The Role of L1 Verb Bias in L2 Sentence Parsing

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1. Introduction

Recent research indicates that verbal information influences the way in which syntactic structure is built during online sentence processing. Two types of verbal information that become available immediately during processing are the verb's subcategorization frame and the verb's preferences or biases (Trueswell, Tanenhaus & Kello, 1993). A verb's subcategorization frame denotes the type of complement that is permissible or required following a verb (i.e., direct object, prepositional phrase, etc.). Verb bias, however, refers to the verb's preferential subcategorization frame and plays a fundamental role in the case of verbs that subcategorize for more than one complement type.

A number of researchers have suggested that verb bias information comes into play quickly during sentence parsing and can ease the difficulty encountered during the resolution of temporary ambiguity (e.g., Garnsey, Pearlmutter, Myers & Lotocky, 1997; Wilson & Garnsey, 2001). For example, sentences in which sentential complement bias-verbs (SC-bias) were embedded in sentence complement structures were found to be easier to process than sentences in which direct object-bias verbs (DO-bias) were embedded in sentential complement structures. To illustrate in English, a sentence containing the SC-bias verb *admitted* in (1) has been found to cause less processing difficulty (as measured by reading times) than a sentence comprised of the DO-bias verb *confirmed* in (2).

(1) The ticket agent admitted the mistake might not have been caught.

(2) The CIA director confirmed the rumor could mean a security leak.

In the former case, the reader's expectations are met and the selection is confirmed as soon as the parser recognizes that the sentence construction supports the favored subcategorization. In the latter instance, however, the reader anticipates a direct object after reading the verb *confirmed* and is forced to reanalyze upon the realization that the NP *the rumor* is, in fact, the subject of the ensuing clause.

Given that information associated with verbs varies cross-linguistically (e.g., Frenck-Mestre & Pynte, 1997), the present paper examines how proficient Spanish-English bilinguals resolve the processing conflict that arises when verb bias information in one of the bilingual's languages is incongruent with verb bias information in the bilingual's other language. This question is relevant because there is compelling evidence that bilingual language comprehension involves the parallel activation of lexical information in both languages (e.g. Jared & Kroll, 2001).

The research question addressed in this study is: Does verbal information influence syntactic processing in the second language of a bilingual? Specifically, do bilinguals use the same sources of information as monolingual speakers during sentence processing, or is the parsing mechanism of bilingual speakers permeable in the sense that information in one language affects processing in the other language?

Spanish and English are examined here given that the two languages have been found to vary with respect to the biases associated with verbs used in prior research with monolingual English speakers (Cramer & Dussias, in progress). Therefore, this provides a fertile testing ground to investigate parsing preferences during second language reading, and in particular to examine whether L2 learners transfer L1 verbal information to the second language. This is an issue that only a handful of studies in the bilingual sentence parsing literature have addressed.

The present paper is organized as follows. First, we provide a brief overview of the findings in the monolingual sentence parsing literature regarding the role of verb bias information during ambiguity resolution. We then mention two theoretical explanations that account for the experimental results found in the literature, and review the extant relevant literature on the role of verbal information in second language sentence parsing. Next, we state our research questions and predictions followed by an explanation of our methods. We then present our results and, finally, we discuss our findings in the context of the current literature.

2. The role of frequency-based verbal information in monolingual English sentence parsing

Much of the discussion on sentence parsing in monolinguals centers around whether there exits a universal set of parsing strategies that is used to process different languages. Universal parsing strategies have been postulated to explain the tendency for readers and listeners to commit to one

interpretation of an ambiguous sentence at points in the sentence where two or more alternative interpretations are possible. One of the earliest models to support the view that the parser is guided by a number of universal principals was proposed by Frazier (1979; Frazier & Rayner, 1982; see Frazier & Clifton, 1996 for a radical revision of the Garden Path Model). The model, better known as the Garden Path Model, postulates that early parsing decisions are determined by a small set of fixed principles, whose function is to increase the speed and efficiency with which the syntactic representation of sentences is built during real-time processing in order to reduce computational load. One of the most important principles in the model is Minimal Attachment, which ensures that the parser constructs a syntactic analysis of a string of words using the smallest permissible number of syntactic nodes. In (1) and (2) above, the parser's initial preference should be to attach the noun phrases (NPs) following the verbs *admitted* and *confirmed* directly to the verb phrase (VP) because, given that this analysis requires the fewest nodes, it avoids the additional work involved in constructing more complex structures. According to the model, when the parser is unable to integrate new incoming material into the current syntactic tree, a revision process is initiated and a number of sources of information (among which is verb bias) come into play to constrain sentence interpretation.

Another mainstream account of syntactic processing, the constraint-based lexicalist theory, maintains that syntactic ambiguity can be reduced to lexical ambiguity (e.g., MacDonald, 1994). Proponents of constraint-based models believe that the parsing mechanism incorporates incoming words into the evolving interpretation of a sentence through the parallel activation of a verb's lexical argument structures. Upon activation, partial commitments that constrain initial parsing decisions are immediately made based on the strength and availability of probabilistic cues.

A signature empirical result taken in support of constraint-based models is the finding that verb bias information can ease the difficulty encountered during ambiguity resolution. For example, Garnsey and colleagues (Garnsey et al, 1997) found that sentences in which sentential complement-bias verbs were embedded in sentence complement structures (e.g., 'The ticket agent admitted the mistake might not have been caught') were easier to process than sentences in which direct object-bias verbs were embedded in sentence complement structures (e.g., 'The CIA director confirmed the rumor could mean a security leak'). However, recently, Frazier (1995) argued that effects similar to those reported in Garnsey et al. are not the crucial test for deciding among models, because the findings can be explained as ease of recovery from misanalysis. A more revealing test would be the opposite scenario, in which a direct object continuation turns out to be difficult to process (e.g., when a sentential complement-bias verb is embedded in a direct object structure). Modular two-stage models, such as the Garden Path model, do not predict such an effect, because the expectation that a noun following a verb is its direct object is not violated in the structure itself. Wilson and Garnsey (2001) tested this

hypothesis by crossing verb bias with sentence continuation types, such that sentential complement-bias verbs appeared in direct object continuations. Wilson and Garnsey found that verb bias had an equally strong influence in simple and complex sentences, a finding that is consistent with constraint-based lexicalist models (but see Kennison, 2001).

Returning momentarily to bilingual sentence parsing, results indicating that bilinguals use L1 verb bias information while parsing in the L2 would fit well with constraint-satisfaction models, because these models predict that the semantic, phonological, orthographic and morphological information of words in the L1, as well as information about their alternative argument structures and frequencies of occurrence, is encoded in the lexicon and is activated to differing degrees during L2 sentence parsing. In the next section, we provide a brief summary of the literature that has investigated the role of lexical information on bilingual sentence parsing.

3. The role of lexical-semantic information in bilingual language processing

A common assumption in the L2 parsing literature is that when verb meaning and argument structure in the L1 and the L2 match, speakers are not expected to show L2 parsing difficulties whose source is argument structure (but see Dussias 2001, 2003; Papadopoulou & Clahsen, 2003). This is because the transfer of L1 information onto the L2 will result in a structure that conforms to the L2 grammar. Conversely, differences between the two languages are expected to cause differences in parsing decisions. Only a handful of studies have investigated the influence of verb subcategorization information during L2 language processing. In general, these studies find that bilinguals are guided by L2 argument structure information during processing, and indeed parse sentences in the second language in accordance with the lexical constraints of that language.

In one such study, Frenck-Mestre and Pynte (1997, Experiment 2) conducted an eye-tracking experiment to investigate the processing of a class of verbs that is optionally transitive in English and obligatorily intransitive in French. The non-compulsory transitivity in English gave rise to temporary direct object/sentential complement ambiguities for English constructions but not for translation equivalents in French. The results failed to show any qualitative differences between the native and second language speakers, suggesting that learners are guided by argument structure information specific to the L2 during online sentence parsing. Additional support for the claim that L2 speakers make use of lexical-semantic information from the L2 during sentence comprehension comes from a study conducted by Juffs (1998), who examined the L2 resolution of reduced relative clause ambiguities with bilingual speakers from various L1 backgrounds. Although advanced L2 learners were unable to keep pace in terms of speed of processing with the

native speaker controls, they were able to parse target language sentences in a manner parallel to native speakers of that language.

To date, the available literature has examined how a verb's inherent subcategorization information influences L2 parsing, when this information is different in the L1 and the L2. One important question, however, is to examine whether proficient L2 learners can extract frequency-based verb bias cues from the target language input and use this information to assist in ambiguity resolution during comprehension. This is precisely the aim of the present study.

4. Present Study

This study is a preliminary analysis elaborating on past research in the monolingual domain that has examined the role of English verb bias information and L1 cues in the comprehension of direct object/sentential complement temporarily ambiguous sentences. Specifically, we ask how proficient Spanish-English bilinguals modulate the conflict between their L1 and L2 during the initial structural assignment to English sentences. Using both offline (norming task) and online (reading moving window) measures, we address the following research questions: Does verb bias information in the bilingual's L1 come into play when parsing sentences in the L2? How do bilinguals resolve the conflict that arises when verbal preferences in the L1 are at odds with verbal preferences in the L2?

Method

Participants

Participants consisted of 60 Spanish-English bilinguals between the ages of 20-26, who were students in their second or third year of study in the translation and interpretation program at the *Universidad de Granada* in Granada, Spain. The Spanish-English bilinguals voluntarily participated in the study for payment. All were native speakers of Spanish and had passed the University of Cambridge Certificate of Proficiency in English. In addition, none of the participants had lived in an English immersion environment for more than 6 months. The bilingual subjects also performed an offline sentence completion norming task, comprised of 130 English verbs, to assess whether the bilingual population had learned English verb bias information. In addition to the bilingual participants, 100 monolingual Spanish speakers participated in a similar norming task with the translated Spanish equivalents of the 130 English verbs.

Materials & Design

Norming Task. Monolingual Spanish speakers and Spanish-English bilinguals were given a paper and pencil task, which consisted of a

questionnaire that instructed them to provide the sentence continuation for a proper noun followed by a verb. All participants saw 65 verbs, exactly half of the total 130 verbs in the norming study. Each bilingual participant was given two of ten distinct versions of the English questionnaire. Spanish monolingual participants completed two of six different versions of the Spanish questionnaire.

On-line Task. The experimental stimuli consisted of 40 English verbs, 20 DO-bias and 20 SC-bias. The two sets of verbs were matched in length and frequency. Verb bias information was taken from previously published English norms (Wilson & Garnsey, 2001). All forty verbs were embedded in three sentence types: sentential complement continuation (ambiguous), sentential complement continuation (unambiguous) and direct object continuation. Three 202-item pseudo-randomized lists were created, each containing 78 experimental sentences, 114 filler items and 10 practice items. Each verb was repeated twice during a list, except for two verbs, that only appeared once. The presentation was counterbalanced so that each verb appeared once in a direct object continuation and once in a sentential complement continuation. Each presentation of a particular verb contained a different subject and post-verbal noun. Comprehension questions were constructed for each experimental, filler, and practice item. All participants viewed six distinct experimental sentence types. A sample of each condition is provided in (4)-(9).

(4) SC-bias/SC cont. ambiguous: The ticket agent admitted the mistake <u>might not</u> have been caught.

(5) SC-bias/SC cont. unambiguous: The ticket agent admitted that the mistake <u>might not</u> have been caught.

(6) DO-bias/ SC cont. ambiguous: The CIA director confirmed the rumor <u>could mean</u> a security leak.

(7) DO-bias/ SC cont. unambiguous: The CIA director confirmed that the rumor <u>could mean</u> a security leak.

(8) SC-bias/DO cont. The ticket agent admitted the mistake <u>when he</u> got caught.

(9) DO-bias/DO cont. The CIA director confirmed the rumor <u>when he</u> testified before Congress.

As hinted in Section 2, according to two-stage models, such as the Garden Path Model, the only information that is <u>initially</u> used in interpreting sentences like those in (4-9) above is that *admitted* and *confirmed* are verbs and *mistake* and *rumor* are nouns. Because the simplest interpretation of a noun following a verb is as the verb's direct object, bilinguals should show an equal amount of difficulty at the disambiguating region in (4) and (6), as compared to (5) and (7). This is so because the correct reading requires, instead, that the noun phrase following the verb be interpreted as the grammatical subject of the embedded clause. In addition, bilinguals are not expected to slow down at the disambiguating region when the direct object continuation follows a verb (e.g., in (8) and (9) above), but are expected to be slower when the sentential complement continuation follows a verb (as in (4) and (6)). Conversely, if experience with how particular words are most likely to be used constitutes one important source of evidence, as argued by constraint-based lexicalist models, Spanish-English bilinguals are expected to show a behavior consistent with biases associated with the L1 or the L2, depending on whether they have learned the relevant information in their second language and can access it during online sentence processing.

Procedure

The stimuli were displayed using a non-cumulative reading moving window technique (Just, Carpenter, & Woolley, 1982). Participants were informed that for each trial, they would see discontinued lines representing each word of the sentence. Each click of the space bar would change a line into the next word and would make the previous word disappear. Each word appeared in its corresponding position within the sentence, while the position of all previous and subsequent words remained indicated on the screen by the place-holding dashes. On each trial, a fixation sign (+) was presented at the center of the computer screen. At the press of the space bar, the fixation sign was replaced with the first word. Participants were informed that their task was to read each word silently and to press the spacebar to display each consecutive word on the screen. One example was given in the instructions. The time between the appearance of each word and the press of the space bar was recorded. When participants reached the end of each sentence, they were asked to answer a comprehension question, by pressing a YES or a NO button accordingly.

5. Results

Analyses were run for the disambiguating sentence region, which is underlined and indicated above in (4) through (9). All experimental items were controlled so both the temporarily ambiguous NP region (*mistake/rumor*) and the disambiguating region consisted of two words each. As is procedurally done for moving window experiments, reading times followed by incorrect

responses to the comprehension questions were excluded from statistical analysis. Furthermore, prior to data analyses, reading times per word below 200 ms or above 2000 ms were eliminated. No additional data trimming was performed.

To address our research questions, three factors were examined: verb bias (DO-bias vs. SC-bias), ambiguity (ambiguous vs. unambiguous) and sentence continuation (direct object continuation vs. sentential complement continuation). Due to the necessary incomplete crossing of the experimental design, two 2x2 analyses of variance (ANOVAs) were run. The first 2x2 ANOVA crossed verb bias with ambiguity (+/-that) and examined the effect of verb bias in sentences containing sentential complement continuations. The second 2x2 ANOVA crossed verb bias with sentence continuation in order to investigate the effect of verb bias in temporarily ambiguous sentences contrasting direct object and sentential complement sentence continuations. All variables for the subject analyses reported herein are treated as within-subjects factors. Item analyses were also conducted, while treating bias as a between-subjects factor.

Because it is at the disambiguating region where participants will detect that they have mis-parsed a particular sentence, only results from this region are reported. In the first 2x2 ANOVA (illustrated in Figure 1), there was a main effect of ambiguity $F(1,59) = 15.90$, $p < .01$. Thus, ambiguous constructions were read significantly slower than unambiguous constructions.
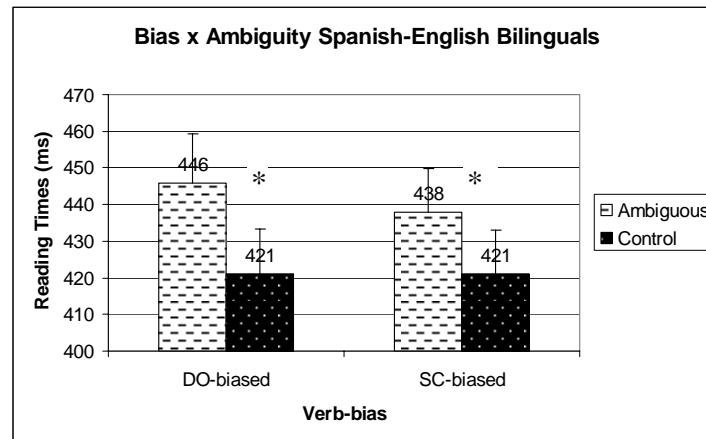

Bias x Ambiguity Spanish-English Bilinguals

Figure 1: Reading times at the disambiguating region (bias x ambiguity)

The ambiguity effect (i.e., the difference between the ambiguous minus the unambiguous control) was larger in sentences with DO-bias verbs (25 msec) than it was for sentences with SC-bias verbs (17 msec). Pairwise comparisons demonstrated that the difference between the two means for DO-bias verbs

was statistically significant (t (59) = 3.59, p = .001) and statistically reliable for SC-bias verbs (t (59) = 1.99, p =. 050).

The second 2x2 ANOVA (illustrated in Figure 2) tested the effect of verb bias in sentences containing both sentential complement and direct object continuations. There were neither effects of verb bias nor sentence continuation type in this analysis ($F < 1$); however there was a reliable interaction between verb bias and sentence continuation F (1,59) = 5.48, p <.05. Pairwise comparisons confirmed that this interaction effect came entirely from sentences with DO-bias verbs (t (59) = 2.48, p =. 016). The difference between the two means for the SC-bias verbs (t (59) = -1.03, p =. 309) was not significant. These findings suggest that highly proficient Spanish-English bilinguals process sentences containing direct object/sentential complement ambiguities differently from monolingual English speakers. In the final section, we discuss the extent to which Spanish-English bilinguals transfer L1 parsing strategies to the L2, while weighing mainstream parsing theories against the bilingual data.
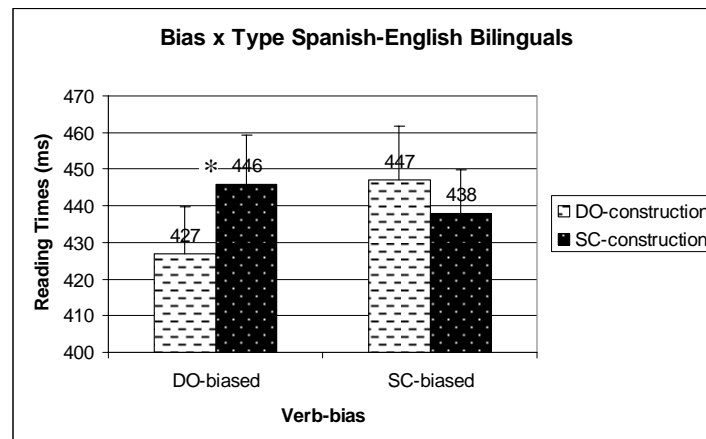

Figure 2: Reading times at the disambiguating region (bias x cont.)

6. Discussion

In this study, we set out to examine whether bilinguals adopt a strategy of building the simplest syntactic structure while reading sentences in their second language, as would be predicted by syntax-first accounts such as the Garden Path Model, or whether verbal information in the bilinguals' languages plays a role. The analysis assessing the effect of verb bias and ambiguity suggests that bilingual speakers assign a direct object interpretation to the noun following the verb, resulting in the failure to produce an interaction between these two factors. Although at first glance this finding is consistent

with the predictions made by the Garden Path Model, this explanation is unlikely when considering the results from the second analysis (i.e., bias x continuation). Contrary to the predictions made by the Garden Path Model, there was a numerical cost when a direct object continuation appeared after a SC-bias verb; the opposite pattern was true for sentential complement continuations, which were read more slowly after DO-bias verbs. As noted earlier, however, the interaction between verb bias and continuation type was not significant. Why might this be the case?

One possibility is that the bilinguals' prior experience with both the L1 *and* the L2 is guiding the interpretation of these sentences. As illustrated in Figure 3, a look at the offline norming data indicates that of the 20 verbs classified by monolingual English speakers in Wilson and Garnsey (2001) as DO-bias, roughly half of their translation equivalents were classified as such by monolingual Spanish speakers. The Spanish-English bilinguals, however, categorized 17 out of 20 of these verbs as DO-bias in English. This suggests that overall, the bilinguals had learned the English biases for these verbs, which accounts for the significant reading time difference obtained when direct object- bias verbs appeared with different continuation types.
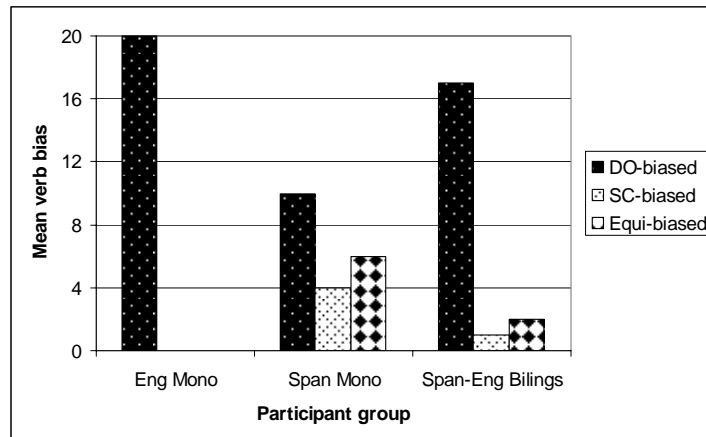

Figure 3: Norming results for English DO-bias verbs

On the other hand, the offline norming data indicate that for the 20 verbs categorized as SC-bias in English (Figure 4), only 9 were classified as such by the Spanish-English bilinguals. The rest were used at least twice as often with a direct object as with a sentential complement, or were followed equally by direct objects and sentential complements (i.e., the so-called *equi-bias* verbs). This indicates that reading times for constructions containing SC-bias verbs reflect the joint contribution of Spanish and English verbal information. The critical test to confirm this hypothesis is to conduct an analysis that includes

only those SC-bias verbs whose English biases have been acquired by the bilingual speakers. If the lack of a significant interaction between bias and continuation type is due to the transfer of verb bias information from the L1 in addition to the implementation of verb bias cues specific to the L2, this interaction should emerge once the L1 information is removed (Dussias & Cramer, in progress).
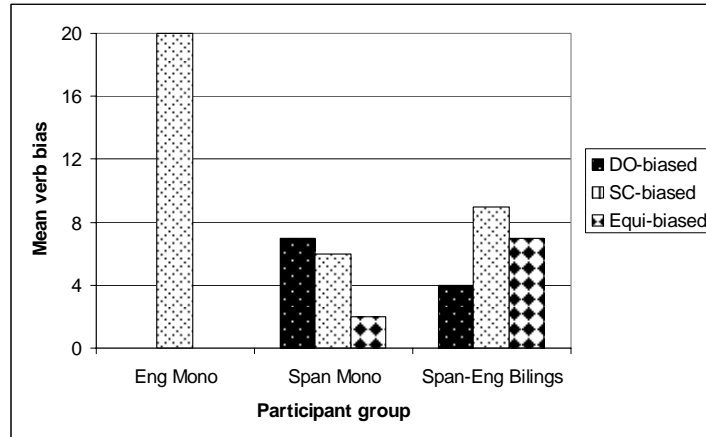

Figure 4: Norming results for English SC-bias verbs

The results of the present study demonstrate that L2 learners are able to extract subtle information from the input, such as the statistical frequencies with which verbs are used with different subcategorization frames. In addition, these data also suggest that in the absence of information specific to the L2, parsing in a second language is not guided by universal principles such as minimal attachment; instead, L1 information comes into play when assigning structure to an incoming string of words. A model such as the one proposed by constraint-based lexicalist theorists, which incorporates statistical frequency as an important variable within the cognitive architecture, can best account for the phenomena reported here. This model can also account for a number of findings stemming from the bilingual sentence parsing literature that have shown clear effects of exposure on the development of parsing strategies (e.g., Frenck-Mestre, 2005).

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