8

Sentence Parsing in Fluent Spanish-English Bilinguals

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Research on bilingualism dates as far back as 1881, when Whitney published his analysis of the grammatical structure of code-switching. A few years later, in 1887, Cattell published an experiment comparing word association and reaction times of bilingual and monolingual speakers. Despite the fact that inquiries into the phenomenon of bilingualism began over a century ago, it was only during the mid-1950s that the field began to earn its place as a phenomenon worthy of scientific research. Weinreich's *Languages in Contact* (1953) remains, without a doubt, the single most influential work of the time. Drawing on a wide range of sources, Weinreich introduced from several research perspectives – linguistic, psycholinguistic and sociolinguistic – every issue that is being investigated today.

From a psycholinguistic perspective, much of the early literature on bilingualism was concerned with problems of how to measure bilingualism objectively (Romaine, 1995), the debate over the existence of a language switch mechanism, and the relationship between bilingualism and intelligence. Psycholinguistic research with bilinguals has shifted in recent years from these matters to considerations of the nature of the bilingual lexicon (e.g. de Groot, 1992b, 1993; de Groot & Nas, 1991; Kroll, 1993; Kroll & Stewart, 1994), bilingual language production (e.g. de Bot & Schreuder, 1993; Myers-Scotton, 1993a; Poulisse & Bongaerts, 1994; Poulisse, 1997), and the perception and production of language in the bilingual's different language modes (e.g. Grosjean & Soares, 1986; Grosjean, 1997a), among others. However, an area of bilingual language performance that still remains largely unexplored deals with the mechanisms that govern sentence processing. Since the early 1980s, a considerable amount of effort has been devoted to the study of monolingual sentence parsing, ignoring the processes that may influence parsing procedures in bilinguals. A likely reason for this may be that in a research domain where numerous variables have to be carefully controlled, the use of bilingual participants adds considerable complications. However, bilingualism is not an exceptional characteristic of human beings. The speculation that a large portion of the world's population is bilingual is much nearer to the truth than many may have thought. Hence, a genuinely comprehen-

sive account of parsing strategies should have something to say about the way bilinguals parse sentences. In addition, bilingual data may provide a valuable tool in testing competing hypotheses of the nature of the human language capacity in general. As will be discussed later, there is evidence suggesting that experience with language may have an impact on parsing routines. For example, Dussias (submitted) has found that L1 Spanish speakers living in an English-speaking environment interpret a particular type of structurally ambiguous Spanish sentences using parsing strategies conventionally associated with English and not with Spanish. Evidence such as this may lend support to exposure-based models like the Tuning theory. At the same time, it suggests that proposals based on the premise that parsing procedures are universal may need revision.

In this chapter, the approach to the issue of bilingual parsing strategies is as follows. First, I give a brief overview of the work on parsing theories, concentrating only on Frazier's (1978, 1987) *Garden Path Theory*, Cuetos and Mitchell's (1988) *Linguistic Tuning* hypothesis, Frazier and Clifton's (1996) *Construal* proposal, and MacDonald, Pearlmutter and Seidenberg's (1994a) *Constraint-Satisfaction* model. Then, I go on to review the research that has been conducted to date on processing strategies in Spanish-English bilinguals. After this brief overview, I embark on a more detailed account of some of my recent work with Spanish-English bilinguals. I conclude with a discussion of the relevance of the findings for a universal human mechanism for parsing sentences.

1 Overview of Parsing Theories

Loosely speaking, there are two types of computations a parser has to perform when faced with an incoming string of words. First, it has to classify word strings in terms of structural categories. Second, it has to establish appropriate dependency relationships between these categories (Mitchell, Cuetos & Zagar, 1990). The discussion here will focus on the aspects of parsing which are responsible for determining syntactic dependencies between structural categories.

Our experience as listeners and readers tells us that the parsing process is very rapid and efficient. The parser is capable of computing the syntactic structure of sentences in a very short period of time, allowing us to determine, with much success, "who did what to whom". However, there are instances in which, for one reason or another, we experience processing difficulties. A classic example of this is given in sentence (1) below:

(1)   Molly said she will go to New Jersey yesterday.

In this case, the ambiguous constituent (*yesterday*) can be linked either to the higher clause or to the lower clause. If linked to the higher clause, the sentence means roughly that it was yesterday that Molly said that she would go to New Jersey. Linking it to the lower clause will result in the mistaken interpretation that Molly will go to New Jersey at some time in the past. For most native English readers, the tendency is to link the ambiguous constituent to the lower clause. The realization that the outcome yields an incorrect interpretation forces reanalysis.

Example (1) shows that the operations the parser follows during sentence analysis are better understood when its workings are disrupted. In other words, it is because readers erroneously interpret *yesterday* as giving additional information about the day of Molly's departure to New Jersey that we infer that the parser has made a decision to

attach the adverb to the lower clause. Structural ambiguities of the type exemplified in (1), then, offer an avenue to the study of the parsing mechanism. It is for this reason that most empirical work on parsing has centered on trying to explain the operations the parser follows when it encounters structural ambiguity.

The Garden Path Model

In order to explain how the parser computes the initial analysis of a sentence, Frazier (1978, 1987) and Frazier and Rayner (1982) have proposed a parsing model known as the *Garden Path* theory. The theory comprises a small number of structural principles, of which the two most important ones are Minimal Attachment and Late Closure, defined below:

(2)   Minimal Attachment: "Do not postulate any potential unnecessary nodes." (Frazier, 1987:562)

Minimal Attachment ensures that, when faced with an ambiguity, the parser will initially select the simplest – and therefore the quickest – structure to build. Structures (3a) and (3b) below illustrate how Minimal Attachment works:

(3)   a. [[Molly said] [she will go to New Jersey yesterday]]
      b. [Molly said [she will go to New Jersey] yesterday]

Although both (3a) and (3b) are plausible analyses for example (1) given above, Minimal Attachment predicts that the preferred analysis would be the one given in (3a), since it contains the fewest possible number of nodes.

Late Closure suggests that we "... attach new items into the clause or phrase currently being processed" (Frazier, 1987:562). This would allow incoming material to be structured more rapidly. To take an example, in the sentence *The thief killed the son of the actress who was on the balcony*, both *son* and *actress* are potential candidates for attachment of the relative clause *who was on the balcony*. Late Closure predicts that the relative clause would attach to *actress* and not to *son*, since *the actress* would be the phrase most recently postulated. This accounts for the low attachment bias found in English.

Linguistic Tuning

Until the late 1980s, the evidence available in support of universal parsing strategies came exclusively from English. To determine the veracity of the universality of parsing mechanisms, Cuetos and Mitchell (1988) conducted a study with a group of subjects other than English. They presented monolingual Spanish subjects with sentences containing a complex NP followed by a relative clause. The most frequently cited example for this type of sentence is found in (4a) below (translated in (4b)):

(4)   a. Alguien disparó contra el criado de la actriz que estaba en el balcón.
      b. Someone shot the servant of the actress who was on the balcony.

In sentences of this kind, the relative clause can modify either one of the two nouns in the complex NP. Late closure dictates that the relative clause should be associated to the phrase "currently being processed" (i.e. *of the actress*); hence, the preferred reading of this sentence should be the one where the relative clause attaches to *actress* rather than to

servant. In response to questions like *¿Quién estaba en el balcón?* ("Who was on the balcony?"), Spanish subjects showed a reliable bias for high attachment (i.e. the servant was on the balcony) over low attachment (i.e. the actress was on the balcony). On the other hand, on a comparable questionnaire, English subjects showed the conventional preference for low attachment[1] (for further detail, see Cuetos & Mitchell, 1988; Mitchell & Cuetos, 1991).

Although the questionnaire showed a clear difference between attachment preferences for the Spanish vis-à-vis the English subjects, these data were only suggestive. As Cuetos and Mitchell (1988) explained, subjects could have obeyed late closure on the first-pass reading, but then reassessed their decision before writing down their answers. Hence, they conducted a series of on-line experiments using a self-paced reading task to determine whether the off-line results could be replicated on-line. The materials – similar to those used in the questionnaires – were constructed by adding an extra phrase to the end of the sentence. A sample set is given in (5):[2]

(5) a. Alguien disparó contra el criado de la actriz/ que estaba en el balcón/ con su marido.
     [Someone shot the servant (masculine) of the actress who was on the balcony with his/her husband]
     b. Alguien disparó contra la criada de la actriz/ que estaba en el balcón/ con su marido.
     [Someone shot the servant (feminine) of the actress who was on the balcony with his/her husband]
     c. Alguien disparó contra la actriz/ que estaba en el balcón/ con su marido.
     [Someone shot the actress who was on the balcony with his/her husband]

Cuetos and Mitchell (1988) reasoned that attachment of the relative clause to *criado* in (5a) (i.e. high attachment) would result in a noticeable cost in reading time for the final clause compared to the two control conditions. Presumably, this would be caused by the oddity of having *el criado* (the male servant) being on the balcony *con su marido* (with his husband), and by the subsequent reanalysis of the sentence to reverse the initial decision on attachment. On the other hand, attachment of the relative clause to *la actriz* (i.e. low attachment) would not cause an increase in reading time.

The on-line results showed that there was no increment in reading times for conditions where there was no structural ambiguity (5c), or where both attachment sites were acceptable (5b). In contrast to this, there was a significant increment in reading time for sentences like (5a), suggesting that a conflict must have arisen in this case. On the basis of these findings, Cuetos and Mitchell (1988) argued that Spanish speakers show a genuine bias against late closure with materials of this kind and challenged the universality of late closure as a processing strategy.[3]

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[1] Although different studies seem to show, unequivocally, that Spanish speakers have a preference for high attachment when faced with ambiguous sentences of this kind, the data in English are less consistent. For a review, the reader is referred to Corley, 1995; Cuetos, Mitchell and Corley (1996); Mitchell and Brysbaert (1998).

[2] The forward slash "/" marks the end of each display.

[3] High attachment preferences have also been reported in other studies. See, for example, Carreiras (1992); Carreiras and Clifton (1993); Gilboy, Sopena, Clifton and Frazier (1995); Mitchell and

To explain their results, Cuetos and Mitchell (1988)[4] raised the possibility that early structural preferences in parsing are not resolved in a manner that is fixed, as suggested by late closure, but by the experience the individual reader or listener has with the environment. In its most general form, their proposal, dubbed *Linguistic Tuning*, states that, in the course of comprehension, the parser's initial analysis of an ambiguous structure is influenced by the reader's (or listener's) previous encounters with ambiguities of the same kind. Every time a person resolves an ambiguous sentence in a given direction successfully, the comprehension system adjusts itself to keep track of the chosen resolution. The result is that on subsequent encounters of comparable ambiguities, the syntactic processor will be more likely to choose that same resolution.

This being the case, the tuning account predicts that in cases of ambiguity, there should be a close correspondence between corpus data and behavioral data. As a test of the linguistic tuning account, Mitchell, Cuetos and Corley (1992, cited in Cuetos, Mitchell & Corley, 1996) conducted a corpus analysis of relative clause attachment in ambiguous sentences of the type *NP1 of NP2 RC*, to determine attachment preferences in discourse. Their findings revealed that in English most tokens of the ambiguity are resolved in favor of low attachment. Contrary to this, and in support of the tuning hypothesis, in Spanish the ambiguity is most often resolved in favor of high attachment.

Construal

The Construal hypothesis (Frazier & Clifton, 1996) is a radical revision of the Garden Path model, which was weakened by the main findings on parsing preferences in languages other than English. The central argument of the hypothesis is that the parser distinguishes between two types of phrases or relations: primary and nonprimary. Primary phrases involve constituents – both obligatory and optional – which are dependent on the main predicate of the sentence. The arguments of a verb like *put*, the object of optionally transitive verbs like *read* or *sing*, or the subject and predicate in a small clause complement constitute instances of primary relations. In contrast, phrases which are not required by the syntactic properties of individual lexical items are termed nonprimary phrases. Relative clauses and adjunct predicates fall under the domain of nonprimary phrases. In terms of parsing processes, the crucial difference between primary and nonprimary phrases is that primary phrases are parsed according to structural principles such as minimal attachment and late closure. Nonprimary phrases, on the other hand, are *construed* or associated with some constituent(s) within a thematic domain of the sentence, through a number of discourse and semantic operations, Gricean principles, and focus effects.

The Construal hypothesis provides an account of the differences in parsing preferences observed in *NP1 of NP2 RC* constructions. To illustrate this, take example (5a), repeated below:

(5) a. Alguien disparó contra el criado de la actriz que estaba en el balcón con su marido.

Cuetos (1991); Mitchell, Cuetos and Zagar (1990); Brysbaert and Mitchell (1996); Carreiras and Clifton (in press).

[4] See also Cuetos, Mitchell and Corley (1996); Mitchell (1994); Mitchell and Brysbaert (1998); Mitchell, Cuetos and Corley (1992).

[Someone shot the servant of the actress who was on the balcony with his/her husband]

Frazier and Clifton (1996:71-80) argue that initially the relative clause will be associated to the entire complex NP phrase, making either NP within the phrase a suitable candidate to host the relative clause. Later, discourse principles, the most important of which is Relativized Relevance (Frazier, 1990), will introduce a general bias for high attachment. Relativized Relevance directs the parser to "... preferentially construe a phrase as being relevant to the main assertion of the current sentence" (Frazier, 1990:321). In (5a) above, this would mean associating the relative clause to *el criado*. Since the principle of Relativized Relevance is assumed to be universal, English is predicted to show the same preference bias as, for example, Spanish. The fact that it doesn't is explained by the workings of an additional factor. In English, a relative clause unambiguously modifies the first noun in a complex NP of the type *NP1 of NP2 RC*, if the Saxon genitive (i.e. "the actress's servant") is used. The ambiguity arises only when the Norman genitive is employed. Frazier and Clifton (1996:80) suggest that, following Grice's maxim of manner ("avoid obscurity and avoid ambiguity"), a speaker intending association of the relative clause to *el criado* would have chosen the Saxon genitive over the Norman genitive. The fact that the Norman genitive was used instead signals to the listener/reader that the intended interpretation is one where the relative clause modifies *la actriz*.

Although this account provides a workable explanation for the prevalent finding of high attachment preferences observed in many languages as well as the idiosyncratic pattern of English, several issues remain unresolved. Since Frazier's original conceptualization of the parser made it "blind" to nonsyntactic information, it is difficult to understand how the parser is able to tell the difference between primary and nonprimary phrases. An added problem comes from the suggestion that a phrase waits (until it is "construed") to be attached, since this begs the question of what happens to such phrases in the meantime. In addition, Brysbaert and Mitchell (1996; see also Mitchell & Brysbaert, 1998) discuss evidence from Dutch which suggests the Construal hypothesis may need revision. These authors explain that Dutch is similar to English in that the Norman genitive co-exists with two other genitive forms: the Saxon form (comparable to English) and a possessive pronoun form (e.g. *vader zijn hoed*, translated as *father his hat*). As in English, the use of the Norman genitive results in an ambiguous sentence, but the use of the two other forms forces attachment of the relative clause to the second NP. Following the arguments presented above to explain the low attachment bias found in English, Dutch readers (or listeners) should interpret the speakers' choice of the Norman form as a sign that the relative clause is intended to modify the second NP. However, as it turns out, Dutch shows a preference for high attachment in constructions of the type *NP1 van NP2 RC*, both off- and on-line (Brysbaert & Mitchell, 1996).

Constraint-Satisfaction Models

The last type of theoretical account discussed here is one that, like the Linguistic Tuning hypothesis, also assigns an important role to adjustments made by the parser as it is exposed to language. The central claim of these types of models, know as Constraint-Satisfaction models (e.g. MacDonald, Pearlmutter & Seidenberg, 1994a; Trueswell & Tanenhaus, 1994), is that ambiguity and ambiguity resolution are guided by lexical information. For example, assuming the Competition Model of MacWhinney and Bates (1989), MacDonald et al. (1994a) suggest that the oddity that arises during the first-pass reading

of the sentence *The horse raced by the barn fell* occurs because the relative frequency of *raced* as a past-tense verb is much greater than that of *raced* as a past participle. When the sentence is read, both types of information become available and enter into competition, but the past-tense reading of the verb "wins", leading to the notorious garden-path effect (see MacDonald et al., pp. 141-3 for further discussion).

In the case of the attachment of a relative clause to an NP within a complex noun phrase, MacDonald, Pearlmutter and Seidenberg (1994b) suggest that cross-linguistic variation may be explained, once again, in terms of variations in lexical biases. The preference for low attachment in English could be accounted for by assuming that the noun *actress* has a stronger lexical bias to appear next to a modifier than the noun *servant* does. This information influences attachment decisions, and hence *actress* ends up being modified by the relative clause. In Spanish, the situation is assumed to be the reverse, resulting in a high attachment preference.

2 Processing Strategies in Bilinguals

The variation in parsing preferences in Spanish and English provides an ideal testing ground to investigate whether the parsing strategies employed by Spanish-English bilinguals and monolinguals differ from each other. One of the purposes of this endeavor is to address certain inherent limitations that arise from the use of monolingual participants. Thus, for example, a model such as Linguistic Tuning predicts that parsing preferences should change if, during an extended period of time, speakers are exposed to an unusual amount of one particular attachment resolution over the other. As Cuetos, Mitchell and Corley (1996) find, testing this hypothesis with monolingual speakers can prove to be ineffective. This is because outside an experimental setting, monolingual participants continue to be exposed to the attachment biases that prevail in their environment. Hence, the lack of a change in parsing preferences cannot be interpreted as disfavoring the Tuning hypothesis. This obstacle in design can be overcome with bilinguals, since depending on the discourse community that they most frequently have contact with, they may be naturally exposed to different types of biases. The result is that researchers may be better equipped to observe the impact that experience has on parsing choices, thereby testing competing parsing theories.

The first study to explicitly investigate the parsing strategies used by bilinguals when reading structures such as those we have been discussing was Fernández (1995). (See also Fernández, 1999 and in press.) The study is concerned with the long-standing problem of explaining why adult learners seem to be only partially successful in the acquisition of a second language. Fernández takes the position that language learning is driven by an innate mechanism (i.e. Universal Grammar) which is dedicated to language and operates independently of more general cognitive processes. At the core of her proposal is the idea that adults generally attain incomplete knowledge of a second language because the processing strategies specific to their L1 are not optimal to develop the underlying grammar of the target language. If parsing strategies are inadequate to process incoming language in the L2, learners may be missing input that is crucial to building the linguistic system in the second language (see also VanPatten, 1996 for a similar proposal). In this state of affairs, it becomes crucial to investigate whether adult learners process L2 input in the same way monolingual speakers of the target language do.

In order to test this hypothesis, Fernández (1995) examined the responses to ambiguous English sentences by three groups of speakers: monolingual English speakers,

early Spanish-English bilinguals (i.e. native Spanish speakers who had learned English before age 10) and L1 Spanish-English bilinguals (i.e. native Spanish speakers who had learned English after the age of 10). A questionnaire technique was used to present subjects with sentences like (6a) and (6b) below:

(6) a. Roxanne read the review of the play that was written by Diane's friend.
    b. The crowd cheered for the singer with the guitarist that was awarded a medal.

Each sentence was immediately followed by a question designed to probe the subject's preferred attachment (e.g. sentence (6a) above was followed by the question *What was written by Diane's friend?*). The questions were followed by two possible answers and subjects were asked to circle the correct answer for each question.

In (6a) there is ambiguity as to whether the relative clause (*that was written ...*) should be attached high (to *the review*) or low (to *the play*). The same is true for (6b), where the relative clause *that was awarded a medal* can modify either *singer* or *guitarist*. The difference between the two types of sentences lies in the status of the prepositional phrase within the complex NP. In sentence (6a), "of the play" is an argument to the head of the complex NP. In (6b), on the other hand, the prepositional phrase "with the guitarist" is an adjunct to the head. This linguistic difference in the materials was used to investigate whether the strategies employed to process arguments were any different from those used to process adjuncts.

Based on previous experimental findings with monolingual English speakers, Fernández (1995) predicted a preference for low attachment by the monolingual subjects. The same was expected for early bilinguals, since presumably they had learned both languages during childhood. For late bilinguals, attachment to the higher noun would indicate that they processed English input in a manner unlike that of English monolinguals. Attachment to the lower noun would indicate that they had learned the same processing strategies followed by monolinguals.

The results showed that the English monolinguals displayed the strongest preference for low attachment (73% collapsing across the two linguistic conditions), followed by the early bilingual group (49%) and then by the late bilingual group (37%). Although monolinguals were found to differ significantly from the early bilinguals, the difference between the two bilingual groups was found to be not significant. This may lead to the conclusion that both groups of bilinguals have the same attachment preferences. However, Fernández reports results which indicate that this is, in fact, not the case. Individual subject scores show that whereas the majority of the late bilinguals (11 out of 15) preferred high attachment, only about half of the early bilinguals displayed a tendency to attach high. The remaining subjects preferred low attachment, and one subject showed no preference. In addition, Fernández also reports that language proficiency seemed to be the best predictor of attachment preferences. Subjects who rated their Spanish proficiency higher than their English proficiency favored high attachment. Subjects who rated English as their dominant language tended to show a preference for low attachment. Somewhat unexpected was the correlation obtained for subjects who rated both languages equally high (approximately half of the early bilinguals). Seemingly, some preferred high attachment and others preferred low attachment. This is a somewhat surprising result. Under the assumption that this group of early bilinguals had extensive experience with English, they might be expected to employ processing strategies specific to English when processing English input.

On the basis of the findings obtained for the late bilingual group, Fernández (1995) suggested that L2 processing strategies may be hard to learn after puberty. This, in turn, may be one of the reasons leading to the irregular or incomplete attainment of a second language by adult learners. Fernández reasoned that in processing L2 input, adult learners might transfer some of their L1 processing strategies. In cases where the L1 strategies may not be suitable for assigning the appropriate structure to the L2 input, learners may end up with an incomplete (or erroneous) representation of the L2 grammar.

In a questionnaire study using *NP1 of NP2 RC* sentences, Dussias (1998) also investigated attachment preferences in Spanish-English bilinguals. The subjects in this study were divided into two groups: monolinguals and bilinguals. The monolingual group served as basis for comparison and consisted of two subgroups: Spanish and English. The bilingual group comprised three subgroups: native Spanish speakers who had learned English during adulthood (henceforth, L1 Spanish bilinguals), native English speakers who had learned Spanish also during adulthood (henceforth, L1 English bilinguals), and early bilinguals (i.e. participants who had learned Spanish and English before the age of 6).

Bilingual subjects completed a language questionnaire designed to tap into several aspects of language proficiency and use by self-report (i.e. language dominance, level of proficiency in the four language skills, and so forth). In addition, they also participated in a 20-minute face-to-face oral interview, for the purpose of determining their proficiency in the second language.[5] Interviews were carried out by native speakers of the language being tested, who were trained in the administration of the test. Only those participants who received a *superior* rating in the oral interview participated in the study.[6]

In order to test attachment preferences in English, subjects were presented with a questionnaire containing sentences like (7) (Dussias, 1998: Experiment 1):

(7) Peter fell in love with the sister of the psychologist who studied in California.

Keeping in line with the procedure followed in Cuetos and Mitchell (1988) and in subsequent work, each sentence was followed by a question and two possible answers. Thus, for example, (7) was followed by the question *Who studied in California?* Subjects were asked to circle either one of two responses (*The sister studied in California* or *The psychologist studied in California*) as the correct answer for the question.

The Late Closure principle imposes the condition that the relative clause be attached to the phrase "most recently postulated", which in this case is the NP containing the noun *psychologist*. The Construal hypothesis and the Tuning account make the same prediction, the former for reasons that have to do principally with the existence of two genitive forms (i.e. Norman and Saxon) in English and how their usage interacts with Gricean principles, and the latter for reasons related to statistical frequency.

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[5] Early bilinguals only participated in an oral interview in Spanish.
[6] Participants displayed superior command of the language if they were able to: discuss extensively, support their opinions by abstracting and hypothesizing, cope with unfamiliar situations that required use of precise vocabulary and shift of registerd, speak without patterns of errors, display richness in vocabulary, speak with minimal non-native language pronunciation. For further details on subject selection and testing procedures, the reader is referred to Dussias (under revision and submitted).

The results for the English monolinguals showed a clear preference for low attachment. (See Figure 8.1.) The mean of low attachment responses for this group of subjects was 13.74 out of a possible 16. This indicates that in approximately 86% of the cases on average, the subjects selected the lower noun (*the psychologist*) rather than the higher noun (*the sister*) as the correct answer. These results replicate attachment preferences for English monolinguals reported in Cuetos and Mitchell (1988) and Mitchell and Cuetos (1991), among others. However, it should be noted that the preference for low attachment observed in Dussias (1998) was considerably higher than that reported in previous studies. For example, Mitchell and Cuetos (1991) noted a preference for attachment to the second site of 58% (experiment 1B).[7]

Attachment preferences in English for the late bilingual groups patterned with those obtained for the English monolinguals. L1 English bilinguals opted for NP2 attachment on 72% of the trials and L1 Spanish bilinguals displayed the same attachment preference 79% of the time. Early bilinguals, on the other hand, showed a lower tendency in favor of low attachment (the second noun was chosen on 56% of the trials). This group of subjects, then, was more likely to select the higher noun as the attachment site than were the late bilinguals. Although the English monolingual group was found not to differ significantly from the late bilinguals, it did differ significantly from the early bilingual group.[8]
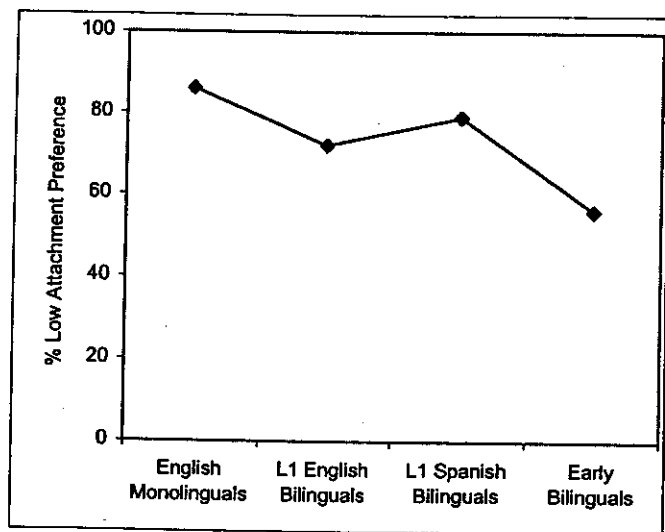

Figure 8.1. Percentage of low attachment preferences in the English questionnaire

The findings for the English questionnaire reported in Dussias (1998) confirmed only partially the attachment preferences reported in Fernández (1999 and in press). In both studies, attachment preferences for English monolinguals and early bilinguals dif-

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[7] An exception is Fernández (1995, 1999), who reports attachment preferences for English monolinguals more in line with the results reported here.
[8] For additional details, the reader is referred to Dussias (1998).

fered significantly from each other, confirming Fernández's proposal that the language histories of the two groups may impact parsing routines. However, the results for the L1 Spanish bilinguals reported in Dussias (1998) point to a low attachment bias, suggesting that parsing routines are learnable after puberty.

In order to determine whether bilinguals' parsing routines differed when processing Spanish input, Dussias (1998) conducted a second experiment in which the bilingual subjects were presented with sentences very similar to those used in Experiment 1.[9] An example is found in (8) below:

(8) Pedro se enamoró de la hija del psicólogo que estudió en California.
[Peter fell in love with the daughter of the psychologist who studied in California]

Once again, the sentence was followed by a question (e.g. *¿Quién estudió en California?*) and two possible answers. Subjects circled the choice that best answered the question. To check that Spanish readers showed the conventional bias in favor of high attachment, a Spanish monolingual group was also used in the experiment.

If the language of the input determines the parsing strategies subjects use, all three bilingual groups should show the same attachment preferences as Spanish monolinguals. However, this is not what happened. Although Spanish monolinguals gave answers indicating that they had attached the relative clause to the higher noun considerably more times than to the lower noun (74% for high attachment vs. 26% for low), Spanish bilinguals showed a marked preference for low attachment (28% for high attachment vs. 72% for low attachment). (See Figure 8.2.) The same was true for L1 English bilinguals, who, on average, preferred low attachment 56% of the time. Finally, early bilinguals were more likely to choose the higher noun as the attachment site for the relative clause (56% for high attachment vs. 44% for low attachment). Although the difference between attachment preferences for Spanish monolinguals and early bilinguals was found not to differ significantly, the difference between the preferences for the two late bilingual groups and the Spanish monolingual group was significant.

In line with the proposal put forth in Fernández (1995, 1999), language dominance appears to be one of the factors determining attachment preferences in bilinguals. Thus, for example, 11 of the 32 L1 English bilinguals that participated in Dussias (1998) indicated that their English was slightly better than their Spanish. This same group of subjects showed a preference for low attachment in both questionnaires. It appears, however, that language dominance is not the only variable influencing parsing preferences. None of the L1 Spanish bilinguals (a total of 31) indicated that their English was better, even slightly better, than their Spanish. However, a majority (23 out of 31) of the subjects displayed a clear bias for low attachment in both questionnaires. It seems, then, that for this group of subjects, day to day exposure to English may have influenced parsing strategies in Spanish. That is, experience with a preponderance of English sentences where relative clause attachments are linked to the second site may have shifted their attachment preferences in the direction of low attachment.

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[9] Although many of the materials used in Experiment 2 were literal translations of the English sentences used in Experiment 1, a small number of sentences were new. For further details, the reader is referred to Dussias (under revision and submitted).
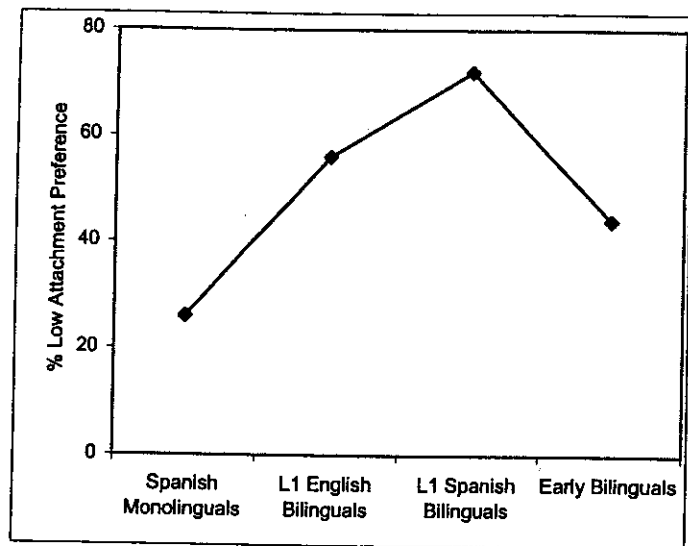
Figure 8.2. Percentage of low attachment preferences in the Spanish questionnaire

Perhaps the most interesting set of results comes from the early bilingual group. Dussias (1998) reported that, on average, the mean for high attachment responses in the Spanish questionnaire was 8.88 and in the English questionnaire 7.2 (both figures out of a possible 16). This indicates that, if there is an attachment preference for this group of subjects, it is a weak one. This finding may be expected on the account that early bilinguals are exposed to large amounts of input in both languages on a daily basis. Since both high attachment and low attachment resolutions often turn out to give correct interpretations of sentences of the form *NP1 of NP2 RC*, bilinguals experience some uncertainty when choosing the attachment site for the relative clause.

To recapitulate, the results reported in Dussias (1998) so far show that L1 Spanish and English bilinguals display a strong tendency to attach relative clauses to the second of two potential noun targets. On the other hand, the underlying bias for the early bilinguals is to associate the relative clause to the higher noun. For the three groups of subjects, parsing preferences seemed not to be constrained by the language of the input. Late bilinguals preferred low attachment and early bilinguals preferred high attachment when processing English and Spanish.

Because questionnaire data do not guarantee that the choices readers make represent actual "first pass" commitments, Dussias (under revision and submitted) conducted three additional experiments to test bilinguals' attachment preferences on-line. Unfortunately, at the time of writing, the results testing on-line attachment preferences in English were unavailable. Hence, only the on-line results for Spanish are reported.

Data were collected using a self-paced reading task. Following Cuetos and Mitchell (1988), the materials for these experiments were constructed by adding a phrase to the end of sentences similar to those used in the questionnaire study. For example, sentence (9) below was changed to (10) by adding the phrase *con su esposo* (translation given in 11):

(9) El perro mordió al cuñado de la maestra que vivió en Chile.
(10) El perro mordió al cuñado de la maestra /que vivió en Chile /con su esposo.
(11) The dog bit the brother-in-law of the teacher who lived in Chile with her husband.[10]

In (10), the final phrase *con su esposo* forces low attachment because the first N (*cuñado*) is a masculine noun and therefore not a suitable candidate for being the head of the relative clause (which also contains a masculine noun).

A variant of (10) was constructed by switching the gender of the noun in the complex NP to force attachment of the relative clause to the higher noun (as in 10b). Finally, two control sentences were added by altering the gender of the first N in the complex NP (10c, the "long" control) and by removing the first N in the complex NP (10d, the "short" control). The complete set of sentences is given below:

(10) a. El perro mordió al cuñado de la maestra /que vivió en Chile /con su esposo.
[The dog bit the brother-in-law of the teacher (feminine) who lived in Chile with his/her husband]
b. El perro mordió a la cuñada del maestro /que vivió en Chile /con su esposo.
[The dog bit the sister-in-law of the teacher (masculine) who lived in Chile with his/her husband]
c. El perro mordió a la cuñada de la maestra /que vivió en Chile /con su esposo.
[The dog bit the sister-in-law of the teacher (feminine) who lived in Chile with his/her husband]
d. El perro mordió a la maestra /que vivió en Chile /con su esposo.
[The dog bit the teacher (feminine) who lived in Chile with his/her husband]

The sentences were segmented into three displays (indicated by the forward slash). Subjects were instructed to press the space bar when they had read the first display of the sentence. When this was done, the first display was immediately replaced by the second display. Subjects continued doing this until they reached the end of the sentence.[11]

As has already been explained in the context of Cuetos and Mitchell (1988), if bilinguals use high attachment as their preferred processing routine, the display forcing resolution in favor of low attachment (i.e. the third display in 10a) should pose greater difficulty to read than the corresponding displays in the other three conditions. If, on the other hand, low attachment is the preferred strategy, the last phrase in sentence (10b) should take longer to read.

The results for the L1 Spanish bilinguals showed that the condition forcing high attachment (i.e. 10b) took significantly longer to read than the other three conditions (1660 msec. for Condition 2 versus 1534, 1411 and 1415 msec. for Conditions 1, 3 and 4, respectively. See Figure 8.3). This result replicated the questionnaire findings reported in

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[10] Unlike the English "his" and "her", the determiner "su" in Spanish is used for both males and females.
[11] For further detail on experimental materials and procedure, the reader is referred to Dussias (under revision and submitted).

Dussias (1998), and confirmed the preliminary conclusion that Ll Spanish bilinguals have changed their parsing preferences in the direction of low attachment.

Results for the Ll English group were less clear. Behavioral data from the questionnaire indicated a reliable preference for low attachment over high attachment. Hence, these bilinguals were expected to take longer to read sentence (10b) than sentence (10a). Although reading time data indicated a trend in the direction expected, the difference between the means was not significant (1538 msec. for (10a), 1592 msec. for (10b), 1510 msec. for (10c) and 1437 msec. for (10d). See Figure 8.4).
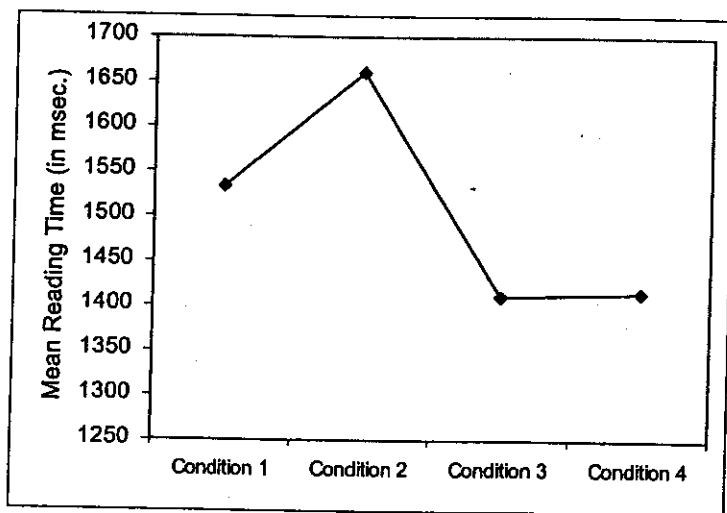

Figure 8.3. Ll Spanish bilinguals' mean reading times for the last display in each of the four conditions

Although these were not the results anticipated, a little thought suggested that this was precisely what should have been expected on the basis of the questionnaire data. That is, this group of subjects was quite heterogeneous in their questionnaire responses. Some subjects showed a preference for low attachment in both languages, others preferred high attachment, and still others parsed English sentences using English parsing strategies and Spanish sentences using Spanish parsing strategies. Given the diversity within the group, the lack of significance in reading times between the four sentence groups is not surprising. In short, though unforeseen, these results were exactly what might have been expected on the basis of the questionnaire data.
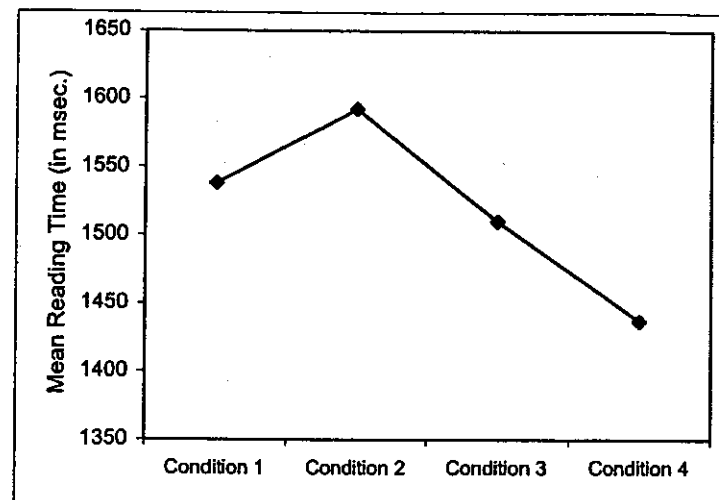
Figure 8.4. Ll English bilinguals' mean reading times for the last display in each of the four conditions

We now turn to the last set of results, the on-line results for the early bilingual group. Turning back to the percentage data from the Spanish and English questionnaires, we see that these bilinguals displayed a weak preference for high attachment in their responses. A glance at individual scores in both questionnaires revealed that most early bilinguals tended to select the first noun as the preferred attachment site in only about half out of the 16 cases (with occasional subjects selecting high attachment on 10 out of the 16 cases). Taken together, the questionnaire data suggested that if early bilinguals showed a reading time advantage for sentences forcing high attachment, it would be a marginal one.

Reading times for the four sentence types are given in Table 8.1. Table 8.1 shows that there was a tendency in favor of high attachment over low attachment. However, the difference between reading times in all four sentence types was non-significant. The fact that the early bilinguals showed no reliable preference for either attachment site is quite significant in itself. This suggests that parsing strategies are determined, at least in part, by the experience the reader has with the environment.

Table 8.1. Early bilinguals' mean reading times for the last display in each of the four conditions (msec.)

Sentence forcing low attachment	Sentence forcing high attachment	Long control	Short control
1623	1523	1592	1593

3 Evaluation of Parsing Models

Taken together, the findings reported in this paper for late bilinguals suggest that during the early stages of second language acquisition, bilinguals process L2 input by using strategies typical of their L1. This conclusion is supported by the questionnaire data reported in Fernández (1995). As the bilingual's experience with the target language increases, the strategies used to process incoming L2 input begin to shift. Ultimately, late bilinguals are able to acquire (at least some of) the processing strategies typically used in the L2. This conclusion is based on the performance of L1 Spanish bilinguals in the English questionnaire reported in Dussias (1998). Recall that this group of subjects chose the second noun as the attachment site for the relative clause on 79% of the trials. This indicates that late learners are able to process target sentences of the form NP1 of NP2 RC using the strategies specifically used by English monolinguals.

The evidence discussed here also suggests that parsing preferences in bilinguals can undergo shifts in directionality. The L1 Spanish bilinguals in Dussias (1998) showed a significant bias for low attachment over high attachment in the Spanish questionnaire data. This finding, which was completely unexpected, was also confirmed in an on-line study (Dussias, submitted). Assuming that Spanish second language learners embark on the task of language acquisition with a set of processing strategies from their L1 (i.e. a preference for high attachment), these results can be explained under the premise that daily exposure to English has shifted the attachment preferences for this group of subjects.

Results from the early bilingual group also suggest that experience with language can have an impact on parsing routines. For example, Fernández (1995, in press) discusses evidence from early bilinguals which suggests that some speakers use a single set of processing strategies regardless of the language of the input. Dussias (1998) reached the same conclusion based on questionnaire and on-line data from early Spanish-English bilinguals.

Overall, the results discussed here are difficult to explain with the Construal hypothesis. The principle of Relativized Relevance discussed in Frazier (1990) introduces a bias for high attachment by dictating that in ambiguous structures of the form NP of NP RC, the relative clause modifier should be associated with what constitutes "the main assertion of the sentence" (e.g. the first N). This is how Frazier and Clifton (1996) explain the high attachment bias found in many languages. Although the principle may be "overweighed" by other factors – grammatical and other discourse factors, as is the case in English – in Spanish, the principle is expected to apply invariably whenever the parser encounters ambiguous structures of this type. Hence, there is no a priori reason to assume that L1 Spanish bilinguals reading Spanish sentences should show a preference for low attachment. However, this is precisely what was found.

An added complication for the Construal hypothesis comes from the results obtained from early bilinguals. Questionnaire data revealed that these speakers preferred high attachment irrespective of the language they were reading. Recall, however, that Gricean principles and the presence of an alternative genitive construction in English predict a preference for low attachment. It follows that early bilinguals, taking note of the peculiarities in English, should have displayed attachment preferences in favor of the lower noun.

Like the Construal account, Constraint-Satisfaction lexicalist models face some difficulty explaining the findings reported here. Under the assumption that, say, the

word *actress* in English has a stronger "modifier-attracting" property than the word *servant*, there should be a bias in favor of low attachment if *actress* appears in the N2 position, regardless of whether it is English monolinguals or Spanish-English bilinguals who are reading the English sentence. The fact that the behavior differs for the two groups of subjects suggests that attachment preferences are not determined solely by the properties of the particular lexical items that appear in the two alternative slots (i.e. N1 and N2). In this respect, these models fall short of providing a fully predictive account of attachment phenomena.[12]

The data presented here are best explained by an exposure-based model like the Tuning theory. As explained earlier, at the core of the Tuning hypothesis is the proposal that processing decisions in comprehension reflect construction frequencies in the environment. Under the assumption that L1 Spanish bilinguals process large numbers of ambiguous English sentences (by virtue of the fact that they live in an English-speaking country where most of their daily activities involve the use of English) where the ambiguity is resolved in the direction of the lower noun, it seems reasonable to assume that when processing Spanish sentences, the frequency of the low attachment preference observed for English "outweighs" any other attachment preference records for the same type of ambiguous structure. Results for the early bilingual group could be explained in a similar fashion. When faced with ambiguous sentences in English and in Spanish, the parser computes the frequency of each syntactic ambiguity resolution it encounters for each of the language systems and ranks them. Since both high attachment and low attachment have proven to give the "best result in the past", speakers display a lack of commitment to one attachment site over the other.[13]

4 Concluding Remarks

One of the main morals of this chapter is that research investigating parsing preferences in bilinguals turns out to be highly productive. It contributes not only by deepening our understanding of the processes that govern sentence parsing in bilinguals, but, most important, it also allows us to examine under a different perspective and using a different set of data, the validity and generality of, at least some, parsing theories that have been proposed, with the purpose of formulating a theory of sentence parsing capable of accounting for monolingual as well as bilingual behavior.

The question addressed all along is the extent to which attachment preferences observed in monolinguals are similar to or different from those observed in bilinguals. With this, our intent is not to compare monolingual and bilingual performance. That bilinguals, at least a vast majority of bilinguals, display behavior unlike that of monolinguals is of little surprise if we depart from the conceptualization that the bilingual is two monolinguals in one person (Grosjean, 1989). Bilinguals may be similar to monolinguals in some respects, but they also differ in many others. Theories that conceptualize the bilingual as two monolinguals would not adequately account for the findings reported in this chapter.

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[12] There is no reason, however, why theorists of this persuasion should not formulate bilingual versions of their models. Such accounts would be very much within the spirit of Constraint-Satisfaction solutions.

[13] A recent proposal by Fodor (1998) can also be used to explain these results. For further discussion the reader is referred to Dussias (submitted).

The data reported here have given additional support to the hypothesis proposed in Cuetos and Mitchell (1988) that parsing principles are best understood as frequency-based strategies. We saw from the data obtained from L1 Spanish bilinguals and early bilinguals that exposure to different languages impacts attachment preferences.

The data presented here are only suggestive and are intended to set the ground for subsequent work examining in more detail how bilinguals' different language histories influence the strategies employed during real-time sentence comprehension. This type of research is important to advance towards a better understanding of the elements and principles that guide the comprehension mechanism in general.

Acknowledgements