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HOW SPANISH SPEAKERS USE REFERENTIAL INFORMATION IN THE RESOLUTION
OF PREPOSITIONAL PHRASE SYNTACTIC AMBIGUITY

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ABSTRACT

Fifty-five participants took part in an eye-tracking study examining how referential information impacts the resolution of syntactic ambiguity. The participants were native speakers of Spanish with varying levels of proficiency in English. The ambiguity under examination here is prepositional phrase (PP) ambiguity, which is exemplified in the following sentence: "Put the frog *on the napkin* in the box". The research question focused on whether participants interpreted the ambiguous PP as a verb phrase modifier (indicating where the frog must be moved to) or a noun phrase modifier (indicating which frog should be moved). An additional feature of the experiment focused on how participants interpreted the ambiguity in the context of a visual scene with one-referent or two-referents. The results showed that Spanish speakers, similar to English speakers, use referential information to guide their parsing decisions. Additionally, Spanish speakers show a preference for VP-attachment as has been shown in speakers of German, Greek and English.

Keywords: sentence processing, ambiguity resolution, cross-linguistic variation, Spanish language processing, referential context, visual-world

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Chapter 1

Introduction

A significant amount of research has examined the type of information that allows speakers to understand the sentences that they hear or speak. This research has made use of syntactic ambiguity to uncover the architecture of the human sentence processing mechanism. Syntactic ambiguity occurs when a sentence can be interpreted in more than one way. For example, in (1) below (taken from Frazier 1979), the phrase *who was on the balcony* is syntactically ambiguous because it can be interpreted as referring to two different entities: the sister is on the balcony or the actor is on the balcony:

(1) An armed robber shot the sister of the actor *who was on the balcony*.

Because speakers are faced with the task of making a choice, the use of syntactic ambiguity allows researchers to uncover the information that guides sentence processing.

There are two general views regarding the type of information that speakers use to guide the interpretation of sentences: the universal view and the language-dependent view. According to the universal view, the initial information that speakers use is innate and therefore universal across languages (Frazier 1979; Frazier & Rayner, 1982). Returning to example (1), research has shown that English speakers interpret the sentence as "an armed robber shot the *actor* who was on the balcony", favoring a strategy that leads to focusing on the last noun (*actor*) in the sentence over the first noun (*sister*). This strategy is referred to as the *late closure strategy* (Cuetos and Mitchell, 1988). Those who hold the universal viewpoint would argue that because English speakers consistently interpret sentences similar to (1) in this way, this is taken as evidence that this strategy must be universal.

Another view suggests that the information speakers access is language-specific (MacDonald, Pearlmutter, & Seidenberg, 1994). This view argues that whereas English speakers prefer to use a late closure strategy when trying to interpret an ambiguous sentence such as in example (1) above, speakers of

other languages may use a different strategy to interpret the same sentence. And in fact, this has been the case. Cuetos and Mitchell (1988) showed that Spanish speakers show a preference for interpreting the syntactically ambiguous phrase *who was on the balcony* as referring to the *sister* (what is termed early-closure). This cross-linguistic difference brings us to several important questions: Do the speakers of all languages interpret syntactically ambiguous sentences in the same way? Or do they apply language-specific strategies? To understand the workings of the human sentence processing mechanism, we must look at different languages and different types of sentence structures.

In recent years, one syntactically ambiguous structure that has been examined quite extensively in English is the so-called Verb phrase/Noun phrase ambiguity. An example is provided in (2):

(2) Put the frog on the napkin in the box.

Here, the prepositional phrase *on the napkin* it is syntactically ambiguous because it can be interpreted as either a noun-phrase modifier (referring to which frog should be placed in the box: the frog on the napkin) or a verb-phrase modifier (referring to where the frog should be placed: on the napkin). A study conducted by Trueswell, Sekerina & Hill (1999) presented English-speaking participants with sentences similar to (2) along with a visual display that showed one of two contexts: (a) A one-referent context (a display with a frog and a distractor animal), and (b) A 2-referent context (a display with two frogs). Examples of the displays are shown in Figure 1 below.
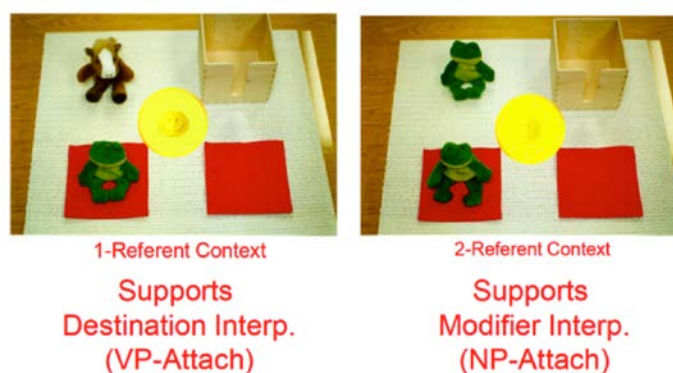
Figure 1: Visual World Display from Trueswell et al., 1999

The study was a visual-world study, which is a technique in which participants are presented with a visual scene while they hear instructions to move the objects in front of them. Participant's eye-movements are recorded as they follow these instructions. The findings showed that in the presence of a one-referent context, which supported the verb-phrase modifier interpretation (also known as the destination interpretation), adults made errors such that they began moving the frog to the empty napkin. Only after hearing the phrase "in the box," were adults able to correct their interpretation. However, in the presence of a two-referent context, which supported the noun phrase modifier interpretation, the participants moved the frog that was on the napkin into the box (Trueswell, 1999).

Although this type of ambiguity has been extensively studied in English (Trueswell et al., 1999; Pozzan, Lucia, & Trueswell, 2016), there is a lack of research analyzing the strategies that Spanish speakers use when faced with the same type of ambiguity. This lack of research leads to the foundation of the current study. The understanding of language parsing strategies in Spanish may help to clarify how certain strategies for resolving ambiguous sentence structures are language dependent. Like in previous studies, in the experiment presented here, the critical structure will contain a syntactically ambiguous

prepositional phrase, much like the one employed in Trueswell et al (1999). Importantly, this structure can be translated into Spanish in one of two ways: (1) "Pon la rana *en la servilleta* encima de la caja" (Put the frog *on the napkin* in the box) and (2) "Pon la rana *de la servilleta* encima de la caja" (Put the frog *of the napkin* in the box). The structure shown in (2) is preferred in Spanish, likely because the prepositional phrase renders the sentence unambiguous, whereas in example (1), the prepositional phrase is ambiguous. In this study, we will focus on structures in Spanish similar to (1).

In the next section, I will discuss cross-linguistic preferences with different ambiguous structures, including evidence that speakers of different languages (e.g., French, Brazilian Portuguese and Greek) engage different strategies when processing syntactically ambiguous structures. Subsequently, I will discuss studies examining how speakers of English, Greek and German interpret the ambiguous structure under examination here and the goals of the present study.

Cross-linguistic differences in parsing preferences

1.   Relative-clause ambiguity resolution

One way that syntactic ambiguity has been studied extensively is through examining sentences that contain relative clause ambiguity. Let's return momentarily to example (1) again (repeated below as (3) for ease of exposition):

(3) An armed robber shot the *sister* of the *actor who was on the balcony.*

The sentence in (3) is composed of a *complex noun phrase* (i.e., sister of the actor) followed by a *relative clause* (i.e., who was on the balcony). Here, the relative clause *who was on the balcony* can be interpreted as referring either to *sister* (termed early-closure attachment in the literature) or to *actor* (termed late-closure attachment); hence, the syntactic ambiguity. Dozens of studies have shown cross-linguistic

variations in the interpretation of relative clause ambiguity through a variety of experimental techniques.

Research has shown that while speakers of English (Cuetos et al., 1988), Brazilian Portuguese

(Miyamoto, 1998), Arabic (Abdelghany and Fodor, 1999), Romanian, Swedish and Norwegian (Ehrlich,

Fernández, Fodor Stenshoel and Vinereanu, 1999) prefer late-closure attachment, speakers of Spanish

(Cuetos et al., 1988), French (Zagar, Pynte and Rativeau, 1997), Dutch (Mitchell, Brysbaert, Grondelaers

and Swanepoel, 2000), German (Brysbaert and Mitchell, 1998), Afrikaans (Hemforth, Konieczny and

Scheepers, 2000) and Greek (Papadopoulou and Clahsen, 2003) prefer early-closure attachment.

A study by Zagar, Pynte and Rativeau (1997) looked at attachment preferences in French in

sentences with relative clause ambiguity similar to example (5):

(5)   Un journaliste aborda l'avocat de la chanteuse qui semblait plus confidante que de
        raison.
        [A journalist approached the barrister of the singer *who seemed more confident* than she
        out to.]

In this example, *who seemed more confident* is the ambiguous relative clause that can be interpreted as

referring to either *the barrister* or *the singer*. An important point to note is that French differs from

English in that French nouns and their corresponding adjectives are assigned a grammatical gender.

Grammatical gender is a feature of nouns that have consequences for surrounding words. For example, in

sentence (6) the word *chanteuse* [singer] carries female gender; *avocat* [barrister], on the other hand,

carries masculine gender. French, like other Romance languages, has rules requiring that words

modifying nouns match the nouns in grammatical gender. In order to form sentences that are

grammatically correct in French, the noun and the adjective modifying it must agree in grammatical

gender. Returning to example (6), *confiante* [confident] is marked for feminine gender. Therefore, it can

only refer to *chanteuse*.

(6)   Un journaliste aborda l'avocat$_{MASC}$ de la chanteuse$_{FEM}$ qui semblait plus confiante$_{FEM}$ que
        de raison.
        [A journalist approached the barrister$_{MASC}$ of the singer$_{FEM}$ who seemed more
        confident$_{FEM}$ than she ought to.]

In Zagar et al. (1997), the authors used two different tasks: a sentence completion task and a reading task to determine attachment preferences in French speakers. In the sentence completion task, participants were asked to complete sentences such as in example (6) that were truncated right before an adjective. This is shown is (7):

(7) Un journaliste aborda l'avocat$_{MASC}$ de la chanteuse$_{FEM}$ qui semblait plus…
[A journalist approached the barrister$_{MASC}$ of the singer$_{FEM}$ who seemed more…]

Given that the only possible completion to the sentence is with an adjective, the authors were interested in examining whether participants assigned it feminine or masculine gender. The results of the sentence completion task showed that participants overwhelmingly preferred to complete the sentence like (7) with adjectives carrying masculine gender, indicating their preference for early-closure attachment. The experiment also included a reading task where participants read completed sentences with the same structure as shown in example (6) above. Two versions of each sentence were prepared, one in which the final adjective agreed in number and gender with the first noun in the complex noun phrase (supportive of early-closure attachment) and one in which the final adjective agreed in number and gender with second noun in the complex noun phrase (supportive of late-closure attachment) as shown in example (8):

Context supportive of late-closure attachment:

(8a) Un journaliste aborda l'avocat$_{MASC}$ de la chanteuse$_{FEM}$ qui semblait plus confiante$_{FEM}$ que de raison.
[A journalist approached the barrister$_{MASC}$ of the singer$_{FEM}$ who seemed more confident$_{FEM}$ than she out to.]

Context supportive of early-closure attachment:

(8b) Un journaliste aborda l'avocat$_{MASC}$ de la chanteuse$_{FEM}$ qui semblait plus confiant$_{MASC}$ que les autres.
[A journalist approached the barrister$_{MASC}$ of the singer$_{FEM}$ who seemed more confident$_{MASC}$ than the others.]

Participants saw only one version of each sentence displayed on a monitor while a standard infrared limbus-tracking device tracked their eye-movements on the screen. Longer reading times were taken to indicate difficulties interpreting the sentence. If French speakers preferred an early-closure strategy they

would be expected to take longer to read sentences such as (8a) as compared to (8b) and this is precisely what they found.

Another study by Papodopoulou and Clahsen (2003) examined the interpretation of sentences containing relative clause ambiguity in Greek. Greek nouns and adjectives, like French, are assigned grammatical gender. The researchers used a reading task where participants saw one of four versions of a sentence; in this review, we will only focus on the two critical sentences: (a) a structure supporting early-closure attachment, where the adjective at the end of each sentence agreed with the first noun in the complex noun phrase; (b) a structure supporting late-closure attachment, where the adjective agreed with the second noun in the complex noun phrase. Examples of these sentences can be found in (9):

Relative clause supporting early-closure:

(9a)　Enas kirios fonakse ton fititi me tin kathighitria pu itan apoghoitevmenos apo to neo ekpedheftiko sistima.
[A man called the student$_{MASC}$ with the teacher$_{FEM}$ *who was disappointed*$_{MASC}$ by the new educational system.]

Relative clause supporting late-closure:

(9b)　Enas kirios fonakse ton fititi me tin kathighitria pu itan apoghoitevmeneni apo to neo ekpedheftiko sistima.
[A man called the student$_{MASC}$ with the teacher$_{FEM}$ *who was disappointed*$_{FEM}$ by the new educational system.]

The sentences were displayed on a computer monitor in a segment-by-segment fashion (i.e., participants read one segment of the sentence before they were able to see the next). The study showed increased reading times for sentences that like (b), supporting the idea that monolingual speakers of Greek, like French speakers (Zagar et al., 1997), show a preference for early-closure attachment.

In a study conducted by Miyamoto (1998), native speakers of Brazilian Portuguese (BP), living in the United States read sentences containing relative clause ambiguities. Nouns and adjectives in Portuguese, similar to French and Greek, must agree not only in grammatical gender, but also in grammatical number (i.e., singular like "dog" and plural like "dogs"). Unlike Zagar et al. (1997) and

Papadopoulou and Clahsen (2003), Miyamoto used grammatical number (instead of grammatical gender) to disambiguate the sentence. Miyamoto presented participants with the following conditions: (A) a sentence containing a relative clause that agreed in number with the first noun (N1) in the noun-phrase complex (supportive of early-closure attachment), (B) a sentence containing a relative clause that agreed in number with the second noun (N2) in the noun-phrase complex (supportive of late-closure attachment), (C) a sentence without a relative clause with an ending statement that agreed in number with N1, (D) a sentence without a relative clause with an ending statement that agreed in number with N2. Examples of the types of sentences used in the study can be seen in (10):

Relative clause supporting early-closure:

(10a)   O ator tentou ignorar a manchete das revistas que foi mencionada no rádio.
[The actor tried to ignore the headline$_{SINGULAR}$ of the magazines$_{PLURAL}$ *that was mentioned$_{SINGULAR}$* on the radio.]

Relative clause supporting late-closure:

(10b)   O ator tentou ignorar as manchetes da revista que foi mencionada no radio.
[The actor tried to ignore the headline$_{PLURAL}$ of the magazine$_{SINGULAR}$ *that was mentioned$_{SINGULAR}$* on the radio.]

Ending statement in agreement with N1:

(10c)   O ator tentou ignorar a manchete das revistas mencionada no rádio.
[The actor tried to ignore the headline$_{SINGULAR}$ of the magazines$_{PLURAL}$ mentioned$_{SINGULAR}$ on the radio.]

Ending statement in agreement with N2:

(10d)   O ator tentou ignorar as manchetes da revista mencionada no rádio.
[The actor tried to ignore the headlines$_{PLURAL}$ of the magazines$_{SINGULAR}$ mentioned$_{SINGULAR}$ on the radio.]

Sentences were presented using a word-by-word moving-window self-paced reading procedure, where participants were presented with one word at a time on a computer monitor, and were required to finish reading one word before the next word appeared on the screen. If speakers of Brazilian Portuguese preferred early closure attachment, sentences like (10a) should have taken less time to read than sentences like (10b). Results showed increased reading times with sentences like (10a) relative to (10b), suggesting

that, unlike French or Greek (Zagar et al., 1997; Papadopoulou & Clahsen, 2003), Portuguese (like English) favors late closure over early closure (Cuetos et al., 1988; Miyamoto, 1998; but see Ribiero, 1998 and Ribiero, 2001 for different findings).

2. Prepositional phrase ambiguity resolution

Many studies have examined how English speakers resolve prepositional phrase (PP) ambiguity. Studies that have previously looked at PP ambiguity resolution with adult English speakers (e.g., Trueswell et al. 1999) show that in the presence of a visual scene that supported the 'destination interpretation' (also dubbed VP-attachment), adults made errors such that they began moving the frog to an empty napkin, when hearing the sentence "Put the frog on the napkin into the box". Only after hearing the phrase *in the box,* were adults able to correct their interpretation. However, in the presence of a visual scene that supported the 'modifier interpretation' (known as NP-attachment), adults moved the frog that was on the napkin into the box. In addition to studying PP ambiguity in adults, Trueswell et al. (1999) also looked at how children interpreted this ambiguity. The studied showed that in the presence of a visual scene that supported the destination interpretation (one-referent context), children similar to adults, made errors such that they began moving the frog to the empty napkin. They were only able to revise their initial interpretation after the phrase *in the box.* However, dissimilar to adults, in the presence of a visual scene that supported the 'modifier interpretation' (two-referent context) children were still unable to correctly resolve the ambiguity. This indicates that children have difficulty using the visual context in order to aid in their interpretation of ambiguous structures, and suggests that children show a preference for VP-attachment regardless of the visual context they are given. These data suggest that the immature (child) parser functions via the use of different strategies than the mature (adult) parser (Trueswell et al., 1999).

Another study by Joseph and Liversedge (2013) looked at prepositional phrase syntactic ambiguity resolution in English-speaking children (6 -11 years old) as compared to English speaking adults. The study involved a reading task where participants' eye-movements were recorded as they saw sentences like (11a):

(11a) The boy poked the elephant *with the long stick* from outside the cage.

The sentence in (11a) is temporarily ambiguous because the prepositional phrase *with the long stick* can interpreted in one of two ways: (1) as a verb-phrase modifier (i.e. modifying *poked*) or, (2) as a noun-phrase modifier (i.e. modifying *the elephant*). Previous studies that have looked at PP ambiguity resolution with similar sentence structures in English-speaking adults have shown that adults prefer attaching the PP to the verb-phrase in sentences like (11a). In order to explore the presence of this phenomenon in children, the children and adults in this study saw one of two versions of each sentence (as depicted in (11a) above and (11b) below):

(11b) The boy poked the elephant *with the long trunk* from outside the cage.

Example (11b) differs from (11a) in that *with the long trunk* forces the noun-phrase modifier interpretation because "trunk" cannot be used as a poking instrument. Based on the previous evidence that adults prefer verb-phrase modifiers to noun phrase modifiers when resolving PP syntactic ambiguity, the researchers hypothesized that adults would show increased reading times for sentences like (11b). Similarly, they hypothesized that children would show increased reading times for sentences like (11b). The researchers also hypothesized that children would experience greater difficulties (shown in increased reading times) in revising their initial parsing agreements than adults. The results of the study supported all of these hypotheses. This can be taken as evidence that children's processing of these structures differs from adults in that children's processing is significantly slower (Joseph & Liversedge, 2013).

A study by Snedeker and Trueswell (2004) also looked at children's processing of PP syntactic ambiguity resolution as compared to adults. The children in the study were 4 -10 years of age. Senedeker and Trueswell (2004) used a visual-world study that recorded participant's eye-movements while they interpreted sentences like (12):

(12) Feel the frog *with the feather*.

The PP *with the feather* is ambiguous because it could be interpreted as modifying the verb-phrase (VP-modifier) or modifying the noun phrase (NP-modifier). Participants heard these sentences in the context of two different types of visual scenes, similar to those in Trueswell et al. (1999). An example of the one-referent display is shown below in figure 2. The 2-referent display varied from the one-referent display in that it contained another target animal without an instrument (i.e., a frog, target, without a feather, instrument) instead of a distractor animal (i.e., a leopard). To reiterate from the study referenced previously by Trueswell et al. (1999), the one-referent display is supportive of the VP-modifier interpretation, while the two-referent display is supportive of the NP-modifier interpretation. Evidence from adult speakers of English supports the idea that the VP-modifier interpretation is highly preferred when adults are confronted with PP ambiguity. The researchers hypothesized that if the children in the study were able to use referential clues to resolve the syntactic ambiguity in the presence of a visual scene (the strategy that has been seen in adults), then both their eye-movements (i.e. looks to the target animal, frog, as opposed to the feather) and actions (i.e. touching the frog that has a feather) should show that they interpreted the ambiguous phrase as a NP-modifier in the two-referent context. This would show that children are able to rely on referential information to guide their parsing preferences as opposed to relying simply on a bias for VP-attachment as has been seen in previous studies. The results showed that children continued to look to the instrument (the feather), which supports evidence from studies such as Trueswell et al. (1999) that have found that children have difficulty using the visual context to aide in their disambiguation of these ambiguous structures. However, the children in this study showed reduced

fixations to the instrument in the two-referent context as compared to the one-referent context, which indicates that children do not consider VP-attachment as strongly in this context as they do in the one-referent context. These data support the idea that children use similar mechanisms as adults to resolve syntactic ambiguity, but that these mechanisms are still undergoing development during adolescence (Snedeker & Trueswell, 2004).

a. One-Referent Context
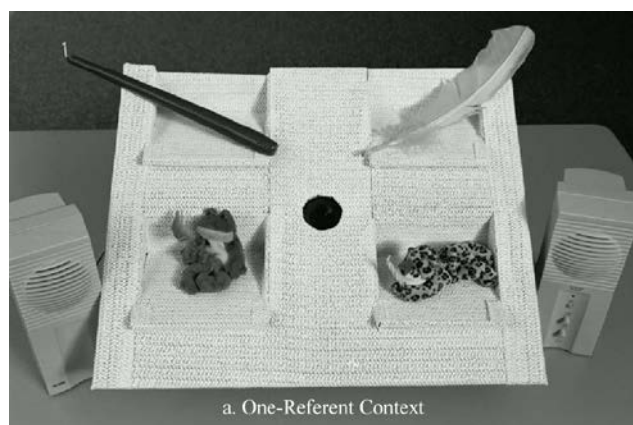
Figure 2: Visual World Display from Snedeker and Trueswell (1999)

In addition to being studied in English, PP ambiguity has been studied in monolingual speakers of Greek and German. Katsika (2009) examined how speakers of Greek process this structure. The study showed participants four versions of the same sentence shown in example (13), although only two versions of the sentence will be discussed here:

Supportive of VP-attachment:

(13a) O kipuros ekopse to kladhi me to maheri.
[The gardener cut the branch with the knife.]

Supportive of NP-attachment:

(13b) O kipuros ekopse to kladhi me to luludhi.
[The gardener cut the branch with the flower.]

The sentence in (13a) is supportive of VP-attachment because a knife is an instrument that can only be used by a human, whereas the sentence in (13b) forces NP-attachment because a flower cannot be used as an instrument. The study included two different research techniques: one time-independent technique and

one time-dependent technique. The time-independent technique consisted of showing participants

sentences similar to those shown in (13a) and (13b) and asking them to rate the sentences on a scale from

one to five in terms of plausibility (i.e., whether the sentence made sense), one being "implausible" and

five being "absolutely plausible". The researcher hypothesized that participants would rate sentences with

VP attachment, such as the example in (13a), as more plausible. The results of the study supported this

hypothesis. The time-dependent portion of the study was a self-paced reading experiment where

participants' eye movements were tracked as they read sentences similar to (13a) and (13b). The

researcher predicted that increased reading times would be indicative of judging sentences such as (13b)

as ungrammatical, showing a preference for VP-attachment over NP-attachment. The results of the study

supported this prediction (Katsika, 2008).

Research by Konieczny, Hemforth, Scheepers & Strube (2010) examined a similar structure in

German, containing either VP- or NP-attachment biases (shown in (14a) and (14b)):

Supportive of VP-attachment:

(14a)   Gersten erfuhrich, daß Franz den Dackel mit der weißen Krücke steiß.
         [Gersten learned that Franz was beating the dachshund with the white crutch.]

Supportive of NP-attachment

(14b)   Gersten erfuhrich, daß Franz den Dackel mit dem struppigen Fell steiß.
         [Gersten learned that Franz was beating the dachshund with the shaggy coat.]

These sentences are ambiguous because the prepositional phrases "with the white crutch" and "with the

shaggy coat" could refer to either "the dachshund or "Franz". However, the PP "with the white crutch"

supports VP-attachment because it is an instrument, whereas the PP "with the shaggy coat" most

reasonably refers to the "dachshund", which supports NP-attachment. This study utilized eye-tracking

technology as participants read sentences similar to those in (14a) and (14b). Longer reading times were

taken to indicate difficulty in processing the structure. The researchers predicted that participants would

show longer overall reading times for sentences supportive of NP-attachment as opposed to VP-

attachment, indicating an overall preference for VP-attachment. The results confirmed this hypothesis,

showing that total reading time was slightly shorter for sentences written in the context supportive of NP-attachment (Konieczny et al., 2010).

Goals of the present study

The focus of this study is to examine the strategies that native Spanish speakers use to resolve prepositional phrase ambiguity. This will lead to a better understanding of whether or not certain strategies for resolving prepositional phrase ambiguities are language-dependent or universal. As stated earlier, Spanish has two ways of expressing the structure under examination, as can be seen in examples (14) and (15):

> (14)   Pon el guante *en* la bolsa encima de la caja.
>   [Put the glove *on* the napkin on the box].
> (15)   Pon el guante *de* la bolsa encima de la caja.
>   [Put the glove *of* the bag on the box].

The structure in (14) is ambiguous because the PP *en la bolsa* [*on the* napkin] can lead to dual interpretations, acting either an NP-modifier or as a VP-modifier. However, the structure in (14) is unambiguous because the PP *de la bolsa* [*of the bag*] gives the glove ownership of the bag, forcing a NP-modifier interpretation of the sentence. We theorize that example (15) would be the most preferred structure in Spanish as it disambiguates the sentence, whereas this structure is not grammatically correct in English and would therefore be dis-preferred. The scope of this study includes looking at syntactically ambiguous structures. Therefore, to maintain the ambiguity of the structure, I have opted to use the word *en* instead of *de*.

Chapter 2

Method

Participants

Fifty-six participants, ages 18-27 (Mean: 21 years, SD: 1.87), took part in the study that was

conducted at the University of Puerto Rico in San Juan, Puerto Rico. Participants were recruited from the

university. All of the participants were compensated monetarily for taking part in the study. The data from

one participant was excluded for too few fixations. This occurred due to the participant using peripheral

vision to compete the task, and therefore not making sufficient eye-movements to the critical areas of

interest. Every participant was a native Spanish speaker with varying levels of English proficiency. The

participants were given the Language Experience and Proficiency Questionnaire (LEAP-Q) to assess their

functional proficiency in both Spanish and English via self-report (e.g. age of acquisition, years of

education, spoken proficiency, written proficiency, etc.). The LEAP-Q contains twenty-three questions in

total with ten open-ended questions and eleven questions that participants answered on a scale from 1-10.

Results from the questionnaire (shown in appendix E) showed that participants reported using Spanish

68% of the time (SD: 23.6) and English 34% of the time (SD: 23.2). The data showed that participants

had lived for an average of 20 years in a Spanish speaking country (SD: 4.51) and 9 years in an English

speaking country (SD: 9.73), and had an average of 16 total years of education (SD: 1.94). Participants'

average self-rated spoken proficiency was a 9 out of 10 in Spanish (SD: 1.21) and 7 out of 10 in English

(SD: 2.59).

Participants' language skills in Spanish and English were also tested on a word production task,

the Verbal Fluency. In this task, participants were shown word categories (e.g,. "fruits", "colors", "parts

of the body", "furniture", "instruments", "animals", "vegetables", "clothing" and their direct translations

in Spanish) on a computer monitor and were asked to list as many exemplars of the category as possible.

For each category, participants were allotted 30 seconds. This task was indicative of participant's

language dominance. Participants scored an average of 44 words on the Spanish Verbal Fluency task (SD:

7.91) and an average of 38 words on the English Verbal Fluency task (SD: 13.6) indicating dominance in

Spanish over English (results shown in Appendix E).

Apparatus

Previous studies examining syntactic ambiguity resolution have used various techniques. In this

experiment, eye-tracking was used to achieve the goals of the study. Eye-tracking was selected due to the

higher level of sensitivity to syntactic processing over other timed techniques (Rayner, Sereno, Morris,

Schmauder, & Clifton, 1989, as referenced in Dussias & Sagarra, 2007). An Eyelink 1000 was used for

data collection. Before the experiment began, there was a nine-point calibration. Prior to each trial, a

fixation cross appeared in the center of the screen and participants were asked to fixate on the cross before

the onset of the next trial, which allowed for the correction of any gaze drift after calibration occurred.

Participants were seated 60 cm away from the monitor.

Materials and Design

Materials were instructions similar to the sentences used in Trueswell et al. (1999):

  (16)   Pon el pez en el libro encima de la bolsa.
          [Put the frog *on the book* on top of the bag.]

For illustrative purposes, the materials will be described here in Spanish and English, however the

materials that participants heard were in Spanish. Each sentence began with the word "Pon" [Put] and

ended with an instruction that asked participants to move one of the objects on a visual display. The rest

of the sentence followed the structure NP1-PP-NP2. The nouns included in the NP1, PP and NP2 were all

everyday nouns and were one to three syllables in length. Forty-eight experimental sentences were

created with this structure, each with four different conditions (ambiguous, unambiguous, one-referent

and two-referents). A list of the experimental sentences used in this experiment can be found in Appendix

A. An example of the ambiguous form of each sentence can be seen in (16) above and an example of the

disambiguated form of this sentence can be seen in (17):

> (17)   Pon el pez *que está en el libro* encima de la bolsa.
>   [Put the fish *that is on the book* on top of the bag.]

Forty-eight filler sentences were created to distract the participants from the purpose of the study. A full

list of the filler sentences used can be found in Appendix B. The filler sentences were similar to those

shown in examples (18), (19) and (20), varying only in the nouns that were used in each structure:

> (18)   Pon las cajas juntas.
>   [Put the boxes together.]
> (19)   Desliza la araña encima del calcentín.
>   [Slide the spider on top of the sock.]
> (20)   Mueve el pájaro cerca del árbol.
>   [Move the bird close to the tree.]

A list of twelve practice sentences was also created with similar structures to both the target sentences and

the filler sentences. All of the sentences were recorded by a native Spanish speaker.

Two visual scenes (referred to earlier as the referential context) were created, corresponding to

each sentence. Several images of each noun were compiled and one image of each noun was selected for

use in the visual scene. Each visual scene contained at least one target image (the subject of NP1), one

correct destination (intended destination based on the intended interpretation of the sentence), one

incorrect destination (incorrect destination based on the intended interpretation of the sentence), and a

distractor image (a distractor image in the two-referent context that was the same as the target image and

a distractor image in the one-referent context that was dissimilar to the target image). Examples of the

displays can be seen below in figures 3 and 4. Figure 3 shows the one-referent context where there is one

target image (i.e., the fish) and one distractor image that is dissimilar to the target image (i.e., the snake)

while figure 4 shows the two-referent context where there a target image (i.e., the fish on top of the book)

and a distractor image that is identical to the target image (i.e., the other fish in the scene). The images

participants saw were both animate and inanimate. In each context, the target image was always presented

on top of another image, termed "the platform" (i.e., the book in this example). Although the images on

the screen could be either animate or inanimate, the platform was always an inanimate object. To avoid

introducing a confounding variable, if the target was an inanimate object, all of the other objects in the

display were also inanimate because past research has shown that people show a preference for looking at

animate objects over inanimate objects (Trueswell, Tanenhaus, & Garnsey, 1994). A list of the animate

nouns and inanimate nouns used in the experiment can be found in Appendices C and D, respectively.

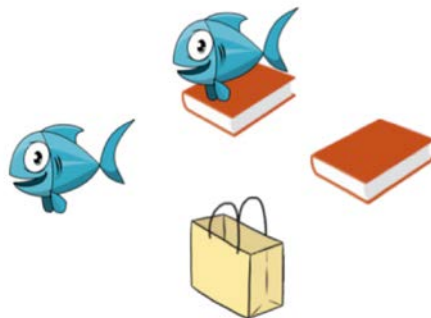**Figure 3: One-Referent Display**

Figure 4: Two-Referent Display

Participants only saw one of the four conditions for each sentence: (a) an ambiguous construction seen with a visual scene containing one-referent, (b) an unambiguous construction seen with a visual scene containing one-referent, (c) an ambiguous construction seen with a visual scene containing two-referents, and (d) an unambiguous construction seen with a visual scene containing two-referents. The sentences were pseudo-randomly interleaved so that participants saw the sentences in a random order, but saw an equal number of stimuli within each condition.

Procedure

Upon arrival, participants were asked to complete the LEAP-Q, which took approximately ten minutes for participants to complete. Participants then completed the Verbal Fluency task. The participants were presented the Spanish version of task prior to the English version task. Each of these production tasks took approximately five minutes to complete. Before the experiment started, participants were then presented with a familiarization task to familiarize them with the names of the pictures used in the eye-tracking task. Each image used in the task appeared on the screen as a voice recording stated the name of the corresponding image. Participants were asked to repeat the name of the image out loud after hearing it before continuing on to the next image using the space bar on the keyboard in front of them. This task was self-paced and took approximately five minutes to complete. After completing the familiarization task, participants were instructed to place their chin on the chin-rest in order to begin calibrating the camera. The calibration of the camera took approximately five minutes. Prior to starting the experiment, the participants were asked to read a set of instructions on the computer monitor that asked them to move the images on the screen in accordance with the directions they heard through the speakers. Participants were instructed to fixate on a cross in the center of the screen prior to the start of each trial. After fixating on the cross, the visual scene would appear for approximately 500 milliseconds prior to the onset of the

audio recording of each sentence. A cursor appeared in the place of the cross in the center of the screen when the images appeared, allowing participants to visualize the movement of their cursor on the screen. Participants were able to move the target image around on the screen to follow the instructions given in the sentence that they heard. To move the image they had to right-click on the image using the mouse and drag it over another image on the screen. The participants were able to drop the image by letting go of the right-clicker. After letting go of the right-clicker, the images on the screen disappeared and were replaced with the fixation cross in the center of the screen indicating that the trial had ended. Each experiment began with twelve practice sentences, followed by forty-eight experimental items that were mixed with 48 filler items. Each participant saw a total of 108 trials. The eye-tracking task took approximately 40 minutes to complete.

Chapter 3

Results

The sample data recorded were output using Data Viewer (SR Research). Only data that fell within the pre-defined interest areas directly around each square image were included for analysis. These data were run through two pre-processing scripts in R. The first script removed fixations in two unwanted interest areas that were included for design purposes (the fixation cross area that did not overlap with any critical interest area). The second script binned time into 10 ms bins to reduce the data size, and calculated the proportion of fixations to each of the four regions of interest for each bin. The pre-processed data were then restricted to 10,000 ms. This determination was made based on the maximum sentence duration (8,913 ms), and include all data from while each sentence was being spoken, and a small margin thereafter simply to round up for graphing purposes.

The data were then broken into the time regions of interest. In the example sentence of "Put the frog on the napkin in the box", the critical regions were "frog", "napkin", and "box". Since the audio files were not normed for duration, these critical regions began at different items for every item. In order to look at the data by region, the data were first split into separate regions (as seen in figure 5) and then each region was aligned to begin at the same time across each sentence. Figures 5, 6, 7 and 8 below depict the process of aligning the critical regions in each sentence.

Figure 5 shows the misalignment of the onset of the three critical regions (highlighted between the black and green bars) in several example sentences, depicting how the sentences looked prior to manipulation.
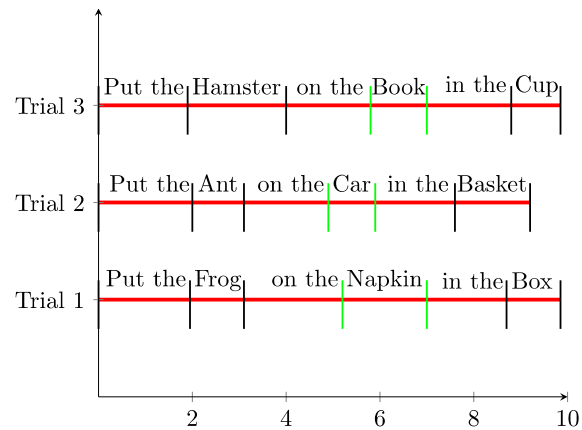
Figure 5. Critical regions misaligned

The focus of this experiment was to see how participants interpreted the ambiguous region (i.e., "the napkin" in "Put the frog *on the napkin* in the box" example). To do this, the proportions of fixations to the incorrect destination (i.e., the empty napkin) were analyzed. This analysis was completed by focusing in on the most relevant critical region (the region containing the ambiguity) as shown in Figure 6.
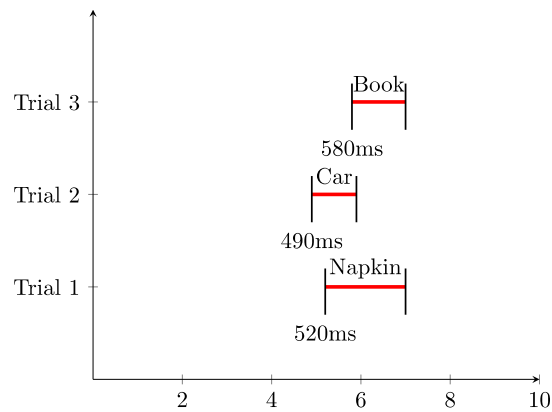
Figure 6. Critical regions sectioned out

Figure 7 shows how the onset data for each critical region was used to align the critical regions by subtraction.

Book

	580	581	582	583	584	...
-	580	580	580	580	580	...
	0	1	2	3	4	...

Car

	490	491	492	493	494	...
-	490	490	490	490	490	...
	0	1	2	3	4	...

Napkin

	520	521	522	523	524	...
-	520	520	520	520	520	...
	0	1	2	3	4	...

Figure 7. Critical region time aligned by subtraction

Figure 8 shows the proper alignment of the critical regions, which allowed for the proportion of fixations to be compared across all of the critical regions. The final aligned regions took from the start of the critical word for 2 seconds. This includes silence after the word and does not overlap with the following word.
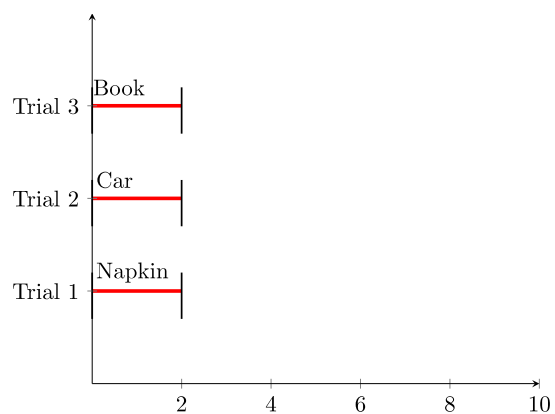
Figure 8. Critical regions aligned

Figure 9 below shows the critical region split by ambiguity and referent. The analysis included only looks to the incorrect goal. Fixations in the one-referent condition are presented in red and fixations in the two-referent condition are presented in black. Fixations in the ambiguous condition are presented in solid lines and fixations in the unambiguous condition are presented in dashed lines. Time in milliseconds is presented on the *x*-axis and proportion of fixations is presented on the *y*- axis.
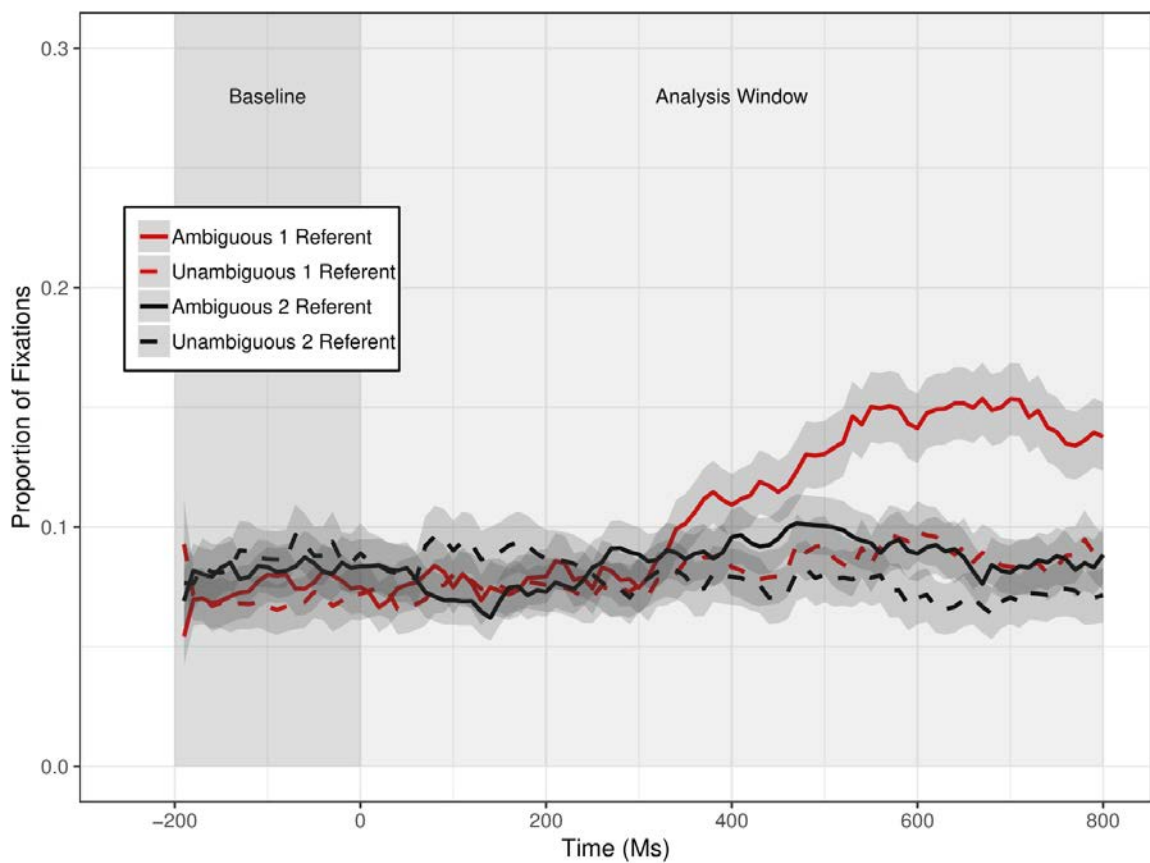
Figure 9: Proportion of fixations to the incorrect goal

Figure 9. Fixations in the one-referent condition are presented in red and fixations in the two-referent condition are presented in black. Fixations in the ambiguous condition are presented in solid lines and fixations in the unambiguous condition are presented in dashed lines. Time in milliseconds is presented on the *x*-axis and proportion of fixations is presented on the *y*- axis. The shaded region represents ±1 standard error of the mean. The shaded windows represent the three analysis windows.

Only the first 1,000ms of the critical region was analyzed. This critical region was then further divided into 2 regions for analysis. The first was a 200 ms baseline region, and then the main analysis region. The proportion of fixations to the incorrect goal was entered into linear mixed-effects models in R using the lme4 package (for discussion, see Baayen, 2008). Three sets of model comparisons were run on the different time windows across the critical region. All models included the fixed effects of ambiguity and referent and their interaction and the random effects of participant and item on the intercept. The unambiguous one-referent condition served as the baseline to which all comparisons were made. The fixed effects and their interaction were added individually to the model, and the models were compared using the ANOVA function. For the baseline model, the best model included referent only. For the Window model, the best model included referent and the interaction between referent and ambiguity. The model estimates are provided in Table 1 below.

Table 1: Models for the fixed effects of the proportion of fixations to the incorrect goal

		Estimate	Std. Error	DF	*t* value	Pr(>F)
Baseline	Intercept	0.0739	0.01031	100	7.174	<0.001
	Referent	0.0116	0.00248	44350	4.674	<0.001
	Ambiguity	0.0005	0.00247	44330	0.201	0.841
Window	Intercept	0.00000296	0.00920	103	8.482	<0.001
	Referent	0.01953	0.00211	136900	9.249	<0.001
	Ambiguity: Referent	-0.01727	0.00300	136900	-5.758	<0.001

Table 1 shows that for the baseline model, the effect of referent was significant and had a positive estimate, indicating that there were a higher proportion of looks to the target in the two-referent condition than in the one-referent condition. For the Window model, the effect of referent was also significant and had a positive estimate, indicating that a higher proportion of looks to the target in the two-referent condition. The interaction between ambiguity and referent was also significant, with a negative estimate indicating that there was a negative relationship between ambiguity and referent.

Chapter 4

Discussion

Much research has been conducted with the goal of understanding the strategies behind sentence processing. In an effort to understand whether sentence-processing strategies are consistent across languages, researchers have explored how speakers resolve various forms of syntactic ambiguity in different languages. Previous studies investigating the resolution of relative-clause (RC) ambiguity show that speakers of some languages have a preference for an early-closure attachment strategy, while speakers of other languages have a preference for a late-closure attachment strategy (Cuetos et al., 1988; Miyamoto, 1998; Abdelghany & Fodor, 1999; Ehrlich et al., 1999; Cuetos et al., 1988; Zagar et al., 1997; Mitchell et al., 2000; Brysbaert & Mitchell, 1998; Hemforth et al., 2000; Papadopoulou & Clahsen, 2003). Fewer studies have looked at prepositional phrase (PP) ambiguity cross-linguistically. The few studies conducted show a trend for VP-attachment in German, Greek and English (Konieczny et al., 2010; Katsika, 2008; Snedeker & Trueswell, 2004; Joseph & Liversedge, 2013; Trueswell et al., 1999). A study by Trueswell et al. (1999) showed that the context in which adults interpret PP ambiguity also influences their strategies for interpretation. Research showed that participants who were presented with a two-referent context were better able to resolve the ambiguity than participants present with a one-referent context. The current study intended to expand the knowledge in this area by studying PP ambiguity resolution in Spanish in a visual world study that included a corresponding context.

The findings of the present study show that Spanish speakers, similar to English speakers, are influenced by referential information when interpreting sentences containing ambiguous prepositional phrases. Additionally, the data support the idea that Spanish speakers show a VP-attachment bias when presented with a one-referent context but not with a two-referent context. Given these findings, it seems as though speakers of Spanish show similar strategies to speakers of English, German and Greek in the

resolution of prepositional phrase ambiguity (Konieczny et al., 2010; Katsika, 2008; Snedeker & Trueswell, 2004; Joseph & Liversedge, 2013; Trueswell et al., 1999).

It is of note that several improvements could be made to the experiment. The experimental sentence seen in example (16) above, repeated here for ease of exhibition as example (21), will be used to explain several improvements.

(21)   Pon el pez *en el libro* encima de la bolsa.
        [Put the fish *on the book* on top of the bag.]

First, the displays corresponding with each of the experimental sentences contained a target object that was to be moved (i.e., the fish indicated with the black arrow) as shown in figure 10.

Figure 10. Experimental display

The target object that participants were instructed to move always appeared on a platform (i.e., the book that the fish is on). Additionally, the fillers did not contain scenes with platforms as depicted in figure 11 below.

Figure 11: Filler display

Therefore, when there was an object on a platform in the visual scene, participants could predict that it was that object (i.e., the target object) that needed to be moved. This bias, however, did not affect the results of the experiment because they heard the name of the object before the ambiguous NP. Therefore, knowing what object needed to be moved did not help them to anticipate where the object needed to be moved, which was the focus of the present study. Nevertheless, an uncompromised experimental design would be one in which filler items should contain visual scenes with objects on top of platforms, where the object to be moved is not on top of a platform as exemplified in example (22) with its corresponding visual scene in figure 12.

(22)   Pon el pez en el libro.
         [Put the fish on the book.]

Figure 12: Proposed improvements to the visual scenes associated with the fillers

This would ensure that participants are unable to anticipate the object that needs to be moved. Also, the study by Trueswell et al. (1999) showed that some participants interpret sentences such as the experimental sentences used in this study as multiple commands. In other words, in the sentences such as example (21) above ("Put the fish on the book onto the bag"), some participants may interpret this sentence to mean "move the fish to the book, then move the fish to the bag". Therefore, additional filler items could be created with more than one instruction present, such as shown in example (23):

(23)   Pon el pez en el libro. *Ahora, pon el pez en la bolsa.*
         [Put the fish on the book. *Now, put the fish on the bag*.]

These fillers would preserve the ambiguity surrounding whether or not the experimental sentences contain two separate commands. Although several elements of the materials could be improved, the effects under examination here were still statistically significant.

In conclusion, previous research has bolstered support for the idea that speakers of English, Greek and German show a preference VP-attachment when resolving PP ambiguity (Konieczny et al., 2010; Katsika, 2008; Snedeker & Trueswell, 2004; Joseph & Liversedge, 2013; Trueswell et al., 1999). Additionally, research by Trueswell et al. (1999) highlighted the importance of the visual context in the interpretation of syntactic ambiguity, which ultimately gave rise to the focus of the current study. The goals of the present study included discovering the mechanisms that Spanish speakers use to interpret PP ambiguity and whether or not clues from a visual scene influence their parsing decisions. The results of this study show that Spanish speakers, similar to English speakers, used referential information to guide their parsing decisions (Truswell et al., 1999). Additionally, the data supported that Spanish speakers showed a preference for VP-attachment as has been shown in speakers of German, Greek and English (Konieczny et al., 2010; Katsika, 2008; Snedeker & Trueswell, 2004; Joseph & Liversedge, 2013; Trueswell et al., 1999).

Appendix A

Experimental Sentences

1. Pon la araña en el árbol encima de la fresa.
   [Put the spider on the tree on top of the strawberry.]
2. Pon la araña que esta en el árbol encima de la fresa.
   [Put the spider that is on the tree on top of the strawberry.]
3. Pon la araña en el avión encima de la flor.
   [Put the spider on the plane on top of the flower.]
4. Pon la araña que está en el avión encima de la flor.
   [Put the spider that is on the plane on top of the flower.]
5. Pon el árbol en el avión encima de la chaqueta.
   [Put the tree on the plane on top of the jacket.]
6. Pon el árbol que está en el avión encima de la chaqueta.
   [Put the tree that is on the plane on top of the jacket.]
7. Pon el avión en el guante encima de la barca.
   [Put the plane on the glove on top of the ship.]
8. Pon el avión que está en el guante encima de la barca.
   [Put the plane that is on the glove on top of the boat.]
9. Pon la barca en el guante encima de la bolsa.
   [Put the boat on the glove on top of the bag.]
10. Pon la barca que está en el guante encima de la bolsa.
    [Put the boat on the glove on top of the bag.]
11. Pon la bolsa en el calcetín encima de la caja.
    [Put the bag on the sock on top of the box.]
12. Pon la bolsa que está en en calcetín encima de la caja.
    [Put the bag that is on the sock on top of the box.]
13. Pon el caballo en la barca encima del vestido.
    [Put the horse on the boat on top of the dress.]
14. Pon el caballo que está en la barca encima del vestido.
    [Put the horse that is on the boat on top of the dress.]
15. Pon la caja en el calcetín encima de la cama.
    [Put the box on the sock on top of the box.]
16. Pon la caja que está en el calcetín encima de la cama.
    [Put the box that is on the sock on top of the bed.]
17. Pon el calcetín en la casa encima de la cama.
    [Put the sock on the house on top of the bed.]
18. Pon el calcetín que está en la casa encima de la cama.
    [Put the sock that is on the house on top of the bed.]
19. Pon la cama en el coche encima de la casa.
    [Put the bed on the car on top of the house.]
20. Pon la cama que está en el coche encima de la casa.
    [Put the bed that is on the car on top of the house.]
21. Pon la casa en el coche encima de la flor.
    [Put the house on the car on top of the flower.]
22. Pon la casa que está en el coche encima de la flor.

[Put the house that is on the car on top of the flower.]

23. Pon el cerdo en el guante encima del coche.
    [Put the pig on the glove on top of the car.]
24. Pon el cerdo que está en el guante encima del coche.
    [Put the pig that is on the glove on top of the car.]
25. Pon la chaqueta en el libro encima del vestido.
    [Put the jacket on the book on top of the dress.]
26. Pon la chaqueta que está en el libro encima del vestido.
    [Put the jacket that is on the book on top of the dress.]
27. Pon el coche en la flor encima de la fresa.
    [Put the car on the flower on top of the strawberry.]
28. Pon el coche que está en la flor encima de la fresa.
    [Put the car that is on the flower on top of the strawberry.]
29. Pon el conejo en la bolsa encima de la chaqueta.
    [Put the rabbit on the bag on top of the jacket.]
30. Pon el conejo que está en la bolsa encima de la chaqueta.
    [Put the rabbit that is on the bag on top of the jacket.]
31. Pon el conejo en la caja encima del calcetín.
    [Put the rabbit on the box on top of the sock.]
32. Pon el conejo que está en la caja encima del calcetín.
    [Put the rabbit that is on the box on top of the sock.]
33. Pon la flor en la fresa encima del gorro.
    [Put the flower on the strawberry on top of the hat.]
34. Pon la flor que está en la fresa encima del gorro.
    [Put the flower that is on the strawberry on top of the hat.]
35. Pon la fresa en el gorro encima de la manzana.
    [Put the strawberry on the hat on top of the apple.]
36. Pon la fresa que está en el gorro encima de la manzana.
    [Put the strawberry that is on the hat on top of the apple.]
37. Pon la gallina en la manzana encima del gorro.
    [Put the chicken on the apple on top of the hat.]
38. Pon la gallina que está en la manzana encima del gorro.
    [Put the chicken that is on the apple on top of the hat.]
39. Pon la gallina en la muñeca encima del libro.
    [Put the chicken on the doll on top of the book.]
40. Pon la gallina que está en la muñeca encima del libro.
    [Put the chicken that is on the doll on top of the book.]
41. Pon el gato en el calcetín encima de la cama.
    [Put the cat on the sock on top of the bed.]
42. Pon el gato que está en el calcetín encima de la cama.
    [Put the cat that is on the sock on top of the bed.]
43. Pon el gorro en el vestido encima de la muñeca.
    [Put the hat on the dress on top of the doll.]
44. Pon el gorro que está en el vestido encima de la muñeca.
    [Put the hat that is on the dress on top of the doll.]
45. Pon el guante en la bolsa encima de la caja.
    [Put the glove on the bag on top of the box.]
46. Pon el guante que está en la bolsa encima de la caja.
    [Put the glove that is on the bag on top of the box.]

47. Pon la hormiga en la cama encima de la manzana.
    [Put the ant on the bed on top of the apple.]
48. Pon la hormiga que está en la cama encima de la manzana.
    [Put the ant that is on the bed on top of the apple.]
49. Pon el libro en el vestido encima de la barca.
    [Put the book on the dress on top of the boat.]
50. Pon el libro que está en el vestido encima de la barca.
    [Put the book that is on the dress on top of the boat.]
51. Pon la manzana en la muñeca encima de la pelota.
    [Put the apple on the doll on top of the ball.]
52. Pon la manzana que está en la muñeca encima de la pelota.
    [Put the apple that is on the doll on top of the ball.]
53. Pon la mariposa en la casa encima de la caja.
    [Put the butterfly on the house on top of the box.]
54. Pon la mariposa que está en la casa encima de la caja.
    [Put the butterfly that is on the bed on top of the box.]
55. Pon la mariposa en el coche encima de la pelota.
    [Put the butterfly on the car on top of the ball.]
56. Pon la mariposa que está en el coche encima de la pelota.
    [Put the butterfly that is on the car on top of the ball.]
57. Pon el mono en la flor encima de la tarta.
    [Put the monkey on the flower on top of the cake.]
58. Pon el mono que está en la flor encima de la tarta.
    [Put the monkey that is on the flower on top of the cake.]
59. Pon la muñeca en la manzana encima del queso.
    [Put the doll on the apple on top of the cheese.]
60. Pon la muñeca que está en la manzana encima del queso.
    [Put the doll that is on the apple on top of the cheese.]
61. Pon el niño en la fresa encima de la silla.
    [Put the boy on the strawberry on top of the chair.]
62. Pon el niño que está en la fresa encima de la silla.
    [Put the boy that is on the strawberry on top of the chair.]
63. Pon la oveja en el gorro encima del avión.
    [Put the sheep on the hat on top of the plane.]
64. Pon la oveja que está en el gorro encima del avión.
    [Put the sheep that is on the hat on top of the plane.]
65. Pon la oveja en el vestido encima de la casa.
    [Put the sheep on the dress on top of the house.]
66. Pon la oveja que está en el vestido encima de la casa.
    [Put the sheep that is on the dress on top of the house.]
67. Pon el pájaro en la chaqueta encima del árbol.
    [Put the bird on the jacket on top of the tree.]
68. Pon el pájaro que está en la chaqueta encima del árbol.
    [Put the bird that is on the jacket on top of the tree.]
69. Pon la pelota en el queso encima de la servilleta.
    [Put the ball on the cheese on top of the napkin.]
70. Pon la pelota que está en el queso encima de la servilleta.
    [Put the ball that is on the cheese on top of the napkin.]
71. Pon el pez en el libro encima de la bolsa.

[Put the fish on the book on top of the book.]

72. Pon el pez que está en el libro encima de la bolsa.
    [Put the fish that is on the book on top of the bag.]
73. Pon el queso en el zapato encima de la silla.
    [Put the cheese on the shoe on top of the chair.]
74. Pon el queso que está en el zapato encima de la silla.
    [Put the cheese that is on the shoe on top of the chair.]
75. Por la rana en la pelota encima de la servilleta.
    [Put the frog on the ball on top of the napkin.]
76. Pon la rana que está en la pelota encima de la servilleta.
    [Put the frog that is on the ball on top of the napkin.]
77. Pon el ratón en la servilleta encima del zapato.
    [Put the rat on the napkin on top of the shoe.]
78. Pon el ratón que está en la servilleta encima del zapato.
    [Put the rat that is on the napkin on top of the shoe.]
79. Pon la serpiente en el queso encima del guante.
    [Put the snake on the cheese on top of the glove.]
80. Pon la serpiente que está en el queso encima del guante.
    [Put the snake that is on the cheese on top of the glove.]
81. Pon la serpiente en la silla encima del queso.
    [Put the snake on the chair on top of the cheese.]
82. Pon la serpiente que está en la silla encima del queso
    [Put the snake that is on the chair on top of the cheese.]
83. Pon la servilleta en la silla encima de la tarta.
    [Put the napkin on the chair on top of the cake.]
84. Pon la servilleta que está en la silla encima de la tarta.
    [Put the napkin that is on the chair on top of the cake.]
85. Pon la silla en la tarta encima del zapato.
    [Put the chair on the cake on top of the shoe.]
86. Pon la silla que está en la tarta encima del zapato.
    [Put the chair that is on the cake on top of the shoe.]
87. Pon la tarta en la servilleta encima del árbol.
    [Put the cake on the napkin on top of the tree.]
88. Pon la tarta que está en la servilleta encima del árbol.
    [Put the cake that is on the napkin on top of the tree.]
89. Pon la vaca en la tarta encima de la barca.
    [Put the cow on the cake on top of the boat.]
90. Pon la vaca que está en la tarta encima de la barca.
    [Put the cow that is on the cake on top of the boat.]
91. Pon el vestido en la chaqueta encima del libro.
    [Put the dress on the jacket on top of the book.]
92. Pon el vestido que está en la chaqueta encima del libro.
    [Put the dress that is on the jacket on top of the book.]
93. Pon el vestido en el árbol encima del avión.
    [Put the dress on the tree on top of the plane.]
94. Pon el zapato en el árbol encima del avión.
    [Put the shoes on the tree on top of the plane.]
95. Pon el zapato que está en el árbol encima del avión.
    [Put the shoe that is on the tree on top of the plane.]

96. Pon el zorro en el zapato encima de la muñeca.
    [Put the fox on the shoe on top of the doll.]
97. Pon el zorro que está en el zapato encima de la muñeca.
    [Put the fox that is on the shoe on top of the doll.]

Appendix B

Filler Sentences

1. Mueve la vaca encima del libro.
   [Move the cow on top of the book.]
2. Pon las serpientes juntas.
   [Put the snakes together.]
3. Mueve el zorro cerca de la chaqueta.
   [Move the fox close to the jacket.]
4. Pon las fresas juntas.
   [Put the strawberries together.]
5. Desliza la araña encima de la casa.
   [Slide the spider on top of the house.]
6. Pon los aviones juntos.
   [Put the planes together.]
7. Mueve el caballo cerca de la servilleta.
   [Move the horse close to the napkin.]
8. Desliza el guante encima de la tarta.
   [Slide the glove on top of the cake.]
9. Mueve la muñeca cerca de la silla.
   [Move the doll close to the chair.]
10. Pon las cajas juntas.
    [Put the boxes together.]
11. Desliza la hormiga encima de la manzana.
    [Slide the ant on top of the apple.]
12. Pon los árboles juntos.
    [Put the trees together.]
13. Desliza el niño encima del sombrero.
    [Slide the boy on top of the hat.]
14. Pon los peces juntos
    [Put the fish together.]
15. Desliza el pájaro encima del queso.
    [Slide the bird on top of the cheese.]
16. Pon los gatos juntos.
    [Put the cats together.]
17. Desliza la araña encima del calcetín.
    [Slide the spider on top of the sock.]
18. Pon los caballos juntos.
    [Put the horses together.]
19. Desliza la oveja encima de la cama
    [Slide the sheep on top of the bed.]
20. Pon el cerdo encima del coche.
    [Put the pig on top of the car.]
21. Desliza la hormiga encima de la flor.
    [Slide the ant on top of the flower.]
22. Pon los conejos juntos.

[Put the rabbits together.]
23. Mueve el pájaro cerca del árbol.
    [Move the bird close to the tree.]
24. Pon los monos juntos.
    [Put the monkeys together.]
25. Desliza el gato encima del queso.
    [Slide the cat on top of the cheese.]
26. Desliza la mariposa encima de la pelota.
    [Slide the butterfly on top of the ball.]
27. Pon el niño en la bolsa.
    [Put the boy on the bag.]
28. Pon las barcas juntas.
    [Put the boats together.]
29. Desliza el pez encima del vestido.
    [Slide the fish on top of the dress.]
30. Pon los coches juntos.
    [Put the cars together.]
31. Pon la gallina encima del gorro.
    [Put the chicken on top of the hat.]
32. Desliza la rana encima de la servilleta.
    [Slide the rat on top of the napkin.]
33. Pon las vacas juntas.
    [Put the cows together.]
34. Desliza la serpiente encima del vestido.
    [Slide the snake on top of the dress.]
35. Mueve las gallinas juntas.
    [Move the chickens together.]
36. Pon la oveja encima de la chaqueta.
    [Put the sheep on top of the jacket.]
37. Mueve la flor encima del libro.
    [Move the flower on top of the book.]
38. Desliza el ratón cerca de la pelota.
    [Slide the rat close to the ball.]
39. Pon los calcetines juntos.
    [Put the socks together.]
40. Pon la mariposa encima del zapato.
    [Put the butterfly on top of the shoe.]
41. Pon los cerdos juntos.
    [Put the pigs together.]
42. Pon el mono encima de la cama.
    [Put the monkey on top of the bed.]
43. Mueve el zorro encima de la silla.
    [Move the fox on top of the chair.]
44. Pon el conejo cerca de la muñeca.
    [Put the rabbit close to the doll.]
45. Pon las manzanas juntas.
    [Put the apples together.]
46. Desliza la araña encima de la tarta.
    [Slide the spider on top of the cake.]

47. Pon el ratón encima del zapato.
   [Put the rat on top of the shoe.]
48. Desliza el ratón encima de la casa.
   [Slide the rat on top of the house.]

Appendix C

List of Animate Nouns

1. araña
   [spider]
2. caballo
   [horse]
3. cerdo
   [pig]
4. conejo
   [rabbit]
5. gato
   [cat]
6. hormiga
   [ant]
7. mariposa
   [butterfly]
8. mono
   [monkey]
9. niño
   [boy]
10. oveja
    [sheep]
11. pájaro
    [bird]
12. pez
    [fish]
13. pollo
    [chicken]
14. rana
    [frog]
15. ratón
    [rat]
16. serpiente
    [snake]
17. vaca
    [cow]
18. zorro
    [fox]

Appendix D

List of Inanimate Nouns

1. árbol
   [tree]
2. avión
   [plane]
3. barco
   [boat]
4. bolsa
   [bag]
5. caja
   [box]
6. calcetín
   [box]
7. cama
   [bed]
8. casa
   [house]
9. coche
   [car]
10. flor
    [flower]
11. fresa
    [strawberry]
12. gorro
    [hat]
13. vestido
    [dress]
14. chaqueta
    [jacket]
15. libro
    [book]
16. manzana
    [apple]
17. muñeca
    [doll]
18. pelota
    [ball]
19. queso
    [cheese]
20. servilleta
    [napkin]
21. silla
    [chair]
22. tarta
    [cake]
23. zapato
    [shoe]

Appendix E

Table 2: Results of the Language Experience and Proficiency Questionnaire (LEAP-Q) and Verbal Fluency

	vars	n	mean	sd	median	min	max	range
Participant	1	56	267.875	190.2356493	132.5	105	521	416
Age	2	55	21.32727273	1.856465633	21	18	27	9
PercentUse_Span	3	55	68.6	23.61151634	70	1	100	99
PercentUse_Eng	4	53	34.33962264	23.44219027	30	0	100	100
YearsEd	5	48	16.64583333	1.940493284	17	13	22	9
YearsLiving_Span	6	54	20.27777778	4.511689918	21	0	27	27
YearsLiving_Eng	7	54	8.833333333	9.729841279	4	0	26	26
ProfSpoken_Span	8	53	9.037735849	1.208340632	9	3	10	7
ProfSpoken_Eng	9	52	7.192307692	2.589863056	8	1	10	9
AoA_Span	10	54	1.5	1.73477202	1	0	9	9
AoA_Eng	11	54	5.62962963	3.692400642	5	0	19	19
VF_Span	12	52	43.67307692	7.905622605	44	23	61	38
VF_Eng	13	52	37.75	13.6178588	40	8	73	65

Table 2 shows the results of the Language Experience and Proficiency Questionnaire (LEAP-Q) and Verbal Fluency. The column on the far left includes information about the questions that participants were asked in the questionnaire. PercentUse_Span represents the amount of time that participants spend speaking Spanish daily as rated out of 100%. PercentUse_Eng represents the amount of time participants spend speaking English daily as rated out of 100%. YearsEd shows how many years of education the participant reported. YearsLiving_Span relays how many years participants reported living in a Spanish speaking country while YearsLiving_Eng relays how many years participants reported living in an English speaking country. ProfSpoken_Eng refers to participants' level of English proficiency out of 10 and ProfSpoken_Eng refers to participants' level of Spanish proficiency out of 10. AoA_Span represents participants' age of acquisition of Spanish and AoA_Eng represents participants' age of acquisition of English. VF_Span refers to participants' scores on the Spanish Verbal Fluency task and VF_Eng refers to participants' scores on the English Verbal Fluency task. The next columns several columns containing abbreviations represent the following: vars (variables), n (number of participants), sd (standard deviation), min (minimum), and max (maximum).

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ACADEMIC VITA

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EDUCATION

The Pennsylvania State University, University Park, PA   May 2019
College of Liberal Arts, Schreyer Honors College
- Bachelor of Science in Psychology (neuroscience focus), Bachelor of Arts in Spanish
- Minor: Women's Studies

IES Abroad Advanced Spanish Language Program
     Barcelona, Spain
- Fluent in Spanish (speaking, reading, and writing)
     Spring 2016

RESEARCH EXPERIENCE   Granada, Spain and San Juan, Puerto Rico
Bilingual Sentence Processing and Code-Switching Lab at the Pennsylvania State University Sept 2016 - Present
- Performed ERP (Event-Related Potential) studies, running participant encounters and analyzing data
- Developed and conducted an eye-tracking study in collaboration with principal investigator, Paola Giuli Dussias, Ph.D.
- Presented research findings at several university-held conferences and speaking engagements

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WORK EXPERIENCE

Physassist Scribes, Inc.
Lewistown, PA
Medical Scribe, Scribe Trainer and Scribe Ambassador   Jan 2018 - Present
- Documented 25-50 patient visits in the Emergency Department per shift via electronic medical charts, while also aiding the providers with patient flow
- Trained scribes to compose medical charts using charting software and increased knowledge of medical terminology
- Collaborated with the corporate recruitment team to create marketing materials to attract prospective employees and shared these materials with pre-health advisors and student organizations on college campuses around central PA

Penn State Biology Department
Teaching Assistant in Physiology Laboratory   Aug 2016 - Present
- Instructed approximately 20 undergraduate students about topics pertaining to human physiology
- Spent 10 hours a week preparing for the laboratory, grading students' work and guided students to follow the correct protocols during the laboratory in order to ensure their safety and the safety of others

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LEADERSHIP

The Pennsylvania State University
President of the Global Brigades Campus Council   May 2018 - Present
- Led a campus-wide international development organization of approximately 600 students, creating educational meeting content related to global health and economic development
- Facilitated collaboration between 40 executives that formed part of six different sub-chapters of Global Brigades on campus by holding weekly meetings with the executives
- Acted as a liaison between the University, the organization on campus, and Global Brigades professional staff
- Implemented additional programming including community service events as well as international volunteering trips

Secretary of Global Medical Brigades   May 2017 – May 2018

- Maintained a membership log to account for the participation of approximately 250 members in club-related activities
- Acted as the main point of contact between active members, prospective members and the executive board
- Organized and attended fundraisers, social events, and other activities to strengthen connections between members

Brigade Leader for Global Medical Brigades   Aug 2017 – May 2018
- Led a 60-student medical brigade to Estelí, Nicaragua
- Held weekly meetings with individuals traveling on the brigade to raise cultural awareness and increase Spanish skills

Resident Assistant, Residence Life   Aug 2017 – May 2018
- Fostered the foundation of a strong community for the 40 students living on my floor in the residence hall via various forms of programming aimed to include everyone in the community
- Enforced university regulations in the residence halls to ensure resident safety
- Mentored residents, acting as a support system and empowering them to take advantage of opportunities on campus

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