RUNNING HEAD: A Bilingual Exploration

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Building Syntactic Structures in Speaking: A Bilingual Exploration

Paul J. A. Meijer and Jean E. Fox Tree

University of California, Santa Cruz

Corresponding author:

Jean E. Fox Tree
Psychology Department
Social Sciences II, room 277
University of California Santa Cruz
Santa Cruz, CA 95064
foxtree@cats.ucsc.edu
(831) 459-5181

Abstract

In a series of three experiments we investigated syntactic priming using a sentence recall task. Participants read and memorized a target sentence for later recall. After reading a prime sentence and engaging in a distraction task, they were asked to produce the target sentence aloud. Earlier investigations have shown that this task is sensitive to a syntactic priming effect. That is, the syntactic form of the prime sentence sometimes influences the syntactic form of the recalled target. In this paper we report on a variation on this task, using Spanish-English bilingual participants. In the first two experiments we replicated the prepositional phrase priming effect using English target sentences and Spanish prime sentences. In the final experiment we investigated two additional syntactic forms, using Spanish target sentences and English prime sentences. Implications for models of syntax generation and bilingual speech production are discussed.

Building Syntactic Structures in Speaking: A Bilingual Exploration

One way researchers explore the generation of syntactically well-formed sentences during speech production is through a phenomenon called syntactic priming (Bock, 1986, 1989; Bock & Loebell, 1990; Branigan, Pickering, Liversedge, Stewart, & Urbach, 1995; Fox Tree & Meijer, 1999; Levelt & Kelter, 1982; Lombardi & Potter, 1992; Potter & Lombardi, 1990). Syntactic priming occurs when the syntactic form of a sentence that is heard, repeated, or read has an increased likelihood of being used again in the production of a subsequent utterance. We used syntactic priming to explore Spanish-English bilingual speakers' production of syntax.

Bock (1986, 1989; Bock & Loebell, 1990) investigated the syntactic priming effect during picture descriptions. Participants were given the task to describe relatively simple pictures, such as a church being hit by lightning, with a single sentence. Many descriptions are possible. For example, the picture can be described using a passive voice*, the church is being struck by lightning*, or an active voice, *lightning is striking the church*. Bock (1986) found that when people were asked to repeat aloud a prime sentence with an active voice prior to the picture presentation, they were more likely to describe the picture using an active voice. Similarly, people preferred more passive voice picture descriptions following a prime sentence with a passive voice.

A syntactic priming effect was also found for spontaneous descriptions of pictures depicting an agent, a recipient, and an action, such as a man reading a child a book. The pictures were preceded with prime sentences with either a double-object (NP-NP; NP = noun phrase) construction or a prepositional-object (NP-PP; PP = prepositional phrase) construction (we use plain brackets around NPs and curly brackets around PPs):

(1) NP-NP: The waiter brought [the customers] [a tray of drinks].

(2) NP-PP: The waiter brought [a tray of drinks] {to the customers}.

Participants were more likely to describe the picture using a double-object construction after a double-object prime than after a prepositional-object prime. Similarly, they generated more picture descriptions with a prepositional-object construction after a prepositional-object prime than after a double-object prime.

The syntactic priming effect is robust and is not related to thematic similarities (Bock & Loebell, 1990). People were just as likely to describe a picture as *The church was hit by lightning* after a full passive where the by-phrase identifies the agent, such *as The construction worker was hit by the bulldozer*, as after a prepositional locative where the by-phrase describes a location, such as *The construction worker was digging by the bulldozer*. Also, the priming effect is not dependent on the use of the same preposition in the prime sentence and the picture description (Bock 1989). That is, the description *The man is reading a book TO the child* is equally likely after the *prime The secretary took a cake TO her boss* and *The secretary baked a cake FOR her boss*. The syntactic priming effect is furthermore unrelated to phonological and metrical similarities between prime and picture descriptions (Bock & Loebell, 1990).

Fox Tree and Meijer (1999) investigated the syntactic priming effect using a sentence recall task. Participants were asked to read and memorize a target sentence. They subsequently read a prime sentence. After the prime sentence presentation, a distraction task was given in which participants were asked whether a certain word was part of the prime sentence. Finally, they were asked to recall the target sentence aloud. Under certain circumstances participants recalled the target sentence using the syntactic form of the prime sentence instead of the target sentence's original syntactic form. For example, a double-object target *sentence While the poet traveled in*

France, she wrote her family many letters was followed by a double-object or a prepositional-object prime sentence:

(3) NP-NP: The father promised to lend [his dishonest son] [the family car].

(4) NP-PP: When she finishes it, the grandmother will display [her quilt] {to the family}.

People were more likely to recall the target sentence with a prepositional-object construction, producing *While the poet traveled in France, she wrote many letters to her family*, after a prime with a prepositional-object construction than after a prime with a double-object construction, replicating Bock (1986). This effect was furthermore not dependent on the use of the same preposition, as was found for picture descriptions by Bock (1989). Because recalled sentences show the same effects as spontaneously produced sentences, we feel confident that this task taps into speaking processes, as others have also argued (Fox Tree & Meijer, 1999; Lombardi & Potter, 1992; Potter & Lombardi, 1990). But unlike some other methods, the sentence recall task has the advantage of allowing greater control over the syntactic structures tested.

Fox Tree & Meijer (1999) used this advantage to explore how syntactic rules are stored. In prior work, syntactic priming effects were interpreted as evidence for the existence of abstract syntactic rules that are employed to build syntactically well-formed sentences during speaking. These syntactic rules are stored as separate units in the mental lexicon and can be selected to be involved in the formation of a sentence. Priming effects are typically explained by positing that selecting a unit activates this unit to a value greater than that of its competitors. After a sentence has been processed, a syntactic unit that was involved in the sentence will have a certain amount of residual activation. As long as some residual activation remains, this syntactic unit has a head start and is thus more likely to be selected again for a new sentence over competitor units that

have no residual activation (Dell, 1986; Levelt, 1989. For an alternative account where structure priming is described as a form of implicit learning exhibited by a non-atomic network rather than the consequence of a selection process in a unit-based network, see Bock & Griffin, 2000; Chang, Dell, Bock, & Griffin, 2000).

Fox Tree & Meijer (1999) investigated whether complex syntactic units were stored as a whole, or broken down into major and minor phrases. They tested this by varying the complexity of the noun phrases in the target and prime sentences. For example, a simple double-object target sentence *The representative of the western nation offered the country an agreement* was paired with three possible primes:

(5) NP-NP, complex: The nurse read [the soldier who was wounded] [the most recent letter].

(6) NP-PP, complex: The nurse read [the most recent letter] {to the soldier who was wounded}.

(7) NP-PP, simple: The nurse read [the most recent letter] {to the wounded soldier}.

If *to the soldier who was wounded* and *to the wounded soldier* activate different syntactic units, only *to the wounded soldier* should prime a switch of the target to *to the country* in comparison to the NP-NP condition. In fact, both simple and complex prepositional-object constructions were more likely to cause a switch in recall compared to double-object constructions (Fox Tree & Meijer, 1999). In terms of the theory just described, simple and complex noun phrases are generated using the same syntactic rules. The presentation of a prepositional-object prime sentence caused residual activation of the NP-PP syntactic rule, making it more likely to be selected for the recall of the target sentence than the less active alternative, the NP-NP rule, regardless of the complexity of the noun phrases of the primes and targets.

Stepping back for a moment, we could ask why any particular syntactic rule is chosen as a candidate for the generation of a sentence in the first place. The *lemma-driven phrase structure theory* of syntax production provides one answer. The central claim of this theory is that when going from a thought-to-be-expressed to a sentence expressing the thought, lemmas, i.e. the syntactic and semantic aspects of words, are chosen before the syntactic structure of the entire utterance. In other words, the lemmas stored in the mental lexicon point to the viable syntactic units that can be used to integrate the word into a syntactically well-formed utterance. The creation of the syntax of the utterance is called lemma-driven because the syntactic rules congruent with the lemmas in the utterance determine what the resulting syntax of the entire utterance will be. That is, as multiple lemmas are selected to create a sentence, the syntactic candidates of these lemmas that in combination create a well-formed sentence are used to create that sentence, while syntactic rules that cannot be combined to create a well-formed sentence are excluded. In this way, syntactic rules can be chosen and integrated into a sentence quickly, while simultaneously avoiding confusion in choosing language-appropriate rules (Bresnan, 1982; Kempen & Hoenkamp, 1987; Kempen & Vosse, 1989; also see Pickering & Branigan, 1998).

Consider the verb *walk*, which requires a subject noun phrase and a verb phrase, but no direct or indirect object noun phrases. When this verb is selected for use, it calls the syntactic procedures that create the subject noun phrase and that create the verb phrase. Similarly, during recall of the target sentence *The representative of the western nation offered the country an agreement*, the verb *to offer* activates the NP-NP rule and the NP-PP rule as possible candidates for selection. The words *agreement* and *country* that need to be integrated into the utterance as direct object and indirect object further activate these rules. The prior presentation of a prepositional-object prime sentence caused residual activation of the NP-PP rule and gave it a

head start over the competing NP-NP rule, increasing its likelihood to be chosen over its competitor.

The lemma-driven model thus incorporates the syntactic priming effects described above. The model was directly tested by Lombardi and Potter (1992; see also Potter & Lombardi, 1990). Participants were given an NP-NP construction such as *The rich widow is going to give the university a million dollars*. They had to memorize the sentence and recall it after a short distraction task. In the distraction task they saw a list of five words followed by a test word and had to indicate whether the test word was in the list. Sometimes a word in the list was a good candidate for mistaken selection during recall of the target sentence, such as the verb *donate* to replace the verb *give* in the example. However, unlike *give*, *donate* can only have an NP-PP construction, creating *The rich widow is going to donate a million dollars to the university*. If the syntactic rule is chosen first and limits the selection of viable verbs, *donate* could not be chosen. On the other hand, if the word is chosen first and drives the selection of viable syntactic rules, *donate* can be chosen by mistake, leading to the recall of the target sentence with this verb using an NP-PP construction. The latter is exactly what was found.

In the current paper we present an extension of the syntactic priming data. Specifically, we investigated whether for bilingual speakers a sentence processed in one language can prime a syntactic construction in another language. We tested cross-linguistic syntactic priming using the sentence recall task first employed in Fox Tree and Meijer (1999). The participants in the experiments were bilinguals who spoke both Spanish and English on a regular basis, such as by speaking one language at home and the other language at work. This fairly strict definition excludes bilinguals who have learned a second language at one time but use it infrequently.

Spanish and English is the most frequent bilingual combination in the region where our studies were conducted.

Investigations of bilingual speakers' language processes often focus on the question of modularity of the languages. That is, for a given language component, is there one set of structures and processes that is used for both languages, or are there separate non-interacting sets for each language? For example, with respect to lexical access, investigations have focused on the question of whether bilingual speakers have two separate lexicons that can be accessed independently, or one lexicon containing words from both languages (Costa, Miozzo, & Caramazza, 1999; Francis, 1999; Heredia, 1997; Kroll & Stewart, 1994; Potter, So, von Eckhardt, & Feldman, 1984).

Following Francis' (1999) compelling argument that the discussion on bilingual modularity sometimes suffers from lack of clarity of concepts and terminology, we would like to be precise as to the locus of our research and possible effects. We take a process-driven approach (the lemma-driven phrase structure theory) in which we assume a separation of lemmas (containing semantic and syntactic information) and lexemes (containing, among other things, the phonological information). With respect to the syntactic information, we believe that there is one central storage containing all the syntactic rules necessary for both languages. This storage is cognitively economical; that is, the rules are not labeled with respect to the language they are used for and there is one structure representing a particular syntactic rule. This single structure guides the creation of all utterances that use that syntactic structure. For example, there is a single NP-PP rule that is used to generate all NP-PP sentences both in Spanish and English. Consequently, we predict that syntactic priming will occur across languages.

In this model, lemmas act as pointers to the syntactic rules, pointing only at the syntactic rules that are permissible for the lemma. For the experiments presented here, we can be agnostic about whether one lemma is used to represent the semantic and syntactic information of an English word and another lemma is used to represent that information of its Spanish translation equivalent, or whether one and the same lemma is used for both the Spanish and English words. However, these two models of lemma representation do make different predictions about bilingual language production in general and syntax production phenomena in particular. These issues will be addressed in the General Discussion.

In the first experiment we set out to replicate the prepositional-object switch effect found in Fox Tree and Meijer (1999). English target sentences were presented in a double-object construction (*The waiter brought the customers a tray of drinks*), although they could also be expressed using a prepositional-object construction (*The waiter brought a tray of drinks to the customers*). The primes were either Spanish NP-PP sentences or Spanish sentences with unrelated structures.

Experiment 1

Method

Participants. Forty-six students from the University of California Santa Cruz participated in this experiment for course credit. Fourteen of them also participated in Experiment 3 in the same session. All participants were fluent Spanish-English bilinguals. They were either native speakers of Spanish and English or had taken a minimum of two years of Spanish at the college level and had subsequently used Spanish on a regular basis. Of the 30 participants whose results were included in the statistical analysis, 21 had learned Spanish and English concurrently.

Frequently these native bilinguals had grown up speaking Spanish at home and English outside the home, such as at school.

Materials. Fifteen dative verbs were chosen to create the target sentences: *bring*, *give*, *hand*, *lend*, *loan*, *make*, *offer*, *read*, *sell*, *send*, *serve*, *show*, *teach*, *tell*, and *write*. These verbs allow both double-object (NP-NP) and prepositional-object (NP-PP) constructions. For each dative verb two target sentences were written containing indirect and direct objects in NP-NP constructions. Half of these sentences were combined with an NP-PP Spanish prime sentence where the prepositional phrase was an indirect object. The other targets sentences were combined with non-NP-PP Spanish sentences:

(8) Critical Condition:

Target: The car salesman sold [the young woman] [a red sports car].

Prime: La mujer le trajo [el niño que dormía] {a su mamá preocupada}.

Verbatim Translation: The woman him/her brought the child that slept to her mother worried.

Translation: The woman brought the child that slept to her worried mother.

(9) Control Condition:

Target: The antiques dealer sold [the couple] [the 18th-century mahogany bed].

Prime: El cocinero y su compañero quieren abrir un restaurante nuevo.

Verbatim Translation: The cook and his partner want to open a restaurant new.

Translation: The cook and his partner want to open a new restaurant.

If syntactic priming can occur across languages, the order of objects should be reversed more frequently in the critical condition than in the control condition. A syntactic switch would change the target sentence *the waitress will bring the noisy customers a tray of drinks* into *the waitress will bring a tray of drinks to the noisy customers*.

In addition to the 30 target pairs, 15 pairs of filler sentences, and 5 pairs of practice sentences were written. None of the filler or practice sentences contained either NP-NP or NP-PP constructions. All sentences were between 10 and 15 words long. The sentences in a pair were unrelated in meaning. All materials in this experiment and the other experiments in his paper were written and double-checked by native Spanish speakers.

Single words were selected for the distraction task that was part of each trial. In this task, a word was presented and participants indicated whether the word had occurred in the prime sentence. The word was in the prime sentence in 29 cases and was not in the prime sentence in the remaining 21 cases. The word appeared in the prime sentence in 6 of the 15 critical sentence pairs and in 5 of the 15 control sentence pairs. In both the critical and control trials the word was neither the dative verb nor the preposition.

Design. One list of 50 trials was created. The list started with the practice pairs and was followed by 45 critical, control, and filler pairs. No more than two control or critical pairs were presented on consecutive trials. Filler trials were interspersed at regular intervals. Target sentences created with the same dative verb were separated by at least five other trials. For exactly half of the experimental trials the target sentence in the critical condition preceded the companion target sentence with the same dative verb in the control condition.

Procedure. Participants were tested one at a time. They read the instructions and were seated in a front of a computer screen in a private booth. The 5 practice trials were administered followed by the other trials. Each trial had the following structure. First participants heard a warning beep of 500 ms. Subsequently the target sentence appeared and participants had 3500 ms to read it. Then the target sentence disappeared and the prime sentence appeared. Participants read the prime at their own pace and pressed a key on the keyboard to continue. A single word

then appeared on the screen and participants pressed either the *yes* or *no* key indicating the presence or absence of the word in the prime. After the key press the word disappeared and a message on the screen asked participants to recall aloud the first sentence they had seen. After they finished recalling the sentence, participants pressed a key to go to the next trial. The recall responses were recorded on tape. The experiment took between 15 and 25 minutes, depending on the participant's pace. Seven of the fourteen participants who did both this experiment and Experiment 3 in the same session, started with Experiment 1.

Results

Targets were scored as remembered, forgotten, or as containing an NP-PP switch. Sentences were considered remembered if most of the lexical items (or near synonyms) were recalled in a well-formed sentence, even when up to two non-critical words in the sentence were forgotten. Non-critical words were those that did not affect the major syntactic constituents of the sentence. Sixteen participants were excluded because they could not remember at least half the critical and control targets. The data of the remaining 30 participants were analyzed with subjects (*t1*) and items (*t2*) as random factors. A syntactic switch was produced in 14.4% of the critical and 7.8% of the control sentences ($t1(29) = 2.95$, $p < .01$; $t2(28) = 2.41$, $p < .025$). That is, people recalled the target sentence but switched to a prepositional-object construction more often after an NP-PP prime than after a non-NP-PP prime. This finding is not a result of control targets being harder to recall than critical targets. The same number of targets were forgotten across conditions, specifically 20.0% of the critical sentences and 23.3% of the control sentences ($t1(29) = -1.45$, p = n.s.; $t2(28) = -.69$, p = n.s.),

The presence of syntactic priming indicates that participants did process the prime sentences. This is further confirmed by an analysis of the distraction task. The data for one item was

excluded because the distraction word appeared in alternative spellings when presented alone and in the prime sentence, making both a *yes* and a *no* response acceptable. Of the remaining 870 responses, 4 were excluded because participants had pressed a key other than the *yes* or *no* key. The correct response was given in 90.4% of the critical trials and 86.4% of the control trials. These high success rates show that participants had been paying close attention to the prime sentences. Furthermore, the 4% difference in accuracy between the two conditions was not significant ($t1(29) = 1.94$, p = n.s.; $t2(27) = 1.35$, p = n.s.). Participants also took a similar amount of time completing the distraction task in both conditions, with an average response time of 1582 ms in the critical condition and 1651 ms in the control condition ($t1(29) = -1.04$, p = n.s.; $t2(27) = -.67$, p = n.s.). There is no reason to assume that the distraction task was instrumental in causing a difference in the number of syntactic switches found in the two conditions.

Finally, we ran a separate analysis for the 21 native bilinguals in the sample and found qualitatively the same results. The rate of forgetting was similar to that of the whole sample (21.0% of the critical sentences and 25.7% of the control sentences; $t1(20) = -1.56$, p = n.s.). Switches were produced in 15.8% of the critical and 9.2% of the control sentences ($t1(20) = 2.16$, $p < .05$), a 6.6% difference that is identical to the difference for the entire sample.

Discussion

We were able to replicate the syntactic priming effect found in Fox Tree and Meijer (1999) using a cross-linguistic manipulation. English sentences with double-object constructions were induced to switch to a prepositional-object construction by Spanish prime sentences with a prepositional-object construction. The 6.6% difference in switch rate across conditions in the current experiment is similar to the 7.4% difference reported for the monolingual experiment in Fox Tree and Meijer (11.6% in the critical condition; 4.2% in the control condition).

The data of this experiment are very suggestive of the notion that the syntactic priming effect found with bilinguals is caused by the same mechanisms that underlie the priming effect in the monolingual experiments. The syntactic priming effect for monolinguals was found not to be mediated by phonological or metrical similarities, and also not to be dependent on the use of the same preposition. These factors seem an unlikely influence here due to the use of two languages. However, Experiment 1 leaves open the possibility that the priming effect was mediated by thematic similarity. The critical target and prime sentences did not only have compatible syntactic structures, but also contained the same thematic roles in the verb phrases. Specifically, they all contained a direct object and an indirect object.

As was reported in the introduction, syntactic priming was not dependent on thematic similarity in the monolingual investigations. Bock and Loebell (1990) found that both primes with full passives and primes with locative prepositional phrases beginning with *by* induced pictures to be described in the passive rather than the active voice. If syntax generation for bilinguals uses one shared set of structures and processes for both languages, syntactic priming should similarly not be dependent on thematic similarity. Experiment 2 tests this possibility. The target sentences of Experiment 1 were paired with new Spanish prime sentences in the critical condition. These primes did not contain an indirect object in the prepositional phrase. Instead they contained a locative (e.g., *in a garden*) or an instrumental (e.g., *with a spoon*) prepositional phrase.

Experiment 2

Method

Participants. Thirty students from the University of California Santa Cruz participated in this experiment for course credit. None had been in Experiment 1, but they all participated in

Experiment 3 in the same session. The same selection criteria applied to the participants here as to those of Experiment 1. Of the 20 participants whose data were included in the statistical analysis, 15 were native bilingual speakers.

Materials. The 15 trials from the control condition and the 15 English target sentences from the critical condition of Experiment 1 were selected. New Spanish NP-PP primes were written and matched up with the targets of the critical condition. These primes had a locative or instrumental prepositional phrase instead of a dative prepositional phrase:

(10) Critical Condition:

Target: The waitress will bring [the noisy customers] [a tray of drinks].

Prime: La bruja cocinaba [su sopa mágica] {en la cazuela} cuando se rió.

Verbatim Translation: The witch cooked her soup magical in the pan when she laughed.

Translation: The witch cooked her magical soup in the pan when she laughed.

The 15 fillers and 5 practice pairs from Experiment 1 were also used. All other aspects of the method were identical to that of Experiment 1.

Results

Targets were scored as remembered, forgotten, or as containing an NP-PP switch using the same criteria as before. Ten participants were excluded because they could not remember at least half of the critical and control targets. The data of the remaining 20 participants were analyzed with subjects (*t1*) and items (*t2*) as random factors. Participants forgot 34.7% of the critical sentences and 39.7% of the control sentences ($t1(19) = -1.29$, p = n.s.; $t2(28) = -.88$, p = n.s.). A syntactic switch was produced in 20.0% of the critical and 9.7% of the control sentences ($t1(19) = 3.75$, $p < .005$; $t2(28) = 2.66$, $p < .025$).

In the distraction task, participants pressed neither the *yes* nor the *no* key in only 2 cases. They gave the correct response in 87.3% of the critical trials and 88.0% of the control trials ($t1(19) = -.27$, p = n.s.; $t2(28) = -.20$, p = n.s.), and took 2239 ms and 2040 ms to complete their responses ($t1(19) = 2.03$, p = n.s.; $t2(28) = .99$, p = n.s.).

We ran a separate analysis for the 15 native bilinguals in the sample and again found qualitatively the same results. The rate of forgetting was similar to that of the whole sample (39.6% of the critical sentences and 45.3% of the control sentences; $t1(14) = -1.14$, p = n.s.). Switches were produced in 22.7% of the critical and 12.0% of the control sentences ($t1(14) = 4.00$, $p < .005$), a 10.7% difference compared to 10.3% for the entire sample.

Discussion

The results of Experiment 2 replicate the findings of Experiment 1. We again found that sentences presented with an NP-NP construction are recalled more often with an NP-PP construction after primes with an NP-PP construction than after primes with a different syntactic structure. The current experiment furthermore showed that thematic similarities are not necessary for switches to occur, replicating for bilinguals an effect already found for monolinguals. The lack of a need for thematic marking supports the idea that languages' shared syntactic representations are semantic-free. Only the most abstract syntactic similarities are needed for priming. It furthermore supports the notion that the syntactic priming effects found with bilingual speakers and the priming effects found with monolingual English speakers can be explained by the same mechanisms. That is, syntax generation for English monolinguals seems to be governed by the same processes as syntax generation for Spanish-English bilinguals.

In Experiments 1 and 2, we measured the frequency of NP-NP to NP-PP switches in English with Spanish primes. In the final experiment, Spanish is the target language, with English primes. The purpose of this experiment is twofold. First, we expand the number of syntactic structures tested. The bulk of syntactic priming research focuses on the NP-NP construction versus the NP-PP construction (this is because the work is done in English). Experiment 3 examines the possibility of switches on two new pairs of syntactic constructions. Second, we test the hypothesis that syntactic priming should also be found when Spanish is the language of recall. If bilinguals use one common set of stored syntactic structures, then syntactic priming should be found in either language.

It might seem evident that if syntactic priming can be found in English for Spanish-English bilinguals, then syntactic priming should also be found in Spanish. This might seem particularly likely given that the priming effects are being elicited from the exact same group of individuals. (The participants of Experiment 3 also participated in either Experiment 1 or Experiment 2.) A related line of research on understanding spoken speech by bilinguals demonstrates that this cannot be assumed a priori (Cutler, Mehler, Norris, and Segui, 1992).

Monolingual speakers of English and monolingual speakers of French employ quite different segmentation strategies during speech comprehension of their respective languages (for details see Cutler, Mehler, Norris, & Segui, 1986; Cutler & Norris, 1988; Mehler, Dommergues, Frauenfelder, & Segui, 1981; also see Sebastián-Gallés, Dupoux, Segui, & Mehler, 1992 for a comparison of Spanish and Catalan). Cutler et al. (1992) investigated whether fluent French-English bilinguals mimicked French monolinguals when understanding French and mimicked English monolinguals when understanding English. They found a complex picture that was related to the language that the bilingual speaker considered the dominant language. English-

dominant bilinguals behaved like English monolinguals with English but did not behave like French monolinguals with French, suggesting that their segmentation processes were based on English. However, the converse with French-dominant French-English bilinguals was not found. French-dominant French-English bilinguals behaved like French monolinguals with French and like English monolinguals with English.

Using these research findings as a precedent, it clearly cannot be considered evident that syntactic priming will be found with Spanish. It is possible that the same Spanish-English bilingual individuals will behave differently depending on the language recalled. That is, syntactic priming may be absent with Spanish targets.

In Experiment 3 we investigated shifts in the order of the verb and direct object pronoun (DOP), and switches between double negation and single negation. In Spanish, the relative order of the verb and the direct object pronoun is more flexible than in English. A direct object pronoun can occur before or after the main verb in Spanish (in verbatim translation, as *she it wants to have* or *she wants to have it*). In English the direct object pronoun must occur after the verb (*she wants to have it*).

To create a negative sentence in Spanish both single negation and double negation can be used. A negative particle such as *nunca* (never) that follows the main verb in the sentence must be accompanied by the word *no* (not) preceding the verb, creating a double negation. *No* is not needed when the negative particle precedes the verb, creating a single negation. Although Standard English does not allow the double negation construction, African-American Vernacular English does. The Standard English sentence *I'm not a strong drinker* would be expressed in African-American Vernacular English as *I'm not no strong drinker* (Labov, 1995).

We manipulated the order of the verb and the direct object pronoun by pairing Spanish target sentences with direct object pronouns preceding the verbs with primes that either encouraged a switch or did not encourage a switch. More precisely, in the critical condition, the primes contained verbs followed by direct object pronouns. In the control condition, the primes did not contain a direct object pronoun. We manipulated negation by pairing Spanish target sentences with double negations with primes that either encouraged a switch or did not encourage a switch. More precisely, in the critical condition, the primes contained single negation constructions. In the control condition, the primes contained affirmative constructions. All primes sentences were written in English.

Experiment 3

Method

Participants. Forty-four students from the University of California Santa Cruz participated in this experiment for course credit. All of them had also been part of one of the previous experiments session. The 18 participants whose results were included in the statistical analysis were all native Spanish-English bilinguals.

Materials. Forty Spanish target and prime pairs were written. Twenty of the pairs tested single versus double negation, and 20 tested verb-DOP order. In 10 of the 20 double negation pairs, the Spanish target sentences contained double negation and the English prime sentences contained single negation. These were the critical pairs. In the other 10 double negation pairs, the Spanish target sentences contained double negation, but the English prime sentences contained no negation. These were the control pairs. In the following examples, negative markers are in italics:

(11) Critical Condition

Target: *No* quedaba *nunca* gente a ese hotel cuando el otro existía.

Verbatim Translation: *No* there-were *never* people in this hotel when the other existed.

Translation: There were *never* people in this hotel when the other existed.

Prime: *Nothing* can be done about the girl's dress which got ruined at the party.

(12) Control Condition

Target: *No* viajaremos *nunca* a un país extranjero por falta de recursos economicos.

Verbatim Translation: *No* we-travel *never* to a country foreign due to lack of resources economic.

Translation: We will *never* travel to a foreign country due to the lack of money.

Prime: The most qualified doctors did what they could to help the dying patient.

If the target sentence in (11) would be recalled with a single negation, it would be expressed as *Nunca quedaba gente a ese hotel cuando el otro existía*.

In 10 of the 20 verb-DOP pairs, the direct object pronoun preceded the verb in the Spanish target sentences and followed the verb in the English prime sentences. These were the critical pairs. In the other 10 verb-DOP pairs, the direct object pronoun preceded the verb in the Spanish target sentences but was absent in the English prime sentences. These were the control pairs. In the following examples, direct object pronouns are in italics:

(13) Critical Condition

Target: La radio es muy fuerte cuando los niños <u>la</u> quieren escuchar.

Verbatim Translation: The radio is very loud when the children <u>it</u> want to listen.

Translation: The radio is very loud when the children want to listen to <u>it</u>.

Prime: The phone probably stopped ringing before Cecilia was able to answer <u>it</u>.

(14) Control Condition

Target: Samuel compró la televisión porque la quería ver en casa.

Verbatim Translation: Samuel bought the television because it wanted to watch at home.

Translation: Samuel bought the television because he wanted to watch it at home.

Prime: The writer outlined the plot for his new novel before he began to write.

If the target sentence in (13) would be recalled with order of the verb and DOP switched, it would be expressed as *La radio es muy fuerte cuando los niños quieren escucharla*. (In written Spanish the direct object pronoun is appended to the verb when it follows the verb.)

In addition to the 40 pairs of critical and control sentences, 10 filler trials and 5 practice trials were written. All other aspects of the method were identical to that of Experiment 1.

Results

The results of 26 participants were excluded from analysis. The data of 12 participants were analyzed incorrectly, and the tapes were lost before the data could be reanalyzed. The data of the other 14 participants were excluded because they forgot at least half of the critical and control targets. The data of the remaining 18 participants were analyzed with subjects (t1) and items (t2) as random factors.

Targets testing double negation were scored as *remembered*, forgotten, *negation forgotten*, *new double negation*, and *single negation*. Participants forgot 22.2% of the critical and 26.1% of the control targets ($t1(17) = -.98$, p = n.s.; $t2(18) = -.55$; p = n.s.). They dropped the negation and created affirmative sentences in 0% of the critical and 2.2% of the control targets ($t1(17) = -2.20$, $p < .05$; $t2(18) = -1.31$; p = n.s.). They used a different negative particle, such as *nothing* instead of *never*, in 12.2% of the critical and 7.8% of the control targets ($t1(17) = 1.84$, p = n.s.; $t2(18) = 1.10$; p = n.s.). And they switched double negation to single negation in 22.8% of the

critical and 22.2% of the control targets ($t1(17) = -.44$, p = n.s.; $t2(18) = -.07$; p = n.s.). In other words, double negation was switched in nearly a quarter of the sentences in both conditions.

Targets testing the order of the verbs and direct object pronouns were scored as *remembered*, *forgotten*, *direct object forgotten*, and *direct object moved*. Participants forgot 27.2% of the critical and 21.1% of the control sentences. This 6.1% difference is not significant ($t1(17) = 1.57$, p = n.s.; $t2(18) = .87$, p = n.s.). They dropped the direct object pronoun from an otherwise correctly recalled sentence in 6.1% of the critical and 10.6% of the control targets ($t1(17) = -1.22$, p = n.s.; $t2(18) = -1.08$, p = n.s.). They moved the direct object pronoun to the position after the verb in 25.6% of the critical and 5.0% of the control targets ($t1(17) = 6.26$, $p < .001$; $t2(18) = 3.27$; $p < .005$).

As before, there is no reason to assume that the distraction task was instrumental in causing a difference in the number of syntactic switches found in the two conditions. Participants pressed neither the *yes* nor the *no* key in zero cases. They gave the correct response in 93.3% of the critical and 88.3% of the control trials of the double negation materials ($t1(17) = 1.31$, p = n.s.; $t2(18) = .96$, p = n.s.), taking on average 2377 ms and 2491 ms to complete the task ($t1(17) = -1.08$, p = n.s.; $t2(18) = -.47$, p = n.s.). Similarly, they gave the correct response to 93.3% of the critical and 90.6% of the control trials of the verb-DOP materials ($t1(17) = .92$, p = n.s.; $t2(18) = .52$, p = n.s.), taking on average 2195 ms and 2206 ms to complete the task ($t1(17) = -.13$, p = n.s.; $t2(18) = -.09$, p = n.s.).

Discussion

In Experiment 3 we set out to find syntactic priming in Spanish target sentences using English prime sentences. We were successful in obtaining a syntactic priming effect. However,

we only found this effect for the verb-DOP order manipulation. We failed to obtain a priming effect for the double negation versus single negation manipulation.

In both the control and critical conditions, almost a quarter of the target sentences containing a double negation were recalled with a single negation. In other words, there is a strong tendency towards expressing the target sentences with a single negation. It may be that single negation and double negation are not truly interchangeable structures. Several participants remarked that they rarely used double negation and had a strong preference for single negation at all times. Others said they did use both structures, but only used double negation for emphasis.

In other words, people may have recalled target sentences with single negation because double negation is a marked structure semantically. This factor may have overridden any potential influence of the experimental manipulation. It remains to be seen whether the same lack of priming will be found with Spanish monolinguals. It is possible that the double negation is especially marked for Spanish-English bilinguals because of the absence of this structure in English.

We were able to find a strong cross-linguistic priming effect for the order of verbs and direct object pronouns, however. Spanish target sentences originally presented with DOP-verb order were recalled more often as verb-DOP after English prime sentences with a verb-DOP order than after English prime sentences without a DOP. The presence of the pronoun in the critical condition versus the absence of the pronoun in the control condition did not lead to a difference in the percentage of pronouns dropped from an otherwise correctly recalled sentence. It was the relative order of the verb and the pronoun rather than the mere presence of the pronoun that was the effective manipulation.

General Discussion

Investigations of bilinguals provide unique opportunities to further extend our knowledge of language processing. Speech production models based on monolingual performance may need to be upgraded to accommodate bilingual speakers. In the remainder of this paper we will recap our experiments and discuss the implications for monolingual and bilingual models of syntax generation.

In three experiments we examined syntactic priming with Spanish-English bilinguals. We tested NP-NP constructions versus NP-PP constructions in English, both with and without thematic similarity. In Spanish, we tested double negation versus single negation and the relative order of the verb and the direct object pronoun. A summary of these findings is given in Table 1.

In the first two experiments, English target sentences with an NP-NP construction were more likely to be recalled with an NP-PP construction after the presentation of Spanish primes with an NP-PP construction than after the presentation of Spanish primes without an NP-PP construction. This effect occurred both when targets and primes shared thematic similarities (Experiment 1) and when they did not (Experiment 2). These results replicate similar syntactic priming effects found with English monolinguals (Bock, 1986; Bock & Loebell, 1990; Fox Tree & Meijer, 1999).

In the third experiment we found syntactic priming in Spanish target sentences. Sentences presented with the direct object pronoun preceding the verb were recalled more frequently with the direct object pronoun following the verb after verb-DOP English primes than after English primes without a direct object pronoun. However, target sentences with a double negation construction were as likely to switch to a single negation construction after English primes with a single negation construction as after English primes with an affirmative construction. In fact, these switches occurred in nearly a quarter of the sentences in both conditions. It is quite possible

that double negation and single negation are not interchangeable structures and that double negation is semantically marked. Therefore, priming the syntactic unit for single negation is inconsequential to target sentence recall, as it is not in competition with the double negation unit. But because it is based on a null effect, further research will have to establish whether this explanation holds, for both Spanish monolinguals as well as Spanish-English bilinguals.

In the introduction we presented the lemma-driven phrase structure theory of syntax production. The theory posits that when going from a message-to-be-expressed to the utterance conveying that message, lemmas are chosen that trigger the selection of an initial set of candidate syntactic structures. The lemmas point to viable syntactic rules that are stored as abstract units in the mental lexicon. The activation metaphor provides a mechanism for understanding syntactic priming within the confines of this theory. In essence, the presentation of a prime sentence leaves residual activation on a syntactic unit, increasing its likelihood for immediate reselection during the recall of the target sentence.

For instance, during recall of the sentence *The man is reading the child a book*, the verb *to read* activates the NP-NP rule and the NP-PP rule among the possible candidates that allow for the integration of the verb into a syntactically well-formed utterance. The words *book* and *child* provide extra activation for these rules because they enable the integration of these words into the utterance while functioning in the thematic roles of direct object and indirect object, and thus creating an utterance that is congruent with the message to be conveyed. (This contrasts with, say, the utterance *The man and the child are reading the book*. Although the same lemmas are being used in a syntactically correct sentence, the meaning of the utterance is inconsistent with the intended message to be conveyed and thus will not be used to express this message.) A prior encountering of a prepositional-object prime sentence would leave the NP-PP rule with residual

activation, giving it a head start over the competing NP-NP rule and increasing its likelihood of selection.

Although the lemma-driven phrase structure theory describes syntax generation in the monolingual situation, it can easily be extended to incorporate the priming effects found for Spanish-English bilinguals. The theory needs to be augmented by assuming the syntactic rules necessary for both languages are centrally stored. These rules are not labeled with respect to the language they are used for.

So, the target sentence *The car salesman sold the young woman a red sports car* is presented with an NP-NP construction but can also be expressed with an NP-PP construction. The prime *La mujer le trajo el niño que dormía a su mamá preocupada* (The woman brought the child that slept to her worried mother) has an NP-PP construction. Because there is a single NP-PP rule that is used to generate sentences both in Spanish and English, the residual activation caused by the presentation of the Spanish prime increases the likelihood for this rule to be selected for the regeneration of the English target sentence. Assuming that it's semantically marked, double negatives shouldn't prime single negatives because the meaning is different (the lemma-driven theory goes from meaning to syntax).

The assumption of a central storage does not complicate utterance construction for bilingual speakers compared to monolingual speakers. Although bilingual speakers will have a larger set of syntactic rules stored, only the appropriate rules will be selected during sentence production; that is, the rules short-listed as viable for the words contained in the utterance. For monolinguals and bilinguals alike, rules that are not pointed at by the selected words will lay dormant and will not influence utterance construction. At the same time, because syntax generation is not completely separate for each language, the possibility remains that inappropriate rule selection

may occur. This could lead to the creation of an English sentence with a syntactic structure that's only permissible in Spanish. Our subjective everyday experience, with a variety of bilingual language combinations, suggests this to be true.

Another common example of the interweaving of two languages is *code switching* (Sridhar & Sridhar, 1980; Grosjean, 1989; Heredia & Altarriba, 2001; Romaine, 1989). Bilinguals engaged in conversations with each other do not have to limit themselves to one language, considering that they have both languages at their mutual disposal. During conversations, these speakers frequently switch back and forth between the two languages to use an expression or word that best describes a certain thought. Switching most commonly involves a single noun. With larger portions, bilinguals switch between rather than within syntactic constituents (Azuma, 1996). Code switching, while allowing for the best semantic expression possible across the languages, does not generally affect the coherence or grammaticality of bilinguals' utterances.

The proposed extension of lemma-driven phrase structure theory provides an explanation for the preservation of coherence and grammaticality of code-switched utterances. Constructing a grammatical code-switched utterance is no different from constructing a grammatical monolingual utterance, because syntactic rules are centrally stored, language-aspecific, and manipulated by a common set of syntax selection processes. That is, if the words chosen to convey a message point to syntactic rules that together can form a coherent utterance, then the appropriate syntactic tree can be built, even if the words in the utterance are from different languages.

Although the mechanisms underlying syntax generation by Spanish-English bilinguals appears to be aspecific to the language of the utterance, it is impossible to imagine that the same holds for all the processes and structures involved in speech production. It is clear that the words

that are part of one language need to be separated from the words of the other language. Having made this observation, there are various models of bilingual lexical access that obey this constraint but vary greatly in the structures and processes they propose as well as their predictions (e.g., Costa, Miozzo, & Caramazza, 1999; Francis, 1999; Heredia, 1997; Kroll & Stewart, 1994; Potter, So, von Eckhardt, & Feldman, 1984). In the introduction we mentioned that our experiments are agnostic as to whether lemma representation is language-specific or not; that is, whether one lemma is used to represent the semantic and syntactic information of an English word and another lemma is used to represent that information of its Spanish translation equivalent, or whether one and the same lemma is used for both the Spanish and English words. Nonetheless, these theoretical stances make different predictions about the process of syntax generation in the bilingual situation.

First, let's consider the case that lemmas are language-specific. In this case, each lemma points only to the syntactic structures that are permissible in the given language. For example, activating *soup* and *magical* would allow the NP *magical soup* (but not *soup magical*), whereas *sopa* and *mágica* would allow the NP *sopa mágica*. Notice that the syntactic rules themselves are language-aspecific (e.g., the syntactic units Adjective-Noun and Noun-Adjective are not labeled for language).

Next, let's consider the case that lemmas are language-aspecific, paralleling the hypothesis that syntactic rules are language-aspecific. If one lemma unit is used to represent the semantic/conceptual information regarding an English word and its translation equivalent, this lemma would have to point to all permissible syntactic units for the combined languages, some of which might be permissible in one language but not the other. This organization of the lemma suggests that bilinguals make a lot of syntactic errors. But we know that fluent bilinguals are

successful in creating well-formed utterances to a level that is comparable to monolinguals, even when the utterance is well-formed in the target language but not permissible in the other language. Another mechanism must then filter out the syntactic rules that are not permissible in the target language. One possibility is that a language-specific selection mechanism prevents the use of language-incongruent syntactic structures. This mechanism could act rather globally, like the mechanism Costa et al. (1999) propose with respect to lexical selection. The lemmas point to language-aspecific rules, but a selection mechanism prevents some rules from being used in particular languages.

The current experiments show that the use of a syntactic structure in one language acts as a prime of the structure in the other language. These effects can be explained by the lemma-driven model where lemmas drink from one and the same pool of syntactic structures. Whether these lemmas are separate, shared and/or interconnected across languages is a separate question that is not addressed by our experiments.

Finally, our study investigated fluent Spanish-English bilinguals who in most cases grew up with both languages while residing in Central California. It remains to be seen whether cross-linguistic syntactic priming effects will also be obtained for other populations, such as bilinguals who are less fluent or speak different languages. Bilingual investigations of other components of language processing, some of which were discussed in this paper, have found that the combinations of languages spoken, the levels of exposure to each language, and language-dominance were influencing factors. Further research should be done to investigate the role of these factors in syntax generation.

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Table 1

Summary of Syntactic Manipulations and Results

	% Switches		
Syntactic Manipulation (Language of the Target)	Critical	Control	Difference
NP-NP/NP-PP, thematic similarity (English)	14.4	7.8	6.6 *
NP-NP/NP-PP, no thematic similarity (English)	20.0	9.7	10.3 *
Double/Single negation (Spanish)	22.8	22.2	0.6
Sentence order, DOP (Spanish)	25.6	5.0	21.6 **

*significant at the .05 level; **significant at the .01 level

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