When Translation Makes the Difference: Sentence Processing in Reading and Translation

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In two experiments we compared normal reading and reading for translation of object relative sentences presented word-by-word. In Experiment 1, professional translators were asked either to read and repeat Spanish sentences, or to read and translate them into English. In addition, we manipulated the availability of pragmatic information given in the sentences. In Experiment 2, we reversed the source language and translators were instructed to read and repeat English sentences or to read and translate them into Spanish. Compared to normal reading, in both experiments, on-line comprehension was slower under reading for translation, showing that sentence comprehension varies depending on the goal of the reading. Pragmatic cues facilitated on-line comprehension only when Spanish was used as input, indicating an asymmetrical use of pragmatic information induced by the source language. Results agreed with a horizontal perspective of the translation task.

Language comprehension includes a set of processes going from speech processing (segmentation and classification of the incoming input), lexical access (recognition of isolated words and access to information associated with them), and sentential processing (extraction and combination of syntactic information to obtain a sentence interpretation), to discourse processing (integration and interpretation of successive sentences to arrive at a global mental representation). All of these comprehension processes are involved during both normal reading and translation. Theories of translation point out the importance of comprehension processes in the translation task (e.g., Dillinger, 1994; Isham, 1994). An example of this is the fact that interpreters do not produce their output instantaneously. Rather, they wait to produce their translation until sufficient information has been comprehended

to form a meaningful unit (Cokey, 1986; Gerver, 1976; Goldman-Eisler, 1972).

Beyond comprehension processes, translation from a Source Language (SL) to a Target Language (TL) involves an additional set of cognitive operations[1]. In addition to SL comprehension, translators have to perform code-switching processes between the two languages, and produce the output in the target language.

However, despite the fact that theorists in translation agree about the existence of these three sets of processes (comprehension, code-switching and TL production), there are two conflicting views regarding the way to articulate these operations in recoding from one linguistic code to another. From a *vertical perspective* in translation, Seleskovitch (1976) formalised the "deverbalization" theory stating that translation involves, first, the processing of an input language to obtain a representation of the discourse in the source language and, at the same time, the loss of the specific linguistic form in which SL was presented. Second, *after* comprehension processes are finished, the message is restructured according to the constraints imposed by the target language grammar. Thus, from this perspective, comprehension and recoding are performed in a sequential order with no direct links between SL and TL at the lexical/syntactic levels of analysis (see Figure 1). On the other hand, from the *horizontal view*, translation includes direct processes of recoding from one linguistic code to another. Translator may engage in partial reformulation processes while reading the source text. Thus, they may establish semantic matches between the lexical and syntactic entries in the two languages involved (Gerver, 1976; see Danks & Griffin, 1997, for a similar approach) while they are reading and comprehending the source text. Thus, from this perspective, code-switch proceeds *before* SL comprehension has been completed (see Figure 2).

Some predictions derive from these two perspectives. According to the vertical perspective there should not be any transfer between the grammatical properties of SL and TL because the "deverbalization" of the message was previous to TL access. In contrast, from the horizontal view, processing of TL should influence SL comprehension processes because of the direct connections between the two language representations, which are active during SL processing. Little experimental evidence, however, has been offered to empirically test these two views of translation; most of the literature has been either theoretical or descriptive in nature (e.g., Gran & Dodds, 1989). However, some related works from bilingual studies seem to support the horizontal perspective in translation (see Brauer, 1998; Forster & Jiang, 2001, for two recent reviews). Miller and Kroll (2002, Experiment 1) used a stroop-type interference paradigm in a word translation task. Spanish/English bilinguals were instructed to ignore a distractor word while translating a L1

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[1] The distinction between Source Language (SL) and Target Language (TL) is based on the language in which the input message (text, sentences or words) is presented. By contrast, the L1 and L2 distinction is based on the language spoken by bilinguals, L1 referring to the native language and L2 to the foreign learned language.

target word. Distractor words were presented in the L2 language and were related to the meaning or to the lexical form of the L1 word to translate. They found significant effects of the distractor on translation performance, demonstrating that access to L2 language occurs early in translation. In addition, they obtained an asymmetry in the effects depending on the direction of the translation: it took a longer time to translate from L1 into L2 than from L2 into L1. They interpreted this asymmetry as implying that L1 to L2 translation (forward translation) requires conceptual access, while L2 to L1 translation (backward translation) can be accomplished on the basis of lexical associations between the L2 and L1 languages. Thus, studies from the bilingual field seem to corroborate the horizontal view of translation; effects of TL language proceed early during comprehension of SL language. However, data from bilingual experiments have mainly focused at the level of single words and concepts, and little has been done to explain sentence or discourse processing in translation (but see Dussias, 2001).

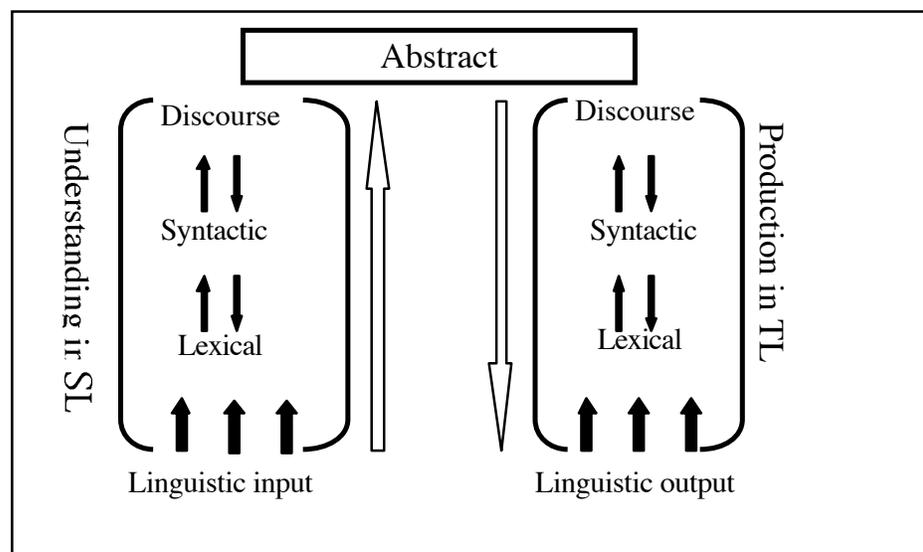**Figure 1. Secuence of processes involved in translation: Vertical approach. LF: Source Language, LM: Target Language.**

In this paper we focus on sentence comprehension during normal reading and translation. In addition, we contrast the horizontal vs. vertical view of translation processes by considering the cognitive demands imposed on Working Memory (WM) during normal reading and translation.
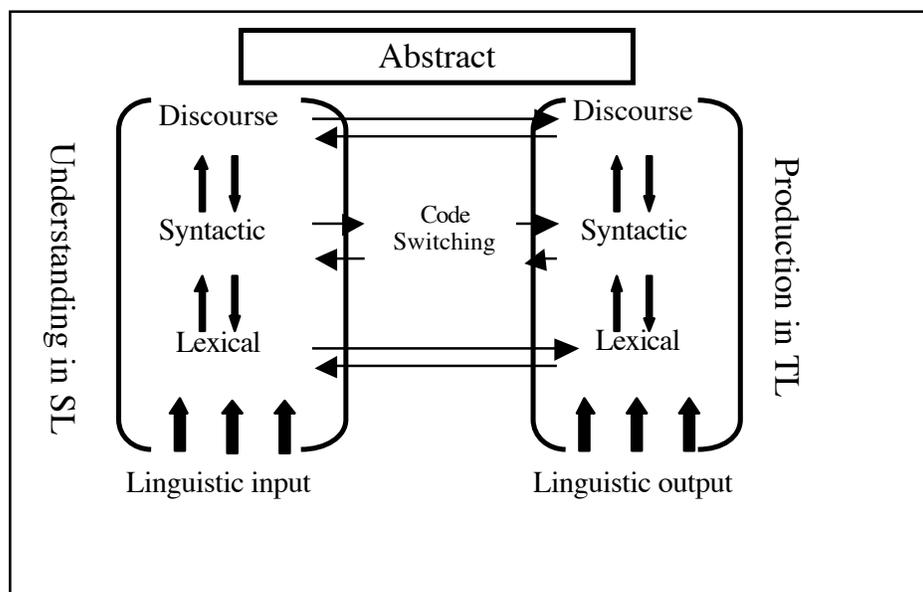
Figure 2. Secuence of processes involved in translation: Horizontal approach. LF: Source Language, LM: Target Language.

     Virtually all models of monolingual language comprehension assume some type of processing limits (Caplan, 1992; Gernsbacher, 1990; Just & Carpenter, 1992; Martin, 1993; Perfetti, 1994). Moreover, the importance that WM plays in SL reading for comprehension has been widely demonstrated. Daneman and Merikle (1996), in a meta-analysis of 77 studies, showed that measures that place simultaneous demands on processing and storage (e.g., scores in the Reading Span Test) correlate well with individual's language comprehension performance (measured with SAT and Nelson-Denny Reading Test). WM constraints in language processing have been shown at several levels of SL language perception, such as lexical access of isolated words (Perfetti, 1994), resolution of lexical ambiguity (Miyake, Just, & Carpenter, 1994), parsing of syntactically complex structures (King & Just, 1991), and access to the meaning of sentences (Van Petten, Weckerly, McIsaac, & Kutas, 1997). However, WM constraints in SL reading comprehension do not manifest themselves in a broad fashion; differences in understanding based on individual WM capacities are most clearly seen when the task imposes heavy demands on WM. For example, King and Just (1991, Experiment 1) found that on-line comprehension did not show much difference between high- and low-capacity participants for subject relative sentences, however on-line comprehension was slower for low-capacity participants when reading object relative sentences.

Besides the importance of Working Memory in monolingual language comprehension, the role of WM has been pointed out from the area of simultaneous interpreting and translation (Bajo, Padilla, & Padilla, 2000; Gile, 1997), bilingualism studies (Kroll, Michael, Tokowicz, & Dufuor, 2002; Kroll & Tokowicz, 2001; Ransdell & Arecco, 2001), and second language acquisition (Gathercole & Thorn, 1998; MacWhinney, 1997; Miyake & Friedman, 1998). For example, Miyake and Friedman showed a positive correlation between TL syntactic comprehension and the L1 reading span of a group of native speakers of Japanese who had studied English as their L2 language (but see De Vega, Cuetos, Domínguez, & Estévez, 1999).

Returning to the horizontal vs. vertical perspectives in translation, different predictions are derived regarding the WM demands imposed in normal reading and translation. From the vertical view (Seleskovitch, 1976), SL comprehension plays the central role in translation and there is no parallel access to TL while perceiving the source language. Because the processes of linguistic recoding are minimal and they proceed after translators have extracted the SL message, normal reading and reading for translation should impose similar demands on WM. Reformulation would not add additional demands on WM during SL comprehension for later translation. In contrast, from the horizontal view, partial reformulation processes take place during SL reading. These processes would consume WM resources that would add to the resources needed for normal comprehension. Hence, reading processes would be harder in reading for translation because of the added demands on WM. The increase in cognitive load would be particularly high in situations in which comprehension is hard because of the difficulty of the source input language.

In the two experiments reported here, we evaluate these hypotheses as they apply to sentence processing. A group of native Spanish speakers, Spanish/English translators were asked either to read and repeat a set of object relative sentences or to read and translate them. We selected sentences with this type of opaque syntactic structure because, as we pointed out above, differences based on WM demands have been more apparent when complex source inputs have been used (Miyake & Friedman, 1998). Object relative sentences are especially difficult because the reader cannot assign syntactic roles until the subordinate verb appears in the sentence. For example, consider the following relative clause sentences:

The judge that interviewed the reporter dismissed the charge at the end of the hearing. (Subject relative sentence).

The judge that the reporter interviewed dismissed the charge at the end of the hearing. (Object relative sentence).

In the subject relative version of the example, the role assignments to the two actors of the sentence (*judge* and *reporter*) can be made on-line during reading when they are encountered. In contrast, in the object relative sentence, the reader cannot assign a thematic role to either *the judge* or *the reporter* until the verb *interviewed* is encountered. Thus, in an object relative sentence, the increased processing demands on WM manifest themselves when the

reader reaches the first verb (the relative clause verb, *interviewed*). At this point, the first noun (*judge*) must be assigned to the thematic role of patient and the second noun (*reporter*) must be assigned to the thematic role of agent of the relative clause.

Hence, according to the horizontal view of translation, although normal reading and reading for translation would involve similar comprehension processes, parallel code-switching processes would increase WM requirements when reading for translation. This increase in demands will produce slower on-line comprehension for the relative clause sentences, especially at the point where the relative clause verb is encountered and role assignment has to be performed. Hence, in the experiments we would expect that the difference between normal reading and translation would be larger in the more demanding regions of the sentences. In contrast, according to the vertical view of translation, no differences between normal reading and translation should be expected since code switching does not proceed until the sentence has been understood.

In addition, across experiments we analysed the effect of the direction of the translation. As we mentioned, bilingualism studies have shown that L2 to L1 translation proceeds faster than from L1 to L2 (Kroll & Stewart, 1994; Miller & Kroll, 2002; Sánchez-Casas, Davis, & García-Albea, 1992). For example, the Revised Hierarchical Model (RHM) proposed by Kroll and Stewart includes independent lexical representations for each language, and a shared conceptual representation. The model assumes that (1) words in L1 can more readily access their meanings than words in L2, (2) lexical representations in L2 are strongly associated to their translations in L1. Thus, the model assumes asymmetric connections in two ways. At the lexical level, L2 words are more strongly associated to their L1 translations than the reverse. At the conceptual level, L1 words have stronger connections to meaning than their L2 counterparts (Kroll and Dussias, in press).

The RHM model proposes that translation from L1 to L2 is more likely to be engaged in a time consuming conceptual processing than translation from L2 to L1, and thus the latter type of translation should be faster and less sensitive to the effect of semantic factors than the former (Kroll & Stewart, 1994). However, the direction of the translation has not been well investigated at higher levels of processing such as sentence processing. In order to explore the asymmetry in sentence comprehension and translation we first evaluated reading and translation from Spanish to English (Experiment 1). In Experiment 2 we reversed the direction of translation and participants read sentences either to repeat them or to translate them from English to Spanish[2]. In both experiments we manipulated the availability of pragmatic

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[2]   All participants in our experiments were native Spanish speakers fluent in English as their second language (thus, their L1 was Spanish and their L2 English). In Experiment 1 we explored forward translation because the source language was Spanish, the same language that the participant's L1. Changing the source language to English in Experiment 2, we were able to investigate backward translation from L2 to L1.

information. There were four different conditions: both verbs were pragmatically biased, only the relative clause verb was biased, only the main clause verb was biased, or neither verb was biased. When we refer to pragmatic information, we are not establishing equivalences between pragmatic content and semantic content. Instead, we consider that the kind of pragmatic knowledge that we manipulated in our experiments (the relation between verbs in the sentences and the more probable actor who could cause the action described by that verb), can be represented in a conceptual frame like the frame structures proposed by Barsalou (e.g., 1992). For example, in a conceptual frame for the verb *prescribe* (included in the material set of the experiments), we should include attributes like *doctor* and *medication*, and the links between the verb and these attributes should be labelled as *agent* and *object* respectively (see Barsalou, 1992, p. 159, for additional examples). If conceptual mediation is more heavily involved in forward translation (L1 to L2) than in backward translation (L2 to L1), participants use of pragmatic cues should be more evident in Experiment 1 than in Experiment 2.

EXPERIMENT 1

In Experiment 1, Spanish sentences were presented word-by-word and translators were asked to *first* read and *then* repeat them in Spanish or to *first* read and *then* translate them into English. After repeating or translating, a sentence was presented and participants had to verify if its meanings were congruent with the meaning of the sentence they had just read. In addition, we manipulated the degree of pragmatic information provided by the sentences. We explored two main hypotheses. First, if the vertical view of translation is correct, we should not find differences between reading for repetition and reading for translation. Otherwise, results would support a horizontal perspective in translation. Thus, reading for translation would be slower than reading for repetition. This increment in reading times when participants are asked to later translate the sentences should be more evident in the more demanding regions of the sentences. Secondly, if there is an asymmetry in the direction of the translation, and forward translation (L1 to L2) is more likely to be involved in conceptual processing, we should find an effect of pragmatic cues in this experiment.

METHOD

Participants. Eight professional translators participated in the experiment. They were paid for their participation. They were experienced translators and/or interpreters (i.e., They had worked as translators for more than two years). All of them were Spanish/English bilinguals (with Spanish as their L1 language) and they had high fluency in both languages.

As we mentioned, WM capacity has been associated with many processes involved in comprehension and translation, and therefore it was of interest to estimate the memory span of our participants. Hence, before

performing the actual experiments, the participants were asked to perform the Reading Span test (Daneman & Carpenter, 1980). Phrase sets were presented to the participants. They were instructed to read each sentence and to recall the last word of each sentence. The number of sentences in the set was increased gradually from two to six. The size of the set of phrases in which all last words were recalled correctly represented the participant's memory span. The mean span for the total set of participants was 3.93. Following criteria used by other authors (e.g., Miyake et al., 1994), our participants were considered as having a high span score (reading span scores higher than 3.5).

Design and Materials. The experimental design conformed a 2 x 2 x 4 within participants model. Type of Reading (reading for comprehension vs. reading for translation), Type of Pragmatic Cues (both verbs, relative clause verb, main verb and neither verbs) and Region of the Sentence (initial area, the relative clause ending, the main verb, and the final area) were manipulated.

A total of 32 experimental Spanish sentences, translated from King and Just (1991) were selected (see Appendix 1). All the sentences were from 11 to 17 words in length. Each sentence contained a reversible relative clause, so that the correct and the reversed versions were appropriate in the context of the sentence. Eighteen transitive verbs that took animated subjects and objects were each used twice in the embedded relative clauses. An example of an experimental sentence is (English translation is given in bracket):

(1) El juez que el periodista entrevistó dejó el cargo después de la audiencia. [*The judge that the reporter interviewed dismissed the charge at the end of the hearing*.]

Each experimental sentence consisted of four parts: (1) The initial region, containing all the words preceding the relative clause verb (*The judge that the reporter*); (2) The relative clause verb (*interviewed*); (3) The main verb (*dismissed*); (4) The final area, a prepositional or adverbial phrase corresponding to the end of the sentence (*the charge at the end of the hearing*).

The thirty-two experimental sentences were divided into four blocks of eight sentences according to the pragmatic cues for both verbs, relative clause verb, main verb or neither verb. The sentences given below are examples of the four conditions: (a) both verbs were pragmatically biased, (b) only the relative clause verb was biased, (c) only the main clause verb was biased, (d) neither verb was biased:

(a) *The judge that the reporter interviewed dismissed the charge at the end of the hearing*. (both verbs)

(b) *The judge that the reporter interviewed drove the sports car through the tiny village*. (relative verb)

(c) *The judge that the reporter admired dismissed the charge at the end of the hearing*. (main verb)

(d) *The judge that the reporter admired drove the sports car through the tiny village*. (neither verb)

Sixty-four additional sentences were included as fillers. Experimental and filler sentences were mixed and presented randomised. Filler sentences were similar to the experimental set in length and semantic content. Filler sentences not containing object relative clauses were constructed. They had a similar level of difficulty as the experimental sentences. One example of this type of sentence is:

(2) El investigador mezcló los materiales líquidos en el tubo de ensayo del laboratorio.[*The researcher mixed the liquid materials inside the test tube of the laboratory.*]

To force participants to engage in comprehension processes, all the experimental and filler trials included a verification task regarding the meaning of the sentences. In the experimental sentences, a comprehension test was constructed by combining one of the two verbs in the sentence with the two actors of the sentence. Possible comprehension targets for the experimental sentence (1) would include any of these possibilities:

(1) *The judge that the reporter interviewed dismissed the charge at the end…*

_*The judge interviewed the reporter*. (False)

_*The reporter interviewed the judge*. (True)

_*The judge dismissed the charge*. (True)

_*The reporter dismissed the charge*. (False)

The number of true and false comprehension tests for each given sentence was balanced across participants, and there were equal number of "true" and "false" items in each condition. Verification sentences in fillers often tested for information that was not explicitly given in order to discourage participants from using an artificial reading strategy.

Procedure. The 32 experimental sentences and 64 fillers sentences appeared word-by-word in the middle of a computer screen (Just, Carpenter, & Woolley, 1982). Participants read at their own pace by pressing the spacebar key every time that they wanted to see a new word. The time between consecutive key presses was taken as an index of the processing time for the displayed word.

Before starting the experiment, participants were told that they had to read and understand each Spanish sentence, then they were given instructions to either repeat in Spanish or translate the sentences into English. Finally they were informed about the comprehension test.

Each trial started with a fixation point (a row of asterisks) followed by the word-by-word sentence. Right after the last word of the sentence, the message "repeat" or "translate" appeared in the middle of the screen. Once participants had finished the repetition/translation task, they had to press a key and the message "verification" appeared followed by a verification sentence. This sentence (written in Spanish) stayed on the screen until the true/false response was made. A new trial started after a 10 sec interval. Participants

were told to favour accuracy over speed in their responses to the probe. A single experimental session took approximately 45-60 min, including the twelve practice trials (with a different set of sentences and test probes) preceding the experiment.

The experiment consisted of two blocks of 48 sentences. In each block, 16 of the trials were experimental sentences and 32 of the trials were filler sentences. Each block contained an equal number of experimental sentences in each level of the pragmatic cue variable. In one block, participants were instructed to read and understand each Spanish sentence and to repeat it after finishing reading, in the other, they were instructed to read and understand and then to translate it into English. Instructions to repeat or to translate were displayed right at the beginning of the block. The order of the two blocks was balanced across participants. The order of the sentences within each block was randomised for each participant.

RESULTS AND DISCUSSION

On-line comprehension was measured by recording the word reading times across all the sentences. Because of the theoretical interest of the word position into each sentence, in each of the experimental conditions, the mean reading time per word was calculated for the four areas of the sentences, initial area, the relative clause ending (the verb of the relative clause), the main verb, and the final area. Although, different regions were composed of different number of words, the reading times of the words within a region were averaged to obtain a single score for each region. For the analysis of the reading times, all observations that were 2.5 standard deviations above the mean for each condition were substituted by the mean for this condition (less than 2.73% of the total). Global comprehension of the sentences was analysed by looking at the accuracy of the responses in the verification task. For the analyses of both reading times and accuracy on the verification task, two ANOVAs were performed, one with participants as the random variable (F_1), and another with items as the random variable (F_2).

On-line Comprehension

The analyses performed on the reading times indicated that there were significant differences in reading times depending on the type of reading for both participants [$F_1(2, 7) = 16.16$, $MS_e = 1262,474.75$, $p < .005$] and items [$F_2(1, 27) = 137.31$, $MS_e = 122,160.73$, $p < .001$]. When participants had to read SL sentences and translate them to TL, reading times were longer (1,427 ms) than those for the reading and repeating condition (862 ms). In addition, there were significant differences in reading times depending on the area of the sentence by participants [$F_1(3, 21) = 28.09$, $MS_e = 871,327.25$, $p < .001$] and items [$F_2(3, 81) = 80.26$, $MS_e = 287,073.94$, $p < .001$]. Moreover, the interaction between region of the sentence and type of reading was reliable for both participants [$F_1(3, 21) = 10.25$, $MS_e = 568,684.36$, $p < .001$] and items [$F_2(3, 81) = 20.62$, $MS_e = 247,755.87$, $p < .001$]. Planned comparisons

showed that reading times on the three first regions of the sentences were reliably longer in reading for translation than in reading for understanding. Although it was a small difference, reading for translation was reliably slower (135 ms) than reading for understanding in the first area for both participants $[F_1(1, 7) = 5.66, MS_e = 51,718.55, p < .04]$ and items $[F_2(1, 27) = 7.87, MS_e = 32,376.48, p < .009]$. At the same time, that effect was reliable in the clause verb region for both participants $[F_1(1, 7) = 14.35, MS_e = 2247,857.50, p < .006]$ and items $[F_2(1, 27) = 64,06, MS_e = 438,177.66, p < .001]$. The effect was again significant in the main verb area for both participants $[F_1(1, 7) = 9.90, MS_e = 506,266.34, p < .01]$ and items $[F_2(1, 27) = 10,96, MS_e = 320,737.03, p < .003]$. Finally, differences between conditions did not reach a significant effect in the last region of the sentences by participants $[F_1(1, 7) = 2.02, MS_e = 329,347.47, p > .20]$ and items $[F_2(1, 27) = 3.56, MS_e = 74,137.17, p > .07]$. Thus, as shown Figure 3, although, in general, reading times increased in the more computationally demanding area of the sentences (the relative final clause), this increase was much larger (1,418 ms), when participants read sentences to translate them into English than when they read and repeated them. In other words, on-line reading comprehension was much slower when participants were engaged in reading to translate the highly complex regions of the Spanish sentences into English than when reading the same Spanish sentences just to understand and repeat them.

On the other hand, the main effect of the type of pragmatic information was reliable by participants $[F_1(3, 21) = 3.17, MS_e = 108,899.39, p < .04]$, although it did not reach significance by items $[F_2(3, 27) = 2.19, MS_e = 129,119.42, p > .11]$. Planned comparisons showed that this overall effect was due to the difference between reading sentences in which the main verb was pragmatically biased vs. reading of non-biased sentences; these differences were reliable by participants $[F_1(1, 7) = 14.35, MS_e = 2247,857.50, p < .006]$, and by items $[F_2(1, 27) = 4.94, MS_e = 129,119.42, p < .03]$. In particular, if the main verb was pragmatically biased, translators spent an average reading time of 1,037 ms, while if no pragmatic cues were given (neither verb pragmatically biased), translators spent an average reading time of 1,196 ms. None of the other comparisons between pragmatic levels were reliable in neither the analyses by participant or by items (p values $> .05$). In addition, the facilitating effect provided by the pragmatic cues was similar for the reading/translation and reading/repeating conditions. Thus, the interaction Type of Pragmatic Bias x Type of Reading was unreliable for both participants $[F_1(3, 21) = 0.52, MS_e = 136,129.09, p > .67]$ and items $[F_2(3, 27) = 0.41, MS_e = 122,160.73, p > .74]$. On the other hand, there was no interaction between pragmatic bias and region of the sentences, neither in the participant analysis $[F_1(9, 63) = 1.45, MS_e = 182,148.36, p > .19]$ nor in the items analysis $[F_2(9, 81) = 0.95, MS_e = 287,073.94, p > .48]$. Finally, there was no evidence of a Pragmatic Cues x Type of Reading x Region interaction by participants $[F_1(9, 63) = 1.55, MS_e = 240,800.39, p > .15]$ and by items $[F_2(9, 81) = 1.21, MS_e = 247,755.88, p > .30]$.
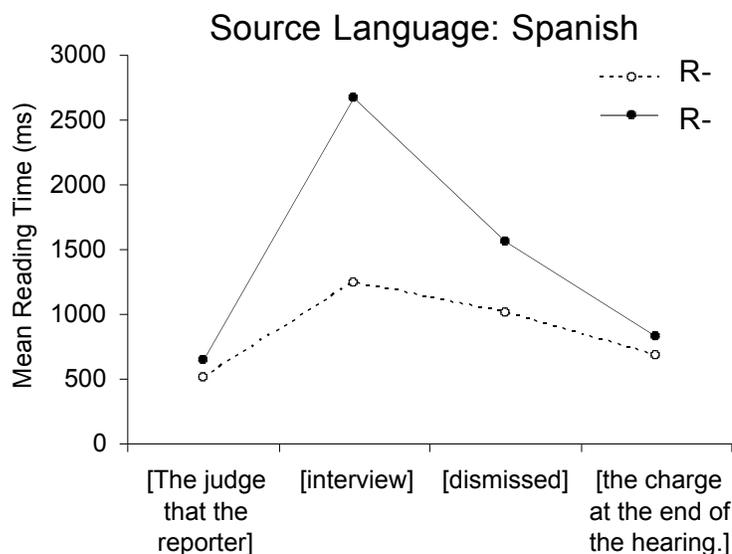
Source Language: Spanish

Figure 3. On-line comprehension in Experiment 1. Mean reading time per word for successive areas of the sentences. R-R is used to plot reading times for Reading Spanish sentences to understand them. R-T is used to plot reading times for Reading Spanish sentences to translate them into English.

Global Comprehension

The mean percentages of errors are shown in Table 1. Overall comprehension accuracy across all the conditions was 84.37% and it was quite similar for the reading/repeating (82.14%) and reading/translation (86.61%) conditions. Thus, the effect of type of reading was unreliable by participants [$\underline{F}_1(1, 7) = 0.03$, $MS_e = 0.04$, $p > .87$] and by items [$F_2(1, 28) = 0.09$, $MS_e = 0.01$, $p > .77$]. Pragmatic bias had no effect on global comprehension for neither participants [$F_1(3, 21) = 0.59$, $MS_e = 0.04$, $p > .63$] or items [$F_2(3, 28) = 0.41$, $MS_e = 0.02$, $p > .74$]. In addition, there was no evidence of interaction between Type of Reading x Type of Pragmatic Cues, by participants [$F_1(3, 21) = 0.79$, $MS_e = 0.05$, $p > .51$] and by items [$F_2(3, 28) = 1.03$, $MS_e = 0.01$, $p > .39$].

Thus, global comprehension was not affected by the type of reading made by the participants, nor by the pragmatic information given in the sentences. Hence, this data suggests that participants involved in reading for translation achieved a level of comprehension similar to that obtained when they were only reading and repeating the sentences. In addition, this level of comprehension is achieved without the additional help of the pragmatic cues

present in the sentence. In fact, the presence of pragmatic cues did not facilitate comprehension for either of the two reading conditions.

Table 1. Mean percentage of comprehension errors and Standard Deviation (in parenthesis) in the verification task of Experiment 1 as a function of Pragmatic Bias and Type of Reading.

	Source Language: Spanish	
	Reading for Understanding	Reading for Translation
Both	25.00 (.20)	7.14 (.12)
Relative Clause	7.14 (.12)	21.40 (.17)
Main Clause	25.00 (.20)	10.70 (.13)
Neither	14.29 (.20)	14.20 (.13)

In summary, results of Experiment 1 showed differences in reading times depending on the reading condition. When translators knew that they had to read and translate the sentences, their reading times slowed down compared to the condition where they had to read and repeat them. This pattern of results supports a horizontal view of translation. In addition to the cognitive demands imposed by normal reading, when reading was oriented to translation there was an increase in WM requirements. These additional demands had the effect of slowing on-line comprehension suggesting that processes other than understanding were being performed in parallel. Probably, when participants were reading for translation they engaged in additional processes needed for translation. In translation, beside the capacity required for comprehension of the input, WM capacity is needed for activating and switching the two languages involved (Gile, 1997; Grosjean, 1997). Language activation and switching would take resources from WM. As expected, the differences between reading for repetition and reading for translation were larger in the region of the sentence which was computationally more demanding: the relative clause boundary.

However, this increment in WM demands did not affect global comprehension for either of the two reading conditions. This indicates that reading for translation increased the time required for sentence processing, but the meaning of the sentences was extracted as complete as in normal reading.

The presence of pragmatic cues affected on-line comprehension independent of the task that translators had to perform after reading the sentence (i.e., repeat or translate). The effect of pragmatic cues suggests that during on-line SL language comprehension there are top-down processes which help sentence processing. These top-down processes, have been widely demonstrated in studies of monolingual normal reading (e.g., semantic effects in parsing of complex sentences, McDonald, Just, & Carpenter, 1992), and in

studies related to L2 language processing (e.g., Blanchard, 1998). In addition, the presence of this effect supports the idea that conceptual access is involved in forward translation (Kroll & Stewart, 1994). As we mentioned previously, bilingual models of word translation predicts semantic mediation when the direction of the translation goes from L1 to L2, whereas they predict a lexical way of translation, non-conceptually mediated, when the translation goes from L2 to L1.

In Experiment 2 we further explored this hypothesis. We reversed the direction of translation and native Spanish speaking participants read sentences either to repeat them or to translate them from English to Spanish (L2 to L1). As in Experiment 1, we manipulated the pragmatic information provided by the sentences. If there is an asymmetry depending on the direction of translation so that less conceptual processing would be involved when translating from English to Spanish, the presence of pragmatic information should not produce effects in this experiment.

EXPERIMENT 2

METHOD

Participants. A new set of eight professional translators participated in Experiment 2. We attempted to match them in L1-L2 language fluency, professional experience and WM capacity to the participants in Experiment 1. Thus, as in the previous experiment, all the participants were Spanish/English bilinguals (with Spanish as their L1 language) and they had high fluency in both languages. In addition, they were experienced translators and/or interpreters. The mean Reading Span score for the total set of participants was 3.87. As in Experiment 1, participants were considered to have high span scores (> 3.5 reading span scores; Miyake et al., 1994).

Design and Materials. The design was essentially the same as in Experiment 1, it conformed a 2 x 2 x 2 within participants model. We manipulated the Type of Reading (reading for comprehension vs. reading for translation), the Type of Pragmatic Cues (both verbs, relative clause verb, main verb and neither verb) and the Region of the Sentence (initial area, the relative clause ending, the main verb, and the final area).

The English translation of the 32 Spanish experimental sentences and 64 Spanish filler sentences used in Experiment 1 comprised the material set in Experiment 2 (see Appendix 1). As in Experiment 1, all the experimental and filler trials included a verification task regarding the meaning of the sentences. In this experiment those sentences were written in English.

Procedure. The procedure was identical to that described for Experiment 1 with the exception that participants were asked to repeat in English in the reading for repeating condition, and they were instructed to translate from English to Spanish in the reading for translation condition.

RESULTS AND DISCUSSION

As in Experiment 1, reading times were considered an index of on-line comprehension. For each of the experimental trials, the mean reading time per word was calculated for each of the same four areas of the object relative clause. All observations that were 2.5 standard deviations above the mean for each condition were trimmed to the mean value in this condition (less than 1.17% of the total). The accuracy of the responses in the verification task was considered an index of global comprehension.

On-line Comprehension

The analyses performed on the mean reading times showed that the main effect of Type of Reading was unreliable in the participant analysis [$F_1(1, 7) = 2.82$, $MS_e = 3365,728.50$, $p > .14$], but was significant in the item analysis [$F_2(1, 28) = 14.27$, $MS_e = 451,830.09$, $p < .001$]. As in Experiment 1, the interaction between type of reading and region of the sentence was significant in both participant [$F_1(3, 21) = 3.04$, $MS_e = 2204,843.3$, $p < .05$] and item analyses [$F_2(3, 84) = 10.64$, $MS_e = 374,477.34$, $p < .001$]. Planned comparisons showed that the two types of reading did not differ in the first area of the sentences in the participant analysis [$F_1(1, 7) = 2.02$, $MS_e = 47,128.27$, $p > .20$], but they were reliably different in the item analysis [$F_2(1,28) = 15.60$, $MS_e = 6,109.65$, $p < .001$]. In the critical more demanding area, the relative clause ending, reading times were reliably longer when reading for translation than when reading for comprehension for both participants [$F_1(1, 7) = 14.35$, $MS_e = 2247,857.5$, $p < .05$] and item analyses [$F_2(1, 28) = 13.15$, $MS_e = 1341,112.3$, $p < .001$]. Translators were on average 1,347 ms faster when reading for understanding than when reading for translation in the relative final clause (see Figure 4). In the third region, the effect of type of reading was not reliable by participants [$F_1(1, 7) = 0.04$, $MS_e = 1001,615.9$, $p > .85$] or by items [$F_2(1, 28) = 0.26$, $MS_e = 183,793.09$, $p > .61$]. Finally, the difference between the type of reading did not reach significance in the last region of the sentence by participants [$F_1(1, 7) = 3.26$, $MS_e = 130,999.41$, $p > .12$] but it was significant by items [$F_2(1, 28) = 14.14$, $MS_e = 44,247.17$, $p < .001$].

The effect of pragmatic information was not significant by participants [$F_1(3, 21) = 0.14$, $MS_e = 181,935.77$, $p > .93$] or by items [$F_2(1, 28) = 0.05$, $MS_e = 430,216.47$, $p > .98$]. None of the planned comparisons between levels of pragmatic bias were reliable by participants or by items (p values > .05). In addition, the interaction Type of Pragmatic Bias x Type of Reading was unreliable for both participants [$F_1(3, 21) = 0.02$, $MS_e = 186,934.61$, $p > .99$] and items [$F_2(3, 28) = 0.43$, $MS_e = 451,830.09$, $p > .72$]; there was no

interaction between pragmatic bias and region of the sentences [$F_1(9, 63) =$ 0.21, $MS_e = 260,214.86$, $p > .99$] and [$F_2(9, 84) = 0.12$, $MS_e = 388,372.28$, $p > .99$]. Finally, there was not evidence of a Pragmatic Cues x Type of Reading x Region interaction by participants [$F_1(9, 63) = 0.60$, $MS_e = 271,443.47$, $p > .79$] or by items [$F_2(9, 84) = 0.96$, $MS_e = 374,477.34$, $p > .48$].
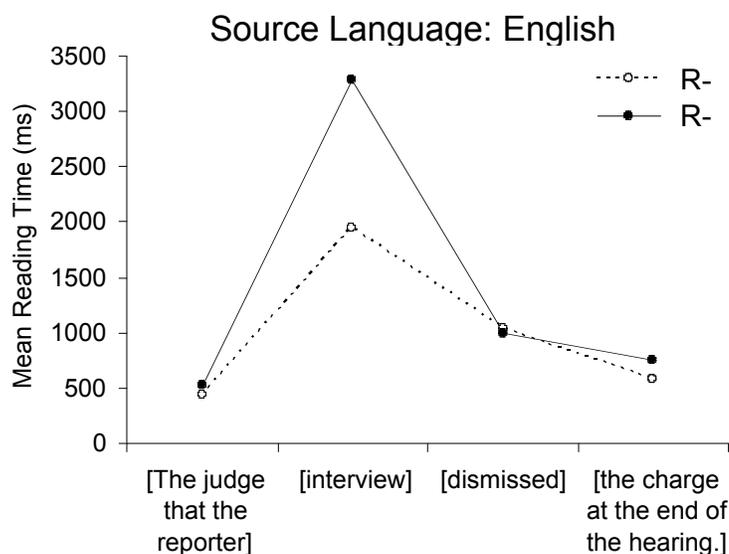

Figure 4. On-line comprehension in Experiment 2. Mean reading time per word for successive areas of the sentences. R-R is used to plot reading times for Reading English sentences to understand them. R-T is used to plot reading times for Reading English sentences to translate them into Spanish.

Global Comprehension

Table 2 shows the mean percentages of errors in the verification task as a function of the experimental conditions. The overall comprehension accuracy was 88.67%. The main effect of Type of Reading was not reliable by participants [$F_1(1, 7) = 1.58$, $MS_e = 0.01$, $p > .25$] or by items [$F_2(1, 28) = 0.02$, $MS_e = 0.04$, $p > .88$]. Thus, the accuracy in comprehending English sentences in the reading/repeating condition (90.62%) was similar to the accuracy obtained in the reading/translating condition (86.72%). Global comprehension was unaffected by the pragmatic cues provided by the verbs in the sentences by participants [$F_1(3, 21) = 0.87$, $MS_e = 0.02$, $p > .47$] and by items [$F_2(3, 28) = 0.31$, $MS_e = 0.03$, $p > .82$]. In addition, the interaction between the type of reading and pragmatic bias was unreliable by participants

$[F_1(3, 21) = 1.81, MS_e = 0.02, p > .18]$ and by items $[F_2(3, 28) = .42, MS_e = 0.03, p > .74]$.

Table 2. Mean percentage of comprehension errors and Standard Deviation (in parenthesis) in the verification task of Experiment 2 as a function of Pragmatic Bias and Type of Reading.

	Source Language: English	
	Reading for Understanding	Reading for Translation
Both	9.38 (.19)	9.38 (.13)
Relative Clause	3.13 (.09)	21.88 (.09)
Main Clause	15.63 (.13)	15.63 (.23)
Neither	9.38 (.13)	6.25 (.12)

Thus, as in Experiment 1, global comprehension was not affected either by the type of reading made by the participants or by the pragmatic information provided by the sentences.

In summary, results of Experiment 2 indicate that there are differences in sentence processing depending on whether participants should repeat or translate the sentence. Thus, on-line reading comprehension slowed down when professional translators were instructed to read for translation. These results replicate those of Experiment 1 and extend them to backward translation. In contrast, the availability of pragmatic information provided by the verbs in the sentences did not facilitate on-line comprehension. The difference between Experiment 1 and 2 regarding the effect of pragmatic information is unlikely due to between-groups differences, since the professional translators who participated in both experiments were carefully matched in language proficiency and on WM capacity. Instead, they appear to be due to changes in processing induced by the language of the source sentences. We will further discuss this asymmetrical effect.

GENERAL DISCUSSION

In two experiments, we examined reading comprehension processes when professional translators were instructed to read for understanding or to read for translation. The results of Experiment 1 in which Spanish sentences were used as the Source Language (SL) and English as the Target Language (TL), demonstrate that on-line comprehension was slower under reading for translation vs. reading for repeating. These effects were larger in the area of the sentence which demanded more Working Memory (WM) resources, the relative clause ending. In addition, an increase in the availability of pragmatic

information facilitated both types of reading. In Experiment 2, we evaluated the generality of these results and investigated whether the differences in reading processes depended on the input source language. Results of Experiment 2, in which the English version of the sentences was used as the source language and Spanish was used as the target language, replicated some of the effects obtained in Experiment 1. That is, when reading for translation, participants showed slower reading time at the end of the relative clause. However, in contrast to Experiment 1, pragmatic cues did not facilitate the reading process, indicating an asymmetrical use of pragmatic information for different source languages. Translinguistic differences in the use of pragmatic information have been reported in other studies. Wichman, Frield, and Harris (2001) investigated the effect on reading times of pragmatic anomalous sentences (e.g., the nun pays an undulating stripper) compared to the reading of normal sentences. They found a slower reading times for anomalous sentences when they were presented in German (Experiment 1), but the effect was not replicated when English was used as the source language (Experiment 2). Thus, this pattern of results indicates a different analysis of pragmatic information for different source languages.

Despite differences in on-line comprehension obtained in both experiments, global understanding was not affected by the type of reading, or by the pragmatic information present in the sentence. The absence of any effects (type of reading and pragmatic information) on global comprehension that we obtained in our experiments corroborates results of previous studies. In a simultaneous interpreting study, Isham (1994) failed to show differences in global comprehension after subjects had listened to a set of English passages. In his study, a group of translators were instructed to listen and to understand passages, and another group of participants was asked to listen to the passages and to interpret them after a tone was presented. Afterward, participants recalled as many of the words in the passages as possible. Considering recall as a measure of global understanding, Isham failed to find differences between listener and translator participants. Thus, interpreters displayed the same basic pattern as did the non-interpreters. In both groups, word position in the presented sentences affected verbatim recall (words recalled in the order which they were presented[3]). Thus, although translation seems to increase the time required for sentence processing, the meaning of the sentences is extracted as completely in translation as in normal reading.

The fact that reading times were slower at the boundaries of the relative clauses for both translation directions (Spanish into English and English into Spanish translation) seems to suggest that the memory load imposed by the structure of the sentence during reading is independent of the language

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[3] However, Isham (1994) did not find homogeneous results. For another set of participants, named Type II interpreters, he found an overall recall inferior to the listener groups. Thus, as he point out, their data do not support completely neither a horizontal nor a vertical view of translation. The author speaks of strategies in translation (Isham, 1994, p. 206): A word-by-word strategy connected to a horizontal view of interpretation processes and a meaning-based approach according with a deverbalization, vertical perspective in translation.

involved. In addition, the larger differences between reading for comprehension and reading for translation observed at the end of the relative clauses are consistent with proposals that suggest that a clause is sufficient to form a proposition (McKoon & Ratcliff, 1980), and to initiate code-switching processes to generate L2 outputs (Isham & Lane, 1993). Goldman-Eisler (1972) and Davison (1992) investigated the amount of L1 input received before the interpreters began to produce L2 sentences. They both concluded that interpreters waited for a clause to end before they began to translate. Accordingly, we observed that the main differences between reading for understanding and reading for translation were at the clause boundary, and these differences were independent of the direction of the translation.

However, results of our experiments suggest that the direction of the translation is an important factor in translation. As we pointed out, theorists have proposed an asymmetrical relation between the two represented languages L1 and L2 in the bilingual's mind (Kroll & Stewart, 1994). Thus, the lexical connections between L2 and L1 are stronger than those between L1 and L2. In contrast, conceptual connections are stronger in forward translation (L1 to L2) than in backward translation (L2 to L1). Consistent with this proposal, our Spanish native bilingual translators used pragmatic information to speed up their reading times when forward translating (Spanish to English), but they did not during backward translation (English to Spanish). The lack of effect of pragmatic bias in Experiment 2 cannot be explained as due to differences in parsing strategies for the two input languages. First, the sentences used in Experiment 2 were virtually equal in semantic and pragmatic content to those used in Experiment 1. The only difference between them was in the linguistic form of the sentences, Spanish in Experiment 1 and English in Experiment 2. Second, studies that focus on sentence parsing by fluent bilinguals (Dussias, 2001; Kroll and Dussias, in press) have shown that the translator's parsing strategies are not constrained by the input language. Instead, our data suggest that the differences in the use of pragmatic information were due to the direction of the translation, more conceptually mediated in forward translation than in backward translation.

In summary, our main finding is the demonstration that on-line processing of Spanish and English sentences is delayed when participants are instructed to translate them. This effect is independent of the use of pragmatic information observed when Spanish is used as the source language. Differences between normal reading and reading for translation are particularly large in the critical area where larger WM demands are imposed, the end of the relative clause. But, why do instructions to translate slow down on-line sentence processing compared to normal reading? What additional processes are taking place when reading for translation? We think that when reading for translation, participants engaged in code-switching processes. These additional processes made on-line comprehension difficult for both forward (Experiment 1) and backward (Experiment 2) translation. In support for this claim, Macizo and Bajo (2004, Experiment 2) reported data indicating that when the participants were reading in the source language and they received instruction for later translation, some properties of the target language

(e.g. cognate status of the words) had effects. Therefore, activation of the lexical entries in the TL seems to proceed in parallel to SL understanding. This interpretation opposes the vertical view of translation. According to this view (Seleskovitch, 1976), reading for comprehension and reading for translation should not differ. Translation processes proceed in serial order, first extracting the meaning of the source message then planning and producing the target language. Thus, the cognitive load when reading for translation should be equal than that for normal reading. Hence, our data are consistent with a horizontal perspective for the translation process: Code-switching and access to the TL lexical forms proceed before SL comprehension is finished (Danks & Griffin, 1997; Gerver, 1976). Even though this sort of parallel processing has an immediate negative cost in on-line comprehension because of the increase in cognitive load, translators get the gist of the message as completely as in normal reading.

RESUMEN

Cuando la traducción produce diferencias: Procesamiento de frases en lectura y traducción. El artículo presenta datos de dos experimentos en que se compara la lectura normal y la lectura para traducir. En ambos Experimentos las frases se presentaban palabra a palabra. En el Experimento 1, un grupo de traductores profesionales leían frases con instrucciones de repetirlas en español o traducirlas al inglés. Además manipulamos la disponibilidad de información pragmática en las oraciones. En el Experimento 2 se invirtió la lengua de origen y se pedía a los traductores que repitiesen las frases en inglés después de su lectura o que las tradujesen al castellano. En los dos experimentos los tiempos de lectura fueron más lentos en la lectura para traducir que en la lectura para repetir, lo que indica que la comprensión de frases es dependiente del objetivo de la lectura. La presencia de información pragmática facilitaba la comprensión, pero sólo cuando el idioma origen era el castellano. Esta asimetría entre idiomas indica que la utilización de pistas pragmáticas para facilitar la lectura puede depender del idioma en el que se lee. Los resultados en su conjunto proporcionan apoyo a las teorías horizontales de traducción.

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APPENDIX 1

Experimental Sentences used in Experiment 1 and 2

Both Verb Phrases Biased

El banquero que el maestro enseñó aprobó el préstamo después de hacer unas preguntas. [*The banker that the teacher instructed approved the loan after asking a few questions.*]

El abogado que el doctor examinó redactó el contrato antes de dejar la oficina. [*The lawyer that the doctor examined drafted the contract before leaving the office.*]

El vendedor que el contable intervino vendió la mercancía con un descuento bastante grande. [*The salesman that the accountant audited sold the merchandise at a rather large discount.*]

El camarero que el humorista entretuvo abrió el vino cuidadosamente pare evitar derramarlo. [*The waiter that the comedian amused opened the wine carefully to avoid spilling any.*]

El detective que el barbero afeitó investigó el accidente en el centro comercial suburbano. [*The detective that the barber shaved investigated the accident at the suburban shopping center.*]

El juez que el periodista entrevistó dejó el cargo después de la audiencia. [*The judge that the reporter interviewed dismissed the charge at the end of the hearing.*]

El ladrón que el bombero rescató robo las joyas de la pesada caja fuerte de acero. [*The robber that the fireman rescued stole the jewellery from the heavy steel safe.*]

El gobernador que el agente aconsejó firmó la legislación justo antes de final de año. [*The governor that the broker advised signed the legislation just before the end of the year.*]

Relative Clause Verb Phrase Biased

El humorista que el banquero financio contestó al teléfono después de la tercera llamada. [*The comedian that the banker funded answered the telephone after the third ring.*]

El contable que el abogado demandó leyó el periódico en el tren de Nueva York. [*The accountant that the lawyer sued read the newspaper on the train to New York.*]

El doctor que el vendedor asistió vio la película después con varios amigos. [*The doctor that the salesman assisted watched the movie later with several friends.*]

El maestro que el camarero sirvió recortó los cupones del periódico. [*The teacher that the waiter served clipped the coupons out of the newspaper.*]

El agente que el detective interrogó condujo el coche deportivo por el pueblo pequeño. [*The broker that the detective questioned drove the sportscar through the tiny village.*]

El bombero que el juez sentenció dirigió esa tarde la conversación en el bar. [*The fireman that the judge sentenced dominated the conversation in the bar that evening.*]

El periodista que el ladrón asaltó cocinó chuletas de cerdo en una sartén de metal grande. [*The reporter that the robber mugged cooked the pork chops in a large metal frying pan.*]

El barbero que el gobernador respaldó subió la montaña el siguiente fin de semana. [*The barber that the governor endorsed climbed the mountain on the following weekend.*]

Main Clause Verb Phrase Biased

El agente que el banquero admiraba compró las acciones en la nueva compañía de alta tecnología. [*The broker that the banker admired purchased the stock in the new hi-tech company.*]

El bombero que el abogado insultó extinguió la llama en la vieja casa abandonada. [*The fireman that the lawyer insulted extinguished the blaze in the old abandoned house.*]

El periodista que el vendedor ignoró escribió el articulo sobre el incremento del fraude. [*The reported that the salesman ignored wrote the editorial about the increase in fraud.*]

El barbero que el camarero detestaba afiló la navaja de afeitar con una piedra engrasada. [*The barber that the waiter disliked sharpened the razor with a fine oiled stone.*]

El humorista que el detective despreció contó el chiste en el atestado club nocturno. [*The comedian that the detective despised delivered the punchline at the crowded night club.*]

El contable que el juez quería hizo balance de los libros con gran dificultad. [*The accountant that the judge liked balanced the books only with great difficulty.]*

El doctor que el ladrón telefoneó prescribió la medicación a pesar de los riesgos. [*The doctor that the robber phoned prescribed the medication despite the risks.*]

El maestro que el gobernador alababa corrigió el ensayo en la gran oficina ocupada. [*The teacher that the governor praised graded the essay in the large busy office.*]

Neither Verb Phrase Biased

El banquero que el barbero alababa escaló la montaña justo al lado de la ciudad. [*The banker that the barber praised climbed the mountain just outside of town.*]

El abogado que el periodista telefoneo cocino los trozos de carne en su propio jugo. [*The lawyer that the reporter phoned cooked the pork chops in their own juices.]*

El vendedor que el bombero quería dirigió la conversación sobre la carrera de caballos. [*The salesman that the fireman liked dominated the conversation about the pennant race.]*

El camarero que el agente despreció condujo el coche deportivo esa tarde desde el trabajo hasta casa. [*The waiter that the broker despised drove the sportscar home from work that evening.]*

El detective que el profesor detestaba recortó los cupones con las pesadas tijeras. [*The detective that the teacher disliked clipped the coupons out with the dull scissors.*]

El juez que el doctor ignoró vio la película sobre los narcotraficantes colombianos. [*The judge that the doctor ignored watched the movie about Colombian drug dealers.]*

El ladrón que el empresario insultó leyó el artículo de periódico sobre el fuego. [*The robber that the accountant insulted read the newspaper article about the fire.*]

El gobernador que el humorista admiró contestó al teléfono en el restaurante animado. [*The governor that the comedian admired answered the telephone in the fancy restaurant.]*

Note. Sentences used in Experiment 1 were presented in Spanish. Sentences used in Experiment 2 (English version) are given in bracket.