommate?	1	2	3	4	5	n/a
at home, to your children?	1	2	3	4	5	n/a
at home, to your relatives?	1	2	3	4	5	n/a
to your friends?	1	2	3	4	5	n/a
to your colleagues at work?	1	2	3	4	5	n/a
to people at school?	1	2	3	4	5	n/a
in other social contexts?	1	2	3	4	5	n/a

How much Spanish/English do the following people speak to you now?	always Spanish				always English	
your spouse, living companion, roommate	1	2	3	4	5	n/a
your children	1	2	3	4	5	n/a
your relatives	1	2	3	4	5	n/a
your friends	1	2	3	4	5	n/a
your colleagues at work	1	2	3	4	5	n/a
people at school	1	2	3	4	5	n/a
other people	1	2	3	4	5	n/a

Rate yourself according to the following categories (circle one on each line):

How would you rate your speaking ability in English/Spanish?

ENGLISH:	very good	somewhat good	so-so	somewhat poor	very poor
SPANISH:	very good	somewhat good	so-so	somewhat poor	very poor

How would you rate your reading ability in English/Spanish?

ENGLISH:	very good	somewhat good	so-so	somewhat poor	very poor
SPANISH:	very good	somewhat good	so-so	somewhat poor	very poor

How would you rate your writing ability in English/Spanish?

ENGLISH:	very good	somewhat good	so-so	somewhat poor	very poor
SPANISH:	very good	somewhat good	so-so	somewhat poor	very poor

How would you rate your comprehension in English/Spanish?

ENGLISH:	very good	somewhat good	so-so	somewhat poor	very poor
SPANISH:	very good	somewhat good	so-so	somewhat poor	very poor

Could you pass as a monolingual speaking on the telephone with someone who doesn't know you?

IN ENGLISH:	always	almost always	sometimes	almost never	never
IN SPANISH:	always	almost always	sometimes	almost never	never

Could you pass as a monolingual speaker in a face-to-face conversation with a stranger?

IN ENGLISH:	always	almost always	sometimes	almost never	never
IN SPANISH:	always	almost always	sometimes	almost never	never

Which language do you feel more comfortable speaking? Why? .....

.....

Which language do you speak when you're really tired? .....

when you're very angry? ..... when you're incredibly happy? .....

Which language do you use to do simple arithmetic (counting, adding, multiplying, etc.)? .....

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Do you hear an inner voice when you read? in English ☐ yes ☐ no
in Spanish ☐ yes ☐ no

When reading a letter, have you ever experienced the sensation of hearing the voice of the person who wrote it as you read the words? in English ☐ yes ☐ no
in Spanish ☐ yes ☐ no

If you were asked to remember twelve items, without being able to write them down, which technique do you think would work better for you? Check only **one**:

- ☐ Visualizing the objects.
- ☐ Visualizing the words for the objects in English.
- ☐ Visualizing the words for the objects in Spanish.
- ☐ Visualizing the words for each object in either Spanish or English, depending on the object type (e.g., cooking utensils in English, animal names in Spanish).

Suppose that you were informed by your doctor that you needed to have immediate brain surgery to save your life, but that one of the consequences of the surgery would be the complete loss of one of your two languages, maintaining your other language intact. The doctor adds that you may choose which language to keep. Disregarding any financial considerations, which language would you choose to keep? Why? .....
.....
.....

Do you have any other comments on your language background that you think are important which you were not asked about in this questionnaire? .....
.....
.....

THANKS FOR YOUR COOPERATION!
Please take a moment now to ensure that you have filled in all the blanks.

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Pan-American Spanish

INFORMACIÓN GENERAL

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No. de Participante: .....

Edad:..... Sexo: ☐ masculino ☐ femenino

Edad al primer contacto con el español: ..... Edad al primer contacto con el inglés: .....

Explica brevemente cuándo empezaste a aprender cada uno de tus dos idiomas:.....
.....
.....

¿Dónde has aprendido tus dos idiomas? español: .....
inglés: .....

¿Qué idioma(s) habla tu madre? ..... tu padre? .....

Si has vivido fuera de EU, describe brevemente dónde, cuándo, y por cuánto tiempo. .....
.....
.....

¿A qué edad llegaste a los Estados Unidos (EU)?: .....

¿Hablas algún otro idioma además de inglés y español? .....
(Indica si lo hablas "con soltura" o "sólo un poco".) .....

Ciudad/País de origen: ..... Profesión: .....

¿Eres zurdo/a o diestro/a? ☐ zurdo/a ☐ diestro/a
¿Tienes algún pariente consanguíneo que sea zurdo/a? ¿De quién se trata? .....
.....

Educación (marca las casillas que correspondan):

☐	educación básica *(elementary school)*	☐ en español	☐ en inglés
☐	escuela secundaria *(high school)*	☐ en español	☐ en inglés
☐	universidad	☐ en español	☐ en inglés
☐	estudios universitarios avanzados	☐ en español	☐ en inglés
☐	otro (indica de qué tipo de estudios se trata).....	☐ en español	☐ en inglés

¿Dónde hiciste tus estudios primarios? ☐ en EU ☐ en otra parte (indica dónde).....
¿Dónde hiciste tus estudios secundarios? ☐ en EU ☐ en otra parte.....
¿Dónde fuiste a la universidad? ☐ en EU ☐ en otra parte.....

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Para responder las siguientes preguntas, marca el número que corresponda a la cantidad de español o inglés que hablas en general, según la siguiente escala:

1	2	3	4	5	n/a
siempre español	español normalmente más que inglés	tanto español como inglés	inglés normalmente más que español	siempre inglés	no aplica

Cuando eras niño/a, ¿cuánto español/inglés hablabas:	siempre español				siempre inglés	
en casa, a tus padres?	1	2	3	4	5	n/a
en casa, a tus hermanos?	1	2	3	4	5	n/a
en casa, a tus abuelos?	1	2	3	4	5	n/a
en casa, a otros parientes?	1	2	3	4	5	n/a
a tus amigos?	1	2	3	4	5	n/a
en otros contextos sociales (vecinos, gente en el mercado, etc.)?	1	2	3	4	5	n/a

Cuando eras niño/a, ¿cuánto español/inglés te hablaban las siguientes personas?	siempre español				siempre inglés	
tus padres	1	2	3	4	5	n/a
tus hermanos	1	2	3	4	5	n/a
tus abuelos	1	2	3	4	5	n/a
otros parientes	1	2	3	4	5	n/a
tus amigos	1	2	3	4	5	n/a
otras personas	1	2	3	4	5	n/a

Cuando eras adolescente, ¿cuánto español/inglés hablabas:	siempre español				siempre inglés	
en casa, a tus padres?	1	2	3	4	5	n/a
en casa, a tus hermanos?	1	2	3	4	5	n/a
en casa, a tus abuelos?	1	2	3	4	5	n/a
en casa, a otros parientes?	1	2	3	4	5	n/a
a tus amigos?	1	2	3	4	5	n/a
a tus maestros en la escuela?	1	2	3	4	5	n/a
en otros contextos sociales?	1	2	3	4	5	n/a

Cuando eras adolescente, ¿cuánto español/inglés te hablaban las siguientes personas?	siempre español				siempre inglés	
tus padres	1	2	3	4	5	n/a
tus hermanos	1	2	3	4	5	n/a
tus abuelos	1	2	3	4	5	n/a
otros parientes	1	2	3	4	5	n/a
tus amigos	1	2	3	4	5	n/a
tus maestros de la escuela	1	2	3	4	5	n/a
otras personas	1	2	3	4	5	n/a

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(Escala repetida aquí para tu referencia.)

1	2	3	4	5	n/a
siempre español	español normalmente más que inglés	tanto español como inglés	inglés normalmente más que español	siempre inglés	no aplica

Actualmente, ¿cuánto español/inglés hablas:	siempre español				siempre inglés	
en casa, a tu esposo/a, compañero/a de casa, etc.?	1	2	3	4	5	n/a
en casa, a tus hijos?	1	2	3	4	5	n/a
en casa, a tus parientes?	1	2	3	4	5	n/a
a tus amigos?	1	2	3	4	5	n/a
a tus colegas en la oficina o lugar de trabajo?	1	2	3	4	5	n/a
a las personas que conoces en la universidad?	1	2	3	4	5	n/a
en otros contextos sociales?	1	2	3	4	5	n/a

Actualmente ¿cuánto español/inglés te hablan las siguientes personas?	siempre español				siempre inglés	
tu esposo/a, compañero/a de casa, etc.	1	2	3	4	5	n/a
tus hijos	1	2	3	4	5	n/a
tus parientes	1	2	3	4	5	n/a
tus amigos	1	2	3	4	5	n/a
tus colegas de la oficina o lugar de trabajo	1	2	3	4	5	n/a
personas que conoces en la universidad	1	2	3	4	5	n/a
otras personas	1	2	3	4	5	n/a

Clasifícate según las siguientes categorías (marca una clasificación en cada línea):

¿Cómo clasificarías tu habilidad para hablar inglés/español?

INGLÉS:	muy buena	bastante buena	regular	bastante mala	muy mala
ESPAÑOL:	muy buena	bastante buena	regular	bastante mala	muy mala

¿Cómo clasificarías tu habilidad para leer inglés/español?

INGLÉS:	muy buena	bastante buena	regular	bastante mala	muy mala
ESPAÑOL:	muy buena	bastante buena	regular	bastante mala	muy mala

¿Cómo clasificarías tu habilidad para escribir inglés/español?

INGLÉS:	muy buena	bastante buena	regular	bastante mala	muy mala
ESPAÑOL:	muy buena	bastante buena	regular	bastante mala	muy mala

¿Cómo clasificarías tu habilidad para comprender inglés/español?

INGLÉS:	muy buena	bastante buena	regular	bastante mala	muy mala
ESPAÑOL:	muy buena	bastante buena	regular	bastante mala	muy mala

¿Podrías pasar como hablante monolingüe hablando por teléfono con alguien que no te conoce?

EN INGLÉS:	siempre	casi siempre	a veces	casi nunca	nunca
EN ESPAÑOL:	siempre	casi siempre	a veces	casi nunca	nunca

¿Podrías pasar como hablante monolingüe hablando cara a cara con alguien que no te conoce?

EN INGLÉS:	siempre	casi siempre	a veces	casi nunca	nunca
EN ESPAÑOL:	siempre	casi siempre	a veces	casi nunca	nunca

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¿En qué idioma te sientes más cómodo/a? ¿Por qué?.....
.....
¿Qué idioma hablas cuando estás muy cansado/a?.....
¿cuando te enojas? ..... ¿cuando estás muy contento/a?.....
¿Qué idioma utilizas para contar, sumar, multiplicar, etc.?.....

Cuando lees, ¿oyes una voz interior? en inglés ☐ sí ☐ no
en español ☐ sí ☐ no

¿Alguna vez has tenido la impresión al leer una carta que estás oyendo la voz de la persona que escribió la carta a la vez que vas leyendo las palabras? en inglés ☐ sí ☐ no
en español ☐ sí ☐ no

Si tuvieras que recordar doce objetos, sin poder escribir los nombres de cada uno, ¿cuál de las siguientes técnicas crees que funcionaría mejor para ti? Marca solamente **una** casilla:

- ☐ Visualizar los objetos.
- ☐ Visualizar las palabras de cada objeto en inglés.
- ☐ Visualizar las palabras de cada objeto en español.
- ☐ Visualizar las palabras de cada objeto en español o inglés, según el tipo de objeto que se trate (por ejemplo, utensilios de cocina en inglés, nombres de animales en español).

Supón que tu médico te informa que necesitas cirugía inmediata para salvarte la vida, pero que una de las consecuencias de la cirugía será la pérdida total de uno de tus dos idiomas, manteniendo el otro idioma intacto. El médico añade que puedes elegir con cuál de las dos lenguas prefieres quedarte. Sin tomar en cuenta consideraciones financieras, ¿con qué lengua prefieres quedarte? ¿Por qué?.....
.....
.....
.....

¿Tienes cualquier otro comentario sobre tu trasfondo lingüístico que crees importante pero sobre el cual no se te ha preguntado en este cuestionario?.....
.....
.....

¡MUCHAS GRACIAS POR TU COLABORACIÓN!

Por favor, repasa tus respuestas para asegurarte de haber rellenado todos los espacios en blanco.

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Appendix D: Instructions for the Experimental Tasks

Appendix D-1: Instructions for the Off-Line Questionnaire

English

INSTRUCTIONS FOR THE READING TEST

For this test, you will read a set of sentences, each followed by a question with two possible answers, printed to the right of the question.

Read all the sentences carefully and mark the word or phrase that best answers the question, based on the meaning of the sentence.

Mark only one answer for each question.

Examples:

Bruce bought a television for his wife and a bicycle for his son.
What did Bruce buy for his wife? (a television) a bicycle

Jules' sister had dinner yesterday with the politician that won the election.
Who won the election? Jules' sister (the politician)

REMEMBER:

- If you use reading glasses, you should use them for this test.
- After you have finished the practice sentences, pause for a moment and ask the experimenter if you have any questions about the procedure.
- Once you have begun, it's important to complete the test without interruptions. Normally it takes about 20 minutes to finish.
- Read all the sentences focusing on their meaning. Try to read at a natural pace for you: neither too fast nor too slow.
- Try not to change your responses, except if you made an error marking the page. It's better to answer spontaneously and without thinking too much or too long about the answer. **Read each sentence separately. Do not go back to any page that you've already read**, except at the end to check that you have answered all questions.

☺ Relax and try to enjoy this exercise. It's not a test of your fluency in English.

PRACTICE SENTENCES

Monica's mother wasn't at the party that Annie gave the other day.
Who organized a party? Monica Annie

Celia is always embarrassed about playing the piano that her uncle gave her for her birthday.
Who is shy about playing the piano? Celia Celia's uncle

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Castillian Spanish

INSTRUCCIONES PARA EL TEST DE LECTURA

En esta prueba, leerás una serie de oraciones, cada una seguida de una pregunta con dos respuestas posibles, impresas a la derecha de la pregunta.

Lee las oraciones cuidadosamente y marca la palabra o frase que mejor responda la pregunta, basándote en el significado de la oración.

Marca solamente una respuesta para cada pregunta.

Ejemplos:

Bruno compró una televisión para su mujer y una bicicleta para su hijo.
¿Qué le compró Bruno a su mujer? una televisión una bicicleta

La hermana de Julio cenó ayer con el político que ganó las elecciones.
¿Quién ganó las elecciones? la hermana de Julio el político

RECUERDA:

- Si utilizas gafas para leer, debes usarlas durante la prueba.
- Después de hacer las oraciones de práctica, haz una pausa y pregunta a la investigadora si tienes cualquier duda.
- Una vez que hayas comenzado, es importante completar el test sin interrupciones. Normalmente se tardan unos 20 minutos en completarlo.
- Lee todas las oraciones prestando atención a su significado. Trata de leer a un paso que sea natural para ti: ni muy rápido ni demasiado lento.
- Intenta no cambiar tus respuestas, excepto en el caso de que hayas cometido un error al marcar la página. Es mejor responder con espontaneidad y sin pensar demasiado sobre la respuesta. **Lee cada oración por separado. No vuelvas a ninguna página que ya hayas leído**, excepto al final para asegurarte de haber hecho todas las preguntas.

☺ Relájate e intenta divertirte con esta prueba. No es un examen de tu habilidad ni de tu destreza con el español.

ORACIONES DE PRÁCTICA

La madre de Mónica no estuvo en la fiesta que dio Anita el otro día.
¿Quién organizó una fiesta? Mónica Anita

A Celia siempre le da vergüenza tocar el piano que le regaló su tío para su cumpleaños.
¿Quién es tímido cuando va a tocar el piano? Celia el tío de Celia

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Pan-American Spanish (used with Spanish/English bilinguals, Experiment 3, and with Puerto Rican Spanish monolinguals, Experiment 5, discussed in Appendix G)

INSTRUCCIONES PARA EL TEST DE LECTURA

En esta prueba, leerás una serie de oraciones, cada una seguida de una pregunta con dos respuestas posibles, impresas a la derecha de la pregunta.

Lee las oraciones cuidadosamente y marca la palabra o frase que mejor responda la pregunta, basándote en el significado de la oración.

Marca solamente una respuesta para cada pregunta.

Ejemplos:

Bruno compró una televisión para su mujer y una bicicleta para su hijo.
¿Qué le compró Bruno a su mujer? una televisión una bicicleta

La hermana de Julio cenó ayer con el político que ganó las elecciones.
¿Quién ganó las elecciones? la hermana de Julio el político

RECUERDA:

- Si utilizas lentes para leer, debes usarlas durante esta prueba.
- Después de hacer las oraciones de práctica, haz una pausa y pregunta a la investigadora si tienes cualquier duda.
- Una vez que hayas comenzado, es importante completar el test sin interrupciones. Normalmente se tardan unos 20 minutos en completarlo.
- Lee todas las oraciones prestando atención a su significado. Trata de leer a un paso que sea natural para ti: ni muy rápido ni demasiado lento.
- Intenta no cambiar tus respuestas, excepto en el caso de que hayas cometido un error al marcar la página. Es mejor responder con espontaneidad y sin pensar demasiado sobre la respuesta. **Lee cada oración por separado. No vuelvas a ninguna página que ya hayas leído**, excepto al final para asegurarte de que has hecho todas las preguntas.

☺ Relájate e intenta divertirte con esta prueba. No es un examen de tu habilidad ni de tu destreza con el español.

ORACIONES DE PRÁCTICA

La madre de Mónica no estuvo en la fiesta que dio Anita el otro día.
¿Quién organizó una fiesta? Mónica Anita

A Celia siempre le da vergüenza tocar el piano que le regaló su tío para su cumpleaños.
¿Quién es tímido cuando va a tocar el piano? Celia el tío de Celia

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Appendix D-2: Instructions for the On-Line Self-Paced Reading Task

English

Subjects were asked to read the following instructions, provided on a sheet of paper:

INSTRUCTIONS FOR THE READING TEST

For this test, you will read a set of sentences which will be presented on the computer screen at whatever pace is most comfortable for you, since you will be controlling the presentation speed. Each sentence will be presented in two consecutive frames, followed by a YES/NO question about the meaning of the sentence.

- The first fragment of each new sentence will appear when you press the footswitch.
- The second fragment will appear when you press the green button.
- The question will appear when you press the green button again.
- Use the green button to answer YES, and the red button to answer NO.
- The next sentence will appear when you press the footswitch again.

(The program will tell you whether your answer was right or wrong. The number following the message "CORRECT" shows the time it took you to read and answer the question.)

When you get to the end of the practice session, pause for a moment and ask the experimenter if you have any question about the procedure.

It usually takes about 15 minutes to complete the test. Once you have begun, it's best to continue until the end without interruptions.

REMEMBER:

- If you use reading glasses, you should use them for this test.
- Sit comfortably and adjust the screen if necessary. (Ask the experimenter for help.)
- If you are right handed, use your right index finger to press the green button, and your left index finger to push the red button. (If you are left handed, use your left index for green, and your right index for red.)
- Place the pedal in a place where you can press it comfortably. You may remove your shoe, if you wish. (You will probably be more comfortable to use your right foot if you're right handed, and your left foot if you're left handed.)
- Read all the sentences focusing on their meaning. If you read too fast, you will see that it's harder to answer the questions accurately. However, reading too slowly is also not good, so don't worry if you make some errors. Try to read at a natural pace for you: neither too fast nor too slow.
- At the beginning of the test there will be a practice session. When you finish the practice, pause for a moment and ask the experimenter if you have any questions.

☺ Relax and try to enjoy this exercise. It's not a test of your fluency in English. The program will simply record the time it takes you to read each fragment of the sentences and the questions.

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Subjects were then asked to sit in front of a lap-top computer, and were shown by the investigator the location and operation of the foot switch. They were also provided with a response key box with two buttons, one red and one green. Subjects were instructed to press the green button using their dominant hand, the red button with their non-dominant hand.

The symbol ‖ represents segmentation of the sentence. Upon subject's request, by pressing one of the buttons, all material before the ‖ was erased and the material following appeared, centered on the screen. Movement from "screen" to "screen" was requested by the subject's pressing the foot switch.

[first screen] Please press the foot switch to continue.

[screen 02] Throughout this experiment, press the foot switch to see the next sentence.

[screen 03] Sentences will be presented in two fragments.

[screen 04] When you have read the first part of a sentence,
press the green button to see the next fragment.

[screen 05] At the end of each sentence there will be a YES/NO question.

[screen 06] Press the green button to answer YES.

[screen 07] Press the red button to answer NO.

[screen 08] Let's try a few practice sentences.

[screen 09] The manager asked the women who had been working all morning ‖
to take a half-hour break.

[screen 10] Was the manager supposed to take a break?

[screen 11] Ted never read the book about the Civil War ‖
that he borrowed from a friend of Mark's over a year ago.

[screen 12] Did Mark borrow a book?

[screen 13] Martha sent a letter to the gallery ‖
where Phil's paintings had been shown.

[screen 14] Were Phil's paintings shown in an art gallery?

[screen 15] That's the end of the practice session.
The rest of the sentences are part of the experiment.

At the end of the experiment, subjects heard a bell and the following line appeared:

[last screen] That's the end of the experiment. Thank you!

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Spanish

The procedure was as above, for the English task.

Castillian Spanish

INSTRUCCIONES PARA EL TEST DE LECTURA

En este test, leerás una serie de oraciones que se presentarán en la pantalla del ordenador al paso que más cómodo sea para ti, ya que tú controlarás la velocidad de la presentación. Cada oración se presentará en dos fragmentos consecutivos, seguidos de una pregunta sobre el significado de la oración; a la pregunta deberás responder SI o NO.

- El primer fragmento de cada oración nueva aparecerá al presionar el pedal.
- El segundo fragmento aparecerá al pulsar el botón verde.
- La pregunta aparecerá al pulsar de nuevo el botón verde.
- Utiliza el botón verde para responder SI, y el botón rojo para responder NO.
- La siguiente oración aparecerá al presionar de nuevo el pedal.

(El programa te indicará si tu respuesta estuvo bien o mal. La cifra después del mensaje "CORRECTO" indica el tiempo que has tardado en leer y responder a la pregunta.)

Cuando llegues al final de la sesión de práctica, haz una pausa y pregúntale a la investigadora si tienes cualquier duda.

Normalmente se tardan unos 15 minutos en completar el test. Una vez que hayas comenzado es mejor continuar sin interrupciones hasta el final.

RECUERDA:

- Si utilizas gafas para leer, debes usarlas durante la prueba.
- Siéntate cómodamente y ajusta la pantalla si es necesario. (Pide ayuda a la investigadora si la necesitas.)
- Si eres diestro/a, utiliza la mano derecha para pulsar el botón verde, y la izquierda para el rojo. (Si eres zurdo/a, utiliza la izquierda para el verde, y la derecha para el rojo.)
- Coloca el pedal en un lugar donde puedas presionarlo cómodamente. Puedes quitarte el zapato, si lo deseas. (Es mejor utilizar el pie derecho si eres diestro/a y el izquierdo si eres zurdo/a.)
- Lee todas las oraciones prestando atención a su significado. Si lees demasiado rápido, verás que es más difícil responder correctamente a las preguntas. Tampoco es bueno leer muy despacio, por eso no te preocupes si cometes algunos errores. Trata de leer a un paso que sea natural para ti: ni muy rápido ni demasiado lento.
- Al principio del test habrá una sesión de práctica. Cuando termines la práctica, haz una pausa y pregúntale a la investigadora si tienes cualquier duda.

☺ Relájate e intenta divertirte con esta prueba. No es un examen de tu habilidad ni de tu destreza con el español. El programa simplemente grabará el tiempo que tardas en leer cada fragmento de las oraciones y las preguntas.

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Pan-American Spanish (used with Spanish/English bilinguals, Experiment 4)

INSTRUCCIONES PARA EL TEST DE LECTURA

En este test, leerás una serie de oraciones que se presentarán en la pantalla de la computadora al paso que más cómodo sea para ti, ya que tú controlarás la velocidad de la presentación. Cada oración se presentará en dos fragmentos consecutivos, seguidos de una pregunta sobre el significado de la oración; a la pregunta deberás responder SI o NO.

- El primer fragmento de cada oración nueva aparecerá al presionar el pedal.
- El segundo fragmento aparecerá al pulsar el botón verde.
- La pregunta aparecerá al pulsar de nuevo el botón verde.
- Utiliza el botón verde para responder SI, y el botón rojo para responder NO.
- La siguiente oración aparecerá al presionar de nuevo el pedal.

(El programa te indicará si tu respuesta estuvo bien o mal. La cifra después del mensaje "CORRECTO" indica el tiempo que has tardado en leer y responder a la pregunta.)

Cuando llegues al final de la sesión de práctica, haz una pausa y pregúntale a la investigadora si tienes cualquier duda.

Normalmente se tardan unos 15 minutos en completar el test. Una vez que hayas comenzado es mejor continuar sin interrupciones hasta el final.

RECUERDA:

- Si utilizas lentes para leer, debes usarlas durante esta prueba.
- Siéntate cómodamente y ajusta la pantalla si es necesario. (Pide ayuda a la investigadora si la necesitas.)
- Si eres diestro/a, utiliza el dedo índice de tu mano derecha para pulsar el botón verde, y el índice de la izquierda para el rojo. (Si eres zurdo/a, utiliza el índice de la izquierda para el verde, y el de la derecha para el rojo.)
- Coloca el pedal en un lugar donde puedas presionarlo cómodamente. Puedes quitarte el zapato, si lo deseas. (Es mejor utilizar el pie derecho si eres diestro/a y el izquierdo si eres zurdo/a.)
- Lee todas las oraciones prestando atención a su significado. Si lees demasiado rápido, verás que es más difícil responder correctamente a las preguntas. Tampoco es bueno leer muy despacio, por eso no te preocupes si cometes algunos errores. Trata de leer a un paso que sea natural para ti: ni muy rápido ni demasiado lento.
- Al principio del test habrá una sesión de práctica. Cuando termines la práctica, haz una pausa y pregúntale a la investigadora si tienes cualquier duda.

☺ Relájate e intenta divertirte con esta prueba. No es un examen de tu habilidad ni de tu destreza con el español. El programa simplemente irá grabando el tiempo que tardas en leer cada fragmento de las oraciones y las preguntas.

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[first screen] Presiona el pedal para continuar.

[screen 02] A lo largo de todo el experimento, presiona el pedal para ver la siguiente oración.

[screen 03] Las oraciones se presentarán en dos fragmentos.

[screen 04] Cuando hayas leído la primera parte de una oración, pulsa el botón verde para ver el siguiente fragmento.

[screen 05] Al final de cada oración habrá una pregunta, a la cual deberás responder SÍ o NO.

[screen 06] Pulsa el botón verde para responder SÍ.

[screen 07] Pulsa el botón rojo para responder NO.

[screen 08] Las siguientes oraciones son de práctica.

[screen 09] El gerente les pidió a las mujeres que habían estado trabajando toda la mañana |

que tomaran un descanso de media hora.

[screen 10] ¿Tenía que tomar un descanso el gerente?

[screen 11] Teo nunca se leyó el libro sobre la Guerra Civil |

que le prestó un amigo de Marcos hace más de un año.

[screen 12] ¿Se le prestó un libro a Marcos?

[screen 13] Marta envió una carta a la galería |

donde habían exhibido las pinturas de Felipe.

[screen 14] ¿Fueron exhibidas las pinturas de Felipe en una galería de arte?

[screen 15] Aquí termina la sección de práctica.

El resto de las oraciones son parte del experimento.

As in the English version, at the end of the experiment subjects heard a bell and the following line appeared:

[last screen] Has llegado al final del experimento. ¡Gracias por participar!

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Appendix E: Summary Tables for Analyses of Variance

The symbols in the rightmost column indicate the significance of the p values, as follows: † = $p \leq .10$, * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$. No symbol following the p value indicates $p > .10$.

Appendix E-1: Test of Plausibility

Test of Plausibility on Target Materials

The 4 factors are:

A: Language of the Materials (English versus Spanish)
B: RC Length (short versus long)
C: Complex NP Number (singular N1, N2 versus plural N1, N2)
D: Host (N1 versus N2)

Subject-Based Mean Rated Plausibility (Target Materials)

SOURCE	SS	df	MS	F	p
A	3.7153	1	3.7153	9.98	0.005 **
R/ABCD	17.8639	48	0.3722		
B	0.0028	1	0.0028	0.01	0.50
R/ABCD	17.8639	48	0.3722		
AB	0.1040	1	0.1040	0.28	0.50
R/ABCD	17.8639	48	0.3722		
C	0.0028	1	0.0028	0.01	0.50
R/ABCD	17.8639	48	0.3722		
AC	0.0390	1	0.0390	0.11	0.50
R/ABCD	17.8639	48	0.3722		
BC	0.2377	1	0.2377	0.64	0.25
R/ABCD	17.8639	48	0.3722		
ABC	0.0176	1	0.0176	0.05	0.50
R/ABCD	17.8639	48	0.3722		
D	0.1640	1	0.1640	0.44	0.50
R/ABCD	17.8639	48	0.3722		
AD	0.0930	1	0.0930	0.25	0.50
R/ABCD	17.8639	48	0.3722		
BD	0.1332	1	0.1332	0.36	0.50
R/ABCD	17.8639	48	0.3722		
ABD	0.0182	1	0.0182	0.05	0.50
R/ABCD	17.8639	48	0.3722		

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SOURCE	SS	df	MS	F	p
CD	0.0182	1	0.0182	0.05	0.50
R/ABCD	17.8639	48	0.3722		
ACD	0.2401	1	0.2401	0.65	0.25
R/ABCD	17.8639	48	0.3722		
BCD	0.0306	1	0.0306	0.08	0.50
R/ABCD	17.8639	48	0.3722		
ABCD	0.0576	1	0.0576	0.16	0.50
R/ABCD	17.8639	48	0.3722		

Item-Based Mean Rated Plausibility (Target Materials)

SOURCE	SS	df	MS	F	p
A	11.141	1	11.141	64.56	0.001 ***
AR/BCD	15.1849	88	0.1726		
B	0.0081	1	0.0081	0.03	0.50
R/BCD	22.3932	88	0.2545		
AB	0.3128	1	0.3128	1.81	0.10
AR/BCD	15.1849	88	0.1726		
C	0.0081	1	0.0081	0.03	0.50
R/BCD	22.3932	88	0.2545		
AC	0.1175	1	0.1175	0.68	0.25
AR/BCD	15.1849	88	0.1726		
BC	0.7191	1	0.7191	2.83	0.10 †
R/BCD	22.3932	88	0.2545		
ABC	0.0550	1	0.0550	0.32	0.50
AR/BCD	15.1849	88	0.1726		
D	0.4951	1	0.4951	1.95	0.10
R/BCD	22.3932	88	0.2545		
AD	0.2738	1	0.2738	1.59	0.10
AR/BCD	15.1849	88	0.1726		
BD	0.3988	1	0.3988	1.57	0.10
R/BCD	22.3932	88	0.2545		
ABD	0.0550	1	0.0550	0.32	0.50
AR/BCD	15.1849	88	0.1726		
CD	0.0550	1	0.0550	0.22	0.50
R/BCD	22.3932	88	0.2545		
ACD	0.7191	1	0.7191	4.17	0.05 *
AR/BCD	15.1849	88	0.1726		

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SOURCE	SS	df	MS	F	p
BCD	0.0941	1	0.0941	0.37	0.50
R/BCD	22.3932	88	0.2545		
ABCD	0.1722	1	0.1722	1.00	0.25
AR/BCD	15.1849	88	0.1726		

Test of Plausibility with Materials Borrowed from Cuetos & Mitchell (1988) and Carreiras & Clifton (1993)

The 2 factors are
A: Language of the Materials (English versus Spanish)
B: Host (implausible versus plausible)

Subject-Based Mean Rated Plausibility (Borrowed Materials)

SOURCE	SS	df	MS	F	p
A	1.97	1	1.97	7.40	0.025 **
B	12.08	1	12.08	45.25	0.001 ***
AB	1.10	1	1.10	4.13	0.10
S	3.20	12	0.27		

Item-Based Plausibility Mean Rated Plausibility (Borrowed Materials)

SOURCE	SS	df	MS	F	p
B	63.44	1	63.44	84.63	0.001 ***
S	29.99	40	0.75		
A	10.36	1	10.36	39.46	0.001 ***
AB	5.76	1	5.76	21.94	0.001 ***
S*A	10.50	40	0.26		

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Appendix E-2: Acceptability of the Norman Construction

Grammaticality
The 2 factors are:
A: Language of the Materials (English versus Spanish)
B: Complex NP Number (singular N1, N2 versus plural N1, N2)

Subject-Based Mean Rated Grammaticality

SOURCE	SS	df	MS	F	p
B	0.00	1	0.00	0.00	1.00
S	1.71	6	0.29		
A	0.59	1	0.59	7.28	0.05 **
AB	0.23	1	0.23	2.88	0.10
S*A	0.49	6	0.08		

Item-Based Mean Rated Grammaticality

SOURCE	SS	df	MS	F	p
A	1.78	1	1.78	6.17	0.025 **
B	0.00	1	0.00	0.00	1.00
AB	0.69	1	0.69	2.38	0.10
S	12.71	44	0.29		

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Appendix E-3: Experiment 1

Percent N2 Preference, Off-Line Questionnaire—Monolinguals

The 4 factors are:

A: Language of the Materials (English versus Spanish)
B: Subject/Item Design Groups
C: RC Length (long versus short)
D: Number (N1, N2 singular versus N1, N2 plural)

Subject-Based % N2 Preference

SOURCE	SS	df	MS	F	p
A	5562.060	1	5562.060	5.48	0.025 *
R/AB	44662.950	44	1015.067		
B	1134.032	1	1134.032	1.12	
R/AB	44662.950	44	1015.067		
AB	23.088	1	23.088	0.02	
R/AB	44662.950	44	1015.067		
C	4867.435	1	4867.435	15.64	0.001 ***
CR/AB	13692.380	44	311.191		
AC	5.782	1	5.782	0.02	0.50
CR/AB	13692.380	44	311.191		
BC	1134.033	1	1134.033	3.64	
CR/AB	13692.380	44	311.1905		
ABC	23.144	1	23.144	0.07	
CR/AB	13692.380	44	311.191		
D	3333.500	1	3333.500	10.68	0.001 **
DR/AB	13739.570	44	312.263		
AD	1481.518	1	1481.518	4.74	0.05 *
DR/AB	13739.570	44	312.263		
BD	52.083	1	52.083	0.17	
DR/AB	13739.570	44	312.263		
ABD	283.435	1	283.435	0.91	
DR/AB	13739.570	44	312.263		
CD	23.116	1	23.116	0.08	0.50
CDR/AB	12163.020	44	276.432		
ACD	578.727	1	578.727	2.09	0.10
CDR/AB	12163.020	44	276.432		
BCD	20144.950	1	20144.950	72.88	

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SOURCE	SS	df	MS	F	p
CDR/AB	12163.020	44	276.432		
ABCD	144.630	1	144.630	0.52	
CDR/AB	12163.020	44	276.432		

Item-Based % N2 Preference

SOURCE	SS	df	MS	F	p
A	4307.698	1	4307.698	56.05	0.001 ***
AR/B	768.513	10	76.851		
B	642.476	1	642.476	0.77	
R/B	8378.29	10	837.829		
AB	26.534	1	26.534	0.35	
AR/B	768.513	10	76.851		
C	2508.500	1	2508.500	2.63	0.10
CR/B	9529.506	10	952.951		
AC	87.650	1	87.650	0.31	0.50
ACR/B	2870.309	10	287.031		
BC	1298.378	1	1298.378	1.36	
CR/B	9529.506	10	952.951		
ABC	1.361	1	1.361	0.01	
ACR/B	2870.309	10	287.031		
D	2075.481	1	2075.481	2.41	0.10
DR/B	8622.105	10	862.211		
AD	612.212	1	612.212	4.37	0.10 †
ADR/B	1399.826	10	139.983		
BD	11971.340	1	11971.340	13.88	
DR/B	8622.105	10	862.211		
ABD	216.270	1	216.270	1.55	
ADR/B	1399.826	10	139.983		
CD	4.468	1	4.468	0.01	0.50
CDR/B	6629.355	10	662.936		
ACD	189.591	1	189.591	1.18	0.25
ACDR/B	1613.274	10	161.327		
BCD	5.689	1	5.689	0.01	
CDR/B	6629.355	10	662.936		
ABCD	12.449	1	12.449	0.08	
ACDR/B	1613.274	10	161.327		

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Independent Subanalyses, Off-Line Questionnaire—Monolinguals

RC Length × Complex NP Number, CSPA Data
The 3 factors are:

A: Subject/Item Design Groups
B: RC Length (long RC versus short RC)
C: Complex NP Number (singular N1, N2 versus plural N1, N2)

Subject-Based % N2 Preference: CSPA Data

SOURCE	SS	df	MS	F	p
A	416.75	1	416.75	0.56	
S	16237.74	22	738.08		
B	2604.38	1	2604.38	8.98	0.01 **
AB	740.59	1	740.59	2.55	
S*B	6377.89	22	289.90		
C	185.20	1	185.20	0.54	0.25
AC	289.26	1	289.26	0.84	
S*C	7581.56	22	344.62		
BC	185.26	1	185.26	0.74	0.25
ABC	8437.88	1	8437.88	33.49	
S*BC	5543.45	22	251.97		

Item-Based % N2 Preference: CSPA Data

SOURCE	SS	df	MS	F	p
A	465.07	1	465.07	0.87	
C	216.62	1	216.62	0.41	0.50
AC	4484.75	1	4484.75	8.42	
S	10647.80	20	532.39		
B	1766.98	1	1766.98	2.95	0.10
AB	607.83	1	607.83	1.01	
BC	126.13	1	126.13	0.21	0.50
ABC	17.48	1	17.48	0.03	
S*B	11991.05	20	599.55		

RC Length × Complex NP Number, USENG Data
The 3 factors are:

A: Subject/Item Design Groups
B: RC Length (long RC versus short RC)
C: Complex NP Number (singular N1, N2 versus plural N1, N2)

Subject-Based % N2 Preference: USENG Data

SOURCE	SS	df	MS	F	p
A	740.37	1	740.37	0.57	
S	28425.21	22	1292.06		
B	2268.84	1	2268.84	6.82	0.025 **
AB	416.58	1	416.58	1.25	

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SOURCE	SS	df	MS	F	p
S*B	7314.49	22	332.48		
C	4629.81	1	4629.81	16.54	0.001 ***
AC	46.26	1	46.26	0.17	
S*C	6158.01	22	279.91		
BC	416.58	1	416.58	1.38	0.25
ABC	11851.70	1	11851.70	39.39	
S*BC	6619.57	22	300.89		

Item-Based % N2 Preference: USENG Data

SOURCE	SS	df	MS	F	p
A	203.94	1	203.94	0.48	
C	2471.07	1	2471.07	5.80	0.05 *
AC	7702.85	1	7702.85	18.08	
S	8520.94	20	426.05		
B	829.17	1	829.17	1.92	0.10
AB	691.90	1	691.90	1.60	
BC	67.93	1	67.93	0.16	0.50
ABC	0.65	1	0.65	0.00	
S*B	8651.39	20	432.57		

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Appendix E-4: Experiment 2

On-Line Self-Paced Reading—Monolinguals

Frame 2 (Relative Clause) Response Times

The 4 factors are:

A: Subject/Item Design Groups
B: Language of the Materials (English versus Spanish)
C: RC Length (long versus short)
D: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2

SOURCE	SS	df	MS	F	p
A	8946662.0625	3	2982220.6880	0.63	
R/AB	340393236.9500	72	4727683.8470		
B	3595096.0125	1	3595096.0130	0.76	0.25
R/AB	340393236.9500	72	4727683.8470		
AB	4926483.9625	3	1642161.3210	0.35	
R/AB	340393236.9500	72	4727683.8470		
C	210065415.3125	1	210065415.3000	357.42	0.001 ***
CR/AB	42316905.9500	72	587734.8049		
AC	20099371.5625	3	6699790.5210	11.40	
CR/AB	42316905.9500	72	587734.8049		
BC	4697.1125	1	4697.1125	0.01	0.50
CR/AB	42316905.9500	72	587734.8049		
ABC	1312954.5625	3	437651.5208	0.75	
CR/AB	42316905.9500	72	587734.8049		
D	2454201.8000	1	2454201.8000	7.77	0.01 **
DR/AB	22756886.3500	72	316067.8660		
AD	3051343.8750	3	1017114.6250	3.22	
DR/AB	22756886.3500	72	316067.8660		
BD	93982.0500	1	93982.0500	0.30	0.50
DR/AB	22756886.3500	72	316067.8660		
ABD	606703.4250	3	202234.4750	0.64	
DR/AB	22756886.3500	72	316067.8660		
CD	390880.8000	1	390880.8000	1.06	0.25
CDR/AB	26642690.9500	72	370037.3743		

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SOURCE	SS	df	MS	F	p
ACD	390794.8750	3	130264.9583	0.35	
CDR/AB	26642690.9500	72	370037.3743		
BCD	14472.2000	1	14472.2000	0.04	0.50
CDR/AB	26642690.9500	72	370037.3743		
ABCD	1753654.6750	3	584551.5583	1.58	
CDR/AB	26642690.9500	72	370037.3743		

Item-Based Response Times, Frame 2

SOURCE	SS	df	MS	F	p
A	3149084.5210	3	1049694.8400	3.16	
R/A	6643553.2080	20	332177.6604		
B	640332.0000	1	640332.0000	7.62	0.025 *
BR/A	1680460.5420	20	84023.0271		
AB	380972.2083	3	126990.7361	1.51	
BR/A	1680460.5420	20	84023.0271		
C	30992602.0800	1	30992602.0800	76.15	0.001 ***
CR/A	8139953.6250	20	406997.6813		
AC	1271627.5420	3	423875.8472	1.04	
CR/A	8139953.6250	20	406997.6813		
BC	500.5208	1	500.5208	0.00	0.50
BCR/A	2869426.6250	20	143471.3313		
ABC	391788.6042	3	130596.2014	0.91	
BCR/A	2869426.6250	20	143471.3313		
D	359321.0208	1	359321.0208	6.15	0.025 *
DR/A	1167913.5420	20	58395.6771		
AD	175928.1875	3	58642.7292	1.00	
DR/A	1167913.5420	20	58395.6771		
BD	5125.3333	1	5125.3333	0.12	0.50
BDR/A	874406.2083	20	43720.3104		
ABD	363716.7083	3	121238.9028	2.77	
BDR/A	874406.2083	20	43720.3104		
CD	81510.0833	1	81510.0833	0.99	0.25
CDR/A	1651313.9580	20	82565.6979		
ACD	493007.7083	3	164335.9028	1.99	
CDR/A	1651313.9580	20	82565.6979		
BCD	266.0208	1	266.0208	0.00	0.50
BCDR/A	1628895.6250	20	81444.7812		

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SOURCE	SS	df	MS	F	p
ABCD	175858.6042	3	58619.5347	0.72	
BCDR/A	1628895.6250	20	81444.7812		

Independent Subanalyses, On-Line Self-Paced Reading (Frame 2)—Monolinguals

Language of the Materials × Attachment Site, Long-RC Data
The 3 factors are:

A: Subject/Item Design Groups
B: Language of the Materials (English versus Spanish)
C: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: Long-RC Data

SOURCE	SS	df	MS	F	p
A	26322261.30	3	8774087.10	2.66	
B	1669948.23	1	1669948.23	0.51	0.25
AB	4953469.28	3	1651156.43	0.50	
S	237581143.60	72	3299738.11		
C	443102.50	1	443102.50	1.13	0.25
AC	2476539.80	3	825513.27	2.10	
BC	91107.02	1	91107.02	0.23	0.50
ABC	755470.08	3	251823.36	0.64	
S*C	28260384.60	72	392505.34		

Item-Based Response Times, Frame 2: Long-RC Data

SOURCE	SS	df	MS	F	p
A	4182830.03	3	1394276.68	2.75	
S	10157217.13	20	507860.86		
B	338318.76	1	338318.76	2.56	0.10
AB	383094.70	3	127698.23	0.97	
S*B	2640591.79	20	132029.59		
C	49277.34	1	49277.34	0.69	0.25
AC	291195.78	3	97065.26	1.37	
S*C	1420512.13	20	71025.61		
BC	1528.01	1	1528.01	0.03	0.50
ABC	475368.11	3	158456.04	2.95	
S*BC	1073771.12	20	53688.56		

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Language of the Materials × Attachment Site, Short-RC Data
The 3 factors are:

A: Subject/Item Design Groups
B: Language of the Materials (English versus Spanish)
C: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: Short-RC Data

SOURCE	SS	df	MS	F	p
A	2723772.33	3	907924.11	0.45	
B	1929844.90	1	1929844.90	0.96	0.25
AB	1285969.25	3	428656.42	0.21	
S	145128999.30	72	2015680.55		
C	2401980.10	1	2401980.10	8.18	0.01 **
AC	965598.95	3	321866.32	1.10	
BC	17347.22	1	17347.22	0.06	0.50
ABC	1604888.03	3	534962.68	1.82	
S*C	21139192.70	72	293599.90		

Item-Based Response Times, Frame 2: Short-RC Data

SOURCE	SS	df	MS	F	p
A	237882.03	3	79294.01	0.34	
S	4626289.71	20	231314.49		
B	302513.76	1	302513.76	3.17	0.10 †
AB	389666.11	3	129888.70	1.36	
S*B	1909295.38	20	95464.77		
C	391553.76	1	391553.76	5.60	0.05 *
AC	377740.11	3	125913.37	1.80	
S*C	1398715.38	20	69935.77		
BC	3863.34	1	3863.34	0.05	0.50
ABC	64207.20	3	21402.40	0.30	
S*BC	1429530.71	20	71476.54		

Frame 3 (Question) Error Rates

The 4 factors are:

A: Subject/Item Design Groups
B: Language of the Materials (English versus Spanish)
C: RC Length (long versus short)
D: Attachment Site (low versus high)

Subject-Based Error Rates, Frame 3

SOURCE	SS	df	MS	F	p
A	12472.6120	3	4157.5373	2.04	
R/AB	146800.5458	72	2038.8965		
B	13350.2362	1	13350.2362	6.55	0.01 *
R/AB	146800.5458	72	2038.8965		

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SOURCE	SS	df	MS	F	p
AB	9972.1300	3	3324.0433	1.63	
R/AB	146800.5458	72	2038.8965		
C	127.1340	1	127.1340	0.11	0.50
CR/AB	86535.0819	72	1201.8761		
AC	4396.8494	3	1465.6165	1.22	
CR/AB	86535.0819	72	1201.8761		
BC	17989.5005	1	17989.5005	14.97	0.001 ***
CR/AB	86535.0819	72	1201.8761		
ABC	4862.6391	3	1620.8797	1.35	
CR/AB	86535.0819	72	1201.8761		
D	34709.0283	1	34709.0283	20.90	0.001 ***
DR/AB	119555.4093	72	1660.4918		
AD	2525.0567	3	841.6856	0.51	
DR/AB	119555.4093	72	1660.4918		
BD	2350.6538	1	2350.6538	1.42	0.10
DR/AB	119555.4093	72	1660.4918		
ABD	2573.2654	3	857.7551	0.52	
DR/AB	119555.4093	72	1660.4918		
CD	1126.8758	1	1126.8758	1.49	0.10
CDR/AB	54651.3125	72	759.0460		
ACD	6453.5445	3	2151.1815	2.83	
CDR/AB	54651.3125	72	759.0460		
BCD	890.1114	1	890.1114	1.17	0.25
CDR/AB	54651.3125	72	759.0460		
ABCD	1918.2519	3	639.4173	0.84	
CDR/AB	54651.3125	72	759.0460		

Item-Based Error Rates, Frame 3

SOURCE	SS	df	MS	F	p
A	637.5000	3	212.5000	0.48	
R/A	8912.5000	20	445.6250		
B	2002.0830	1	2002.0830	7.55	0.01 *
BR/A	5304.1670	20	265.2083		
AB	318.7500	3	106.2500	0.40	
BR/A	5304.1670	20	265.2083		
C	18.7500	1	18.7500	0.05	0.50

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SOURCE	SS	df	MS	F	p
CR/A	7145.8330	20	357.2917		
AC	710.4167	3	236.8056	0.66	
CR/A	7145.8330	20	357.2917		
BC	2700.0000	1	2700.0000	18.38	0.001 ***
BCR/A	2937.5000	20	146.8750		
ABC	437.5000	3	145.8333	0.99	
BCR/A	2937.5000	20	146.8750		
D	5208.3330	1	5208.3330	6.38	0.025 *
DR/A	16329.1700	20	816.4583		
AD	1987.5000	3	662.5000	0.81	
DR/A	16329.1700	20	816.4583		
BD	352.0833	1	352.0833	1.22	0.25
BDR/A	5754.1670	20	287.7083		
ABD	1318.7500	3	439.5833	1.53	
BDR/A	5754.1670	20	287.7083		
CD	168.7500	1	168.7500	0.61	0.25
CDR/A	5562.5000	20	278.1250		
ACD	543.7500	3	181.2500	0.65	
CDR/A	5562.5000	20	278.1250		
BCD	133.3333	1	133.3333	0.58	0.25
BCDR/A	4620.8330	20	231.0417		
ABCD	820.8333	3	273.6111	1.18	
BCDR/A	4620.8330	20	231.0417		

Independent Subanalyses, On-Line Self-Paced Reading (Frame 3)—Monolinguals

RC Length × Attachment Site, English Materials Data
The 3 factors are:

A: Subject/Item Design Groups
B: RC Length (long versus short)
C: Attachment Site (low versus high)

Subject-Based Error Rates, Frame 3: English Materials Data

SOURCE	SS	df	MS	F	p
A	3688.05	3	1229.35	0.56	
S	79162.39	36	2198.96		
B	10570.63	1	10570.63	13.39	0.001 ***
AB	5185.38	3	1728.46	2.19	

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SOURCE	SS	df	MS	F	p
S*B	28429.03	36	789.70		
C	9497.18	1	9497.18	3.92	0.10 †
AC	909.82	3	303.27	0.13	
S*C	87114.70	36	2419.85		
BC	2010.02	1	2010.02	2.91	0.10 †
ABC	5075.66	3	1691.89	2.45	
S*BC	24888.28	36	691.34		

Item-Based Error Rates, Frame 3: English Materials Data

SOURCE	SS	df	MS	F	p
A	511.46	3	170.49	0.36	
S	9537.50	20	476.88		
B	1584.38	1	1584.38	13.27	0.002 **
AB	553.12	3	184.37	1.54	
S*B	2387.50	20	119.37		
C	1426.04	1	1426.04	2.14	0.10
AC	994.79	3	331.60	0.50	
S*C	13304.17	20	665.21		
BC	301.04	1	301.04	1.27	0.25
ABC	169.79	3	56.60	0.24	
S*BC	4754.17	20	237.71		

RC Length × Attachment Site, Spanish Materials Data
The 3 factors are:

A: Subject/Item Design Groups
B: RC Length (long versus short)
C: Attachment Site (low versus high)

Subject-Based Error Rates, Frame 3: Spanish Materials Data

SOURCE	SS	df	MS	F	p
A	18756.70	3	6252.23	3.33	
S	67638.16	36	1878.84		
B	7546.01	1	7546.01	4.68	0.05 **
AB	4074.11	3	1358.04	0.84	
S*B	58106.05	36	1614.06		
C	27562.50	1	27562.50	30.59	0.001 ***
AC	4188.50	3	1396.17	1.55	
S*C	32440.71	36	901.13		
BC	6.97	1	6.97	0.01	0.50
ABC	3296.14	3	1098.71	1.33	
S*BC	29763.04	36	826.75		

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Item-Based Error Rates, Frame 3: Spanish Materials Data

SOURCE	SS	df	MS	F	p
A	444.79	3	148.26	0.63	
S	4679.17	20	233.96		
B	1134.38	1	1134.38	2.95	0.10
AB	594.79	3	198.26	0.52	
S*B	7695.83	20	384.79		
C	4134.38	1	4134.38	9.42	0.01 **
AC	2311.46	3	770.49	1.76	
S*C	8779.17	20	438.96		
BC	1.04	1	1.04	0.00	1.00
ABC	1194.79	3	398.26	1.47	
S*BC	5429.17	20	271.46		

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Appendix E-5: Experiment 3

Percent N2 Preference, Off-Line Questionnaire—Bilinguals

The 5 factors are:

A: Dominance (English-dominant versus Spanish-dominant)
B: Language of the Materials (English versus Spanish)
C: Subject/Item Design Groups
D: RC Length (long versus short)
E: Number (N1, N2 singular versus N1, N2 plural)

Subject-Based % N2 Preference

SOURCE	SS	df	MS	F	p
A	19804.690	1	19804.690	9.05	0.005 **
R/ABC	87557.560	40	2188.939		
B	765.522	1	765.522	0.35	0.50
R/ABC	87557.560	40	2188.939		
AB	325.677	1	325.677	0.15	0.50
R/ABC	87557.560	40	2188.939		
C	2431.907	1	2431.907	1.11	
R/ABC	87557.560	40	2188.939		
AC	1054.313	1	1054.313	0.48	
R/ABC	87557.560	40	2188.939		
BC	6112.182	1	6112.182	2.79	
R/ABC	87557.560	40	2188.939		
ABC	522.522	1	522.522	0.24	
R/ABC	87557.560	40	2188.939		
D	1216.959	1	1216.959	5.56	0.025 *
DR/ABC	8761.135	40	219.028		
AD	175.071	1	175.071	0.80	0.25
DR/ABC	8761.135	40	219.028		
BD	1390.407	1	1390.407	6.35	0.025 *
DR/ABC	8761.135	40	219.028		
ABD	325.4167	1	325.417	1.49	0.10
DR/ABC	8761.135	40	219.028		
CD	174.994	1	174.994	0.80	
DR/ABC	8761.135	40	219.028		
ACD	1.453	1	1.453	0.01	
DR/ABC	8761.135	40	219.028		

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SOURCE	SS	df	MS	F	p
BCD	244.532	1	244.532	1.12	
DR/ABC	8761.135	40	219.028		
ABCD	1.449	1	1.449	0.01	
DR/ABC	8761.135	40	219.028		
E	1216.356	1	1216.356	3.50	0.10 †
ER/ABC	13899.520	40	347.488		
AE	1.446	1	1.446	0.00	0.50
ER/ABC	13899.520	40	347.488		
BE	1054.688	1	1054.69	3.04	0.10 †
ER/ABC	13899.520	40	347.488		
ABE	765.282	1	765.282	2.20	0.10
ER/ABC	13899.520	40	347.488		
CE	1.446	1	1.446	0.00	
ER/ABC	13899.520	40	347.488		
ACE	1.439	1	1.439	0.00	
ER/ABC	13899.520	40	347.488		
BCE	36.192	1	36.192	0.10	
ER/ABC	13899.520	40	347.488		
ABCE	36.157	1	36.157	0.10	
ER/ABC	13899.520	40	347.488		
DE	70.956	1	70.956	0.23	0.50
DER/ABC	12510.910	40	312.773		
ADE	36.123	1	36.123	0.12	0.50
DER/ABC	12510.910	40	312.773		
BDE	418.015	1	418.015	1.34	0.25
DER/ABC	12510.910	40	312.773		
ABDE	637.802	1	637.802	2.04	0.10
DER/ABC	12510.910	40	312.773		
CDE	7292.456	1	7292.456	23.32	
DER/ABC	12510.910	40	312.773		
ACDE	1.442	1	1.442	0.01	
DER/ABC	12510.910	40	312.773		
BCDE	36.175	1	36.175	0.12	
DER/ABC	12510.910	40	312.773		

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SOURCE	SS	df	MS	F	p
ABCDE	175.147	1	175.147	0.56	
DER/ABC	12510.910	40	312.773		

Item-Based % N2 Preference

SOURCE	SS	df	MS	F	p
A	23077.820	1	23077.820	59.36	0.001 ***
AR/CE	7775.943	20	388.797		
B	681.089	1	681.089	2.81	0.10
BR/CE	4844.110	20	242.206		
AB	453.255	1	453.255	1.39	0.25
ABR/CE	6506.305	20	325.315		
C	1.175	1	1.175	0.00	
R/CE	24207.560	20	1210.378		
AC	0.706	1	0.706	0.00	
AR/CE	7775.943	20	388.797		
BC	43.777	1	43.777	0.18	
BR/CE	4844.110	20	242.206		
ABC	43.796	1	43.796	0.14	
ABR/CE	6506.305	20	325.315		
D	1259.315	1	1259.315	1.51	0.10
DR/CE	16652.170	20	832.609		
AD	271.558	1	271.558	1.00	0.25
ADR/CE	5444.991	20	272.250		
BD	1276.275	1	1276.275	5.17	0.05 *
BDR/CE	4942.290	20	247.115		
ABD	338.672	1	338.672	1.21	0.25
ABDR/CE	5588.106	20	279.405		
CD	7354.958	1	7354.958	8.83	
DR/CE	16652.170	20	832.609		
ACD	13.889	1	13.889	0.05	
ADR/CE	5444.991	20	272.250		
BCD	72.915	1	72.915	0.30	
BDR/CE	4942.290	20	247.115		
ABCD	61.043	1	61.043	0.22	
ABDR/CE	5588.106	20	279.405		

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SOURCE	SS	df	MS	F	p
E	1453.651	1	1453.651	1.20	0.25
R/CE	24207.560	20	1210.378		
AE	29.297	1	29.297	0.08	0.50
AR/CE	7775.943	20	388.797		
BE	911.415	1	911.415	3.76	0.10 †
BR/CE	4844.110	20	242.206		
ABE	596.219	1	596.219	1.83	0.10
ABR/CE	6506.305	20	325.315		
CE	3074.881	1	3074.881	2.54	
R/CE	24207.560	20	1210.378		
ACE	1031.288	1	1031.288	2.65	
AR/CE	7775.943	20	388.797		
BCE	5724.046	1	5724.046	23.63	
BR/CE	4844.110	20	242.206		
ABCE	1094.239	1	1094.239	3.36	
ABR/CE	6506.305	20	325.315		
DE	119.796	1	119.796	0.14	0.50
DR/CE	16652.170	20	832.609		
ADE	29.297	1	29.297	0.11	0.50
ADR/CE	5444.991	20	272.250		
BDE	516.928	1	516.928	2.09	0.10
BDR/CE	4942.290	20	247.115		
ABDE	985.819	1	985.819	3.53	0.10 †
ABDR/CE	5588.106	20	279.405		
CDE	81.380	1	81.380	0.10	
DR/CE	16652.170	20	832.609		
ACDE	19.776	1	19.776	0.07	
ADR/CE	5444.991	20	272.250		
BCDE	287.679	1	287.679	1.16	
BDR/CE	4942.290	20	247.115		
ABCDE	5.214	1	5.214	0.02	
ABDR/CE	5588.106	20	279.405		

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Independent Subanalyses, Off-Line Questionnaire—Bilinguals

Language Dominance × RC Length × Complex NP Number, English Materials
The 4 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: RC Length (long versus short)
D: Complex NP Number (N1, N2 singular versus N1, N2 plural)

Subject-Based % N2 Preference: English Materials Data

SOURCE	SS	df	MS	F	p
A	12604.85	1	12604.85	6.44	0.025 *
R/AB	39144.02	20	1957.20		
B	416.63	1	416.63	0.21	
R/AB	39144.02	20	1957.20		
AB	46.19	1	46.19	0.02	
R/AB	39144.02	20	1957.20		
C	2604.48	1	2604.48	8.90	0.01 **
CR/AB	5856.03	20	292.80		
AC	11.56	1	11.56	0.04	0.50
CR/AB	5856.03	20	292.80		
BC	416.63	1	416.63	1.42	
CR/AB	5856.03	20	292.80		
ABC	0.00	1	0.00	0.00	
CR/AB	5856.03	20	292.802		
D	2268.16	1	2268.16	6.74	0.025 *
DR/AB	6735.68	20	336.78		
AD	416.63	1	416.63	1.24	0.25
DR/AB	6735.68	20	336.78		
BD	11.59	1	11.59	0.03	
DR/AB	6735.68	20	336.78		
ABD	11.59	1	11.59	0.03	
DR/AB	6735.68	20	336.78		
CD	416.71	1	416.71	1.40	0.25
CDR/AB	5948.91	20	297.45		
ACD	185.18	1	185.18	0.62	0.25
CDR/AB	5948.91	20	297.45		
BCD	4177.93	1	4177.93	14.05	
CDR/AB	5948.91	20	297.45		

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SOURCE	SS	df	MS	F	p
ABCD	104.19	1	104.19	0.35	
CDR/AB	5948.91	20	297.45		
Item-Based % N2 Preference: English Materials Data					
SOURCE	SS	df	MS	F	p
A	14999.75	1	14999.75	38.00	0 ***
AR/BD	7894.32	20	394.72		
B	29.65	1	29.65	0.04	
R/BD	14509.55	20	725.48		
AB	16.69	1	16.69	0.04	
AR/BD	7894.32	20	394.72		
C	2535.56	1	2535.56	3.29	0.10 †
CR/BD	15434.45	20	771.72		
AC	1.85	1	1.85	0.01	0.50
ACR/BD	5859.92	20	293.00		
BC	4446.25	1	4446.25	5.76	
CR/BD	15434.45	20	771.72		
ABC	66.58	1	66.58	0.23	
ACR/BD	5859.92	20	293.00		
D	2333.57	1	2333.57	3.22	0.10 †
R/BD	14509.55	20	725.48		
AD	444.92	1	444.92	1.13	0.25
AR/BD	7894.32	20	394.72		
BD	204.14	1	204.14	0.28	
R/BD	14509.55	20	725.48		
ABD	0.47	1	0.47	0.00	
AR/BD	7894.32	20	394.72		
CD	567.21	1	567.21	0.74	0.25
CR/BD	15434.45	20	771.72		
ACD	337.61	1	337.61	1.15	0.25
ACR/BD	5859.92	20	293.00		
BCD	337.54	1	337.54	0.44	
CR/BD	15434.45	20	771.72		
ABCD	22.65	1	22.65	0.08	
ACR/BD	5859.92	20	293.00		

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Language Dominance × RC Length × Complex NP Number, Spanish Materials
The 4 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: RC Length (long versus short)
D: Complex NP Number (N1, N2 singular versus N1, N2 plural)

Subject-Based % N2 Preference: Spanish Materials Data

SOURCE	SS	df	MS	F	p	
A	7525.51	1	7525.51	3.11	0.10 †	
R/AB	48413.54	20	2420.68			
B	8127.46	1	8127.46	3.36		
R/AB	48413.54	20	2420.68			
AB	1530.65	1	1530.65	0.63		
R/AB	48413.54	20	2420.68			
C	2.88	1	2.89	0.02	0.50	
CR/AB	2905.10	20	145.26			
AC	488.93	1	488.93	3.37	0.10 †	
CR/AB	2905.10	20	145.26			
BC	2.90	1	2.90	0.02		
CR/AB	2905.10	20	145.26			
ABC	2.90	1	2.90	0.02		
CR/AB	2905.10	20	145.26			
D	2.88	1	2.88	0.01	0.50	
DR/AB	7163.84	20	358.19			
AD	350.10	1	350.10	0.98	0.25	
DR/AB	7163.84	20	358.19			
BD	26.05	1	26.05	0.07		
DR/AB	7163.84	20	358.19			
ABD	26.01	1	26.01	0.07		
DR/AB	7163.84	20	358.19			
CD	72.26	1	72.26	0.22	0.50	
CDR/AB	6562.00	20	328.10			
ACD	488.75	1	488.75	1.49	0.10	
CDR/AB	6562.00	20	328.10			
BCD	3150.70	1	3150.70	9.60		
CDR/AB	6562.00	20	328.10			

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SOURCE SS	df	MS	F	p
ABCD	72.40	1	72.40	0.22
CDR/AB	6562.00	20	328.10	

Item-Based % N2 Preference: Spanish Materials Data

SOURCE	SS	df	MS	F	p
A	8531.32	1	8531.32	26.71	0.001 ***
AR/BD	6387.93	20	319.40		
B	15.30	1	15.30	0.02	
R/BD	14542.11	20	727.11		
AB	27.81	1	27.81	0.09	
AR/BD	6387.93	20	319.40		
C	0.03	1	0.03	0.00	0.50
CR/BD	6160.01	20	308.00		
AC	608.38	1	608.38	2.35	0.10
ACR/BD	5173.18	20	258.66		
BC	2981.62	1	2981.62	9.68	
CR/BD	6160.01	20	308.00		
ABC	8.35	1	8.35	0.03	
ACR/BD	5173.18	20	258.66		
D	31.50	1	31.50	0.04	0.50
R/BD	14542.11	20	727.11		
AD	180.59	1	180.59	0.57	0.25
AR/BD	6387.93	20	319.40		
BD	8594.79	1	8594.79	11.82	
R/BD	14542.11	20	727.11		
ABD	2125.06	1	2125.06	6.65	
AR/BD	6387.93	20	319.40		
CD	69.51	1	69.51	0.23	0.50
CR/BD	6160.01	20	308.00		
ACD	677.50	1	677.50	2.62	0.10
ACR/BD	5173.18	20	258.66		
BCD	31.52	1	31.52	0.10	
CR/BD	6160.01	20	308.00		
ABCD	2.34	1	2.34	0.01	
ACR/BD	5173.18	20	258.66		

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Appendix E-6: Experiment 4

On-Line Self-Paced Reading, Bilinguals

Frame 2 (Relative Clause) Response Times

The 5 factors are:

A: Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: Language of the Materials (English versus Spanish)
D: RC Length (long versus short)
E: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2

SOURCE	SS	df	MS	F	p
A	10898784.32	1	10898784.32	1.64	0.10
R/ABC	636826656.00	96	6633611.00		
B	35854720.20	3	11951573.40	1.80	
R/ABC	636826656.00	96	6633611.00		
AB	9149612.05	3	3049870.69	0.46	
R/ABC	636826656.00	96	6633611.00		
C	15227900.04	1	15227900.04	2.30	0.10
R/ABC	636826656.00	96	6633611.00		
AC	10675340.04	1	10675340.04	1.61	0.10
R/ABC	636826656.00	96	6633611.00		
BC	20114150.98	3	6704716.99	1.01	
R/ABC	636826656.00	96	6633611.00		
ABC	36590610.98	3	12196870.33	1.84	
R/ABC	636826656.00	96	6633611.00		
D	542766617.30	1	542766617.30	672.54	0.001 ***
DR/ABC	77475574.71	96	807037.24		
AD	92920.32	1	92920.32	0.12	0.50
DR/ABC	77475574.71	96	807037.24		
BD	30320593.45	3	10106864.48	12.52	
DR/ABC	77475574.71	96	807037.24		
ABD	2589536.63	3	863178.88	1.07	
DR/ABC	77475574.71	96	807037.24		
CD	10544838.89	1	10544838.89	13.07	0.001 ***

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SOURCE	SS	df	MS	F	p
DR/ABC	77475574.71	96	807037.24		
ACD	8751704.14	1	8751704.14	10.84	0.001 ***
DR/ABC	77475574.71	96	807037.24		
BCD	8724502.84	3	2908167.61	3.60	
DR/ABC	77475574.71	96	807037.24		
ABCD	3685629.23	3	1228543.08	1.52	
DR/ABC	77475574.71	96	807037.24		
E	34090.32	1	34090.32	0.07	0.50
ER/ABC	45978393.71	96	478941.60		
AE	1003592.89	1	1003592.89	2.10	0.10
ER/ABC	45978393.71	96	478941.60		
BE	345308.13	3	115102.71	0.24	
ER/ABC	45978393.71	96	478941.60		
ABE	786602.05	3	262200.68	0.55	
ER/ABC	45978393.71	96	478941.60		
CE	3171.57	1	3171.57	0.01	0.50
ER/ABC	45978393.71	96	478941.60		
ACE	864514.29	1	864514.29	1.81	0.10
ER/ABC	45978393.71	96	478941.60		
BCE	1850928.80	3	616976.27	1.29	
ER/ABC	45978393.71	96	478941.60		
ABCE	1531364.73	3	510454.91	1.07	
ER/ABC	45978393.71	96	478941.60		
DE	504108.89	1	504108.89	0.94	0.25
DER/ABC	51576117.00	96	537251.22		
ADE	244783.00	1	244783.00	0.46	0.50
DER/ABC	51576117.00	96	537251.22		
BDE	861147.05	3	287049.02	0.53	
DER/ABC	51576117.00	96	537251.22		
ABDE	1172837.09	3	390945.70	0.73	
DER/ABC	51576117.00	96	537251.21		
CDE	116874.32	1	116874.32	0.22	0.50
DER/ABC	51576117.00	96	537251.22		
ACDE	11603.57	1	11603.57	0.02	0.50

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SOURCE	SS	df	MS	F	p
DER/ABC	51576117.00	96	537251.22		
BCDE	7513986.48	3	2504662.16	4.66	
DER/ABC	51576117.00	96	537251.22		
ABCDE	991551.09	3	330517.03	0.62	
DER/ABC	51576117.00	96	537251.22		

Item-Based Response Times, Frame 2

SOURCE	SS	df	MS	F	p
A	1724848.17	1	1724848.17	9.89	0.005 **
AR/B	3486943.31	20	174347.17		
B	5470851.10	3	1823617.04	2.64	
R/B	13819958.73	20	690997.94		
AB	283276.52	3	94425.51	0.54	
AR/B	3486943.31	20	174347.17		
C	2902669.26	1	2902669.26	9.73	0.005 **
CR/B	5968161.15	20	298408.06		
AC	2900583.01	1	2900583.01	32.67	0.001 ***
ACR/B	1775858.06	20	88792.90		
BC	1819622.59	3	606540.86	2.03	
CR/B	5968161.15	20	298408.06		
ABC	185196.43	3	61732.14	0.70	
ACR/B	1775858.06	20	88792.90		
D	120814719.00	1	120814719.00	135.91	0.001 ***
DR/B	17778493.35	20	888924.67		
AD	1496.26	1	1496.26	0.02	0.50
ADR/B	1762202.10	20	88110.11		
BD	41651.89	3	13883.96	0.02	
DR/B	17778493.35	20	888924.67		
ABD	176532.39	3	58844.13	0.67	
ADR/B	1762202.10	20	88110.11		
CD	2540853.37	1	2540853.38	10.16	0.005 **
CDR/B	5004217.27	20	250210.86		
ACD	2023623.38	1	2023623.38	15.18	0.001 ***
ACDR/B	2667013.19	20	133350.66		
BCD	1569770.10	3	523256.70	2.09	
CDR/B	5004217.27	20	250210.86		

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SOURCE	SS	df	MS	F	p
ABCD	7275838.19	3	2425279.40	18.19	
ACDR/B	2667013.19	20	133350.66		
E	51615.375	1	51615.38	0.24	0.50
ER/B	4347661.479	20	217383.07		
AE	188682.67	1	188682.67	1.93	0.10
AER/B	1955059.73	20	97752.99		
BE	8298091.65	3	2766030.55	12.72	
ER/B	4347661.48	20	217383.07		
ABE	1365507.10	3	455169.03	4.66	
AER/B	1955059.73	20	97752.99		
CE	311.76	1	311.76	0.00	0.50
CER/B	2943592.06	20	147179.60		
ACE	188594.01	1	188594.01	2.08	0.10
ACER/B	1812548.31	20	90627.42		
BCE	895648.68	3	298549.56	2.03	
CER/B	2943592.06	20	147179.60		
ABCE	1127551.68	3	375850.56	4.15	
ACER/B	1812548.31	20	90627.42		
DE	102377.34	1	102377.34	0.63	0.25
DER/B	3254993.02	20	162749.65		
ADE	60752.34	1	60752.34	0.47	0.50
ADER/B	2599371.10	20	129968.56		
BDE	1081284.39	3	360428.13	2.22	
DER/B	3254993.02	20	162749.65		
ABDE	530243.80	3	176747.93	1.36	
ADER/B	2599371.10	20	129968.56		
CDE	41583.38	1	41583.38	0.40	0.50
CDER/B	2070423.94	20	103521.20		
ACDE	10333.50	1	10333.50	0.06	0.50
ACDER/B	3367995.52	20	168399.78		
BCDE	3567646.94	3	1189215.65	11.49	
CDER/B	2070423.94	20	103521.20		
ABCDE	700697.23	3	233565.74	1.39	
ACDER/B	3367995.52	20	168399.78		

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Independent Subanalyses, On-Line Self-Paced Reading (Frame 2)—Bilinguals

Language Dominance × RC Length × Attachment Site, English Materials
The 4 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: RC Length (long versus short)
D: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: English Materials Data

SOURCE	SS	df	MS	F	p
A	21573545.79	1	21573545.79	3.95	0.05 *
R/AB	262247414.36	48	5463487.80		
B	15443702.18	3	5147900.73	0.94	
R/AB	262247414.36	48	5463487.80		
AB	19213351.54	3	6404450.51	1.17	
R/AB	262247414.36	48	5463487.80		
C	201002661.16	1	201002661.16	318.08	0.001 ***
CR/AB	30332169.36	48	631920.19		
AC	5324094.45	1	5324094.45	8.43	0.01 **
CR/AB	30332169.36	48	631920.19		
BC	6077727.80	3	2025909.27	3.21	
CR/AB	30332169.36	48	631920.19		
ABC	1127447.23	3	375815.74	0.60	
CR/AB	30332169.36	48	631920.19		
D	29029.02	1	29029.02	0.07	0.50
DR/AB	20918665.64	48	435805.53		
AD	1865515.02	1	1865515.02	4.28	0.05 *
DR/AB	20918665.64	48	435805.53		
BD	1484992.59	3	494997.53	1.14	
DR/AB	20918665.64	48	435805.53		
ABD	1666161.73	3	555387.24	1.27	
DR/AB	20918665.64	48	435805.53		
CD	67762.57	1	67762.57	0.10	0.50
CDR/AB	33038405.79	48	688300.12		
ACD	181488.29	1	181488.29	0.26	0.50
CDR/AB	33038405.79	48	688300.12		
BCD	6654411.68	3	2218137.23	3.22	
CDR/AB	33038405.79	48	688300.12		

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SOURCE	SS	df	MS	F	p
ABCD	303614.68	3	101204.89	0.15	
CDR/AB	33038405.79	48	688300.12		

Item-Based Response Times, Frame 2: English Materials Data

SOURCE	SS	df	MS	F	p
A	4549468.88	1	4549468.88	43.80	0.001 ***
R/AB	2077212.10	20	103860.61		
B	2541548.77	3	847182.92	1.79	
R/AB	9490982.35	20	474549.12		
AB	251403.89	3	83801.30	0.81	
R/AB	2077212.10	20	103860.61		
C	44157155.88	1	44157155.88	103.08	0.001 ***
CR/AB	8567868.94	20	428393.45		
AC	1067585.88	1	1067585.88	13.92	0.001 **
CR/AB	1533621.69	20	76681.08		
BC	655083.06	3	218361.02	0.51	
CR/AB	8567868.94	20	428393.45		
ABC	4055694.81	3	1351898.27	17.63	
CR/AB	1533621.69	20	76681.08		
D	29975.01	1	29975.01	0.13	0.50
DR/AB	4770016.69	20	238500.83		
AD	377276.67	1	377276.67	3.95	0.10 †
DR/AB	1911467.44	20	95573.37		
BD	2379693.18	3	793231.06	3.33	
DR/AB	4770016.69	20	238500.83		
ABD	299299.27	3	99766.42	1.04	
DR/AB	1911467.44	20	95573.37		
CD	6733.17	1	6733.17	0.04	0.50
CDR/AB	3576572.77	20	178828.64		
ACD	10487.30	1	10487.30	0.08	0.50
CDR/AB	2596215.52	20	129810.78		
BCD	848256.43	3	282752.14	1.58	
CDR/AB	3576572.77	20	178828.64		
ABCD	224847.06	3	74949.02	0.58	
CDR/AB	2596215.52	20	129810.78		

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Language Dominance × Attachment Site, English Long-RC Materials
The 3 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: English Materials, Long-RC Data

SOURCE	SS	df	MS	F	p
A	24166077.01	1	24166077.01	7.69	0.01 **
B	8003693.67	3	2667897.89	0.85	
AB	12348821.17	3	4116273.72	1.31	
S	150767255.43	48	3140984.49		
C	92747.58	1	92747.58	0.15	0.50
AC	441634.72	1	441634.72	0.72	0.25
BC	6510603.46	3	2170201.15	3.55	
ABC	597066.17	3	199022.06	0.33	
S*C	29334468.57	48	611134.76		

Item-Based Response Times, Frame 2: English Materials, Long-RC Data

SOURCE	SS	df	MS	F	p
B	1311551.46	3	437183.82	0.71	
S	12342647.00	20	617132.35		
A	5012376.00	1	5012376.00	46.24	0.001 ***
AB	2918957.83	3	972985.94	8.98	
S*A	2167923.67	20	108396.18		
C	32560.67	1	32560.67	0.15	0.50
BC	1617514.83	3	539171.61	2.41	
S*C	4467438.00	20	223371.90		
AC	130980.38	1	130980.38	1.24	0.25
ABC	80274.79	3	26758.26	0.25	
S*AC	2110238.33	20	105511.92		

Language Dominance × Attachment Site, English Short-RC Materials
The 3 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: English Materials, Short-RC Data

SOURCE	SS	df	MS	F	p
A	2731563.22	1	2731563.22	0.92	0.25
B	13517736.31	3	4505912.10	1.53	
AB	7991977.60	3	2663992.53	0.90	
S	141812328.29	48	2954423.51		
C	4044.01	1	4044.01	0.01	0.50

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SOURCE	SS	df	MS	F	p
AC	1605368.58	1	1605368.58	3.13	0.10 †
BC	1628800.81	3	542933.60	1.06	
ABC	1372710.24	3	457570.08	0.89	
S*C	24622602.86	48	512970.89		

Item-Based Response Times, Frame 2: English Materials, Short-RC Data

SOURCE	SS	df	MS	F	p
B	1885080.36	3	628360.12	2.20	
S	5716204.29	20	285810.21		
A	604678.76	1	604678.76	8.38	0.01 **
AB	1388140.86	3	462713.62	6.41	
S*A	1442910.12	20	72145.51		
C	4147.51	1	4147.51	0.02	0.50
BC	1610434.78	3	536811.59	2.77	
S*C	3879151.46	20	193957.57		
AC	256783.59	1	256783.59	2.14	0.10
ABC	443871.53	3	147957.18	1.23	
S*AC	2397444.63	20	119872.23		

Language Dominance × RC Length × Attachment Site, Spanish Materials
The 4 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: RC Length (long versus short)
D: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: Spanish Materials Data

SOURCE	SS	df	MS	F	p
A	578.57	1	578.57	0.00	0.50
R/AB	374579241.64	48	7803734.20		
B	40525169.00	3	13508389.67	1.73	
R/AB	374579241.64	48	7803734.20		
AB	26526871.50	3	8842290.50	1.13	
R/AB	374579241.64	48	7803734.20		
C	352308795.02	1	352308795.02	358.71	0.001 ***
CR/AB	47143405.36	48	982154.28		
AC	3520530.02	1	3520530.02	3.58	0.10 †
CR/AB	47143405.36	48	982154.28		
BC	32967368.48	3	10989122.83	11.19	
CR/AB	47143405.36	48	982154.28		

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SOURCE	SS	df	MS	F	p
ABC	5147718.63	3	1715906.21	1.75	
CR/AB	47143405.36	48	982154.28		
D	8232.88	1	8232.88	0.02	0.50
DR/AB	25059728.07	48	522077.67		
AD	2592.16	1	2592.16	0.01	0.50
DR/AB	25059728.07	48	522077.67		
BD	711244.34	3	237081.45	0.45	
DR/AB	25059728.07	48	522077.67		
ABD	651805.05	3	217268.35	0.42	0.50
DR/AB	25059728.07	48	522077.67		
CD	553220.64	1	553220.64	1.43	0.10
CDR/AB	18537711.21	48	386202.32		
ACD	74898.29	1	74898.29	0.19	0.50
CDR/AB	18537711.21	48	386202.32		
BCD	1720721.86	3	573573.95	1.49	
CDR/AB	18537711.21	48	386202.32		
ABCD	1860773.50	3	620257.83	1.61	
CDR/AB	18537711.21	48	386202.32		

Item-Based Response Times, Frame 2: Spanish Materials Data

SOURCE	SS	df	MS	F	p
A	75962.30	1	75962.30	0.48	0.50
R/AB	3185589.27	20	159279.46		
B	4748924.93	3	1582974.98	3.08	
R/AB	10297137.52	20	514856.88		
AB	217069.06	3	72356.35	0.45	
R/AB	3185589.27	20	159279.46		
C	79198416.51	1	79198416.51	111.43	0.001 ***
CR/AB	14214841.69	20	710742.08		
AC	957533.76	1	957533.76	6.61	0.025 *
CR/AB	2895593.60	20	144779.68		
BC	956338.93	3	318779.64	0.45	

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SOURCE	SS	df	MS	F	p
CR/AB	14214841.69	20	710742.08		
ABC	3396675.77	3	1132225.26	7.82	
CR/AB	2895593.60	20	144779.68		
D	21952.13	1	21952.13	0.17	0.50
DR/AB	2521236.85	20	126061.84		
AD	0.01	1	0.01	0.00	1.00
DR/AB	1856140.60	20	92807.03		
BD	6814047.14	3	2271349.05	18.02	
DR/AB	2521236.85	20	126061.84		
ABD	2193759.52	3	731253.17	7.88	
DR/AB	1856140.60	20	92807.03		
CD	137227.55	1	137227.55	1.57	0.10
CDR/AB	1748844.19	20	87442.21		
ACD	60598.55	1	60598.55	0.36	0.50
CDR/AB	3371151.10	20	168557.56		
BCD	3800674.89	3	1266891.63	14.49	
CDR/AB	1748844.19	20	87442.21		
ABCD	1006093.97	3	335364.66	1.99	
CDR/AB	3371151.10	20	168557.56		

Language Dominance × Attachment Site, Spanish Long-RC Materials
The 3 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: Spanish Materials, Long-RC Data

SOURCE	SS	df	MS	F	p
A	1715422.51	1	1715422.51	0.33	0.50
B	62468547.81	3	20822849.27	4.00	
AB	22061820.96	3	7353940.32	1.41	
S	249989529.14	48	5208115.19		
C	348214.51	1	348214.51	0.60	0.25
AC	24811.51	1	24811.51	0.04	0.50
BC	2316957.67	3	772319.22	1.33	
ABC	2026825.96	3	675608.65	1.17	
S*C	27804466.86	48	579259.73		

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Item-Based Response Times, Frame 2: Spanish Materials, Long-RC Data

SOURCE	SS	df	MS	F	p
B	4953015.28	3	1651005.09	1.57	
S	21004216.96	20	1050210.85		
A	786445.01	1	786445.01	4.60	0.05 *
AB	1255125.61	3	418375.20	2.45	
S*A	3421768.63	20	171088.43		
C	134475.51	1	134475.51	1.12	0.25
BC	9574805.78	3	3191601.93	26.66	
S*C	2394729.96	20	119736.50		
AC	30281.51	1	30281.51	0.22	0.50
ABC	3051618.11	3	1017206.04	7.55	
S*AC	2693435.63	20	134671.78		

Language Dominance × Attachment Site, Spanish Short-RC Materials
The 3 factors are:

A: Language Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: Attachment Site (low versus high)

Subject-Based Response Times, Frame 2: Spanish Materials, Short-RC Data

SOURCE	SS	df	MS	F	p
A	1805686.08	1	1805686.08	0.50	0.25
B	11023989.67	3	3674663.22	1.03	
AB	9612769.17	3	3204256.39	0.90	
S	171733117.86	48	3577773.29		
C	213239.01	1	213239.01	0.65	0.25
AC	52678.94	1	52678.94	0.16	0.50
BC	115008.53	3	38336.18	0.12	
ABC	485752.60	3	161917.53	0.49	
S*C	15792972.43	48	329020.26		

Item-Based Response Times, Frame 2: Spanish Materials, Short-RC Data

SOURCE	SS	df	MS	F	p
B	752248.58	3	250749.53	1.43	
S	3507762.25	20	175388.11		
A	247051.04	1	247051.04	1.86	0.10
AB	2358619.21	3	786206.40	5.91	
S*A	2659414.25	20	132970.71		
C	24704.17	1	24704.17	0.26	0.50
BC	1039916.25	3	346638.75	3.70	
S*C	1875351.08	20	93767.55		
AC	30317.04	1	30317.04	0.24	0.50
ABC	148235.37	3	49411.79	0.39	

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SOURCE	SS	df	MS	F	p
S*AC	2533856.08	20	126692.80		

Frame 3 (Question) Error Rates

The 5 factors are:

A: Dominance (English-dominant versus Spanish-dominant)
B: Subject/Item Design Groups
C: Language of the Materials (English versus Spanish)
D: RC Length (long versus short)
E: Attachment Site (low versus high)

Subject-Based Error Rates, Frame 3

SOURCE	SS	df	MS	F	p
A	4375.00	1	4375.00	2.28	0.10
R/ABC	183879.90	96	1915.42		
B	2074.74	3	691.58	0.36	
R/ABC	183879.90	96	1915.415		
AB	1524.48	3	508.16	0.27	
R/ABC	183879.90	96	1915.42		
C	1198.65	1	1198.65	0.63	0.25
R/ABC	183879.90	96	1915.42		
AC	247.22	1	247.22	0.13	0.50
R/ABC	183879.90	96	1915.42		
BC	8222.16	3	2740.72	1.43	
R/ABC	183879.90	96	1915.42		
ABC	10525.70	3	3508.57	1.83	
R/ABC	183879.90	96	1915.42		
D	3972.22	1	3972.22	3.47	0.10 †
DR/ABC	109851.90	96	1144.29		
AD	992.46	1	992.46	0.87	0.25
DR/ABC	109851.90	96	1144.29		
BD	9549.27	3	3183.09	2.78	
DR/ABC	109851.90	96	1144.29		
ABD	6726.38	3	2242.13	1.96	
DR/ABC	109851.90	96	1144.29		
CD	40.08	1	40.08	0.04	0.50
DR/ABC	109851.90	96	1144.29		

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SOURCE	SS	df	MS	F	p
ACD	636.51	1	636.51	0.56	0.25
DR/ABC	109851.90	96	1144.29		
BCD	10442.58	3	3480.86	3.04	
DR/ABC	109851.90	96	1144.29		
ABCD	1724.82	3	574.94	0.50	
DR/ABC	109851.90	96	1144.29		
E	34545.44	1	34545.44	19.57	0.001 ***
ER/ABC	169436.70	96	1764.97		
AE	486.39	1	486.39	0.28	0.50
ER/ABC	169436.70	96	1764.97		
BE	4694.15	3	1564.716	0.89	
ER/ABC	169436.70	96	1764.97		
ABE	4057.04	3	1352.34	0.77	
ER/ABC	169436.70	96	1764.97		
CE	803.57	1	803.57	0.46	0.50
ER/ABC	169436.70	96	1764.97		
ACE	9.84	1	9.84	0.01	0.50
ER/ABC	169436.70	96	1764.97		
BCE	1480.34	3	493.45	0.28	
ER/ABC	169436.70	96	1764.97		
ABCE	2901.65	3	967.22	0.55	
ER/ABC	169436.70	96	1764.97		
DE	990.08	1	990.08	0.81	0.25
DER/ABC	117971.00	96	1228.86		
ADE	356.43	1	356.43	0.29	0.50
DER/ABC	117971.00	96	1228.86		
BDE	8943.08	3	2981.03	2.43	
DER/ABC	117971.00	96	1228.86		
ABDE	6096.53	3	2032.18	1.65	
DER/ABC	117971.00	96	1228.86		
CDE	993.65	1	993.652	0.81	0.25
DER/ABC	117971.00	96	1228.86		
ACDE	4805.08	1	4805.08	3.91	0.05 *
DER/ABC	117971.00	96	1228.86		

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SOURCE	SS	df	MS	F	p
BCDE	1451.77	3	483.92	0.39	
DER/ABC	117971.00	96	1228.86		
ABCDE	4543.08	3	1514.36	1.23	
DER/ABC	117971.00	96	1228.86		

Item-Based Error Rates, Frame 3

SOURCE	SS	df	MS	F	p
A	941.25	1	941.25	4.26	0.05 *
AR/B	4421.46	20	221.07		
B	1707.76	3	569.25	0.49	
R/B	23247.07	20	1162.35		
AB	738.40	3	246.13	1.11	
AR/B	4421.46	20	221.07		
C	255.78	1	255.78	1.03	0.25
CR/B	4954.43	20	247.72		
AC	53.25	1	53.25	0.37	0.50
ACR/B	2891.77	20	144.59		
BC	787.59	3	262.53	1.06	
CR/B	4954.43	20	247.72		
ABC	652.16	3	217.39	1.50	
ACR/B	2891.77	20	144.59		
D	850.85	1	850.85	1.82	0.10
DR/B	9356.47	20	467.82		
AD	211.82	1	211.82	0.74	0.25
ADR/B	5740.11	20	287.01		
BD	364.00	3	121.33	0.26	
DR/B	9356.47	20	467.82		
ABD	1717.55	3	572.52	2.00	
ADR/B	5740.11	20	287.01		
CD	8.58	1	8.58	0.02	0.50
CDR/B	7194.58	20	359.72		
ACD	136.09	1	136.09	0.61	0.25
ACDR/B	4451.25	20	222.56		
BCD	475.24	3	158.41	0.44	
CDR/B	7194.58	20	359.73		
ABCD	1198.10	3	399.37	1.79	

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SOURCE	SS	df	MS	F	p
ACDR/B	4451.25	20	222.56		
E	7402.59	1	7402.59	5.33	0.05 *
ER/B	27760.47	20	1388.02		
AE	102.92	1	102.92	0.40	0.50
AER/B	5200.75	20	260.04		
BE	2503.21	3	834.40	0.60	
ER/B	27760.47	20	1388.02		
ABE	890.04	3	296.68	1.14	
AER/B	5200.75	20	260.04		
CE	172.54	1	172.54	0.70	0.25
CER/B	4925.54	20	246.28		
ACE	2.07	1	2.07	0.02	0.50
ACER/B	2260.96	20	113.05		
BCE	2415.90	3	805.30	3.27	
CER/B	4925.54	20	246.28		
ABCE	1126.44	3	375.48	3.32	
ACER/B	2260.96	20	113.05		
DE	211.82	1	211.82	0.22	0.50
DER/B	19314.59	20	965.73		
ADE	76.33	1	76.33	0.45	0.50
ADER/B	3428.21	20	171.41		
BDE	831.49	3	277.16	0.29	
DER/B	19314.59	20	965.73		
ABDE	596.01	3	198.67	1.16	
ADER/B	3428.21	20	171.41		
CDE	212.12	1	212.12	0.40	0.50
CDER/B	10707.57	20	535.38		
ACDE	1029.01	1	1029.01	7.62	0.025 *
ACDER/B	2699.32	20	134.97		
BCDE	935.40	3	311.80	0.58	
CDER/B	10707.57	20	535.38		
ABCDE	1240.95	3	413.65	3.07	
ACDER/B	2699.32	20	134.97		

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Appendix F: Bilinguals' Background Information, Separated for Questionnaire and Self-Paced Reading Participants

Language Dominance

Primary Language Dominance Criteria (cf. Table 6-1)

Table F-1: Mean Self-Reported Proficiencies for EDOM and SDOM Bilinguals, Questionnaire (Quest) and Self-Paced Reading (SPR) Participants

	EDOM (N=40)		*SDOM (N=40)*	
	Quest (N=12)	*SPR (N=28)*	*Quest (N=12)*	*SPR (N=28)*
Oral Comprehension	–0.42	–0.59	+0.75	+0.46
Oral Production	–0.42	–1.18	+1.08	+0.79
Reading Comprehension	–0.75	–1.11	+0.83	+0.64
Written Production	–1.08	–1.43	+1.08	+0.71
Pass as Monolingual, Face-to-Face	–0.25	–1.18	+1.58	+1.50
Pass as Monolingual, Telephone	–0.17	–1.32	+1.50	+1.57

Note: Scores represent the difference between English and Spanish; a positive figure indicates Spanish is rated better than English, and a negative figure that English is rated better than Spanish.

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Secondary Language Dominance Criteria (cf. Table 6-2)

Table F-2: Preferred Language for Special Circumstances for EDOM and SDOM Bilinguals, Questionnaire Participants

	EDOM (N=12)						*SDOM (N=12)*					
	English		*Spanish*		*Either*		*English*		*Spanish*		*Either*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Comfortable	8	66.7	3	25.0	1	8.3	0	0.0	10	83.3	2	16.7
Tired	4	33.3	2	16.7	4	33.3	1	8.3	6	50.0	4	33.3
Angry	7	58.3	2	16.7	2	16.7	2	16.7	6	50.0	4	33.3
Happy	7	58.3	0	0.0	4	33.3	0	0.0	7	58.3	5	41.7
Arithmetic	9	75.0	2	16.7	1	8.3	1	8.3	8	66.7	3	25.0
MEAN (%)		58.3		30.0		20.0		6.7		61.7		30.0

Note: The percentages are computed in terms of subjects responding, per dominance group. Occasionally subjects recorded no response to a question; this applied to 6.7% of the data for the EDOM sample, 1.7% for the SDOM sample.

Table F-3: Preferred Language for Special Circumstances for EDOM and SDOM Bilinguals, Self-Paced Reading Participants

	EDOM (N=28)						*SDOM (N=28)*					
	English		*Spanish*		*Either*		*English*		*Spanish*		*Either*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Comfortable	25	89.3	1	3.6	1	3.6	1	3.6	23	82.1	4	14.3
Tired	21	75.0	2	7.1	5	17.9	3	10.7	10	35.7	15	53.6
Angry	16	57.1	7	25.0	5	17.9	2	7.1	16	57.1	10	35.7
Happy	20	71.4	2	7.1	6	21.4	6	21.4	6	21.4	16	57.1
Arithmetic	26	92.9	0	0.0	2	7.1	5	17.9	15	53.6	8	28.6
MEAN (%)		77.1		8.6		13.6		12.1		50.0		37.9

Note: The percentages are computed in terms of subjects responding, per dominance group. Occasionally subjects recorded no response to a question; this applied to 0.7% of the data for the EDOM sample.

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Ternary Language Dominance Criterion (cf. Table 6-3)

Table F-4: Preferred Language for "Neurosurgery" Question, for EDOM and SDOM Bilinguals, Questionnaire Subjects

	EDOM				SDOM			
	Keep English		Keep Spanish		Keep English		Keep Spanish	
Responses	*N*	*% (N=11*)*	*N*	*% (N=11*)*	*N*	*% (N=11*)*	*N*	*% (N=11*)*
	9	81.8	2	18.2	4	36.4	7	63.6
Reasons for Choice	*N*	*% (N=9)*	*N*	*% (N=2)*	*N*	*% (N=4)*	*N*	*% (N=7)*
Dominant Language	2	22.2	—	0.0	—	0.0	1	14.3
Harder Language	—	0.0	—	0.0	—	0.0	1	14.3
First Language	—	0.0	1	50.0	—	0.0	—	0.0
Majority Language	5	55.6	—	0.0	2	50.0	—	0.0
Language of Finance	1	11.1	—	0.0	—	0.0	—	0.0
Family Language	—	0.0	—	0.0	1	25.0	—	0.0
Heritage Language	—	0.0	1	50.0	—	0.0	3	42.9
Emotional Reasons	1	11.1	—	0.0	1	25.0	2	28.6

* One English-dominant and one Spanish-dominant bilingual did not record an answer for this question.

Table F-5: Preferred Language for "Neurosurgery" Question, for EDOM and SDOM Bilinguals, Self-Paced Reading Task

	EDOM (N=40)				SDOM (N=40)			
	Keep English		Keep Spanish		Keep English		Keep Spanish	
Responses	*N*	*% (N=28)*	*N*	*% (N=28)*	*N*	*% (N=27*)*	*N*	*% (N=27*)*
	20	71.4	8	28.6	7	25.9	20	74.1
Reasons for Choice	*N*	*% (N=20)*	*N*	*% (N=8)*	*N*	*% (N=7)*	*N*	*% (N=20)*
Dominant Language	10	50.0	—	0.0	—	0.0	4	20.0
Harder Language	—	0.0	—	0.0	1	14.3	0	0.0
First Language	—	0.0	—	0.0	—	0.0	5	25.0
Majority Language	7	35.0	—	0.0	4	57.1	—	0.0
Language of Finance	1	5.0	—	0.0	1	14.3	—	0.0
Family Language	1	5.0	3	37.5	1	14.3	7	35.0
Heritage Language	1	5.0	3	37.5	—	0.0	2	10.0
Emotional Reasons	—	0.0	2	25.0	—	0.0	2	10.0

* One English-dominant bilingual did not record an answer for this question.

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Background

General Demographics (cf. Table 6-4)

Table F-6: Bilinguals' General Demographics, Questionnaire and Self-Paced Reading Participants

	EDOM (N = 40)				*SDOM (N = 40)*			
	Quest (N=12)		*SPR (N=28)*		*Quest (N=12)*		*SPR (N=28)*	
Mean Age (Years)	28.3		24.1		27.0		25.5	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Full-Time Students	5	41.7	18	64.3	6	50.0	18	64.3
Sex Ratio, F	11	91.7	19	67.9	11	91.7	21	75.0
Handedness Ratio, R	12	100.0	24	85.7	9	75.0	27	96.4

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Language History (cf. Table 6-5 and Table 6-6)

Table F-7: Language History of the EDOM Bilinguals, Questionnaire and Self-Paced Reading Participants

	Only English				***Only Spanish***				***Both***				***English and LOTE/LOTS****			
	Quest		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Monolingual Mother	2	16.7	3	10.7	6	50.0	13	46.4	4	33.3	10	35.7	—	0.0	2	7.1
Monolingual Father	1	8.3	2	7.1	6	50.0	11	39.3	5	41.7	12	42.9	—	0.0	3	10.7
	In English-Majority Environment				***In Spanish-Majority Environment***				***In Both***				***In LOTE/LOTS*-Majority Environment***			
	Quest		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Elementary Ed.	6	50.0	23	82.1	5	41.7	1	3.6	1	8.3	4	14.3	—	0.0	—	0.0
Secondary Ed.	9	75.0	24	85.7	—	0.0	2	7.1	3	25.0	2	7.1	—	0.0	—	0.0
College, University	12	100.0	27	96.4	—	0.0	—	0.0	—	0.0	1	3.6	—	0.0	—	0.0
Graduate School	4	33.3	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
Other (Vocational School, etc.)	1	8.3	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
Place of Birth	7	58.3	21	75.0	3	25.0	7	25.0	—	0.0	—	0.0	—	0.0	—	0.0
Domicile History	3	25.0	15	53.6	—	0.0	—	0.0	9	75.0	13	46.4	—	0.0	—	0.0

* LOTE = languages other than English; LOTS = languages other than Spanish. For parental languages, these included German and Italian (N=2), German (N=1), French (N=1) and Chinese (N=1).

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Table F-8: Language History of SDOM Bilinguals, Questionnaire and Self-Paced Reading Participants

	Only English				*Only Spanish*				*Both*				*English and LOTE/LOTS**			
	Quest		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Monolingual Mother	—	0.0	1	3.6	8	66.7	24	85.7	3	25.0	3	10.7	—	0.0	1	3.6
Monolingual Father	—	0.0	1	3.6	10	83.3	22	78.6	1	8.3	4	14.3	—	0.0	2	7.1

	In English-Majority Environment				*In Spanish-Majority Environment*				*In Both*				*In LOTE/LOTS*-Majority Environment*			
	Quest		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*		*Quest*		*SPR*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Elementary Ed.	1	8.3	3	10.7	8	66.7	20	71.4	3	25.0	5	17.9	—	0.0	—	0.0
Secondary Ed.	5	41.7	10	35.7	3	25.0	14	50.0	4	33.3	4	14.3	—	0.0	—	0.0
College, University	10	83.3	25	89.3	—	0.0	—	0.0	2	16.7	3	10.7	—	0.0	—	0.0
Graduate School	5	41.7	2	7.1	—	0.0	—	0.0	1	8.3	—	0.0	—	0.0	—	0.0
Other (Vocational School, etc.)	—	0.0	1	3.3	—	0.0	1	3.3	—	0.0	1	3.3	—	0.0	1	3.3
Place of Birth	1	8.3	3	10.7	11	91.7	25	89.3	—	0.0	—	0.0	—	0.0	—	0.0
Domicile History	—	0.0	—	0.0	—	0.0	—	0.0	12	100.0	28	100.0	—	0.0	—	0.0

* LOTE = languages other than English; LOTS = languages other than Spanish. For parental languages, these included Italian (N=2) and Catalan (N=1). For languages of the environment, this included Italian (N=1).

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Language Frequency of Use (cf. Table 6-7)

Table F-9: Mean Rated Frequency of Language Use for EDOM and SDOM Bilinguals, in Different Time Periods and Contexts, Questionnaire and Self-Paced Reading Participants

Time Period	*EDOM*		*SDOM*		*Context*	*EDOM*		*SDOM*	
	Quest	*SPR*	*Quest*	*SPR*		*Quest*	*SPR*	*Quest*	*SPR*
Child					*Family*				
Output	2.80	3.36	1.46	1.33	*Output*	2.85	3.24	1.67	1.61
Input	2.77	3.32	1.69	1.27	*Input*	3.27	3.21	1.79	1.63
Adolescent					*Private*				
Output	3.36	3.60	1.76	1.74	*Output*	3.26	3.55	1.79	1.96
Input	3.87	3.60	1.96	1.79	*Input*	3.60	3.84	2.12	2.10
Adult					*Public*				
Output	3.97	3.95	2.90	3.25	*Output*	4.29	4.28	2.89	3.04
Input	3.94	3.98	2.93	3.27	*Input*	4.16	4.26	3.03	3.02

Note: Mean values above 3 indicate that English is more frequent, and below 3, that Spanish is more frequent.

Table F-10: Mean Rated Frequency of Language Use with Immediate Family During Childhood and Adolescence, for EDOM and SDOM Bilinguals, Questionnaire and Self-Paced Reading Participants

	EDOM				*SDOM*			
	Parents		*Siblings*		*Parents*		*Siblings*	
	Quest	*SPR*	*Quest*	*SPR*	*Quest*	*SPR*	*Quest*	*SPR*
Output	2.33	2.64	3.60	4.26	1.42	1.20	1.71	1.36
Input	3.88	2.45	3.60	4.20	1.54	1.05	1.92	1.48

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Acquisition history (cf. Table 6-9)

Table F-11: EDOM and SDOM Bilinguals in Three Acquisition History Categories, Questionnaire and Self-Paced Reading Participants

	EDOM						*SDOM*					
	Quest (N=12)			*SPR (N=28)*			*Quest (N=12)*			*SPR (N=28)*		
	N	*%*	*Age L2*	*N*	*%*	*Age L2*	*N*	*%*	*Age L2*	*N*	*%*	*Age L2*
Simultaneous	2	16.7	—	9	32.1	—	—	0.0	—	2	7.1	—
L2 Spanish	3	25.0	8.3	5	17.9	10.6	1	8.3	7.0	—	0.0	—
< age 15	3	100.0	8.3	4	80.0	8.0	1	100.0	7.0	—	0.0	—
≥ age 15	—	0.0	—	1	20.0	21.0	—	0.0	—	—	0.0	—
L2 English	7	58.3	8.7	15	53.6	4.4	11	91.7	13.1	26	92.9	13.0
< age 15	7	100.0	8.7	15	100.0	4.4	9	81.9	10.3	17	65.4	9.5
≥ age 15	—	0.0	—	—	0.0	—	2	18.1	25.5	9	34.6	19.6

Encoding preferences (cf. Table 6-10)

Table F-12: Encoding Preferences for EDOM and SEDOM Bilinguals, Questionnaire and Self-Paced Reading Participants

	EDOM				*SDOM*			
	Quest (N=12)		*SPR (N=28)*		*Quest (N=12)*		*SPR (N=28)*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Inner Voice (Self) in English	10	83.3	21	75.0	7	58.3	20	71.4
Inner Voice (Self) in Spanish	5	41.7	17	60.7	8	66.7	20	71.4
Inner Voice (Others) in English	10	83.3	18	64.3	7	58.3	17	60.7
Inner Voice (Others) in Spanish	7	58.3	15	53.6	10	83.3	20	71.4
Preference for Words over Images	7	58.3	16	57.1	4	33.3	11	39.3
Visualize Words in English	2	28.6	5	31.3	—	0.0	1	9.1
Visualize Words in Spanish	—	0.0	—	0.0	1	25.0	2	18.2
Visualize Words in English or Spanish, Depending on the Type of Object	5	71.4	11	68.8	3	75.0	8	72.7

Note: In the breakdowns of subjects preferring words over images, the denominators used for EDOM were N=7 and N=16, for questionnaire and SPR participants, respectively; those used for SDOM were N=4 and N=11, for questionnaire and SPR participants, respectively

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Appendix G: Experiment 5, Puerto Rican Spanish Data on Relative Clause Attachment Preferences

The monolingual experimental data provided in Chapter 5 provided the baseline comparison for the bilingual data presented in Chapter 6. The subjects in both the monolingual and the bilingual experiments speak the same variety of English, namely, English from the Northeast region of the United States. However, the subjects in the monolingual sample speak a variety of Spanish different from that spoken by the subjects in the bilingual sample: the monolingual Spanish speakers speak Castillian Spanish while the bilingual Spanish speakers speak Pan-American varieties of Spanish (the sample includes speakers from Argentina, Colombia, Cuba, the Dominican Republic, Ecuador, El Salvador, Panama, Peru, Puerto Rico, Uruguay and Venezuela, as well as speakers of US Spanish).

There exist no studies to date comparing RC attachment preferences among speakers of different varieties of Spanish. However, as discussed in Chapters 2 and 6, examination of existing studies that have used speakers from different regions of the Spanish-speaking world suggests that all speakers of Spanish exhibit an ultimate preference for high attachment, regardless of their dialect.

To confirm (at least tentatively) that the norm for monolingual Spanish speakers of Pan-American Spanish is similar to the norm for monolingual Castillian Spanish, a pilot study was carried out to examine the off-line preferences of monolingual Spanish speakers from San Juan, Puerto Rico, and

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compare them to those of the Castillian Spanish speakers used in Experiment 1. The results of this pilot experiment are presented in this appendix.

Language History of Puerto Rican Spanish Sample

A concern with this group of speakers of Puerto Rican Spanish (PRSPA) is the possibility that their exposure to English is far more extensive than that of the Castillian Spanish group. The table below summarizes the Puerto Rican Spanish speakers' background (cf. Table 5-1 in Chapter 5, for Castillian Spanish speakers).

Table G-1: General Demographics, Language History and Encoding Preferences for PRSPA Monolinguals

General Demographics	***PRSPA (N = 24)***	
Mean Age (Years)	18.2	
	N	**%**
Full-Time Students	24	100.0
Sex Ratio, F	18	75.0
Handedness Ratio, R	23	95.8
Language History		
Monolingual Mother	23	95.8
Monolingual Father	21	87.5
Never Lived in Non-L1 Environment	24	100.0
Born in L1 Environment	22	91.7
Elementary Education	24	100.0
Secondary Education	24	100.0
College, University	24	100.0
Graduate School	0	0.0
Other (Vocational School, etc.)	1	4.2
Encoding Preferences		
Inner Voice (Self)	23	95.8
Inner Voice (Others)	17	70.8
Preference for Words over Images	1	4.2

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The table indicates that the PRSPA group is highly homogeneous, and very comparable to the CSPA group regarding general demographics, language history and encoding preferences.

The PRSPA monolinguals were asked, as was the CSPA group, whether they speak English and/or any other second (or third) languages. None of the PRSPA speakers indicated they speak a second language in addition to English. The 13 (54.2%) who indicated they speak English as a second language also indicated they only speak it at a beginner level. From the background questionnaire data, it appears that the PRSPA monolinguals whose data are reported here have less proficiency in English than do the CSPA monolinguals reported in Chapter 5 (see especially Table 5-2 and Table 5-3, where the figures indicate that 96.9% of the CSPA monolinguals tested speak English, most of them at a beginner level, but a small number of them at an advanced level).

Even though the speakers of Puerto Rican Spanish reside in a region where English is more widely spoken than the region where the Castillian Spanish speakers reside, they report that their fluency in English is minimal. (The subjects were recruited from beginner English classes at the University of Puerto Rico, classes which are required of incoming freshmen who do not pass a language proficiency hurdle.)

Method

Materials. The materials for this pilot study were identical to those used in Experiment 3, which in turn were identical to those used in Experiment 1 with

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minor dialectal differences in lexical content in some of the items, as indicated in Appendix A-1 and Appendix A-2.

Procedure. The procedure was identical to that used in Experiment 1, except that the sheet of instructions provided to the subjects was the dialect-appropriate Pan-American Spanish version, rather than the Castillian Spanish version.

Subjects. The PRSPA data reported are from 24 subjects (12 in each versions of the questionnaire) who received $5 for their participation. The subjects were all undergraduate students at the Universidad de Puerto Rico, Río Piedras Campus (in San Juan), and their mean age was 18.2 years. Of the 39 subjects who participated in the study, those selected had language backgrounds meeting the criteria for monolinguality used for selecting CSPA and USENG monolinguals (see §5.2), and incurred fewer than 5% errors in responses to filler items (the mean error rate was 3.5%). Six participants were excluded based on their self-reported language histories, and nine on the filler-accuracy criterion.

Data Treatment. The response-coding and analysis followed a procedure identical to that followed in Experiment 1. Responses to target items were coded in terms of attachment site (high or low) implied by the choice of noun; responses which had self-evidently been altered were treated as missing data. These, along with any items left blank, constituted 5.0% of the total data set. The response-coding supported subject- and item-based calculations of summary

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values which were cast in terms of the proportion of responses indicating low attachment, for each of the cells of a design factorially combining RC Length (short versus long) and Complex NP Number (N1 and N2 singular versus plural). An additional dummy factor, Design Groups (subject groups in the subject-based analysis, item groups in the item-based analysis) takes into account the assignment of subjects and items to the two versions of the questionnaire over which materials were counterbalanced. This factor is included in the analysis of variance design to extract irrelevant variance, but is not reported in what follows. For the purposes of the comparison, the analysis included a final factor, Dialect (Castillian versus Puerto Rican Spanish). The analyses of variance reported for this pilot experiment are listed at the end of this appendix.

Results

Figure G-1 below plots the results for the pilot experiment with speakers of Puerto Rican Spanish.

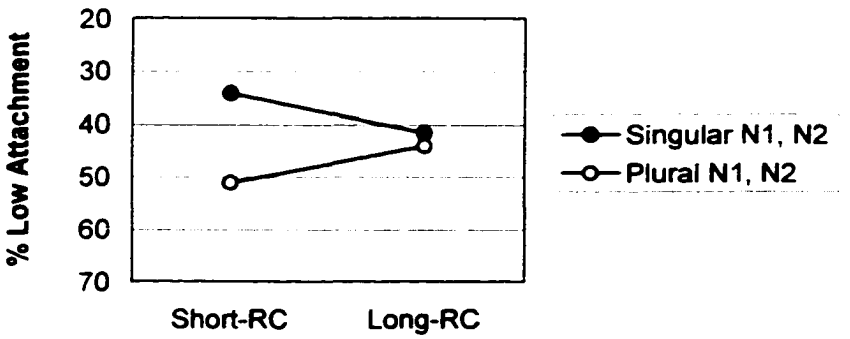

Figure G-1: Mean percentage low attachment as a function of RC length, for PRSPA monolinguals, with materials containing two singular and two plural nouns in the complex NP.

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The results for the PRSPA monolinguals provide, as desired, confirmation of the assumption that ultimate attachment preferences are similar in Spanish speakers of different dialectal backgrounds. The overall low attachment rate for the PRSPA sample was 42.7%, a rate very close to the 43.3% low attachment reported in Chapter 5 for the CSPA sample (with identical materials and procedure). In the analysis of variance comparing the PRSPA results reported here to the CSPA results reported in Chapter 5, the main effect of dialect was not significant (F_1, $F_2 < 1$).

The interaction of dialect and length was significant in the subject-based analysis ($F_1(1,44) = 4.43$, $p < .05$) but did not reach significance in the item-based analysis ($F_2(1,10) = 3.03$, $p > .10$). The three-way interaction of dialect, length and number was not significant ($F_1(1,44) = 1.17$, $p > .25$; $F_2 < 1$).

In the omnibus analysis, there was a significant interaction of dialect and number ($F_1(1,44) = 7.53$, $p < .01$; $F_2(1,10) = 10.20$, $p < .01$). As reported in Chapter 5, the Castillian Spanish speakers exhibit no sensitivity to number. The Puerto Rican Spanish speakers, on the other hand, show a marked preference, particularly with short RCs, to attach the RC high if both of the host nouns are singular. However, an independent subanalysis of the PRSPA data alone indicates that the effect of number, while significant in the subject-based analysis, $F_1(1,22) = 10.44$, $p < .005$, fails to reach significance in the item-based analysis, $F_2(1,10) = 1.76$, $p > .20$. (This main effect does not interact with length in the item-based analysis, $F_1(1,22) = 5.02$, $p < .05$, $F_2(1,10) = 2.27$, $p > .15$, which itself is not significant, F_1, $F_2 < 1$.) These unexpected findings with respect

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to number in the Puerto Rican pilot data highlight the need to investigate, independently of additional variables, the effect of number in RC attachment in English and Spanish.

The correlation of % N2 attachments computed using the item-based responses in the PRSPA data against the item-based responses in the CSPA data is significant ($r(22) = 0.754$, $p < .01$). This correlation is plotted in the figure below.

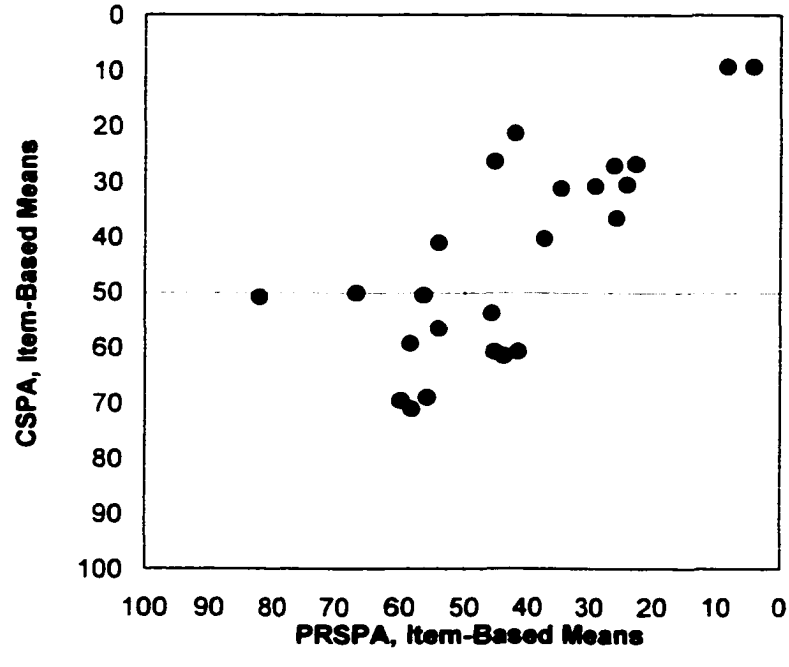

Figure G-2: Item-based means generated from PRSPA data against item-based means generated from CSPA data.

The correlation illustrates the fact that there is stability in the item-based data. In other words, some items have intrinsic characteristics which make the RC more

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likely to be attached high, and yet others have characteristics which make the RC more likely to be attached low. Crucially, the item-based stability comes from a comparison of data gathered from speakers of the two different varieties of Spanish of concern, Puerto Rican and Castillian Spanish.

An additional point of convergence for the PRSPA and the CSPA samples is in the fact that both groups have similar distributions of altered responses.[137] For the PRSPA group, alterations from an N2 to an N1 response made up 3.8% of the data set, while alterations from an N1 to an N2 response made up only 1.0% of the data set. Of the altered responses in the PRSPA data set, N2-to-N1 changes were more frequent, $\chi^2(1) = 9.14$, $p < .005$.

Discussion

This pilot study provides evidence that PRSPA speakers are not markedly different from speakers of Castillian Spanish. This evidence facilitates the comparison between the CSPA monolingual data presented in Chapter 5 and the bilingual data (using speakers of Spanish from the Americas) presented in Chapter 6.

[137] As reported above, 5.0% of the PRSPA questionnaire data were missing or altered, and were excluded from the analysis. Of this figure, 0.2% were missing responses, and the remaining 4.8% were altered responses.

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Analyses of Variance Reported in this Appendix

Mean Attachment to N2 (%), Off-Line Questionnaire: PRSPA versus CSPA Data

The 4 factors are:

A: Dialect (Castillian versus Puerto Rican Spanish)
B: Subject/Item Design Groups
C: RC Length (long versus short)
D: Complex NP Number (singular N1, N2 versus plural N1, N2)

Subject-Based % N2 Attachment

SOURCE	SS	df	MS	F	p
B	2200.5885	1	2200.5885	1.63	
R/AB	59471.7937	44	1351.6317		
AB	325.4428	1	325.4428	0.24	
R/AB	59471.7937	44	1351.6317		
C	1216.8084	1	1216.8084	3.88	0.10 †
CR/AB	13803.3120	44	313.7116		
AC	1390.4611	1	1390.4611	4.43	0.05 *
CR/AB	13803.3120	44	313.7116		
BC	325.5469	1	325.5469	1.04	
CR/AB	13803.3120	44	313.7116		
ABC	417.9266	1	417.9266	1.33	
CR/AB	13803.3120	44	313.7116		
D	904.1522	1	904.1522	2.80	0.10
DR/AB	14218.4654	44	323.1469		
AD	2431.9786	1	2431.9786	7.53	0.01 **
DR/AB	14218.4654	44	323.1469		
BD	244.5550	1	244.5550	0.76	
DR/AB	14218.4654	44	323.1469		
ABD	1575.3490	1	1575.3490	4.88	
DR/AB	14218.4654	44	323.1469		
CD	1390.5687	1	1390.5687	5.00	0.05 *
CDR/AB	12250.1419	44	278.4123		
ACD	325.4948	1	325.4948	1.17	0.25
CDR/AB	12250.1419	44	278.4123		
BCD	14180.2024	1	14180.2024	50.93	
CDR/AB	12250.1419	44	278.4123		

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SOURCE	SS	df	MS	F	p
ABCD	117.2031	1	117.2031	0.42	
CDR/AB	12250.1419	44	278.4123		

Item-Based % N2 Attachment

SOURCE	SS	df	MS	F	p
A	11.0229	1	11.0229	0.08	0.50
AR/B	1396.6900	10	139.6690		
B	370.2455	1	370.2455	0.44	
R/B	8337.5920	10	833.7592		
AB	126.7071	1	126.7071	0.91	
AR/B	1396.6900	10	139.6690		
C	859.9846	1	859.9846	1.39	0.25
CR/B	6172.0701	10	617.2070		
AC	907.3096	1	907.3096	3.03	0.10
ACR/B	2999.7361	10	299.9736		
BC	1539.1216	1	1539.1216	2.49	
CR/B	6172.0701	10	617.2070		
ABC	19.0549	1	19.0549	0.06	
ACR/B	2999.7361	10	299.9736		
D	180.4839	1	180.4839	0.17	0.50
DR/B	10571.7397	10	1057.1740		
AD	1172.9919	1	1172.9919	10.20	0.01 **
ADR/B	1149.5602	10	114.9560		
BD	8146.9823	1	8146.9823	7.71	
DR/B	10571.7397	10	1057.1740		
ABD	19.7744	1	19.7744	0.17	
ADR/B	1149.5602	10	114.9560		
CD	661.4476	1	661.4476	1.24	0.25
CDR/B	5353.4128	10	535.3413		
ACD	96.7414	1	96.7414	0.42	0.50
ACDR/B	2282.4414	10	228.2441		
BCD	270.3124	1	270.3124	0.51	
CDR/B	5353.4128	10	535.3413		
ABCD	499.7306	1	499.7306	2.19	
ACDR/B	2282.4414	10	228.2441		

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Independent Subanalyses, PRSPA Monolinguals

RC Length × Complex NP Number, PRSPA Data

The 3 factors are:

A: Subject/Item Design Groups
B: RC Length (long versus short)
C: Complex NP Number (N1, N2 singular versus plural)

Subject-Based % N2 Attachment: PRSPA Data

SOURCE	SS	df	MS	F	p
A	2109.28	1	2109.28	1.07	
S	43234.05	22	1965.18		
B	2.89	1	2.89	0.01	0.50
AB	2.88	1	2.88	0.01	
S*B	7425.42	22	337.52		
C	3150.93	1	3150.93	10.44	0.005 **
AC	1530.64	1	1530.64	5.07	
S*C	6636.90	22	301.68		
BC	1530.80	1	1530.80	5.02	0.05 *
ABC	5859.53	1	5859.53	19.22	
S*BC	6706.69	22	304.85		

Item-Based % N2 Attachment: PRSPA Data

SV	SS	df	MS	F	p
A	31.88	1	31.88	0.07	
S	4349.03	10	434.90		
B	0.32	1	0.32	0.00	1.000
AB	950.34	1	950.34	4.69	
S*B	2027.42	10	202.74		
C	1136.85	1	1136.85	1.76	0.10
AC	3682.00	1	3682.00	5.70	
S*C	6458.75	10	645.88		
BC	632.06	1	632.06	2.27	0.10
ABC	752.56	1	752.56	2.70	
S*BC	2789.19	10	278.92		

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