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USING EYE-TRACKING TO STUDY AUDITORY COMPREHENSION IN CODESWITCHING: EVIDENCE FOR THE LINK BETWEEN COMPREHENSION AND PRODUCTION

A Dissertation in

Spanish, Italian, and Portuguese

&

Language Science

by

Jorge Valdés Kroff

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Abstract

Bilinguals in the presence of other known bilinguals engage in codeswitching, broadly defined as the fluid alternation between languages in bilingual discourse (Poplack, 1980). Although the specific factors that influence codeswitching are varied, bilingual members of a community of codeswitchers are more likely to engage in intra-sentential codeswitching (e.g. **El niño** caught his friend **a punto de romper el** blender, "The boy caught his friend about to break the blender") in contrast to bilinguals who maintain a functional separation between the two languages. Codeswitching has been studied extensively in production, particularly from structural and social perspective . In contrast, few studies have examined the comprehension of codeswitched speech from an experimental perspective. This dissertation attempts to address this gap by employing an innovative eye-tracking methodology known as the visual world paradigm (Cooper, 1974; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995) to examine the role of grammatical gender in the processing of Spanish-English codeswitched speech.

We focus on grammatical gender because researchers have observed a production asymmetry in its use in Spanish-English codeswitching. Specifically, article – noun constructions (Mixed NPs) frequently appear as Spanish masculine articles followed by English nouns regardless of the gender of the Spanish translation equivalent, e.g. **el** *juice*, Sp. el_{masc} $jugo_{masc}$ and **el** *cookie*, Sp. la_{fem} $galleta_{fem}$. Alternatively, Mixed NPs with Spanish feminine articles are infrequent and restrictively appear with English nouns that have feminine Spanish translation equivalents, e.g. **la** *cookie*, Sp. la_{fem} $galleta_{fem}$ but *__la__ *juice*, Sp. el_{masc} $jugo_{masc}$. This observation leads us to propose that codeswitching is an ideal test case to investigate the direct link between production and comprehension. Working within the Production-Distribution-Comprehension (PDC) framework (Gennari & MacDonald, 2009), we hypothesize that the gender production asymmetry reported in the production of codeswitched speech should be reflected in comprehension.

To investigate this hypothesis, we first quantified the distribution of Mixed NPs using a bilingual spoken language corpus (Deuchar, Davies, Herring, Parafita Cuoto, & Carter, 2012) as a means to confirm the production asymmetry described by other researchers (Jake, Myers-Scotton, & Gross, 2002a; Otheguy & Lapidus, 2003; Clegg, 2006). Validating previous observations, we found that masculine marked Mixed NPs constitute the overwhelming majority of Mixed NPs (92%). In contrast, feminine marked Mixed NPs were rare in our corpus (3%). To examine the impact of this production asymmetry in comprehension, we recruited 2 groups of Spanish-English bilinguals from City College of New York (CCNY) categorized by their place of birth (U.S. born, $N = 21$, v. Latin born, $N = 25$). Both groups of bilinguals participated in three separate eyetracking experiments within one experimental session: a Spanish unilingual block, a lexical-level codeswitching block, and a sentence-level codeswitching block. In all three blocks, participants were shown a simple 2-picture display of concrete objects. While listening to recorded stimuli in Spanish (Spanish unilingual block) or in codeswitching, a target picture was named, and participants were instructed to click on the target picture. Concurrently, participants' eye movements were recorded with a desk-mounted eyetracker at a sampling rate of 1000 Hz.

We capitalized on two previous findings in the eye-tracking literature. First, Spanish gender has been shown to be used as a facilitatory morpho-syntactic cue in informative contexts (Lew-Williams & Fernald, 2007). In contrast, phonological competition (i.e. overlapping phonology in potential target candidates) is shown to delay spoken language recognition (e.g. Allopenna, Magnuson, & Tanenhaus, 1998). Therefore, our experimental items in the codeswitching blocks introduced a phonological manipulations such that all paired items overlapped in initial phonology but had Spanish translation equivalents that differed in gender, e.g. *candy* [kændi], Sp. *caramelo$_{masc}$* and *candle* [kændl], Sp. *vela$_{fem}$*. Furthermore, in both the Spanish unilingual and lexical-level codeswitching block, target items were embedded phrase-finally in a simple carrier phrase. In the sentence-level block, target items were embedded in sentence-medial position in variable sentential contexts. In order to encourage listening for comprehension, we introduced a plausibility judgment at the end of each trial. Moreover, half of the sentences began in English and the other half in Spanish. Each member of an experimental pair was a target and was combined with both Spanish articles resulting in four experimental conditions: feminine match trials, feminine mismatch trials, masculine match trials, and masculine mismatch trials. If the predictions of the PDC framework are correct, then bilinguals should not show any facilitatory processing for masculine conditions given its documented preference as the default article in Spanish-English codeswitching. In contrast, the feminine mismatch trial should result in increased delayed processing in comparison to feminine match trials.

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In our analysis, we compared the proportion of fixations to target items and distractor items for each condition in each experimental block. We conducted paired-t tests on the difference between the mean proportion of target and distractor fixations in 100 msec time regions from article onset. The Spanish unilingual block served as a baseline to examine gender processing in Spanish. To further support the validity of our materials and to interpret the bilingual data, we included a control group of Spanish monolinguals ($N = 24$). Replicating a previous study, the Spanish monolinguals revealed the online use of grammatical gender in informative contexts as evidenced by significantly higher mean proportion of fixations to target items in different gender trials at earlier time regions than for same gender trials. In contrast, the U.S. born bilingual group showed no facilitation due to gender in spoken language processing, exhibited by a similar timecourse for both different and same gender trials. The Latin born group showed facilitatory effects only for feminine conditions.

The lexical level codeswitching block revealed that U.S. born bilinguals can use grammatical gender to strongly facilitate target identification in masculine conditions. Differences were also found for feminine conditions but were mainly attributable to increased difficulty in integration of feminine mismatch targets. In contrast, the Latin born group continued to exhibit strong facilitatory effects for feminine conditions. For masculine conditions, differences were found but were mainly attributable to increased difficulty in integration of masculine mismatch targets. For the sentence-level codeswitching block, the U.S. born bilinguals showed little modulation attributable to grammatical gender except for a strong facilitatory effect for feminine mismatch targets in Spanish-first codeswitching trials. In contrast, the Latin born group did reveal differences based on language manipulation and gender. Specifically, in English-first codeswitching trials, the Latin born bilinguals exhibited a weak facilitatory effect for feminine conditions that was neutralized in Spanish-first codeswitching trials. For masculine conditions, the masculine match trials revealed a similar timecourse of processing in both English-first and Spanish-first codeswitching trials, but masculine mismatch trials were more difficult to integrate in Spanish-first codeswitching trials. We discuss the findings in terms of gender processing in bilingualism and implications for the PDC model.

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Dedication

A mi querida mamá, Riga Kroff, who has always nurtured my health, my mind, and my bilingualism. Te quiero mucho.[1]

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[1]And Kivo, I dedicate this footnote to you, my love. Don't let anyone say that you weren't on the dedication page.

Investigating Auditory Comprehension in Codeswitching

1.1 Introduction

Bilinguals in the presence of other known bilinguals are likely to engage in *code-switching*, broadly defined as the fluid alternation between two (or more) languages in bilingual speech (Poplack, 1980). Long considered a sign of agrammaticism or as evidence for a lack of competence in either of a bilingual's languages, since the 1970s linguists have documented the systematicity underlying codeswitched speech (e.g. Timm, 1975; Lipski, 1978; Pfaff, 1979). This systematicity consequently fueled the search over the next two decades for universal grammatical constraints licensing codeswitching (e.g. Poplack, 1980; Sankoff & Poplack, 1981; Joshi, 1985; Di Sciullo, Muysken, & Singh, 1986; Myers-Scotton, 1993; Belazi, Rubin, & Toribio, 1994). Yet after three decades of study, including the publication of several volumes dedicated to research on codeswitching (Jacobson, 1997, 2000; Bullock & Toribio, 2009a; Isurin, Winford, & de Bot, 2009), we know surprisingly little concerning the grammatical nature of codeswitching other then that bilinguals engage in it. Researchers continue to be beset by the same questions asked at the advent of serious linguistic inquiry into codeswitching and, fundamentally, in how to define what constitutes codeswitching *vis-a-vis* other contact phenomena such as borrowing (e.g. see response papers between Stammers & Deuchar, 2011; Poplack,

2011; Deuchar & Stammers, 2011), loanwords and calques (e.g. Backus & Dorleijn, 2009), and interference phenomena (e.g. Weinreich, 1963; van Coetsem, 1988).

During the same period of time, bilingualism, more generally, has captured the interest of psycholinguists. Here, the focus has traditionally been on how the constituent languages of the bilingual interact within the same mind and whether adults who learn a second language later in life can achieve native-like proficiency and processing. Whereas earlier accounts suggested that bilinguals compartmentalize their two languages by way of a switching mechanism (Macnamara & Kushnir, 1971), contemporary models suggest a high degree of interactivity between the two languages both in production and comprehension and as present at the phonological, morpho-syntactic, and discourse levels—an approach termed **non-selectivity** (see Kroll & De Groot, 2005, for comprehensive review). Strikingly, this interactivity has been documented using a diverse set of experimental methods and paradigms and at various levels of proficiency. Despite the evidence in favor of non-selectivity, bilinguals rarely are affected to the point of unintentionally switching between the two languages. That is, bilinguals do not haphazardly switch into an unintended language even in the face of continued co-activation. This apparent feat has led to many researchers implicating a higher degree of engagement in domain-general inhibitory control and/or attentional processes in bilinguals (Green, 1998; Bialystok, 2005; Bialystok, Craik, Green, & Gollan, 2009). In essence, bilinguals are mental jugglers exercising constant engagement between the two language (Kroll, Dussias, Bogulski, & Valdes Kroff, 2012).

Still, even with this increased focus on bilingualism, the principle goal of psycholinguistic approaches to bilingualism continues to be how bilinguals are able to ultimately produce or comprehend in one language alone, i.e. a **unilingual** approach to bilingualism. Thus, unsurprisingly, a search for experimental approaches on codeswitching reveals a relative dearth of studies (see Gullberg, Indefrey, & Muysken, 2009; van Hell & Witteman, 2009, for review). Moreover, a closer inspection of these experimental approaches reveals a lack of differentiation between codeswitching of the type found in bilingual communities and the main focus of linguists and sociolinguists with *language switching*, which examines how bilinguals recover from artificially cued switches between languages done mainly at the lexical level (e.g. Meuter & Allport, 1999). For example, in their review of neurocogni-

tive approaches to language switching, van Hell and Witteman (2009) include in their scope "the switching of languages between single, unconnected items (e.g., words, numbers) as well as the switching of languages between words or phrases embedded in a meaningful sentence or discourse context (p. 55)." Similarly, in the same volume Marian (2009) characterizes codeswitching as part of a set of processes involved in language interaction claiming that switching involves overt influences of the non-target language whereas transfer is a similar process involving covert influences. Although these processes may be related, a clearer understanding of the production and comprehension of codeswitching is necessary to get a more representative account of how bilinguals use their two languages (Myers-Scotton, 2006). As will become clearer in our literature review, in many ways we may characterize psycholinguistic studies on codeswitching as underspecifying what is meant by codeswitching, whereas linguistic approaches may overspecify what defines codeswitching, e.g. Myers-Scotton on the differences between *classic* and *composite* codeswitching (Myers-Scotton, 2000).

In contrast to a strictly unilingual approach, codeswitching allows for a **dual language** approach to bilingualism which leads to important and empirically testable research questions otherwise left unanswerable. From a processing efficiency perspective, a parsimonious assumption on bilingual language processing most likely entails the view that speech should remain in the same language between speakers. Codeswitching challenges this assumption. If in unilingual settings bilinguals continue to exhibit effects of non-selectivity in both production and comprehension, then codeswitching by its very act must heighten co-activation between the two participating languages. Furthermore, if cognitive control (i.e. inhibitory and/or attentional control) is implicated as the primary set of processes that effectively guide ultimate selection of the target language, then bilinguals who engage in codeswitching plausibly exercise exquisite use of these processes in order to fluidly alternate between languages within discourse and to successfully integrate dual language information across phonological, morpho-syntactic, and semantic domains. All of this must be accomplished while following putative grammatical constraints, due to the observation that the hallmark of codeswitched speech is that it is not random (e.g. Lipski, 1978; Pfaff, 1979; Poplack, 1980, and many others).

This dissertation unifies linguistic approaches to codeswitching with the experimental paradigms utilized by psycholinguists to study the auditory comprehension of codeswitched speech. In particular, we make use of an eye-tracking methodology known as the **visual world** paradigm (Cooper, 1974; Tanenhaus et al., 1995), which we describe in more detail in Section 1.3. Briefly, researchers present participants with a visual scene on a computer screen or using real objects situated in front of the participant. Participants' eye movements are recorded while listening to auditory stimuli. Participants are then typically instructed to carry out a simple task such as clicking on the object that they heard named using a computer mouse or by picking up the named object in front front of them[1]. Critically, this action has no direct impact on the experimental manipulation of interest to the researcher. Furthermore, because the dependent measure in visual world studies is fixations to the different candidates presented in the visual scene, this experimental paradigm avoids reliance upon overt judgments (e.g. grammaticality judgments) or reactions to the linguistic stimuli (e.g. reaction time in self-paced reading). That is, participants are not directly asked to respond to the grammaticality of the trials that they just heard.

One of the primary challenges that experimental approaches to codeswitching has faced is that it can be a highly stigmatized speech register (Pfaff, 1979; Bullock & Toribio, 2009b). As such, the grammaticality judgments that have made up the bulk of empirical work in linguistic approaches to codeswitching are not well-suited or reliable (Guzzardo Tamargo et al., 2011; Guzzardo Tamargo, 2012). Likewise, most experimental work claiming to test the processing of codeswitched speech has focused on single lexical switches and mostly makes use of experimental stimuli presented in the written domain[2] (e.g. Li, 1996; Altarriba, Kroll, Sholl, & Rayner, 1996; Moreno, Federmeier, & Kutas, 2002). Therefore, experimental approaches on the auditory comprehension of codeswitched speech will help fill a critical gap. We accomplish this by pairing language stimuli that is representative of codeswitching

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[1]The carrying out of a simple task is not strictly necessary. See, for example, Altmann and Kamide (1999) or Huettig and Altmann (2005) for use of the visual world without explicit instruction to click on objects.

[2]However, see Dussias (2001), (2003), Guzzardo Tamargo (2012) for experimental approaches that test written codeswitches with multi-word constituents in both languages, and Dorleijn and Nortier (2009), Callahan (2004), and Montes-Alcalá (Montes-Alcala2000,Montes-Alcala2001,Montes-Alcala2005) for linguistic approaches to written codeswitches.

as it is spoken in bilingual communities with experimental methods that avoid use of overt grammatical judgments and intuitions.

Therefore, we argue that the visual world paradigm is a well-suited experimental methodology for this goal. First, the paradigm allows for the inclusion of sentence-length auditory stimuli that can be heard without any overt interruptions. This characteristic has the benefit of not artificially interrupting the auditory stream (contra self-paced tasks) and more importantly, permits researchers to record codeswtiching as produced by bilinguals who codeswitch. Given the fact that not all bilinguals codeswitch, the relative importance of high proficiency across both languages for the fluid production of intra-sentential codeswitches, and that codeswitching is largely a spoken language phenomenon, the use of auditory stimuli as produced by codeswitchers is not trivial. Second, the dependent measure—total fixations to target items—is a highly ecological measure. As participants inspect a visual scene, they will naturally look towards named and relevant information as the auditory signal unfolds. Crucially, it is not necessary to explicitly instruct participants to look at objects as they are named. This characteristic allows researchers to observe real-time processing (i.e. as the speech signal unfolds) under different experimental conditions where grammatical features and/ or structures are manipulated. Furthermore, because the dependent measure does not require an overt response, we can mask the primary manipulation of the experiment by simply instructing participants to carry out a secondary task such as clicking on the named picture or making a plausibility judgment based on the meaning of the sentence. Critically, our dependent measure does not require participants to make any judgments on the codeswitches themselves.

Additionally, this dissertation tests models of sentence processing that propose a tight link between production and comprehension by using codeswitching as the empirical data set. This approach is novel in that most models of sentence processing have primarily been formulated based on monolingual data (e.g. Gennari & MacDonald, 2009; MacDonald & Thornton, 2009) and secondarily tested with bilingual data but only in unilingual contexts (e.g. Dussias & Sagarra, 2007; Dussias & Cramer Scaltz, 2008). One prominent model, the Production-Distribution-Comprehension (PDC) model (MacDonald, 1999; Gennari & MacDonald, 2009), proposes that distributional patterns in production accumulated over time are

learnable by communities of speakers. These distributional patterns form the basis for how comprehension is facilitated or delayed. In other words, the more prevalent a structure is in production *vis-a-vis* equivalent alternatives (e.g. ditransitive v. prepositional alternation in English: "John gave [Mary]$_{\text{NP}}$ [the book]$_{\text{NP}}$" $\sim$ "John gave [the book]$_{\text{NP}}$ [to Mary]$_{\text{PP}}$"), the more easily it is processed in comprehension.

Codeswitching provides a fruitful testing ground to further examine the predictions of the PDC framework because it primarily involves the selection between across-language alternatives (i.e. Language A or Language B) for the bilingual speaker. In contrast, absent any known linguistic or extra-linguistic cues that prompt an upcoming switch, codeswitching should logically be difficult on the part of the bilingual listener. Successful integration of incoming auditory material from either language necessitates that bilingual listeners maintain expectations for the possible production of dual language elements. Nevertheless, bilinguals do not appear to suffer any apparent and lasting processing costs to comprehension.

Potentially, one cue that guides comprehension of codeswitched speech involves the heightened probability of an upcoming switch. One way to test this claim is to examine the distribution of alternative across-language structures in the production of codeswitching and to subsequently investigate whether comprehension reflects these distribution patterns. In other words, we can ask whether bilingual speakers show preferences for specific codeswitching patterns in production, and if that is the case, we should subsequently be able to test whether comprehension is impacted in a parallel fashion. This line of logic falls directly from the PDC framework. That is, this dissertation directly tests whether distributional patterns in codeswitching production form the basis for where bilingual listeners are most likely to expect codeswitches.

Moreover, because codeswitching is a specialized linguistic skill which by its very definition involves the use of two languages, codeswitching also allows us to examine how bilingual speakers negotiate cross-linguistic differences within discourse. In this dissertation, we specifically test the processing of *Mixed NP*s in Spanish-English codeswitching which contain elements of both languages, e.g. ***el juice***, Sp. *el jugo*, Eng. *the juice*. We focus on this particular structure because Spanish obligatorily encodes for grammatical gender (i.e. masculine or feminine)

whereas English does not. Interestingly, linguists who have examined Spanish-English codeswitching note that switches between the Spanish article and the English noun are highly frequent (Timm, 1975; Pfaff, 1979; Poplack, 1980). This well-documented observation leads us to quantify how bilinguals assign gender in Mixed NPs by use of a Spanish-English bilingual corpus (Deuchar et al., 2012). This quantification will allow us to explore whether gender assignment follows a Spanish-like strategy and assigns gender based on the translation equivalent of the English noun (e.g. **la_{fem}** *cookie*, Sp. *la_{fem} $galleta_{fem}$*), whether speakers elect an English-like strategy where gender is effectively neutralized (e.g. **$el_{\emptyset}$** *cookie*), or whether the patterns in gender assignment are a hybrid system that make use of both Spanish and English strategies (e.g. both **$el_{\emptyset}$** *cookie* and **la_{fem}** *cookie*). Consequently, this quantification will establish our baseline predictions for the visual world eye-tracking studies investigating comprehension. Put simply, we predict that whichever pattern found to be most frequent in production should be favored in comprehension. Conversely, any patterns that are highly infrequent or unattested in our production data should result in costlier integration in comprehension.

The remainder of the chapter is structured as follows. First, we explore in more depth how linguists have studied codeswitching. We follow with a section where we contrast codeswitching as studied by linguists, with language switching experiments of the type utilized by psycholinguists. Next, we review various constraints on grammatical codeswitching that researchers have proposed, subdivided into two families of constraints—linguistically-based constraints and processing-based constraints. The following section focuses on experimental approaches to codeswitching examining how both production and comprehension have been studied. We segue into a general description of the visual world paradigm and how it can be applied to the auditory comprehension of codeswitching. The next section discusses in more depth the Production-Distribution-Comprehension framework including how it has been applied in previous studies. Finally, we close with a roadmap for the remainder of the dissertation chapters.

1.2   Empirical Studies on Codeswitching

Linguists have broadly defined two main types of codeswitches as illustrated below[3].

(1)   **Ayer fui al supermercado**, and I bought an apple [inter-sentential codeswitching]
       "Yesterday I went to the supermarket, and I bought an apple"

(2)   **El niño recogió el** bottle on the street [intra-sentential codeswitching]
       "The boy picked up the bottle on the street"

As the names imply, inter-sentential codeswitches occur at major syntactic boundaries[4]. On the other hand, intra-sentential codeswitches occur within major clause boundaries, and therefore, require a higher degree of integration of prosodic, lexical, and syntactic information across the bilingual's two languages. As such, the use of intra-sentential codeswitching is taken to be an indicator of high proficiency across both languages (Poplack, 1980; Miccio, Sheffner Hammer, & Rodríguez, 2009). Consequently, bilinguals who are more dominant in one of their two languages are more likely to engage in inter-sentential codeswitching whereas bilinguals who are highly proficient in both languages are more likely to engage in intra-sentential codeswitching although community norms may also affect this tendency (Poplack, 1987).

Bullock and Toribio (2009b) broadly describe three different approaches for the study of codeswitching: social, structural, and cognitive. Studies examining codeswitching from a social perspective investigate the discourse functions of codeswitching, speaker choices at the community and individual level, and extra-linguistic factors that may influence codeswitching patterns such as sex, age, or language attitude. Structural approaches direct their attention towards determining grammatical (and putatively universal) constraints on licit codeswitches, understanding the contribution of each participating language, and whether codeswitch-

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[3]Throughout the dissertation, all examples of Spanish-English codeswitching will be presented with Spanish elements in bold.

[4]There is still considerable debate on what should be the appropriate level of syntactic analysis to differentiate between these two kinds of codeswitches. For example, some researchers consider the sentence the basic level of constituency that defines the difference between inter-sentential and intra-sentential codeswitching. Others instead use the terms inter- and intra-clausal codeswitching, reflecting their preference for the COMPLEMENTIZER PHRASE (CP) as the level of analysis.

ing differs from other contact phenomena such as loan translations and borrowings. Researchers working within the cognitive domain examine the production and comprehension processes underlying codeswitched speech and more broadly, how the two languages interact. These approaches are not necessarily discrete nor mutually exclusive.

In general, most studies have focused on the production of codeswitches. Production studies have received particular emphasis both from structural (Belazi et al., 1994; Deuchar, 1999, 2005, 2006; MacSwan, 1999, 2000; Muysken, 2000; Myers-Scotton & Jake, 2001; Jake et al., 2002a) and sociolinguistic (Bentahila & Davies, 1997; Deuchar & Davies, 2009; Lipski, 2005; Fishman, 1972; Gumperz, 1982; Kachru, 1978; Milroy & Li Wei, 1995; Myers-Scotton, 1993; Singh, 1983) perspectives, although some psycholinguistic work has also been done (Azuma, 1996; Gullberg et al., 2009; Kootstra, van Hell, & Dijkstra, 2011). Alternatively, comprehension in codeswitching has remained vastly understudied and primarily done by experimental methods (e.g. Li, 1996; Altarriba et al., 1996; Hernandez, Dapretto, Mazziota, & Bookheimer, 2001; Moreno et al., 2002; Dussias, 2001, 2002, 2003). With the exception of the studies by Dussias, the majority of these studies investigate comprehension in codeswitched contexts by use of single insertional switches in otherwise unilingual contexts. As a result, the scope of inquiry has been largely limited to the study of the lexical integration of one grammatical category, nouns, thereby missing the broad repertoire of codeswitching found amongst bilingual communities.

One study in particular highlights both the advantage of studying codeswitches embedded in sentential contexts and the limitations of including just single lexical switches. Moreno et al. (2002) conducted an event-related potential (ERP) study comparing highly expected nouns in both regular expressions and idiomatic expressions (Ex. 3a), to what they term lexical switches, i.e. less expected synonyms (Ex. 3b), and across-language switches, i.e. code switches in their terminology, that were direct Spanish translations of the expected noun (Ex. 3c).

(3)   Examples of materials used in Moreno et al. (2002):

      a. Each night the campers built a <u>fire</u> [expected]

      b. Each night the campers built a <u>blaze</u> [lexical switch]

> c. Each night the campers built a <u>fuego</u> [code switch]

At issue was whether a switch across languages inherently incurs processing costs. The results from their study suggest otherwise. Whereas the within-language switch elicited higher N400s[5] as compared to the control baseline, across-language switches did not, indicating no additive cost to semantic integration. Instead, the reserachers found a late positive component (LPC) which they interpreted as an index of an unanticipated lexical item. In other words, a codeswitch was unexpected in the context of their experimental stimuli but did not elicit processing costs to comprehension.

The finding that codeswitches did not elicit large costs to integration is welcome particularly because these results stand in contrast to typical costs observed in language switching studies (e.g. Meuter & Allport, 1999); however, it remains unclear whether the LPC component is an inherent component that is generally elicited in codeswitching contexts, or if this result was due to the specific experimental manipulation in Moreno et al. (2002). Because the across-language switch condition only included single word switches, sentential context did not guide participants to expect a codeswitch. Furthermore the specific direction of the switch from English determiner into Spanish noun, e.g. *a **fuego***, has largely been found to be infrequent in the literature on Spanish-English codeswitching. Instead, researchers have found that Spanish-English bilinguals are more likely to produce switches from Spanish determiners into English nouns, e.g. ***el** fire* (Pfaff, 1979; Poplack, 1980, see also Chapter 2). Thus, the use of unrepresentative codeswitches may have resulted in electrophysiological responses associated with surprisal (e.g. Hale, 2001; Levy, 2008) and not necessarily associated with integration of codeswitches *per se*. In the following section we expand further into the differences between codeswitching and language switching paradigms.

1.2.1 Codeswitching v. Language Switching

Whereas codeswitching has been the focus of study of linguists and sociolinguists, psycholinguists have largely turned their attention towards investigating the ability

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[5]The N400 is largely taken to be an index for semantic integration. The more negative amplitude that a condition elicits relative to another condition, the less semantic integration. (Kutas & Hillyard, 1980).

of bilinguals to switch between languages by way of external cues in a set of experiments broadly called the *language switching* paradigm or the *mixed language naming* task (Guo, Liu, Misra, & Kroll, 2011). The basic experimental paradigm consists of presenting participants a series of items to name, e.g. digits or pictures of objects, and cues that indicate the language in which to name the trials. Crucially, the sequence of trials can either stay in the same language (i.e. no-switch trials) or change to the other language (i.e. switch trials). This experimental design allows for a direct comparison of time to name between no-switch trials and switch trials for both languages, thus constituting a measure of switch cost and directionality.

The use of this experimental paradigm has greatly contributed to our understanding of how bilinguals negotiate competing across-language candidates in production and therefore allow us to explore the cognitive mechanisms underlying language control. This body of research has led to two critical findings. First, when comparing switch trials to non-switch trials, researchers find an overall cost to production, i.e. responses are measurably longer in switch trials. Second, switches from the second language (L2) into the first language (L1) are more costly than switches from L1 into L2 (e.g. Meuter & Allport, 1999). Although the first finding is largely a replication of earlier studies albeit with finer techniques (e.g. Kolers, 1966; Macnamara & Kushnir, 1971; Macnamara, Krauthammer, & Bolgar, 1968), the second constitutes an innovative finding and has led researchers to interpret this asymmetric switch cost in production as implicating the use of cognitive control as the primary set of processes underlying language selection. To that effect, they argue that bilinguals exercise more inhibitory control on the L1 in contexts where L2 must be produced. Thus, when these bilinguals are cued to switch back into L1, they must overcome that initial inhibition in order to produce in the indicated language.

We argue that there are at least three differences between language switching studies and codeswitching as characterized by linguists and sociolinguists. The clearest difference is the nature of what is being switched. Language switching typically involves the use of unconnected words or digits that come from the same grammatical class or category (Ex. 4). On the other hand, codeswitching involves switches between words that are embedded in a sentential or phrasal context and that come from different grammatical categories (Ex. 5).

(4)   Typical Language Switching trials

    ...one   five   **tres ocho** seven two ...
    ...digit digit digit digit digit digit ...

    one five three eight seven two

(5)   Spanish-English codeswitching (Ex. 1 from Poplack, 1987, p. 53)

    Después yo hacía uno de   esos concoctions: the garlic **con cebolla**
    adverb   pro verb det prep det   noun   det noun prep noun

    "Afterwards, I'd make one of those concoctions: the garlic with onion ..."

In a recent set of experiments, Tarlowski, Wodniecka, and Marzecová (2012) attempt to address this difference. Paralleling our observations, they point out that psychologists and psycholinguists have mainly studied production and language switching of single words while linguists have focused on switching in sentences and phrases where the analysis is based on syntactic structure. Their study continues to employ the language switching technique of externally cueing the intended language for production; however, they introduce phrase level utterances that differ on grammatical structure. In other words, rather than switching between single and unconnected words, participants produced grammatical phrases. In the experiment, they focus on the progressive (e.g. *he is drinking*) and perfective (e.g. *he has drunk*) verbal aspects in Polish-dominant Polish-English bilinguals. These structures are produced and used differently across the two languages. They argue that if language switching mirrors a general process involved in language control, then there should be no difference in switch costs between the two grammatical structures. Interestingly, they found that switch costs were different depending on the grammatical structure. Whereas they did find an asymmetrical switch cost for perfective in line with the results from Meuter and Allport (1999), they instead found a symmetrical switch cost with reversed dominance (i.e. English was faster than Polish) for the progressive structure. Although this study is not fully reflective of codeswitching, it constitutes a beginning step towards broadening the scope of language switching beyond the level of single words.

The second difference is the consideration of the proficiency of the two languages of the bilingual. As noted previously, the classic finding from language switching studies alludes to differences in proficiency across the two languages.

Because the L1 is more dominant than the L2, a bilingual speaker must differentially apply more inhibitory control in order to selectively speak in the L2. This finding begs the question of how these costs are modulated by proficiency across the two languages. Indeed, other studies that have investigated bilinguals with high levels of proficiency in both languages and speakers with more than two languages show that the asymmetrical production cost is reduced or is not present (Costa & Santesteban, 2004; Costa, Santesteban, & Ivanova, 2006).

The third difference is the linguistic profile of the participants typically studied in language switching studies as compared to bilinguals who codeswitch. The underspecification of the linguistic profile of bilingual participants in language switching studies leaves us unsure of whether habitual codeswitching in and of itself modulates switch costs (Meuter, 2009). More recent work has investigated this issue indirectly. Prior and MacWhinney (2009) provide evidence of bilinguals performing better than monolinguals on task switching paradigms. The task switching paradigm is similar to the language switching paradigm in that an external cue indicates what task the participant needs to carry out (e.g. a shape task or a color task where both shape and color are used). They argue that experience in switching between languages in daily life directly confers benefits for bilinguals in the more general task switching paradigm. In line with this prediction, Prior and MacWhinney find that bilinguals did perform better on task switching than monolinguals. Furthermore, Prior and Gollan (2011) follow up with a similarly related study. Here, they compare two groups of bilinguals, Spanish-English and Chinese-English bilinguals. Interestingly, they asked the participants to indicate on a language history questionnaire how often they used both of their languages, which Prior and Gollan utilized as a measure of switching frequency. They found that the Spanish-English bilinguals generally switched more frequently between their two languages throughout the day. Even when proficiency was controlled across the two languages for the two bilingual groups, the Spanish-English group (i.e. the more frequent language switchers) showed smaller costs in both the task switching and language switching paradigm than the Chinese-English bilnguals. This set of findings is incredibly suggestive that engaging in codeswitching may result in less difficulty in language switching in general; however, we note that the self-reported ratings on language switching that the authors used may not directly

reflect the degree to which the bilingual participants habitually codeswitched (particularly in the more intricate skill of intrasentential codeswitching). Instead, the question that they asked was more general, i.e. "How often [do you] switch languages currently: 1—almost never, 5—constantly (Prior & Gollan, 2011, p. 684)."

The idea that codeswitching may involve different processes from language switching is by no means a new one (Sridhar & Sridhar, 1980); however, it appears not to have gained much attraction or further notice until relatively recently (Gullberg et al., 2009; Meuter, 2009; Green, 2011; Prior & Gollan, 2011). In part, we believe that the tendency to discuss the two processes as interchangeable is largely driven by methodological limitations and a general misunderstanding of what is meant by codeswitching. As to the first point, Gullberg et al. (2009) have claimed that it is likely impossible to study the comprehension of codeswitching in the laboratory without use of language switching techniques even though they share our concern on whether the processes involved in language switching are representative of the processes underlying codeswitching (pp. 21–22). As we discussed in the introduction and cover in more depth in Section 1.3, we believe that the visual world paradigm is one potential experimental technique that can help overcome these challenges.

On misconceptions of what is codeswitching, many studies that putatively investigate codeswitching with experimental methods in reality examine switch costs associated with the integration of single lexical items that overwhelmingly come from one grammatical category alone, i.e. nouns. These studies also rarely make reference to how codeswitching occurs in the language pair of the experiment (c.f. Dussias, 2003). For example, many experimental studies do not address what is the most common codeswitching patterns, i.e. what are the most frequently switched constituents; are bilinguals who codeswitch with the language pair of study more likely to switch with single word insertions or are multi-word alternations more common? We emphasize that this critique is not novel. Indeed, Sridhar and Sridhar (1980) were prescient in discussing the importance of codeswitching[6] as used amongst bilingual communities as an important area of investigation for psychologists. Reviewing earlier work that had largely documented switch costs in

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[6]They use the term *code mixing*. For a discussion on the finer-grained differences between codeswitching and code mixing (and code alternation) and how different researchers have used these terms, see Boeschoten (1998).

production, they caution that these switch costs may not be fully representative of what goes on in codeswitching. In particular, they note that those studies involved words that were, for example, "haphazardly in English or French (Kolers, 1966, cited in Sridhar & Sridhar, 1980, p. 414)". They make two further observations relevant to our discussion here. First, Sridhar and Sridhar discuss findings in Macnamara et al. (1968) that show that more regular switches reduced switching costs. They point out that codeswitching is a "rule governed phenomenon (Sridhar & Sridhar, 1980, p. 414)," thus suggesting that codeswitches should result in reduced switching costs as they are, in effect, more regular than ungrammatical switches. Second, Sridhar and Sridhar return to another finding in Kolers whereby practiced switches were also found to have reduced switching costs. Here, they highlight that codeswitching "is a stable, habitual mode of language use (p. 414)." With these considerations, they suggest that codeswitching may reveal very small or no switching costs at all. The next two decades were largely silent on the matter.

In light of the practice in experimental approaches of underspecifying potential differences between codeswitching and language switching, it is remarkable that one of the principle architects of contemporary language switching studies has herself made the strong case that the processes underlying these two phenomena may be different. More generally, Meuter (2009) presents a novel perspective on codeswitching. While maintaining that codeswitching is fluent, she argues that evidence[7] continues to favor a probable cost associated with codeswitching—both in production and comprehension. Nevertheless, she argues that codeswitching may not be inefficient. One piece of her hypothesis rests on the assumption that bilingual speakers attempt to optimize their performance. Therefore, codeswitching contexts require a "readiness to respond in any language, if both might be called on, thus facilitating the ability to switch between them (Meuter, 2009, p. 32)." She continues:

> ...switching between languages can be conceptualised as switching between language sets. The ability to do so may be simply another instance of our general cognitive ability to switch between and control task sets. Alternatively, the use of multiple language systems may

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[7]Interestingly, Meuter (2009) cites the same studies that Sridhar and Sridhar (1980) caution as possibly unrepresentative of codeswitching.

trigger the development of a form of task control that is unique to multilingual speakers (Meuter, 2009, p. 32)

At the very least, when we take into consideration the linguistic profile of bilinguals (i.e. switchers v. non-switchers) we may expect differences in performance on language switching studies. Additionally, Meuter suggests that *preparedness* may also be a component for efficient and optimal language selection (including codeswitching).

> Preparedness involves determining the likelihood that one or the other language is more or less likely to be used and adjusting the relative levels accordingly, remaining vigilant for (socio)linguistic cues signaling language use (single or multiple) under those specific circumstances. Such control processes could facilitate frequent language switches or, alternatively, enable the speaker to maintain a selected language. (Meuter, 2009, p. 37)

In other words, bilinguals should expect codeswitches in order to optimally process them. This expectation is most likely community driven. That is, bilinguals would need to be a part of a community of codeswitchers in order to facilitate the expectation that codeswitching will arise.

Finally, Green (2011) also makes a strong argument for the importance of studying codeswitching as a separate phenomenon in order to better understand language control. He claims that although neuroimaging studies have revealed the regions of the brain associated with language interference and switching, "[o]ur current understanding is nonetheless constrained because we have not explored the extent to which differences in the community use of two languages (the behavioral ecology of bilingual speakers) affects the processes of language control (Green, 2011, p. 1)." He specifically makes reference to the need for comparisons between bilinguals speakers who codeswitch and those who do not and suggests that experience with codeswitching may lead to the recruitment of different neural circuitry in language control. Interestingly, Green (p. 2) hypothesizes that the production and comprehension of codeswitching may recruit higher levels of activation in the right cerebellum due to its role in morphosyntactic integration and for timing and synchronization. The necessity to integrate morphosyntactic

information across two languages may perhaps be the central characteristic that differentiates unconnected language switching from codeswitching.

This dissertation attempts to bridge the gap between structural linguistics and psycholinguistics by applying an experimental paradigm where we utilize controlled stimuli that more closely resemble codeswitching as described by linguists. Furthermore, we target a community of Spanish-English bilinguals from New York City—a known community where codeswitching takes place frequently (Poplack, 1980; Zentella, 1997; Otheguy & Lapidus, 2003). By targeting this specific population of bilinguals, we are more confident that we are approximating the comprehension processes that bilinguals experience when integrating codeswitched speech. Importantly, we have selected an experimental paradigm that does not artificially interrupt the speech stream while participants are listening to auditory stimuli. The auditory stimuli are previously recorded by a Spanish-English bilingual who habitually codeswitches in daily life. Additionally, while listening to the auditory stimuli, we instruct participants to click on the object that they heard named and to focus on the meaning of the sentences in order to carry out a subsequent plausibility judgment. One benefit of these instructions is that they encourage participants to listen for comprehension and ensure higher looks to target items as they orient towards selecting the named object. The dependent measure of interest is total fixations to target items, which does not rely on overt grammatical judgments on the part of the participant. We turn now in the following section to a review of the major constraints on codeswitching that have been proposed by linguists.

1.2.2 Constraints in Codeswitching

Linguists have devoted much effort over the past three decades to generating the specific constraints or rules that may be operant in codeswitching. Due to the underlying systematicity in codeswitching, the primary goal for linguists has been to formulate such constraints that are also generalizable across any language pair. This endeavor has been complicated by the numerous subsequent counter-examples that appear to beleaguer any given proposed constraint. This challenge has led several prominent sociolinguists and contact linguists to claim that there

are no grammatical constraints that will universally capture the way in which any two language pairs will interact in any given community of bilingual speakers (e.g. Bokamba, 1989; Muysken, 2000; Gardner-Chloros & Edwards, 2004; Gardner-Chloros, 2009; Clyne, 1987); rather, they claim that codeswitching is too inseparable a linguistic phenomenon to be characterized as the interaction of two discrete and compartmentalized grammars. In turn, this observation leads many sociolinguists to favor a more holistic approach that views codeswitching as yet another linguistic tool accessible to bilinguals to further communicative goals and to express identity (e.g. Gardner-Chloros, 2009; Gafaranga, 2007; Auer, 1998). Nevertheless, the search for possible constraints or theories on codeswitching continues. To formulate these constraints on codeswitching, linguists have primarily considered naturalistic data, whether in isolation or extracted from bilingual corpora, or have elicited judgments and intuitions from off-line measures, e.g. grammaticality judgments, surveys, phrase-level repetition, etc. The constraints are diverse in both the unit of analysis considered (e.g. status of single word switches) and the relative contribution of each participating language (explained below). Many of the differences found amongst the proposed constraints are in large part due to the preliminary assumptions or theoretical frameworks that a particular researcher may adopt. For illustrative purposes, we adopt a subdivision based on whether constraints make reference to syntactic structure or surface word order, which we term **Linguistically-based Constraints** (Section 1.2.2.2) or to speech production models, which we label **Processing-based Constraints** (Section 1.2.2.3). For a thorough review, consult Chapter 2 of Dussias (1997).

1.2.2.1 Theoretical Preliminaries

Before reviewing several prominent codeswitching constraints that have been proposed in the field, we turn first to three issues that we consider to be preliminary assumptions that a researcher confronts when formulating generalizable constraints on codeswitching[8]. The first issue centers on the relative status of each participat-

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[8]Other researchers propose taking a more holistic or 'common sense' approach to codeswitching and therefore circumvent the need to start with any theoretical assumptions. Refer to Gardner-Chloros (2009) and references therein for an excellent explanation of this approach. One other prominent alternative framework (Muysken, 2000) stakes the position that any given language pairing will result in different codeswitching patterns due to both linguistic, e.g. whether

ing language in codeswitching. The next issue concerns the status of single word switches. Finally, we discuss the issue of whether codeswitching constitutes a third grammar.

One important dimension upon which researchers differ is their view on the relative status of each participating language with respect to each other. Broadly, linguists either take the position that the participating languages are roughly equivalent or asymmetrical in their relative contributions to the grammatical frame of a codeswitched utterance (Gardner-Chloros, 2009; Muysken, 2000; Gafaranga, 2007). Under the assumption of equivalence (e.g. Lipski, 1978; Pfaff, 1979; Poplack, 1980; Di Sciullo et al., 1986; MacSwan, 1999), researchers remain agnostic as to the general direction of a codeswitch. Instead, these researchers search for likely syntactic junctures where codeswitches are permitted or not permitted to occur, making reference either to structural equivalence across the two languages or to the local grammatical constraints that a specific lexical item may place upon its neighboring complements. Alternatively, other researchers posit that the participating languages have an asymmetric contribution in codeswitching (e.g. Joshi, 1985; Myers-Scotton, 1993; Azuma, 1993). Under this assumption, one of the languages will set the grammatical frame of a planned codeswitched utterance whereas the other language is free to insert certain types of lexical elements into this grammatical frame. Researchers working under such a framework have used words such as *matrix* and *embedded* language (Joshi, 1985; Myers-Scotton, 1993) or *host* and *guest* language (Azuma, 1993) reflecting this underlying assumption of asymmetry.

A second issue dominating research in codeswitching relates to the status of single word items. In general, researchers make a basic distinction between established borrowings and codeswitches[9]. Established borrowings are the result of a gradual process where previously foreign elements become integrated into the native lexicon. Established borrowings thus show elements of integration such as phonological adaptation and affixation with native functional morphemes. For ex-

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any given language pair exhibit typological differences or are highly cognate languages, and extra-linguistic factors, e.g. whether the bilingual setting is a stable bilingual community or a former colonial setting with unequal levels of prestige for the two languages.

[9]While maintaining the terminological distinction, some researchers have argued that borrowing and codeswitches are inseparable processes of language contact (Thomason, 2001; Treffers-Daller, 1994).

ample, the Spanish verb *faxear* [faksear] is derived from English *fax* [fæks][10]. Not only has it been phonologically integrated, (i.e. no [æ] and addition of epenthetic [e]) but it also bears verbal morphology (i.e. the infinitival bound morpheme -*ar*) and is represented as an entry in the *Diccionario de la lengua española*[11]. The heuristics that delineate established borrowings may differ from researcher to researcher but the basic premise remains the same. While these forms are uncontroversial, the question arises as to the status of single words that are not established in the native lexicon yet are otherwise in unilingual clauses. Consider the following example:

(6) **Dejé el**   car [kaɹ] **estacionado al**   **lado de la**   **casa**
     I left the$_{\text{masc}}$ car   parked   at the$_{\text{masc}}$ side of the$_{\text{fem}}$ house
     "I left the car parked at the side of the house"

What is the status of the word *car* in this example? The word is not phonologically adapted into Spanish (e.g.. use of retroflex [ɹ]) and does not show morpho-syntactic integration. Furthermore, *car* is not listed in the *Diccionario* with the intended meaning of "vehicle"[12].

This issue has proven to be highly controversial amongst researchers. On the one hand, some researchers have argued that these unadapted single word elements should simply be considered codeswitches (e.g. Treffers-Daller, 1994; Jake et al., 2002a; Myers-Scotton, 2006). They state that discounting these elements unnecessarily disregards a considerable portion of bilingual speech. To that effect, several researchers have noted that single word elements comprise the largest number of dual language items in bilingual speech (Pfaff, 1979; Poplack, 1980; Jake et al., 2002a). Moreover, proponents assert that single word items pattern similarly to multi-word constituents and that any theory of codeswitching should subsequently account for both single word and multi-word constituents (Jake et al., 2002a). Alternatively, Poplack and colleagues suggest that the status of these singly occurring

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[10]Interestingly, *fax* is an abbreviated and lexicalized form derived from *facsimile*, which in turn, is a borrowing from Latin *fac simile* "make similar", entering English circa 1660, see <http://www.etymonline.com/index.php?allowed_in_frame=0&search=facsimile&searchmode=none>.

[11]Retrieved from <http://buscon.rae.es/draeI/SrvltConsulta?TIPO_BUS=3&LEMA=faxear>.

[12]A similar search online at <http://buscon.rae.es/draeI/SrvltConsulta?TIPO_BUS=3&LEMA=car> does reveal non-related low-frequency meanings for the entry *car*.

forms should be examined carefully in order to determine whether they should be treated separately or as unknown at best (Poplack, Sankoff, & Miller, 1988; Sankoff, Poplack, & Vanniarajan, 1990; Poplack & Meechan, 1998; Poplack, 2011). Under this perspective, even if singly occurring words do not exhibit phonological or morpho-syntactic integration, they may be treated as borrowings by bilingual participants. In other words, a bilingual speaker engaged in discourse with other bilinguals may spontaneously borrow in addition to their propensity to codeswitch (Poplack, 2011). Poplack and colleagues label this class of singly occurring words that pattern differently from codeswitches as *nonce borrowings* (Poplack et al., 1988). Several critics of this approach suggest that delineating a class of words as nonce borrowings serves as a convenient means of excluding problematic examples (e.g. Myers-Scotton, 2006; Gardner-Chloros, 2009; Stammers & Deuchar, 2011; Deuchar & Stammers, 2011). However, Poplack (2011) takes painstaking effort to clarify the original intent of the hypothesis by stating that there is no *a priori* reason to discount singly occurring words as codeswitches; rather, she advocates a multi-pronged method of triangulation as a diagnostic to differentiate between the two.

Finally, we consider the assumptions underlying the status of the grammar of codeswitching. The vast majority of linguists devoted to codeswitching research have worked under the framework that codeswitching does not constitute a third grammar (e.g. Lipski, 1978; Woolford, 1983; Myers-Scotton & Jake, 2001; Joshi, 1985; MacSwan, 1999; Bullock & Toribio, 2009a). Mainly, this assumption is driven by a general goal of parsimony. Researchers are motivated to search for the simplest mechanism possible to describe codeswitching within the framework of the two contributing grammars. In many ways this assumption is a logical consequence of the first assumption outlined above, i.e. the status of each participating language with respect to each other. For proponents of an equivalent status between languages, the grammars of each contributing language remain independent; thus, a switch from Language A to Language B also represents a switch from Grammar A to Grammar B. In contrast, under the framework of asymmetry, one of the languages determines the grammatical frame of the utterance, and subsequently, both languages contribute content words into the grammatical frame. Here, although elements of Language A and Language B are present in a codeswitched utterance,

only Grammar A is operant throughout the utterance[13]. Moreover, Joshi (1985) makes the argument that under the possibility of a third grammar for codeswitching, a strong prediction would be that codeswitching is the most efficient means of speaking for a bilingual. Many linguists are adverse to this notion yet offer no clear empirical evidence to support or refute this claim.

In contrast, a minority view (and mainly one held by sociolinguists) is that codeswitching does constitute a third grammar existing as a hybrid version built from the constituent languages (e.g. Bhatia & Ritchie, 1989). Evidence in favor of this view are the codeswitching specific "compromise" strategies that occur, particularly with language pairings that are typologically distinct (Chan, 2009). Compromise strategies include examples such as double morphemes (e.g. double determiner in French–Morrocan Arabic codeswitching (Bentahila & Davies, 1997)), portmanteau structures (e.g. use of prepositions and postpositions in head-first and head-final language pairings (Chan, 2009)), and compound verbs (e.g. use of a dummy helping verb in codeswitching-specific structures in otherwise incongruent pairings (Azuma, 1993)). These compromise strategies are by definition forms that are not possible in unilingual contexts. Moreover, in an approach central to our dissertation, we hypothesize that usage patterns in codeswitching (not constraints) may differ from unilingual contexts, especially when switches occur at syntactic junctures that involve cross-linguistic differences (e.g. Mixed NPs). We argue that if usage patterns are different, which entails the view that a third grammar is likely possible, then comprehension will consequently reflect these differences. Nevertheless, we acknowledge that the field has been dominated by a constraint-based approach to codeswitching. We cover the major constraints that have been proposed in the next section, which all work under the assumption that codeswitching does not constitute a third grammar.

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[13]This characterization is a simplified view as proponents acknowledge that the matrix language can change throughout bilingual discourse. Myers-Scotton and colleagues also acknowledge the possibility that embedded language (EL) islands can arise in otherwise matrix language frames. EL islands are exceptional in that they maintain embedded language grammar within a matrix language frame.

1.2.2.2 Linguistically-based Constraints

As mentioned above, linguistically-based constraints focus on the syntactic sites where codeswitches can occur. As such, the constraints described here explicitly account for licit and illicit codeswitches either by way of linear surface order congruency (i.e. Equivalency Constraint) or by local constraints imposed on neighboring complements (e.g. Government Constraint, Functional Head Constraint). Apart from the Equivalency Constraint, the remainder of the constraint-based approaches discussed in this section have been formulated under the generative approaches proposed by Chomsky. In part due to its generative perspective, we also include the Minimalist approach to codeswitching espoused by MacSwan and colleagues (MacSwan, 1999, 2009) although they term their approach a constraint-free or null theory approach to codeswitching.

The **Equivalency Constraint** is amongst one of the first constraints to have been formulated for codeswitching. Independent from one another, Lipski (1978), Pfaff (1979), and Poplack (1980) all formulated this constraint with slight variations (i.e. is equivalence necessary before or after the switch point, see Chapter 2 Dussias, 1997). At the heart of the Equivalence Constraint is the simple notion that if a switch is to occur, then the two grammars of the participating languages must be congruent. Thus, this constraint makes specific reference to linear surface order. Two principal critiques have been raised concerning the notion of word order and grammatical congruence (Muysken, 2000; Gardner-Chloros, 2009). First, this constraint would appear to be a strong constraint against codeswitching between language pairs that are typologically different with respect to word order, e.g. SVO v. SOV word order, yet several counter-examples have been documented (Chan, 2009). The second critique concerns the notion of equivalence. Both Lipski and Poplack operationally defined equivalence in somewhat underspecified terms, referring instead to a general sense of equivalence. Furthermore, others question the concept of grammatical congruence on the observation that the same grammatical category (as defined by linguists) across languages are not necessarily equivalent (Muysken, 2000; Deuchar, 2005). In reaction to this underspecification, Sridhar and Sridhar (1980) proposed the **Dual Structures Principle**. Here, a strict sequential word order across the two languages does not have to be exactly equivalent as long as the major syntactic constituent in the codeswitched element(s) fulfills

the subcategorization of the preceding material. Therefore, even though Spanish typically takes post-nominal adjectives, a codeswitch with a prenominal English adjective–noun order would be acceptable because the major constituency of NP continues to follow the determiner as would be expected in Spanish (Ex. 7).

(7) a. el   [hombre viejo]$_{NP}$
         the$_{det}$ man$_{noun}$ old$_{adj}$
         "the old man"

     b. **el**   [old   man]$_{NP}$
         the$_{det}$ old$_{adj}$ man$_{noun}$
         "the old man"

The **Government Constraint** was formulated within the Government-Binding generative framework proposed by Chomsky (1981). Generative syntacticians counter that a linear and sequential approach as espoused by the Equivalency Constraint fails to take into account the hierarchical structure that has been the hallmark of syntactic theory for much of the last half of the 20th century. In response, Di Sciullo et al. (1986) resort to the notion of *government* to explain syntactic junctures where codeswitches are not permissible. The basic tenet of the Government Constraint states that if a lexical element of the categories NOUN, VERB, ADJECTIVE, or PREPOSITION is in a government relationship with another element such that the syntactic node that dominates the lexical element also dominates the following element, then those two elements must be in the same language. In other words, the Government Constraint does not specify where codeswitches can occur so much as where codeswitches cannot occur. To illustrate, compare the following two prepositional phrases with their respective syntactic trees.

(8)

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                        PP
                       /  \
                      P    DP
                      |   /  \
                     on  D    NP
                         |    |
                        the   N
                              |
                            table
```
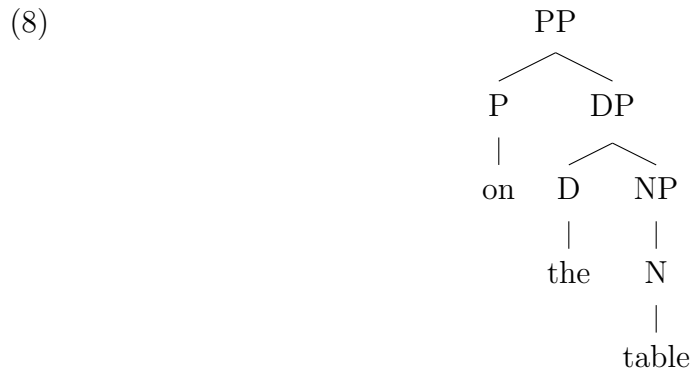
The simple prepositional phrase *on the table* consists of a prepositional phrase

(PP), a determiner phrase (DP), and a noun phrase (NP)[14]. Because the preposition directly dominates the determiner, i.e. the preposition governs the DP which is headed by the determiner, both elements are required to be in the same language according to the constraint, but no such constraint exists between the preposition and the noun, *table*, which therefore, is free to appear in the same or another language.

(9)

```
              PP
             /  \
            P    NP
            |     |
           for    N
                  |
                school
```

In contrast, in the prepositional phrase *for school* the preposition *for* is in a government relationship with *school*, i.e. the syntactic node that dominates *for*, PP, also dominates *school*, and therefore, according to the Government Constraint, both elements must appear in the same language. In contrast to the Equivalency Constraint, this approach does not resort to surface order nor even to grammatical congruency as illustrated in both examples above. Both examples are equivalent across English and Spanish, yet only one is predicted to not contain a codeswitch (Ex. 9). This constraint is novel in that it makes specific reference to the hierarchical structure largely presumed to exist between syntactic elements. Nevertheless, several counter-examples have also been documented in the codeswitching literature (Di Sciullo et al., 1986).

The **Functional Head Constraint** continues in the same tradition as the Government Constraint by proposing syntactic junctures where neighboring elements in a hierarchical structure must appear in the same language. However, the proposal centers on *function* elements and their complements in contrast to the Government Constraint. Belazi et al. (1994) expand upon an earlier proposal by Abney (1987) that suggested that functional heads selected their complements by evaluation of feature checking in a process known as *f-selection*. Specifically they state that in addition to features such as [± Tense], function words also evaluate

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[14]In current generative syntactic theory, the noun is dominated by a determiner phrase (DP); thus, we follow this practice in our example tree.

a language feature, thus ensuring that functional elements and their complements appear in the same language. Because the constraint is restricted to functional elements, the constraint prohibits switches between complementizers and inflectional phrases, auxiliary and verb phrases, negation heads and their complements, determiners and noun phrases, and quantifiers and their complements (Belazi et al., 1994). Of relevance to the the current dissertation, this constraint predicts that Mixed NPs should not occur, yet as many other researchers have noted, switches between determiners and noun phrases are fairly common (e.g Poplack, 1980; Jake et al., 2002a). Additionally, the restriction to functional heads and their complements is limited in scope and thereby misses the broader repertoire of syntactic combinations where codeswitching may also be prohibited (MacSwan, 2009).

Largely due to the radical shift in generative syntactic theory from Government-Binding Theory (Chomsky, 1981) to the Minimalist Program (Chomsky, 1995), generative theories on codeswitching have also changed. In particular, the shift from Government-Binding Theory marked a turn away from syntactic operations that were largely independent of the lexicon to a strongly lexicalist framework. That is, movement operations that fell mainly under the purview of syntactic rules in Government-Binding are now driven by feature valuation in the Minimalist Program (MacSwan, 2009). Movement can either be overt or covert, which depends on whether feature checking is strong (interpretable features) or weak (uninterpretable features) for any given set of features. For example, the difference between SVO (e.g. Spanish, English, etc.) and VSO (e.g. Irish, Zapotec) word order is hypothesized to be due to strong feature checking in SVO languages and weak feature checking in VSO languages of ϕ features—a general cover term for agreement checking of features such as person, number, gender (Cantone & MacSwan, 2009).

With the strong emphasis on the lexicon, MacSwan (1999, 2000, 2004, 2009) has greatly promoted the use of the Minimalist Program for codeswitching. Crucially, MacSwan states that no additional mechanism or constraints are necessary for codeswitching because the minimalist approach is strongly lexicalist; rather, codeswitching represents the interaction of lexical items from either language. Therefore, under this approach, any codeswitch is free to occur as long as the switching between lexical items respects the feature checking requirements for each lexical item. MacSwan considers this perspetive a *constraint-free* approach that

falls under the general class of codeswitching theories known as **null** theories (Mahootian, 1993; Chan, 1999; MacSwan, 2009; Cantone & MacSwan, 2009). Although novel in its approach, the minimalist approach is also met with its own criticism. First, it cannot account for compromise strategies that appear to be specific to bilingual speech (Chan, 2009). Second, because the minimalist approach functions within a modular perspective, core syntax is taken to be encapsulated from other aspects of grammar, i.e. phonology and semantics. This assumption allows for MacSwan to posit the **PF Disjunction Theorem** (later called the PF Interface Condition) which disallows switching between bound morphemes (MacSwan, 2000, 2009). MacSwan resorts to this reasoning to account for differences in the codeswitching patterns between Spanish and Nahuatl (see Example (25) in MacSwan, 2009, p. 326). Although switching between Nahuatl negation and Spanish is attested, the reverse pattern of Spanish negation and Nahuatl is prohibited. MacSwan states that because Spanish negation is a clitic, and therefore bound to its host, the PF Disjunction Theorem prohibits this switch.

1.2.2.3 Processing-based Constraints

Processing-based constraints are based on the principal findings of speech production and planning as described by psychologists and psycholinguists (e.g. Levelt, 1989; Bock, 1996; Garrett, 1993). The key insight provided by these approaches is that morphemes are accessed differentially in speech production. At an elementary level, researchers posit a distinction between content and function elements. Because function morphemes provide grammatical information, they are hypothesized to be accessed before content morphemes in speech planning[15]. That is, speech planning consists of setting a grammatical frame first, followed by the selection of content morphemes to be inserted into the grammatical frame. Psychologists have cited speech errors as one source of evidence for the differential access of content and function morphemes as illustrated in the following examples:

(10)   Examples from Garrett (1975) cited in Azuma (1993)

      a.   Fancy getting your *model* re*nose*d.
          Intended: Fancy getting your nose remodeled

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[15]However, this level of speech planning is preceded by a conceptual level where the actual pre-linguistic message is first created.

b. She's already *truck*ed two *pack*s.

Intended: She's already packed two trucks

c. It just *sound*ed to *start*.

Intended: It just started to sound

In these examples, we observe that only the content morphemes switch, whereas the function morphemes remain set in a well-planned grammatical frame, e.g. in Ex. 10b, the function morphemes, *-ed* and-*s*, remain in place in the grammatical frame and only the content morphemes, *truck* and *pack*, switch. This observation has led several codeswitching researchers to hypothesize that one language sets the grammatical frame of a planned codeswitched utterance (e.g. Joshi, 1985; Azuma, 1993; Myers-Scotton, 1993). Following the logic of this approach, the functional elements will surface in one language alone, whereas content elements can appear in either language. The following constraints that we describe here are variations of this central tenet, and subsequently all of the following constraints work within the framework that the relationship between the two participating languages in codeswitching is asymmetrical. In addition, we point out that Joshi stands apart in that his constraint was developed within a computational perspective.

Joshi (1985) was among the first to propose the asymmetric relationship between languages in codeswitching. Based on the terminology of *host* and *guest* languages used in Sridhar and Sridhar (1980), Joshi coined the now prevalent use of *matrix* and *embedded* language to describe this asymmetry. Asymmetry is a key component of his approach because he implements a strong constraint against the switching of function elements[16], which explicitly must come from the matrix language. Interestingly, Joshi also resorts to the notion of equivalency across the participating languages. However, unlike the Equivalency Constraint, the scope of equivalency is limited to content elements only. Thus, under Joshi's framework, codeswitching ultimately occurs via an asymmetric switching rule where switches can occur unidirectionally from the matrix to the embedded language but is prohibited from the embedded language to the matrix language. This approach raises several issues concerning the matrix language. Primarily, how do researchers determine the matrix language? Joshi does not offer a clear diagnostic for determining

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[16]Where we use the terms content and function elements, Joshi uses the terms closed-class words and open-class words, respectively.

the matrix language. Instead, he mentions that bilinguals will know what is the matrix language of any given utterance (Joshi, 1985, p. 191). Furthermore, researchers question whether the matrix language is set for the entire discourse or if the matrix language can change throughout a bilingual conversation. If the matrix language can change, then are there any predictable factors that determine when this change happens? The identifiability of the matrix language is a criticism that affects all three proposals discussed in this section.

Unlike previous proposals, Azuma (1993) approaches codeswitching as the empirical data set for testing his hypothesis on speech production more generally. He calls his proposal the **Frame-Content Hypothesis** which claims that the grammatical frame of an utterance is planned first in sequence in speech production. This grammatical frame, which he calls the planning frame, "...includes closed-class morphemes, intonational representation, and vacant slots that are subsequently filled in by content words. (Azuma, 1993, p. 1072)." Central to his hypothesis is the assumption that speech planning is a strictly serial process that proceeds from the planning frame stage to the content word insertion stage. Therefore, he speculates that if this hypothesis is correct, then it should be observable in other acts of speech production besides speech errors (see Ex. 10 from Garrett (1975) above). He claims that one such piece of evidence is intra-sentential codeswitching. Azuma finds Joshi's constraint on the switchability of function elements as fully compatible with the Frame-Content Hypothesis. Essentially, the planning frame is set to one language in codeswitching, i.e. the matrix language. Content elements from both the matrix and embedded language are subsequently free to be inserted into this matrix language frame.

Azuma further claims that codeswitching corroborates the predictions of the Frame-Content hypothesis because cross-linguistic subcategorization clashes do not occur in codeswitching. To illustrate, the English verb *graduate* subcategorizes[17] for a prepositional phrase headed by the preposition *from* (Ex. 11). Alternatively, the Japanese translation equivalent, *sotsugyō suru*, subcategorizes for a direct object as evident by the optional direct object particle *-o* (Ex. 12)[18].

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[17]Subcategorization refers to the required arguments of words. For example, prepositions subcategorize for noun phrases, e.g. *on the table*, and ditransitive verbs subcategorize for direct objects and indirect objects, e.g. *Juan gave Lucy the gift*.

[18]Examples adapted from (Azuma, 1993, p. 1080).

(11) Greg graduated **from** Penn State University.

(12) Greg-san wa   Waseda   (**o**) sotsugyō shimashita
     Greg   topic Waseda University acc graduate did
     "Greg graduated from Waseda University."

Because only one language sets the grammatical frame, any potential subcategorization clashes will be avoided thus accounting for the following observations (Ex. (27) in Azuma, 1993, p. 1080).

(13)   a.   * Watashi wa   Waseda   kara **graduate** shimashita
           I   topic Waseda University from graduate   did
          "I graduated from Waseda University."

     b.   Watashi wa   Waseda   (o) **graduate** shimashita
         I   topic Waseda University acc graduate   did
        "I graduated from Waseda University."

Azuma documents Ex. 13b as a naturally occurring codeswitch in his Japanese-English corpus. In contrast, he elicited the judgement of Ex. 13a from eight Japanese-English bilinguals and found that none of his participants accepted this example as possible. Azuma's approach is innovative in that he attempts to use codeswitching as a naturally occurring data set to test a production model with the intended goal of the model being generalizeable to any speech act. However, as in Joshi's approach, the model does not address whether the matrix language can be changed in conversation. This leaves open the question of what the minimal unit of the planning frame is.

Myers-Scotton and colleagues have been prolific in formulating the **Matrix Language Frame (MLF) Model** (Myers-Scotton, 1993, 1997, 2000, 2005; Myers-Scotton & Jake, 2000, 2001, 2009; Jake & Myers-Scotton, 2009). The model has been updated several times in response to criticisms from other researchers and to account for apparent counter-examples. Here, we briefly describe the central principles of the model as described in Myers-Scotton (1997, 2000). For the most recent iteration of the current state of the model, consult Myers-Scotton and Jake (2009) and Jake and Myers-Scotton (2009). In line with the other processing-based constraints discussed here, the model assumes asymmetry between the participating languages. As in Azuma (1993), the MLF model hypothesizes that the grammatical elements in a codeswitched utterance come from the matrix language. Further-

more, Myers-Scotton and Jake are explicit in defining the unit of analysis as the Complementizer Phrase (CP). Under this view, the matrix language can be different from CP to CP (although it is not necessarily predicted), but crucially, the grammatical elements will only be from the matrix language of that CP. Finally, in perhaps the most innovative component of the model, in addition to the basic distinction between content and function morphemes, which they call content and system morphemes respectively, they further subdivide function morphemes into three types: early system, bridge late system, and outsider late system morphemes.

Unlike earlier proposals, this finer-grained distinction acknowledges that morphemes that belong to the same grammatical category may actually function as different types of morphemes. Consider the following two examples.

(14)   the student **of** Chemistry

(15)   I bought the gift **for** my brother

Although *of* and *for* are both considered as belonging to the grammatical category PREPOSITION in the above examples, the model classifies them as separate morphemes because they serve different functions. Specifically, *for* has the capacity to assign a thematic role—in Ex. 15, [+ benefactive] on the NP *my brother*. In contrast, *of* does not assign a thematic role. Instead, it functions as a link between the NP *the student* and the NP *Chemistry*; thus, it would be classified as a bridge late system morpheme (for an in depth discussion of how the four different morphemes are classified, see Myers-Scotton & Jake, 2000). This subdivision of system morphemes further acknowledges the differences that may arise cross-lingusitically. Similar grammatical categories across languages may function as different morphemes. This model therefore addresses earlier criticisms concerning the notion of grammatical equivalence across languages. Of the the three system morphemes the strongest constraint agains embedded language switching falls on the outsider late system morpheme (Myers-Scotton & Jake, 2001). In other words, the matrix language strongly constrains the outsider late system morpheme such that these morphemes in particular must be in the same language as the matrix language. The Matrix Language Frame model has been strongly criticized for being overly elaborate. In addition to stating that only one type of system morpheme is constrained to being in the matrix language, the MLF model also allows for multi

word constituents to appear in the embedded language in an additional construct called embedded language (EL) islands. However, the model does not have the capacity to predict when EL islands will occur; rather, it is a *post hoc* construct leading some researchers to criticize the model as being unfalsifiable and subsequently not a theory (Bentahila & Davies, 1997; Gardner-Chloros, 2009; MacSwan, 2009; Cantone & MacSwan, 2009). Moreover, later formulations of the model (e.g. Myers-Scotton & Jake, 2001) introduce a difference between *classic* and *composite* codeswitching, thus, further narrowing the scope of what the model "truly" accounts for.

Although brief, this overview shows the diversity with which researchers approach the problem of formulating fully generalizable constraints on codeswitching. Working within a variety of linguistic frameworks—both linguistically and cognitively informed—researchers have either approached the problem with the intent of accounting for grammatical codeswitches or starting from the opposite angle and prohibiting ungrammatical codeswitches. These disparate approaches all putatively concern the same linguistic phenomenon, yet several disagreements exist between researchers regarding what constitutes codeswitching. Researchers define the basic unit of analysis for a codeswitched constituent in different ways. Additionally, researchers must address whether the mechanisms that account for codeswitching can account for a wider scope of production phenomena, including other consequences of language contact, e.g. borrowings and loan translations, speech errors, and aphasic speech (Muñoz, Marquardt, & Copeland, 1999; Myers-Scotton & Jake, 2000). One missing component to these debates relates to the comprehension of codeswitched speech. We believe that understanding how the bilingual listener integrates dual language speech is instrumental and a key piece to uncovering the mechanisms involved in the processing of codeswitching. In the next section, we discuss an experimental methodology that we believe will help illuminate the underlying cognitive processes of the comprehension of codeswitched speech.

1.3   Visual World Paradigm

The last decade has seen an impressive growth of experimental approaches using the visual world paradigm. The visual world combines an experimental design used for spoken language comprehension with eyetracking, a research tool that is becoming increasingly ubiquitous at research institutions. This experimental paradigm has successfully been utilized to test research questions applied to virtually any linguistic level (e.g. Salverda et al., 2007 for sub-phonetic variation; Allopenna et al., 1998 for phonology; Snedeker and Trueswell, 2003 for prosody; Hanna, Tanenhaus, and Trueswell, 2003, Kaiser and Trueswell, 2004 for discourse and contextual cues) and to non-traditional populations (e.g. Trueswell, Sekerina, Hill, and Logrip, 1999, Snedeker and Trueswell, 2004 for developmental approaches; Spivey and Marian, 1999, Marian and Spivey, 2003, Ju and Luce, 2004, Weber and Cutler, 2004, Weber and Paris, 2004, Blumenfeld and Marian, 2007, Chambers and Cooke, 2009, Hopp, 2012 for bilingual applications). Our goal in this section is to describe the basic experimental design of a visual world study and to describe the effects that researchers test for, including how these effects help address the original research question. In part, we cover these points by illustrating with two studies that are particularly relevant to the current dissertation (Allopenna et al., 1998; Lew-Williams & Fernald, 2007). Several chapters and articles have been written that extensively cover the visual world paradigm in depth. For thorough reviews concerning the paradigm, see Tanenhaus (2007), Tanenhaus and Trueswell (2006), Huettig, Rommers, and Meyer (2011), and Altmann (2011c).

Cooper (1974) is widely cited as the first experimenter advocating for the use of eye movements as a measure of comprehension; however, it was not until Tanenhaus et al. (1995) that researchers took notice of the strong link between eye movements and comprehension. In that seminal study, Tanenhaus et al. presented participants with one of two scenes with 4 options, e.g. a towel, a towel with an apple on it, a pencil, and an empty box (one-referent scene). Participants were asked to carry out a simple task by auditory instruction such as "*Put the apple on the towel in the box.*" While listening to experimental instructions, participants' eye movements were recorded by way of a head-mounted eye-tracker. Here, the auditory instruction is locally ambiguous at the point of *towel* because this NP

could be interpreted as the goal, i.e. move the apple to the empty towel, or as a modifier, i.e. focus on the apple that is on the towel. This ambiguity is resolved at the moment that participants hear the actual goal, *box*. Nevertheless, upon encountering the region of ambiguity, Tanenhaus et al. found that participants' eye movements toward the incorrect target location (e.g. the empty towel) increased. In other words, participants' eye movements reflected the local syntactic ambiguity, thereby confirming that eye movements are closely time-locked to the unfolding auditory signal. Additionally, eye movements in this scene were compared to a separate scene that included two apples, one on the towel as in the previous scene and one on a napkin, thus creating a two-referent scene. When participants were given the same instructions, looks to the incorrect target location were significantly reduced and looks to the potential target location (e.g. the empty box) increased as compared to the one-referent scene. Thus, participants were more likely to interpret *the towel* as a modifier NP in the two-referent scene and subsequently anticipate the probable goal location. Tanenhaus et al. interpret this finding as suggesting that participants were able to integrate contextual information (i.e. how many referents were present in a visual scene) as a relevant cue to modulate syntactic ambiguity. This at-the-time novel approach to understanding the spoken language processing of syntactic ambiguity proved highly fruitful in informing debates on syntactic modularity.

Since the publication of Tanenhaus et al. (1995), researchers' understanding of eye-tracking data has changed. Namely, researchers now look for the presence (or absence) of **competitor** and **anticipatory** effects. Broadly, these effects are taken to reflect delayed or facilitated processing, respectively. Whereas the original Tanenhaus et al. study calculated the proportion of total trials on which participants looked at one region versus another, contemporary studies also include timecourse information. Typically, total proportion of fixations over trials and participants are calculated and plotted over a millisecond timescale. This method of data visualization permits a closer inspection of how processing is affected in real time. We now briefly review two studies, one that makes use of competitor effects elicited from phonological competition (Allopenna et al., 1998) and another that focuses on anticipatory effects in morpho-syntactic processing (Lew-Williams & Fernald, 2007) to describe how researchers use these effects to answer research

questions in the domain of spoken language comprehension.

Allopenna et al. (1998) investigated the role of phonological competition in real-time processing in monolingual English speakers. Participants were presented a scene of four simple line drawings set in a 5 × 5 grid on a computer screen. The line drawings were centered around a fixation cross. At the beginning of each trial, participants were asked to focus on the fixation cross and subsequently were instructed to click on one of the objects. In critical trials, target items were paired with phonological competitors. For example, if participants heard, "*Click on the beaker* [bikɚ]," a line drawing of a beaker was presented alongside a picture of a *beetle* [bitl̩], *speaker* [spikɚ], and *carriage* [kæɹɛdʒ]. The non-target candidate *beetle* is a phonological cohort due to the phonological overlap in the first syllable [bi]. Interestingly, *speaker* also competes phonologically but as a rhyme cohort as both objects overlap in phonology after the onset, i.e. [ikɚ]. Results showed an initial overlap in looks to the target item (e.g. *beaker*) and to the phonological cohort (e.g. *beetle*) indicating that participants considered both items in real-time processing. However, after around 400 msec, looks to target items began to increase and looks to the phonological cohort diminished, indicating the participants' convergence on the target item. The momentary overlap between the target item and the phonological cohort is the classic competitor effect. In other words, because of the phonological competition, participants required more auditory input in order to correctly identify the target item. Additionally, the rhyme competitor *speaker* did elicit some fixations later in the timecourse (not to the levels of the phonological cohort), indicating that participants looked to the rhyme competitor even though they did not share initial phonological overlap.

In a more recent study, Lew-Williams and Fernald (2007) explored the real-time processing of grammatical gender in Spanish-speaking children[19]. Spanish exhibits

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[19]We note that this study utilizes an experimental paradigm known as the looking-while-listening procedure (Fernald, Perfors, & Marchmann, 2006). Although similar to a visual world design, there are some differences due to its intended use with very young children. Namely, young participants are seated in a booth with two monitors presented side by side. An occluded video camera is embedded between the two monitors and records young children as they turn to look at each monitor. In a highly intensive procedure, data coders who are blind to the objectives of any particular experiment hand code the location of eye movements of the video recorded session frame by frame (with a standard frame refresh rate of 33 msec). To our knowledge, no study has directly compared the results of an eye-tracking study using the visual world paradigm with the looking-while-listening procedure.

a binary grammatical gender system for all nouns, i.e. masculine or feminine. In addition, definite articles obligatorily agree in gender with their noun referents thus producing two possible definite articles, i.e. *el* for masculine and *la* for feminine. Because of this difference in form, Lew-Williams and Fernald ask whether young Spanish children are able to utilize this gendered information in spoken language processing. In order to investigate this question, they showed young children pairs of objects that either matched in gender, e.g. *la pelota* "the$_{fem}$ ball$_{fem}$" and *la galleta* "the$_{fem}$ cookie$_{fem}$," or differed in gender, e.g. *la pelota* "the$_{fem}$ ball$_{fem}$" and *el carro* "the$_{masc}$ car$_{masc}$." During each trial, the young children heard the simple carrier phrase, *Encuentra el/la* _____ "Find the ____." In different-gender trials the definite article is potentially informative and therefore possibly facilitatory in target identification. That is, when the young children heard *la* in a trial where they were presented a picture of a cookie and a car, the gender of the article could guide them to look towards the cookie even before the onset of the noun. Consequently, Lew-Williams and Fernald did find a facilitation for target identification in different-gender trials. Visual world researchers call this facilitation in target identification an anticipatory effect, because participants are successfully able to make use of a cue (linguistic or otherwise) in comprehension.

Although it is tempting to assume that competitor and anticipatory effects are opposite effects, they are in fact not. They are relative effects that can only be determined relative to a neutral baseline. For example, in the case of the Spanish grammatical gender finding reported in Lew-Williams and Fernald (2007), absent the cue of grammatical gender, the basic task is target word identification. This elementary task is exactly what happens in the same-gender trials, and therefore, these trials constitute the neutral baseline for the timecourse of real time processing. Subsequently, the effect of interest is whether the gender information present on a definite article will change that neutral timecourse. As described above, in the case of Spanish, it does and does so by quickening the timecourse, hence the presence of an anticipatory effect. Finally, a potentially confusing point is the means by which researchers can determine whether or not a competitor or anticipatory effect is present. In the Allopenna et al. (1998) study, a competitor effect was determined relative to the cohort distractors that were co-present in the same visual scene. That is, the timecourse of fixations to the target items was compared

to the timecourse of fixations to the phonological cohort, the rhyme cohort, and the non-phonological control. A competitor effect was determined by statistically comparing the distractor proportion of fixations to the proportion of fixations of the target item. In the case of the phonological cohort distractor (e.g. *beetle* for target word *beaker*), proportion of fixations to both items were not statistically different until roughly around 400 msec from target noun onset. Nevertheless, the overall timecourse for the target item is ultimately different from the timecourse plot of all other distractor candidates which also look different from each other, i.e. they all affect spoken word recognition in different ways. In contrast, Lew-Williams and Fernald compare the timecourse of proportion of fixations only to target items but in separate conditions. In other words, an anticipatory effect was determined because a shift in a critical mass of looks to the target item happened faster in the different gender trials than the same gender trials. However, overall, both trials have a similar timecourse plot. We describe this issue in more detail in Chapter 4, where we report the results of our visual world study.

1.4 Production-Distribution-Comprehension Framework

In the domain of sentence processing, some models of sentence comprehension suggest that production and comprehension are tightly linked with primary evidence taken mainly from monolingual data. MacDonald and colleagues have proposed one such model, the **Production-Distribution-Comprehension** (PDC) framework (MacDonald, 1999; MacDonald & Thornton, 2009; Gennari & MacDonald, 2009). This framework adopts an *emergentist* view of language use, promoting the hypothesis that language use leads to broad distributional patterns over time. The PDC framework explicitly suggests that these accumulated distributional patterns will have an impact on the comprehension system such that in alternating linguistic structures, the more frequently used alternative will consequently facilitate comprehension. These consequences will be most visible in optionally equivalent structural choices that speakers regularly encounter in any language. For example, some verbs may optionally take either a direct object or sentential complement as

an argument, e.g. in English the verbs *admit* and *believe* as illustrated below.

(16) a. The boy <u>admits</u> [the truth]$_{DO}$

      b. The boy <u>admits</u> [the truth was not discovered]$_{CP}$

(17) a. The boy <u>believes</u> [the truth]$_{DO}$

      b. The boy <u>believes</u> [the truth was not discovered]$_{CP}$

Yet several studies have shown that speakers show preferences for associating these verbs with certain argument structures, and this information may be language-specific, i.e. *verb bias* or *verb subcategorization* (Garnsey, Pearlmutter, Myers, & Lotocky, 1997; Dussias & Cramer Scaltz, 2008). Thus, in English, *admit* more frequently occurs with direct object complements (example 16a, *direct object biased*) whereas *believe* with sentential complements (example 17b, *sentential complement biased*) (Garnsey et al., 1997). The PDC framework would thus predict that speakers will have more difficulty parsing direct object biased verbs with sentential complement arguments (example 16b) and sentential complement verbs with direct object arguments (example 17a)[20].

MacDonald and colleagues have put forward a succinct research methodology for testing their framework (see Gennari & MacDonald, 2009, for detailed explanation). First, researchers need to identify structural alternations—in the examples above, verbs which take direct object or sentential complements. Then, distributional patterns must be quantified. Quantification can occur via experimental methods, i.e. norming data, or by extraction from large scale corpora of natural language use. Finally, researchers can directly test how these quantified distributional patterns impact the comprehension system. In other words, the results from the quantification of distributional patterns become the empirically testable hypotheses for experiments investigating comprehension.

Although not directly following this framework, Garnsey et al. (1997) and Dussias and Cramer Scaltz (2008) carry out this methodological procedure. First, in order to investigate their specific research questions, both research teams investigate verb bias preferences. Specifically, they characterize verbs as biased if an independent group of participants completing a production norming study (i.e. ex-

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[20]These predictions are in contrast with universal parsing strategies which would suggest an initial direct object reading for all verbs of this class, e.g. Clifton, Speer, and Abney (1991)

perimental quantification) produces verbs with one structure (i.e. direct object or sentential complement) at least twice as much as the alternative structure. This quantification serves as the foundation for investigating their research questions on comprehension—for Garnsey et al., whether native speakers privilege verb bias over universal parsing strategies, i.e. syntax first processing (Clifton et al., 1991; Frazier & Fodor, 1978), and semantic information, i.e. plausibility; for Dussias and Cramer Scaltz whether second language speakers are able to utilize verb bias in their non-native language. Ultimately, both research groups were able to compare results from eye-tracking and reaction times to their predictions and confirmed that verb bias guides sentence processing and that with sufficient proficiency, second language speakers are capable of utilizing verb bias.

These studies illustrate how to implement the PDC framework using primarily unilingual data either in native or non-native speakers. Codeswitching provides yet another means of testing the production-comprehension link. Namely, in terms of production, codeswitching can be characterized as a choice between languages, thereby drawing an analogy to structural alternations in unilingual contexts. Furthermore, researchers can extend the utility of the PDC framework by investigating not only the impact on comprehension as determined by asymmetric distributional patterns (i.e. the preference of one structure over an alternative), but also what happens in the case of cross-linguistic differences. In other words, we can extend the methodology of the PDC framework to target alternating structural choices that involve codeswitches and cross-linguistic differences.

This dissertation sets out to test the PDC framework by examining the real-time processing of grammatical gender in Spanish-English codeswitching. Grammatical gender is the morpho-syntactic feature in focus due to its role in **Mixed NP** constructions, i.e. codeswitched noun phrases in which a Spanish article (e.g. *el* or *la*) is paired with an English noun, e.g. *el cookie* "the_{masc} cookie". Several researchers have noted that switches between the Spanish determiner and the English noun are highly frequent, e.g. *el juice* and not *the **jugo*** (Clegg, 2006; Poplack, 1980; Pfaff, 1979). Additionally, researchers have documented a production asymmetry in gender assignment in Mixed NPs (Poplack, 1980; Otheguy & Lapidus, 2003; Jake, Myers-Scotton, & Gross, 2002b). Specifically, the Spanish masculine article *el* surfaces with English nouns regardless of the gender of its translation equiva-

lent, e.g. ***el*** *juice* "the$_{masc}$ juice" (Sp. *el$_{masc}$ jugo$_{masc}$*) , ***el*** *cookie* "the$_{masc}$ cookie" (Sp. *la$_{fem}$ galleta$_{fem}$*). In contrast, Mixed NPs with the Spanish feminine article *la* are less frequent (e.g. $< 10\%$ in Jake et al., 2002b) and only surface with English nouns whose Spanish translations are feminine, e.g. ***la*** *cookie* but *****la*** *juice.* Interestingly, these production distributions in Spanish-English codeswitching stand in marked contrast to Spanish, where grammatical gender is obligatorily encoded and not interchangeable, and the distribution between masculine and feminine nouns is roughly half (Eddington, 2002; Otheguy & Lapidus, 2003).

1.5   Dissertation Roadmap

We conclude this chapter by providing an outline for the remaining chapters. In Chapter 2 we examine the production of Mixed NPs in Spanish-English codeswitching, e.g. ***el*** *cookie.* Recall, in terms of the PDC framework (Gennari & MacDonald, 2009), once we have identified an alternating structure, we must quantify their use by means of either a natural language corpus or by experimental means. We follow the former route and make use of a bilingual corpus of speakers from Miami, FL made accessible to us by colleagues from Bangor University (UK). After presenting the results of the quantification of Mixed NPs, we discuss the use of gender in Mixed NPs, which leads us to propose an emergentist account for codeswitching. The results of the quantification of Mixed NPs will form the basis for our predictions for the comprehension of codeswitched speech in the subsequent chapters.

In Chapter 3, we discuss the experimental design that we adopt for the three visual world experiments that we carried out. The first experiment is an attempt to replicate Lew-Williams and Fernald (2007) with a group of Spanish monolingual controls recruited from the University of Granada (Spain) and our group of bilingual participants who were all students at City College of New York (CCNY). The second experiment presents the bilingual participants with single English noun switches in an otherwise invariant, Spanish phrase. In the third experiment we embed the codeswitched NP in variant, codeswitched sentences, which was followed by a plausibility judgment. We describe in detail the materials that we used and the procedure that we utilized for the three experiments. Additionally, we present the results of several proficiency measures and self-reported language

history questionnaires to provide a linguistic profile for our bilingual participants.

In Chapter 4, we begin with a discussion of the analyses that we adopt for our experiments. This discussion is not trivial considering that there is little consensus on how best to analyze visual world data (Barr, 2008; Mirman, Dixon, & Magnuson, 2008; Tanenhaus & Hare, 2007; Altmann, 2011a). We follow the presentation of our results for the three experiments with subsequent follow-up analyses. We conclude with Chapter 5 where we provide a general discussion of our results and their implication for the PDC model and experimental approaches to codeswitching.

Chapter 2

Mixed NPs in Spanish-English bilingual speech: A corpus study

2.1 Introduction

Current psycholinguistic research on bilingualism converges on the finding that a bilingual's two languages are simultaneously active to varying degrees, a view known as the **non-selective hypothesis** of lexical access (e.g. see Kroll, Sumutka, & Schwartz, 2005; Costa, 2005, for review). This hypothesis suggests that although a speaker may intend to produce or comprehend solely in one language, lexical information from the non-target language is also accessible. Yet this non-target linguistic information rarely becomes an obstacle for speakers. Although researchers have been greatly informed by the evidence suggestive of parallel co-activation, the overwhelming focus in bilingualism research is on how bilinguals are ultimately able to produce or comprehend solely in one language, i.e. a **unilingual** approach to bilingualism. Nevertheless, bilinguals are known to engage in a specialized linguistic skill known as *codeswitching*, generally defined as the fluid alternation between languages in discourse (Poplack, 1980). By its very act, codeswitching requires the heightened co-activation of a bilingual's languages in order for a speaker to successfully integrate both languages across several linguistic domains. Thus, research on codeswitching necessitates a look at how parallel co-activation is efficiently maximized in one speaker—both in production and comprehension.

Additionally, codeswitching presents a potentially informative scenario into how bilinguals negotiate cross-linguistic information that at times may not fully be equivalent across the two languages. Often times, codeswitches occur within major syntactic clause boundaries (i.e. intra-sentential codeswitching), yet the grammatical features of the bilingual's two languages need not be exactly compatible at the switch juncture. For example, Spanish nouns encode for grammatical gender (masculine and feminine, e.g. *carro* "car$_{masc}$", *casa* "house$_{fem}$") which obligatorily determines agreement with other grammatical categories such as determiners and adjectives (e.g. *el carro rojo* "the$_{masc}$ red$_{masc}$ car$_{masc}$", *la casa roja* "the$_{fem}$ red$_{fem}$ house$_{fem}$"). English, on the other hand, does not have grammatical gender (e.g. *the$_{ø}$ car$_{ø}$*). In light of the evidence in favor of non-selectivity, bilinguals who codeswitch must confront these cross-linguistic differences and yet seamlessly integrate them in order to successfully codeswitch. Following this observation, the study of the production of codeswitched speech presents a useful tool to investigate how a speaker negotiates cross-linguistic differences and the subsequent impact to the comprehension system of the listener.

Furthermore, researchers who have studied Spanish-English codeswitching have noted two key observations. First, the switch from Spanish determiner to English noun, i.e. the Mixed NP, is prevalent in bilingual discourse (Pfaff, 1979; Poplack, 1980; Jake et al., 2002a). Second, several researchers have noted a production asymmetry in the gender assignment of these Mixed NPs such that Mixed NPs with Spanish masculine determiners occur with English nouns with both masculine and feminine translation equivalents, e.g. **el** *juice*, Sp. *el$_{masc}$ jugo$_{masc}$* "the$_{masc}$ juice" and **el** *cookie* Sp. *la$_{fem}$ galleta$_{fem}$* "the$_{masc}$ cookie" are both attested in Spanish-English codeswitching. In contrast, Mixed NPs with feminine determiners are restricted to English nouns with feminine translation equivalents and not masculine, e.g. **la** *cookie* Sp. *la$_{fem}$ galleta$_{fem}$* "the$_{fem}$ cookie" is attested but not ***la** *juice* Sp. *el$_{masc}$ jugo$_{masc}$*. Following the predictions of the PDC framework (Section 1.4), we ask whether this production asymmetry is reflected in comprehension.

In order to investigate the consequences of the grammatical gender production asymmetry in comprehension—an asymmetry that is derived both in terms of a masculine preference in determiner production and a usage pattern that is different from either unilingual mode of the bilingual (i.e. gender concord is obligatory in

Spanish and absent in English)—the aim of the study reported in this chapter is to quantify the production of Mixed NPs specifically focusing on the gender assignment of the Spanish determiner, e.g. **el** in **el** *juice.* This study makes use of the second type of quantification method laid out in Gennari and MacDonald (2009). That is, Mixed NPs were extracted from a spoken language corpus of Spanish-English bilingual speech collected in Miami, Florida in the mid-2000s. At the onset of quantification, we set out to extract both types of Mixed NPs: Spanish article with English noun (e.g. **el** *juice*) and English article with Spanish noun (e.g. *the **jugo***). Our analysis consisted of the distributional quantification of extracted Mixed NPs, followed by cross-tabulations of the gender assignment of the Spanish article of the Mixed NP with the concurrent gender of the Spanish translation equivalent of the English noun. For example, the *el* in **el** *cookie* would be counted as a masculine-marked determiner with a feminine Spanish translation equivalent (Sp. la_{fem} $galleta_{fem}$). The quantification of the distribution patterns will provide the foundation for the comprehension experiments in subsequent chapters. That is, the results from the study reported in this chapter serve as the predictions for how comprehension is impacted.

The remainder of this chapter is organized as follows: first, Spanish-English Mixed NPs are described briefly highlighting the issue of cross-linguistic differences and codeswitching. The following section describes the corpus used for the study and the methodology for the extraction of Mixed NPs. Next, we present the results of quantification and cross-tabulations. Finally, the chapter ends with a discussion on how Mixed NPs have traditionally been discussed in the literature. We extend this traditional view by hypothesizing that codeswitching is an emergent linguistic system built from the bilingual's constituent languages. We conclude with an overview of how the results of the current chapter inform our predictions for the eyetracking experiments described in the following chapters based on the framework of the PDC model.

2.2   Spanish-English Mixed NPs

The Mixed NP consists of two main elements, DETERMINER (DET) and NOMINAL PHRASE (NP). In contrast to noun phrases in unilingual Spanish or English, Mixed

NPs have elements that are in both of the bilingual's languages. Determiners in Spanish and English differ in that Spanish obligatorily encodes for grammatical gender on some determiners (Ex. 18), whereas English only sometimes encodes for number on determiners (Ex. 19). Therefore, Mixed NPs can surface in several ways (Ex. 20).

(18) Spanish[1]

En [alguna parte]$_{NP}$ tiene que ser [las cinco]$_{NP}$ de [la
in some$_{fem}$ part$_{fem}$ has that to be the$_{fem.pl}$ five of the$_{fem}$
tarde]$_{NP}$ (herring11.GRA)
afternoon

'Somewhere it has to be 5 o'clock in the afternoon'

(19) English

And you went to work with [those shoes]$_{NP}$? (herring08.ROB)

(20) Bilingual Speech

a. English-Spanish

She got [the **manguera**]$_{NP}$ (sastre4.fem1)
She got the$_?$ hose$_{fem}$

'She got the hose'

b. Spanish-English, feminine determiner

I'm looking for something **con** [**las tres** bee's]$_{NP}$: **bueno**,
I-am looking for something with the$_{fem}$ three bee's$_{fem}$ good
bonito y barato (zeledon5.fem1)
beautiful and cheap

'I'm looking for something with the three bee's [features]: something good, beautiful, and cheap'

c. Spanish-English, masculine determiner

You need to tell him, "Look! Leave me alone! **Te voy a**
You need to tell him look leave me alone you$_{obj}$ will$_{1st.person}$ to
poner [**un** restraining order]$_{NP}$ on you" (sastre4.fem1)
put a$_{masc}$ restraining order$_{fem}$ on you

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[1]All examples that are taken directly from the corpus are followed by a filename and speaker label.

'You need to tell him, "Look! Leave me alone! I'm going to put a restraining order on you!"'

As the examples in (20) highlight, when excluding gender-less determiners in Spanish, e.g. **su** *house* 'his/her$_\emptyset$ house', there are three possible mixed NP constructions: English determiner + Spanish NP (example 20a), Spanish feminine determiner + English NP (example 20b), and Spanish masculine determiner + English NP (example 20c). Of interest to this chapter is examining gender assignment of the Spanish determiner in the Mixed NPs. As shown in Ex. (20c), the gender of the article and that of the Spanish translation equivalent of the noun do not obligatorily match. Here, a Spanish masculine determiner *un* "a" is used with an English noun that is feminine in Spanish, *restraining order* Sp. *orden$_{fem}$ de restricción.*

Given these possible permutations for Spanish-English Mixed NPs, our research question is whether speakers show a clear preference for one combination versus the others. Because of the cross-linguistic difference between Spanish and English in the use of grammatical gender, speakers may adopt an English-like pattern and neutralize the grammatical gender of Spanish nouns. Thus, speakers may show an overwhelming preference for the use of masculine determiners regardless of the gender of the Spanish translation equivalent, e.g. **el** *cookie.* On the other hand, speakers may choose to adhere to the Spanish grammatical gender system, favoring a constraint hierarchy that follows similar constraints used in Spanish. For example, the gender of human referents may constrain gender assignment in codeswitching, e.g. **la** *mother.* Possibly, speakers may exhibit a strategy that is neither fully English- or Spanish-like. We explore this question using the Bangor Miami Corpus, explained in more detail in the following section.

2.3 Current Study

2.3.1 Materials and Participants

The bilingual corpus used in the current study was obtained in collaboration with Dr. Margaret Deuchar and colleagues at the ESRC Centre for Research on Bilingualism in Theory and Practice housed at Bangor University in Ban-

gor, Wales. They have made the corpus publicly available online at <`http://talkbank.org/browser/index.php?url=BilingBank/Bangor/Miami`>. Detailed information concerning the bilingual corpus is found in Deuchar et al. (2012). Here, we summarize the most relevant information.

The corpus was collected over a period of two months, April–June, in 2008 in Miami, FL. Two on-site assistants helped a member of the Bangor research team in recruitment of Spanish-English bilingual participants, which involved employing the "friend of a friend" strategy advocated by Milroy (1987, cited in Deuchar et al., 2012). Potential recruits were administered a Language History questionnaire, which in addition to asking demographic information and self-reported proficiency measures, asked participants about their attitudes towards their two languages and their use of both languages in everyday life.

In order to address inherent problems concerning the *Observer's Paradox*[2], recruited individuals were asked to choose their own conversation partners and to select their preferred place for recordings (e.g. home, school, office, lunch, etc.). Individuals were briefed before recordings began that the primary objective of the study was to investigate how bilinguals speak with each other. In other words, there was no mention of codeswitching as a primary interest of the research team. Recordings were made by way of either a Marantz portable digital recorder or a Microtrack recorder and by use of lapel pin microphones attached to each participating individual. Most recordings were made in pairs, although some of the recordings include more than 2 individuals. All recordings lasted at least 30 minutes (after subsequent subtraction of the first five minutes, explained below).

The completed corpus includes 27 separate sound files composed of 85 speakers, 62% of which were female. Of the total group, 73% of participants rated their proficiency as high in both languages based on the results of the Language History questionnaire. Ages ranged from 9 to 66 years old with a mean age of 32 and a median age of 29. There were 43 different responses for Occupation with the top three responses including Student ($n = 23$), Teacher ($n = 6$), and Office Manager

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[2]The *Observer's Paradox*, simply put, is the observation that speakers will change their speech habits in the presence of others who are not members of their speech community (Tagliamonte, 2006). Here, the Bangor team was concerned that Miami bilinguals would be less likely to codeswitch naturally in front of a researcher who is a second language speaker of Spanish from the U.K.

($n = 4$). There were 19 different responses for Nationality with the top three responses including American ($n = 23$), Cuban or Cuban-American[3] ($n = 28$), and Colombian ($n = 7$).

This procedure resulted in spontaneous and natural conversation that at times reached very intimate levels, indicating that conversation partners did not feel constrained by the presence of the recording equipment. Topics ranged widely, including discussions on food, social life, jobs, school, travels, etc. Once the recordings were completed, the researchers acquired consent from any individual who was recorded, including unannounced visitors, and those individuals were given the opportunity to indicate if there were sections of their conversations that they did not want to include in the final recording. According to Deuchar et al. (2012), participants did not elect to omit any significant portion of their recordings reflecting the high degree of comfort they felt upon being recorded. As an additional step to ensure that participants had become accustomed to the use of a recording device, researchers omitted the first five minutes of each recording.

2.3.2 Methods

From the Bangor Miami Corpus, we extractd Mixed NPs from 25 sound files out of the total 27 sound files. At the time of our extraction, only a subset of the files ($n = 16$) had been completely transcribed (they are currently all transcribed). For those transcribed files, we used the CLAN transcription program (MacWhinney, 2000) to listen to the sound files while concurrently reading the transcription. CLAN was a convenient program for purposes of our extraction because sound files are time locked to transcriptions. Therefore, while listening to sound files, the CLAN program automatically highlights the concurrent text in the transcription. For nontranscribed files ($n = 9$), we instead relied upon Praat (Boersma & Weenink, 2012), publicly available software typically used for acoustic phonetic analyses. Here, without the advantage of transcribed files, we solely listened to sound files through high quality Sony over-the-ear binaural headphones. As we read the transcripts and/or listened to the sound files, we extracted every instance of a Mixed NP and recorded each token in a separate excel spreadsheet file (see Table 2.1). The

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[3]Cuban and Cuban-American were counted separately in Deuchar et al. (2012) but are collapsed here.

following columns were included in the excel file for each token.

- **File**: The filename of the sound file from which the Mixed NP was extracted.

- **Line**: The line number of the corresponding transcription or the timestamp of the sound recording of the extracted Mixed NP.

- **Sample**: The full sentence context of the extracted Mixed NP.

- **Token**: The Mixed NP extracted from the sound file.

- **Comments**: Extraneous comments indicating notes such as whether the token had been mentioned previously in unilingual speech, whether the token refers to a human referent, what the token refers to if the meaning was ambiguous, etc.

- **Spanish Translation**: The full Spanish translation of the Mixed NP.

Table 2.1: Sample of data entry in Excel Spreadsheet

File	Line	Sample	Token	Comments	Spanish Translation
sastre11.mal1	1:45	and put all [the muebles]	the muebles	female speaker asks about los muebles in previous Spanish turn	los muebles
herring10.SAR	265– 267	entonces todos [esos restaurants] that are participating will have booths	esos restaurants		los restaurantes
zeledon8.fem1	6:52	ahí está Sunset Lakes, que es la escuela donde yo estaba que es [un neighborhood very upscale]	un neighborhood very upscale	very fluid alternation	el barrio

Mixed NPs were of the form DET NP where the NP could be comprised of a single word, e.g. *dress*, or a multi-word constituent, e.g. *red dress*. We excluded Mixed NPs with Spanish determiner that did not mark for grammatical gender. For example, Mixed NPs with possessives, such as ***su*** *house*, "his/her$_\emptyset$ house", were not included in extraction. In addition, bare nouns were also excluded from

our analysis. Finally, we restricted our analysis to only phonologically unadapted nouns[4] (cf. *la breca* "the brake"; in non-contact varieties of Spanish, *el freno*, Clegg, 2006).

2.3.3 Results

From the compiled bilingual corpus, we extracted a total of 322 Mixed NP tokens. We present the distribution of Mixed NPs in Table 2.2.

Table 2.2: Total distribution of Mixed NPs in Miami Bangor Corpus

Determiner	Total	Percentage
English	16	5%
Spanish:		
Masculine	297	92%
Feminine	9	3%
Total	322	100%

Overwhelmingly, Mixed NPs were comprised of Spanish determiners with a following English noun (total of 95%). This distribution pattern replicates previous findings in Spanish-English codeswitching stating that Mixed NPs are more likely to include a Spanish determiner and an English noun (e.g. Poplack, 1980; Pfaff, 1979). However, feminine marked Spanish determiner Mixed NPs were exceedingly infrequent in the corpus ($n = 9$). These Mixed NPs were the least frequent form even compared to English determiner Mixed NPs (3% v. 5%). Focusing our analysis on Spanish determiner Mixed NPs, the dominant pattern is for masculine marked determiners followed by English nouns, e.g. ***el*** *cookie*. This overwhelming preference for masculine Spanish determiner Mixed NPs further replicates previous findings (e.g. Jake et al., 2002b) providing tentative support for the hypothesis that masculine is the default gender in Spanish-English bilingual speech.

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[4]We admit that our method for determining phonological adaptation is subjective. However, we note that we were raised in the Miami region until the age of 9 and continue to visit family in the region. Furthermore, we have received extensive training both in phonological theory and phonetic transcription.

2.3.4 Feminine Referent Mixed NPs

Despite the low number of tokens of feminine Mixed NPs, of interest are the usage patterns underlying their assignment. One constraint that has been cited as strongly favoring feminine gender assignment is animacy (Otheguy & Lapidus, 2003; Clegg, 2006). However, despite the perceived strength of this constraint, Otheguy & Lapidus observe that either this constraint has shifted or never has been as strong as claimed.

> Both the tendency to assign gender to animates on the basis of sex of the referent, and to assign feminine gender to words perceived as ending in /-a/ have been widely noted in most studies dealing with English loanwords. It is significant, however, that even this pattern is losing hold among our contact speakers. Many of them, in a usage that is very unlike that of non-contact speakers, use masculine ELI's [English lexical items] to refer to females, as in *un social worker* or *los midwives*. (Otheguy & Lapidus, 2003, p. 215)

However, the innovative usage of masculine Spanish determiners with female human referents is not categorical. In other words, even though masculine is the preferred gender of Mixed NPs, its use is not exclusive.

Nevertheless, the Bangor corpus reveals several instances of human female referents that surface with masculine determiners[5].

(21) **Ella es** [**un** renaissance woman]$_{NP}$ (sastre5.fem1)
She is a$_{masc}$ renaissance woman
'She is a renaissance woman'

(22) A.—she was in Platinum before @al **y** **ahora es** [**el**
A.—she was in P. before xx and now is$_{3rd.person}$ the$_{masc}$
manager]$_{NP}$ **aquí** (zeledon8.fem1)
manager here
'A.—she was in Platinum [Gym] before. Now she is the manager here'

In Example (21), the referent is transparently a biological female, as evidenced by mention of the word *woman* as well as use of the pronoun, *ella* "she". In contrast,

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[5]In the examples, proper names of individuals are obscured and represented with an arbitrary initial, e.g. A. Any phonetic utterances that are not identifiable as words nor specific to either language are represented with the symbol @.

this example would unambiguously surface with the Spanish feminine determiner *una* "a$_{fem}$" in Spanish. Similarly, in Example (22) the pronoun *she* indicates that the referent is female. Nevertheless *manager* appears with a Spanish masculine determiner, *el*.

Examples are also present of referents that refer to humans but do not immediately indicate biological gender. Nevertheless, in cases where biological sex can be determined by context—that is, in situations where gender-marked pronouns are not present but semantic gender is clear from discourse context—we continue to find tokens of Mixed NPs with Spanish masculine determiners Ex. (23).

(23) **tú eres el**,   **tú eres [el**   case manager]$_{NP}$ **y**   **quiere**
you are the$_{masc}$ you are the$_{masc}$ case manager   and wants$_{3rd.person.sing}$
que [el   case manager]$_{NP}$ **lo**   **revise**
that the$_{masc}$ case manager   it$_{3rd.person.obj}$ revise$_{3rd.person.sing.subj}$
(zeledon6.fem2)

' You're the . . . you're the case manager and he/she wants [that person] to check it'

Here, the context leading up to the utterance in Ex. (23) establishes that the referent is female. The speaker is an administrative assistant at a health services management office. She is retelling a workplace conflict she encountered with a co-worker. She recounts passing on a message from a boss to another co-worker who was the case manager in charge of several patients' records. The speaker repeatedly refers to the co-worker by name thereby establishing unambiguous female reference.

In order to explore the role of biological gender as a possible constraint on gender assignment in Mixed NPs, we analyzed the subset of Mixed NPs with human referents. This subset only included tokens where biological gender could be unambiguously established either by clear reference (use of a name or pronoun) or by previous discourse. This criteria resulted in 19 tokens. We cross-tabulated Spanish determiner with biological gender. Results are presented in Table 2.3.

Table 2.3 reveals two important findings. First, human male referents are all categorically assigned masculine Spanish determiners. On the other hand, only 27% of human female referents are assigned Spanish feminine determiners. This distribution indicates that biological gender and animacy do not appear to con-

strain the Spanish grammatical gender system in Spanish-English codeswitching. Additionally, although there are only a limited number of feminine-marked Mixed NP tokens ($n = 9$), human referents represent 1/3 of the subset. Alternatively, male human referents only represent 3% of all masculine marked tokens. Feminine determiners potentially are more associated with human referents even though they do not represent the majority of feminine-marked NPs.

Table 2.3: Percentage of human referents in mixed NPs by assigned gender of determiner

Determiner	Males	Females	Total
Masculine	8 (100%)	8 (73%)	16 (84%)
Feminine	0 (0%)	3 (27%)	3 (16%)
Total	8 (42%)	11(58%)	19 (100%)

2.4   Discussion

In this chapter we set out to establish the basis for testing the PDC Framework using codeswitching as a test case. We focus our investigation on the Mixed NP construction due to its status as a thoroughly investigated form in Spanish-English codeswitching. The PDC model promotes the hypothesis that production and comprehension are tightly linked; therefore, in order to understand how the comprehension system is impacted, distributional patterns in production must be quantified. Proponents of the model describe two methods for quantification—experimental elicitation of production (i.e. norming studies) or use of natural language corpora. For the study reported here, we utilized a bilingual corpus collected in Miami, FL. Our methodology included the extraction of two kinds of Mixed NPs, English determiners with Spanish nouns (e.g. *the **manguera*** "the hose") and gender-marked Spanish determiners with English nouns (***el** house* "the house").

Our results point towards an overwhelming preference for the use of masculine gender in the production of Mixed NPs in Spanish-English bilingual speech. Specifically, the usage of masculine Spanish articles with English nouns is not constrained by gender assignment in Spanish. This apparent neutralization of gender

assignment in bilingual speech is in contrast to how Spanish gender is assigned in Spanish where gender concord on the article is obligatory. Interestingly, Mixed NPs with feminine marked determiners do not follow the same usage pattern. Although the number of feminine tokens was quite small, $\approx 3\%$ of the entire corpus, these infrequent Mixed NPs were categorically restricted to English nouns with feminine Spanish translation equivalents, e.g. **la** *cookie*, Sp. *la$_{fem}$ galleta$_{fem}$*. This immensely asymmetric distribution favors a default gender assignment strategy in bilingual speech production (Jake et al., 2002b).

In terms of the PDC model, the predictions for comprehension of Mixed NPs are now clear. We predict bilinguals build expectations that a codeswitch is more likely to follow a masculine determiner than a feminine determiner. Therefore, bilinguals should be less affected in how they process gender in masculine marked Mixed NPs. That is, regardless of the gender of the Spanish translation equivalent of the English noun in the Mixed NP, bilinguals should show no modulation in how they process these Mixed NPs. Conversely, we predict that bilinguals are in general less likely to expect a codeswitch after a feminine determiner. Subsequently, we strongly predict a gender effect when bilinguals process feminine marked Mixed NPs. Specifically, bilinguals should show delayed processing when feminine marked Mixed NPs include English nouns with masculine Spanish translation equivalents, e.g. **la juice* Sp. *el$_{masc}$ jugo$_{masc}$*, an unattested pattern in our corpus data. Finally, if our prediction concerning the higher expectation for a codeswitch after a masculine determiner is correct, then this effect may even alter how bilinguals process masculine gender in Spanish. Whereas previous studies have shown that Spanish monolingual speakers are facilitated by gender marking articles in informative contexts (Lew-Williams & Fernald, 2007), bilinguals who codeswitch may show diminished facilitation for masculine articles in Spanish. We directly test these predictions in the following chapters.

Our goal for this chapter was to quantify the production of Mixed NPs. We focused on a bilingual community of speakers to help inform our predictions for our subsequent eyetracking experiments. Below, we expand our Discussion by speculating on the overwhelmingly asymmetric production distribution of Mixed NPs. First, we discuss how traditional accounts have explained gender assignment in Mixed NPs. This section is followed by our hypothesis that feminine marked

Mixed NPs are exceptional codeswitches that reflect *on-the-fly* speech planning. Finally, we close with a broader hypothesis suggesting that codeswitching is an emergent system.

2.4.1 Traditional Accounts on Gender in Mixed NPs

As stated above, several studies have noted the preference for masculine determiners in Mixed NPs (Poplack, 1980; Poplack & Sankoff, 1982; Jake et al., 2002b). Despite this preference for masculine determiners, feminine determiners do surface in Mixed NPs; however, their production is prohibitively restricted to English words with Spanish translation equivalents that are feminine, e.g. **la** *house*, Sp. la_{fem} $casa_{fem}$. Although researchers agree on the asymmetrical status of the Spanish determiner in Mixed NPs, there is considerable debate as to how gender is assigned in Mixed NP constructions. Some researchers have proposed that phonological factors determine gender assignment while others suggest that a semantic approach strongly favors gender assignment (Clegg, 2006). Essentially, these perspectives diametrically argue that gender assignment will either pattern with the underlying constraint hierarchy of Spanish gender assignment, or gender assignment will be neutralized in bilingual speech, in effect following an English-like strategy. Below, we further explore how phonology and semantics may influence gender assignment in Mixed NPs.

2.4.1.1 A phonological account for gender assignment

In Spanish, many words end in phonemes or morphemes that are transparently correlated to gender assignment. In general, nouns ending in *-o* (e.g. *sombrero* 'hat') are masculine, and nouns ending in *-a* (e.g. *casa* 'house') are feminine. In addition, Bull (1965, cited in Clegg, 2006) devised a list of word-final phoneme and morpheme rules that highly indicated the gender of Spanish nouns. Of this list, the most prevalent word-final phonemes that correlated with masculine were /e/, /n/, /o/, /r/, and /s/. For feminine gender, Bull listed /a/, /d/, /ión/, and /is/ as being the most reliable word-final endings. Therefore, if a phonological constraint is operant in gender assignment in Mixed NPs, then English words that fall into these phonological categories should also apply this phonologically-driven

gender assignment rule, e.g. English words ending in -*a* should be assigned feminine gender.

Many researchers have suggested that phonology is the key determinant for gender assignment in Mixed NPs. For example, Clegg (2006), following a variationist framework, examined the predictions borne out from two competing hypotheses, the **Default Gender** theory espoused by Jake et al. (2002b) which states that a default gender is assigned to the majority of loan words and the **Patterned Gender Assignment** theory postulated by Poplack and Sankoff (1982), which claims that gender assignment is a set process that follows a hierarchy of native language parameters. Clegg concluded that the results of his study provided stronger support for the Patterned Gender Assignment theory; however, we note one outstanding issue that challenges his claim. Namely, only 453 ($\approx 50\%$) of the 899 English words examined by Clegg matched Bull's phonological class endings for Spanish. Because half of the data set did not easily fall under Bull's classification, Clegg claimed that these atypical phoneme endings should be assigned masculine gender, following Spanish phonology[6]. We believe that this assumption unnecessarily inflated the success of the phonological account by applying a circular logic to classification. The results were more a reflection that the phonological systems of English and Spanish do not overlap. Furthermore, Clegg's study was more broadly defined to include several types of English-origin nouns. The scope of his study also included phonologically adapted nouns, e.g. *troca* from Eng. *truck*, *breca* from Eng. *brake*. The very presence of these phonologically adapted nouns further reflects the differences between Spanish and English phonology.

Interestingly, Jake et al. (2002b) noted the well-documented asymmetry between feminine and masculine Mixed NPs in their study. In fact, the small percentage of Spanish feminine determiner Mixed NPs motivated their theory on default gender assignment. Regardless, they examined phonological form as an indicator for gender assignment. Out of 16 total Spanish feminine determiner Mixed NPs in their corpus, 14 of their tokens matched in gender only (i.e. not phonology), one token matched in phonology, and one token neither matched phonology nor

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[6]This approach is based under an assumption that masculine is the unmarked gender in Spanish. In other words, Spanish words that are not explicitly marked for gender, e.g. ending in -*a* or -*o*, are classified as masculine.

gender[7].

Our results do not lend strong support for phonologically-driven gender assignment in Mixed NPs. Of our feminine-marked tokens, none fall under Bull's classification for feminine gender. For masculine-marked tokens, 36 tokens ($\approx 13\%$) follow Bull's classification. Of this subset, the most frequent final phoneme was /r/. Furthermore, we note several instances ($n = 6$) in which the cognate morpheme *-ion* did not result in feminine marked Mixed NPs, e.g. **estos** *conversat<u>ions</u>* Sp. *estas*_{fem} *conversac<u>iones</u>*_{fem} "these conversations". Additionally, our feminine tokens discount the logic of labeling non-classified endings as atypical phoneme endings, a classification which should have resulted in our feminine marked tokens surfacing with masculine determiners instead.

2.4.1.2 A semantic approach for gender assignment

Many researchers have investigated whether biological (or natural) gender strongly influences gender assignment in Mixed NPs as it does in Spanish (Poplack, Pousada, & Sankoff, 1982; Jake et al., 2002b; Otheguy & Lapidus, 2003; Clegg, 2006). Spanish, in addition to biological gender-specific noun forms, e.g. *el maestro* "the_{masc} teacher_{masc} (male referent)" *la maestra* "the_{fem} teacher_{fem} (female referent)", also distinguishes nonvariant noun forms on the basis of biological gender solely through the use of gender-marking determiners, e.g. *el estudiante* "the_{masc} student (male or unspecified referent)[8]", *la estudiante* "the_{fem} student (female referent)". Given the strong constraint biological gender places on gender assignment in Spanish, if this factor is operant in gender assignment in Mixed NPs, this cue should predictably favor gender assignment in English words that have human referents. However, this constraint can only operate on a small set of words as not all nouns used in Mixed NPs have human referents.

The evidence from past studies points towards a mixed scenario. Some authors state that Mixed NPs replicate the gender assignment of Spanish when the noun is a human referent. For example, Clegg (2006) claimed that biological gender was categorical in his corpus, e.g. *la gramma* "the grandmother". On the other hand,

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[7]The one token that did not match in phonology nor gender was **una** *rent*, which they translated as *el alquiler*. However, depending on the dialect of the speaker, the translation may actually be *la renta* which does match in gender.

[8]The masculine form also denotes unspecified biological gender.

Poplack et al. (1982) found that biological gender did not exclusively constrain Mixed NPs in their corpus. Furthermore, both Jake et al. (2002b) and Otheguy and Lapidus (2003) listed several examples in which explicit feminine human referent appeared with masculine determiners in Mixed NPs, e.g. **los** *midwives*. The Jake et al. corpus found no examples of female human referents appearing with feminine determiners.

Our results fall in line with the latter group of researchers who failed to find strong support for biological gender as a constraint on gender assignment in Mixed NPs. As presented in Section 2.3.4, we found instances of explicit female referents surfacing with masculine determiners, e.g. **el** *manager*, forms that would likely appear with feminine determiners in Spanish. However, we observed that despite the evidence against biological gender as a strong constraint in gender assignment, a considerable portion (1/3) of feminine marked tokens were human referents.

2.4.2 Codeswitching as an Emergent System

Absent any strong constraints determining gender assignment in Mixed NPs, we conclude that our results support the hypothesis that masculine is the default gender in Spanish-English Mixed NPs in tandem with Jake et al. (2002b). We turn, then, to the remaining issue of the role of feminine marked tokens in Mixed NPs. Under what circumstances do feminine marked Mixed NPs surface? How can a theory that specifies the use of a default gender in Mixed NPs also account for the production of feminine marked Mixed NPs? Our results highlight that these feminine marked forms are a highly restricted set. Therefore, in order to resolve the apparent discrepancy between the overwhelming use of a default gender strategy with the appearance of feminine marked determiners, we propose that codeswitching is an emergent linguistic system built upon the bilingual's constituent languages. Under this view, bilingual speakers who codeswitch have learned a set of distributional patterns for codeswitching that are different from distributions underlying the speakers' unilingual modes. As such, bilingual speakers plan upcoming codeswitches in discourse. For Mixed NPs, a planned codeswitched utterance therefore involves the adoption of a default gender strategy and resulting in the use of masculine determiners. It follows that feminine marked Mixed NPs

are not planned codeswitched utterances. Instead, they are exceptional switches that occur *on-the-fly.*

2.4.2.1 Feminine Gender in Mixed NPs

The highly infrequent use of the feminine determiner in Mixed NPs suggests that these tokens may be the exception to regular production patterns in codeswitching. The number of feminine marked tokens in our corpus is too few to allow for a deeper investigation of this hypothesis in this chapter. However, we speculate on two pieces of evidence which offer tentative support to the idea that feminine marked Mixed NPs are *less planned* than masculine marked Mixed NPs. First, feminine marked Mixed NPs as exceptions should singly be embedded in otherwise unilingual discourse. Under this hypothesis, we predict that feminine marked tokens are more likely to appear as singleton switches in larger stretches of Spanish as illustrated in Example (24).

(24) **sí   pero fíjate   que a tí   todavía no te   han**
     yes but   pay attention-you$_{obj}$ that to you$_{obj}$ still$_{neg}$ no you$_{obj}$ have$_{3rd.pl}$
     puesto [la   assistant]$_{NP}$ ahí   a trabajar (sastre3.fem1)
     put   the$_{fem}$ assistant   there to work
     'Yeah, but look, they still haven't put in place the assistant to work for you'

Conversely, masculine marked determiners are more likely to appear in alternational type switches or in longer stretches of discourse in which elements in both languages are apparent.

(25) **pero no tenían [el   flag]$_{NP}$ out there?** (sastre9.fem2)
     but   not had$_{3rd.pl}$ the$_{masc}$ flag   out there
     'but didn't they have the flag out there?'

With our limited subset, we find only one out of 9 ($\approx 11\%$) feminine marked tokens in which the Mixed NP is not a singleton switch (illustrated as Ex. 20b above).

Second, we predict that if feminine marked Mixed NPs are less planned switches, speakers should produce more disfluencies and pauses leading up to the Mixed NP. In support of this hypothesis, we illustrate with two examples. The first example (Ex. 26) demonstrates a speaker with a high number of disfluencies and a reformulation of the target NP, **la** *pesada* "the bossy [one]", with a feminine marked Mixed

NP, **la** *cheerleader* **pesada** "the bossy cheerleader". The second example (Ex. 27) highlights a disfluency with a feminine marked determiner where the speaker is unable to retrieve the intended Spanish noun, *hamaca* "hammock$_{fem}$", then recovers by switching to a Mixed NP started with a masculine determiner, **un** *hammock*.

(26) **no no no no hay   un   hay   una parte que que [la**
no no no no there is a$_{masc}$ there is a$_{fem}$ part   that that the$_{fem}$
pesada]$_{NP}$ [la   cheerleader pesada]$_{NP}$ está tomando
bossy   the$_{fem}$ cheerleader bossy   is   taking
(herring7.SEB)

'No, no, no, no … there's a, there's a part [of a performance] that that the bossy the bossy cheerleader is taking'

(27) **y   eso   que no la   has   puesto en una** [pause]
and that$_{masc}$ that no it$_{3rd.sing.fem.obj}$ have$_{2nd.sing}$ put   in a$_{fem}$ X
cómo se   llama   esto   una [un hammock]$_{NP}$ de esos
how   it$_{3rd.exp}$ named$_{passive}$ this$_{masc}$ a$_{fem}$ a$_{masc}$ hammock   of these$_{masc}$
(sastre1.SOF)

'and you didn't even put it on a [pause] what are those things called, one of those, a, a hammock'

Both examples underscore the exceptional status of the feminine marked Mixed NP. We find Ex. (27) particularly striking due to the observation that the speaker explicitly indicates difficulty retrieving the Spanish word—a momentarily unretrievable word that nevertheless elicits a congruent feminine determiner. Failure to retrieve the intended Spanish noun results in a subsequent switch to English with a concurrent switch to using default gender.

Alternatively, the surfacing of feminine marked Mixed NPs that categorically follow gender assignment in Spanish does not completely rule out speakers' use of a mixture of strategies. Under this view, grammatical gender may not be fully neutralized in Mixed NPs; rather, its use is only sometimes apparent on feminine tokens. To elaborate, due to the use of Spanish masculine determiners with English nouns that can be either feminine or masculine in Spanish, researchers cannot definitively know the locus of gender assignment for masculine derived tokens. On some occasions, selection may be due to gender concord, e.g. *el$_{masc}$ car$_{masc}$*,

Sp. el_{masc} $carro_{masc}$, whereas in other situations speakers may be utilizing a default gender strategy, e.g. $el_{default}$ $car_{\o}$. Based on the current analyses, the difference is obfuscated. Potentially, future research may reveal some differences on whether the Spanish masculine determiner is due to gender concord in Spanish or due to a default gender strategy by examining the linguistic contexts in which these Mixed NPs surface. For example, codeswitches that follow language-specific morpho-syntactic structures, as in a codeswitch after a subjunctive verb form in Spanish (***Quiero que coma**$_{subjunctive}$ **el** *cake that I made* "I want him to eat$_{subjunctive}$ the cake that I made"), may favor a stricter adherence to Spanish gender assignment[9].

Regardless of the strategy that a bilingual speaker adopts in production, the bilingual listener must learn the gender asymmetry of Mixed NPs in order to successfully comprehend codeswitched speech. In other words, bilingual listeners may generally expect an increased likelihood for codeswitches to happen after a masculine determiner, but they must also be prepared for the more infrequent occasions in which a codeswitch follows a feminine determiner. Alternatively, codeswitchers must learn that feminine determiners will not be followed by masculine translation equivalents whereas masculine determiners may be followed by either masculine or feminine translation equivalents. Thus, bilinguals who codeswitch ultimately must learn a hybridized pattern for gender assignment of Mixed NPs in order to successfully comprehend codeswitched speech. This pattern for gender assignment is noticeably different from gender assignment in Spanish. If codeswitching is an emergent and learned system, then this gender asymmetry must be learned amongst a community of codeswitchers. Consequently, whether a bilingual has immersed herself in such a community, i.e. the linguistic profile of a bilingual in terms of usage and exposure to codeswitching, should result in observable group differences both in the production and comprehension of Mixed NPs.

Although codeswitching as an emergent system receives scant support in the literature, emergent approaches offer an alternative as to how to account for asym-

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[9]We attempted an analysis using VARBRUL, a common analysis used by sociolinguists that makes use of multivariate logistic regression, coding for the following linguistic factors: word status of the NP (i.e. single word or multi-word constituent), language of determiner (i.e. English or Spanish), determiner type (i.e. definite, indefinite, demonstrative, or other), Spanish gender of head noun (i.e. masculine or feminine), and codeswitch type(i.e. insertional or alternational, following Muysken, 2000). However, the analysis was untenable due to the low number of tokens per factor resulting in a high number of empty cells, i.e. *knockouts* in VARBRUL.

metrical structural distributions. Specifically, in the case of grammatical gender, although the syntactic construction DET NP has several different and syntactically equivalent forms, Spanish-English bilinguals in the U.S. show an overwhelming preference for one form, $DET_{Span.masc}$ NP_{Eng}[10]. Currently, most theoretical approaches either try to fit codeswitching into parsimonious accounts of permissible syntactic switch sites without addressing asymmetric distributions, e.g. on the status of whether codeswitches can happen between a determiner and a noun phrase (e.g. Belazi et al., 1994; Di Sciullo et al., 1986), or address asymmetries in the overall contribution of each language to codeswitched speech, i.e. The Matrix Language Frame hypothesis (Myers-Scotton & Jake, 2000; Myers-Scotton, 2000, 2005, 2006). Yet only an emergent approach accepts asymmetric differences in usage as not only possible but highly likely.

2.4.2.2 Distributional Differences in Determiner Usage Rates

Otheguy and Lapidus (2003) similarly report the asymmetry between masculine and feminine determiners in Mixed NPs; however, they approach the production of Mixed NPs from a different perspective. In contrast with the previous accounts discussed in Section 2.4.1, they are more concerned with the type of Mixed NP produced in bilingual discourse. Their investigation leads them to motivate the **Linguistic Adaptiveness** hypothesis, which suggests that structural choices are determined by functional utility. They reason that if the primary function of a syntactic structure cannot be conveyed or is diminished, then this change should be reflected in an overall decreased frequency of use.

For codeswitching, cross-linguistic differences, like grammatical gender in Mixed NPs, should result in less use when compared to Spanish, i.e. usage patterns in codeswitching should differ from unilingual patterns. Otheguy and Lapidus (2003) (p. 216) state that the function of gender agreement is to indicate through morphosyntactic features which words are to be construed together, thereby "insuring

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[10]We narrowly define this preference for U.S. Spanish-English bilinguals. Although there are possible structural reasons for the selection of masculine as the default gender, evidence which primarily comes from work on heritage language speakers, first language acquisition, and computation approaches (Eddington, 2002, and references therein), we do not claim that all bilinguals will universally show preferences for masculine as the default gender. Indeed, our colleagues at Bangor University have recently documented an apparent preference for feminine gender as the default gender in Basque-Spanish codeswitching.

textual cohesion and facilitating the parsing of strings." Therefore, they claim that the masculine-feminine asymmetry observed in Mixed NPs demonstrates that gender usage is constrained in bilingual discourse. Thus, following the predictions of the Linguistic Adaptiveness hypothesis, constrained gender usage should result in lower overall production of Mixed NPs with gender bearing structures, such as definite articles, demonstratives, and adjectives.

To test their claims, they expand the focus of their investigation to include the quantification of three types of NPs in bilingual speech: DET NP (same as in our study), ADJECTIVE NP, and NPs exhibiting anaphoric reference with demonstratives, headless articles, and clitics[11]. As predicted by the Linguistic Adaptiveness hypothesis, Otheguy and Lapidus found that overall, Mixed NPs surfaced less frequently with articles and adjectives than in Spanish. On the other hand, they found that anaphoric referents exhibit similar frequency rates of use between Spanish and bilingual discourse. They concluded that their analysis provides strong support for the view that rates of usage in codeswitching may differ from their parallel structures in unilingual discourse—a view that is consonant with our proposal that codeswitching is an emergent system.

The results of our study are not directly comparable to the Otheguy and Lapidus (2003) study because we do not quantify Mixed NPs with non-gender marking Spanish determiners nor do we quantify the concurrent rates of usage of Spanish or English NPs in our corpus. Nevertheless, our data does allow for a comparison of usage rates of definite and indefinite determiners. We can then compare these rates of usage with previously documented rates of usage in Spanish and English (Torres Cacoullos & Aaron, 2003) with the necessary caveat that we are making between group comparisons. Although we cannot directly test whether bilingual speakers are less likely to produce determiners that mark gender—a direct prediction of the Linguistic Adaptiveness hypothesis—we extend its logic to examine whether rates of usage of Mixed NPs differ significantly from Spanish and/or English. In our view, a corollary of the Linguistic Adaptiveness hypothesis

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[11]Anaphoric reference occurs when an expression such as a demonstrative, e.g. *that*, refers to another expression such as a noun,e.g. book. In their examples, the noun and the co-referring expression are separated by intervening syntactic constituents, e.g. **That** *is the* **book**. In Spanish, gender-marking determiners that are in anaphoric reference with nouns must agree in gender, e.g. **Ese**$_{masc}$ *es el* **libro**$_{masc}$.

is that when bilinguals produce gender marking Mixed NPs, distributional differences should also exist between codeswitching and unilingual contexts. That is, if the functional utility of gender agreement has been diminished in codeswitched speech as claimed by Otheguy and Lapidus, then bilinguals are less likely to produce definite and indefinite determiners in a Spanish-like way. Conversely, their distribution may pattern more like English where no such gender function exists.

In their study, Torres Cacoullos and Aaron (2003) compare rates of determiner usage in Spanish and English. We focus on just the subset of their data that includes definite and indefinite articles. For Spanish, they quantified a usage rate of 52% for definites and 18% for indefinites. In contrast, they found in English a usage rate of 43% for definites and 27% for indefinites. These percentages do not add up to 100% due to the inclusion of other types of NPs such as bare nouns and demonstratives. The distributions of our corpus indicate that feminine marked Mixed NPs appear with definite articles 100%. Alternatively, masculine marked Mixed NPs appear with definite articles 66%, indefinites account for 28% of masculine marked Mixed NPs, and the remaining 7% of masculine marked tokens are composed of gender marking demonstratives, e.g. *estos conversations*, "these$_{masc}$ conversations." For a more direct comparison to the Torres Cacoullos and Aaron study, we recalculate their distributions as a percentage of total definite and indefinite determiners only and present the results in Table 2.4. Data taken from Torres Cacoullos and Aaron are presented in the Spanish and English columns to the left of the vertical line bisecting the table. The results from our corpus are presented to the right of this vertical line under the Bilingual headings.

Table 2.4: Distribution of definite and indefinite NP's in Spanish, English, and Code-switching

	Spanish	English	Bilingual Masculine	Bilingual Feminine	Bilingual Total
Definite	723 (74%)	330 (61%)	195 (70%)	9 (100%)	204(71%)
Indefinite	250 (26%)	209 (39%)	82 (30%)	0 (-)	82 (29%)
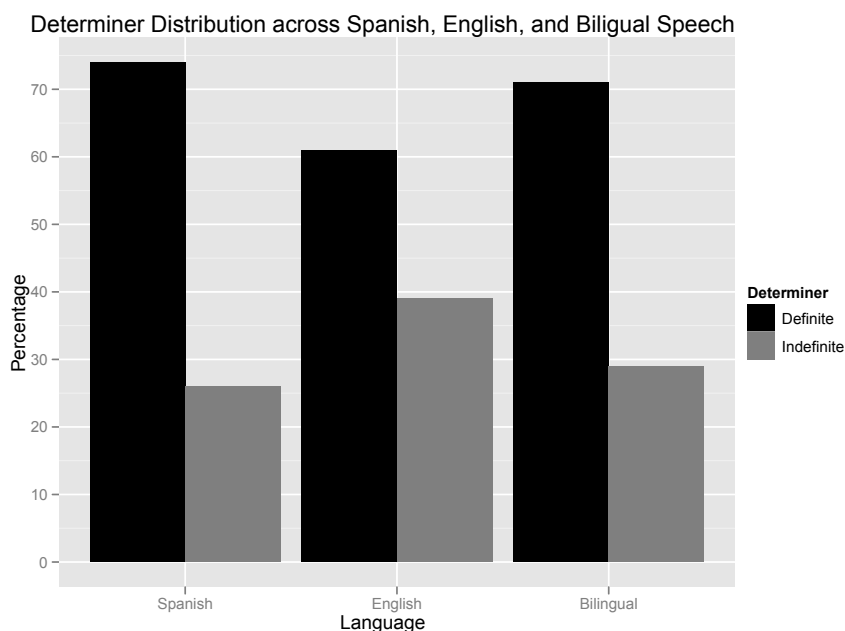
Figure 2.1: Distribution of Percentage of Definite and Indefinite Determiners Across English, Spanish, & Bilingual Speech

Percentages are calculated out of the total number of definite and indefinite determiners. Data for Spanish and English are taken from Torres Cacoullos and Aaron (2003).

A χ^2 test statistic reveals a significant difference between all 3 groups: English, Spanish, and bilingual speech, $\chi^2 = 28.543, df(2), p < .001$. However post-hoc comparisons with a Bonferonni correction of $\alpha = .05/3 \approx .0167$, reveal that this significant difference lies with Spanish and English, $\chi^2 = 27.46, df(1), p < .001$; bilingual speech and English, $\chi^2 = 7.92, df(1), p < .01$; but fails to reach significance between Spanish and bilingual speech, $\chi^2 = 0.86, df(1), n.s.$ Thus, at least in the limited subset examined here, bilingual speech patterns more like Spanish and differs from English in terms of distributional differences between definite and indefinite determiners (see Figure 2.1).

This finding appears to refute the Linguistic Adaptiveness hypothesis; however, when taken together with the gender asymmetry of Mixed NPs, we note several observations. First, while bilingual speech shows patterns of determiner production statistically similar to Spanish usage, Spanish gender assignment does not strongly constrain the gender assignment of Mixed NPs. In other words, de-

spite the similarities in determiner production between Spanish and codeswitching, a possibly strong constraint in favor of a Spanish-like strategy in gender assignment, bilinguals prefer a default gender strategy. In contrast, despite the evident non-utility of gender in Mixed NPs, bilinguals do not produce determiners in an English-like manner while codeswitching. Second, feminine marked Mixed NPs categorically surface with definite determiners in our corpus. We hesitate to make strong predictions given the low number of tokens in our corpus; however, this restricted (or highly limited) use of determiners in Mixed NPs further points towards an exceptional status for feminine marked Mixed NPs in planned codeswitching. We argue that if feminine marked Mixed NPs are not exceptional in codeswitched speech, then bilinguals would likely use a variety of determiners in Mixed NP production. Interestingly, this aspect of our comparison is the most compatible with the Linguistic Adaptiveness hypothesis. Feminine marked Mixed NPs as a highly restricted set, show diminished structural differences, a likely consequence of its limited functionality.

In sum, our closer inspection of determiner type in Mixed NPs offers tentative support for our proposal that codeswitching is an emergent system that must be learned amongst a community of speakers. Specifically, we claim that bilinguals elect to use a default gender strategy in Mixed NPs. Despite the use of a default gender strategy, bilinguals also infrequently produce feminine marked Mixed NPs which are highly restricted to congruent feminine translation equivalents and to use with definite determiners. In light of their restricted use, we argue that feminine marked Mixed NPs are exceptional codeswitches, most likely a reflection of switches that occur with minimal speech planning. Although our determiner type comparison does not support a strong version of the Linguistic Adaptiveness hypothesis (noting that our comparison does not directly match the comparison in Otheguy and Lapidus, 2003), we believe that our results are complementary to the assumption underlying the hypothesis. That is, bilingual speakers have *adapted* the way in which they produce gender-marking determiners as a consequence of their change in function.

2.5 Conclusion

This abbreviated corpus study replicates previous findings documenting a preferred, default status for masculine determiners in Spanish-English codeswitched speech, e.g. ***el*** *cookie* (Jake et al., 2002b). The current study extends previous findings by quantifying the distribution of all Mixed NPs, including combinations of DET NP that include English determiners with Spanish NPs, e.g. *the* ***manguera*** "the hose". By broadening the scope of quantification, our results reveal that in addition to the more frequently cited Spanish determiner + English NP combination, we also find examples of English determiner + Spanish NPs. Nevertheless, as in previous studies, the vast majority of tokens in our corpus are of the form masculine-marked Spanish determiner + English NP. Interestingly, English determiner Mixed NPs numbered more than feminine-marked Spanish Mixed NPs, highlighting the rarity of this construction in production.

Furthermore, this study examines the gender agreement between gender-marked Spanish determiners and the Spanish translation equivalents of the following English nouns. Results confirm the asymmetric nature of gender assignment in Spanish-English codeswitching. Whereas Spanish masculine determiners are produced with English nouns irrespective of the gender of the equivalent Spanish translations, feminine determiners categorically surface with English nouns with feminine Spanish translations. In light of experimental evidence revealing non-selective access in bilingual production and comprehension, gender-marked determiner usage in codeswitching implicates the need to learn a hybridization of Spanish and English strategies in gender assignment for successful comprehension of codeswitched speech.

In terms of the PDC framework (Gennari & MacDonald, 2009), we are now in a position to test the predictions of how distribution patterns in production impact comprehension. In particular, given the overwhelming preference of the masculine gender, we expect that masculine-marked determiners in Mixed NPs function as neutralized, gender-less articles analogous to *the* in English. In contrast, the feminine article should exhibit asymmetrical effects in comprehension such that English nouns with Spanish translation equivalents that are masculine should result in delayed processing of these Mixed NPs. These predictions will be explored

in a series of eye-tracking experiments in the following chapters.

Chapter 3

Materials and Procedures

3.1 Introduction

In this chapter, we describe the materials and procedure for three visual world eye-tracking experiments. The three experiments consisted of gender processing in Spanish, followed by gender processing in single word codeswitches embedded in an invariant carrier phrase, and ending with multi-word codeswitches embedded in variant sentences. These experiments were conducted during one experimental session in the Fall of 2011 at City College of New York (CCNY) in New York City, NY. For purposes of comparison for the Spanish gender processing eye-tracking experiment, we also include a Spanish monolingual control group recruited from the University of Granada, Spain as a part of an undergraduate honors thesis project.

   This chapter begins with a detailed linguistic and demographic profile of the participants, which ultimately were split into two bilingual groups on the basis of whether the participant was born in the U.S. or in Latin America. We compiled these profiles which includes self-reported measures from our language history questionnaire (LHQ) and proficiency measures obtained in both English and Spanish using grammar tests and picture naming tests. Next, we cover the experimental materials used in each experiment, explaining how the materials were recorded and compiled for each experiment. We close with a description of the procedural protocol that we adopted in our experimental session.

3.2   Participants

3.2.1   Spanish Monolinguals

As part of her undergraduate honors thesis, Perrotti (2012) recruited 24 Spanish monolinguals from the University of Granada (Spain) in Spring of 2011. All 24 participants reported that they were functionally monolingual, which is a common characteristic in the southern region of Spain where the university is situated, i.e. Andalucia. All 24 participant were students at the University of Granada recruited by way of posted flyers and word-of-mouth. All participants were monetarily compensated for their time. For detailed characteristics on the participants and the experimental procedure (which was part of a larger study), refer to Perrotti (2012).

3.2.2   Spanish-English Bilinguals

In the Fall of 2011, we contacted Spanish-English bilinguals who had earlier participated in the study reported in Guzzardo Tamargo (2012). This initial contact consisted of a uniform e-mail explaining that we were currently conducting a new and separate round of experiments. The e-mail also provided a general description of the experimental session stating that participants would listen to sentences containing both English and Spanish where the task consisted of clicking on the correct picture named in the auditory stimuli. Potential recruits were further informed that their eye movements would be recorded while they carried out the experimental task and that they would be compensated for their time. All potential recruits were informed that their participation in the new round of experiments was completely voluntary and to respond to the e-mail if they were interested in participating or requested more information. Ultimately, 54 bilinguals contacted us, and participated in the experimental session. Of these 54 participants, 8 were post-hoc removed from all analyses because of failing to register the minimum threshold of 25% total fixations on target items on more than 75% of trials in at least one of the three experiments (explained in more detail in Chapter 4). This minimum fixation threshold filtering resulted in a final group of 46 participants.

Furthermore, we split the 46 participants into two separate groups of Spanish-

English bilinguals based on whether they were born in the U.S. or in Latin America[1]. By this classification, our U.S. born group consists of 21 participants, and our Latin born group consists of 25 participants. In the next two sections, we describe the results of the participants' self-reported LHQ and proficiency measures by group.

3.2.2.1 Demographic and LHQ Measures

Demographic and self-reported proficiency measures were obtained from a language history questionnaire (LHQ) created in Google documents and administered online. Potential participants who indicated interest during initial recruitment for (Guzzardo Tamargo, 2012) were sent an online link to the LHQ through e-mail. The LHQ was composed of 81 questions with a mixture of multiple choice and open-ended questions. Questions included demographic information, self-reported proficiency measures in English and Spanish, questions about a person's cultural identity, the frequency with which a person interacted in both languages and with whom, and questions about how often a person engaged in oral and written codeswitching. Once completed, responses were tabulated in a google spreadsheet that was then exported to Microsoft Excel.

The participants in the U.S. group ($N = 21$) include 15 females and 6 males. The mean age for the group is 20.90 years ($SD = 2.39$). The mean self-reported age of acquisition for English is 4.33 ($SD = 2.83$) and for Spanish is 1.52 ($SD = 1.47$). The U.S. group rated themselves as having acquired English later than Spanish, mean difference = 2.81 years ($t(20) = 4.81$, $p < 0.001$). All participants provided self-reported ratings in speaking, listening, reading, and writing for both English and Spanish. These ratings were on a scale from 1 to 10 with 10 indicating highest proficiency. For speaking, the mean rating in English was 9.05 ($SD = 0.86$) and in Spanish was 8.05 ($SD = 1.91$), indicating that the group rated themselves higher in English, mean difference[2] = 1 ($t(20) = 2.21$, $p = 0.039$). For listening, the U.S. group had a mean English rating of 9.38 ($SD = 0.74$) and a mean Spanish

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[1]We define Latin America as any Spanish-majority speaking country in the Americas outside of the U.S. Thus, this catchall-term includes speakers from the Caribbean, Central America, and South America. We did not have any participants from Spain or its territories.

[2]For in-group comparisons on self-reported proficiency measures, mean difference is calculated as English score – Spanish score. Thus, a positive value indicates a higher value in English.

rating of 8.67 ($SD = 1.02$). As before, participants rated themselves higher in English than in Spanish for listening, mean difference = 0.71 ($t(20) = 2.75$, $p = 0.012$). In reading, the U.S. group had a mean rating of 9.33 ($SD = 0.8$) for English and a mean rating of 7.76 ($SD = 1.67$) for Spanish, thus rating themselves higher in English than Spanish, mean difference = 1.57 ($t(20) = 4.34$, $p < 0.001$). Finally, the mean self-rating for English writing was 9.19 ($SD = 0.81$) and for Spanish writing was 6.76 ($SD = 2.14$), as in all other cases, the participants rated themselves higher in English than Spanish, mean difference = 2.43 ($t(20) = 5.27$, $p < 0.001$).

Additionally, participants provided self-reported ratings on their use of and exposure to both spoken and written codeswitching. Here, participants selected one of five possible responses which we list in order: never, seldom, sometimes, most of the time, and always. Because the responses are ordinal levels, we present total sums of responses to each category for the U.S. group in Table 3.1. Both exposure to and frequency of use of oral codeswitching occurred more than written codeswitches for the U.S. group.

Table 3.1: Self-reported ratings of frequency of use and exposure to oral and written codeswitching for U.S. born participants.

Rating	Oral CS Frequency	Written CS Frequency	Oral CS Exposure	Written CS Exposure
never	-	5	-	2
seldom	2	10	1	4
sometimes	11	4	8	11
most of the time	4	1	6	2
always	4	1	6	2

The Latin born group ($N = 25$) consists of 19 females and 6 males. The mean age of the group is 22.6 years ($SD = 3.96$). Participants had a mean age of acquisition rating for English of 9.2 years ($SD = 3.56$) and a mean rating for age of acquisition of Spanish of 1.04 years ($SD = 1.54$). As in the case of the U.S. group, the Latin group reported their age of acquisition of Spanish to be earlier than for English, mean difference = 8.16 years ($t(24) = 10.32$, $p < 0.001$). Participants, using a scale from 1 to 10 (10 is best), rated their English speaking as a mean of

8.56 ($SD = 1.19$) and their Spanish speaking as a mean of 9.24 ($SD = 0.88$), thus rating themselves as higher in Spanish than in English, mean difference = -0.68 ($t(24) = -2.47$, $p = 0.021$). In listening, the Latin born group had a mean rating of 9.15 ($SD = 0.93$) for English and a Spanish mean rating of 9.48 ($SD = 0.65$). Here, Spanish is rated marginally higher than English, mean difference = -0.33 ($t(24) = -1.89$, $p = 0.071$). Participants gave a mean rating for English reading of 9.08 ($SD = 1.38$) and for Spanish reading a mean rating of 8.72 ($SD = 1.7$). There was no statistical difference between mean ratings in English and Spanish, ($t(24) = 0.77$, $p = 0.45$). Finally, in writing, the Latin born group had a mean rating of 8.68 ($SD = 1.35$) for English and a mean rating of 8.16 ($SD = 1.89$). As in reading, participants did not rate themselves differently in English and Spanish for writing, ($t(24) = 1.05$, $p = 0.306$).

As in the case of the U.S born group, participants in the Latin born group provided self ratings as to the frequency of use and exposure to oral and written codeswitching. As described above, they selected a response from an ordinal scale with 5 levels from never to always (see above). We report their tabulated values in Table 3.2. As in the case of the U.S. group of bilinguals, the Latin group rated themselves engaging more in and having more exposure to spoken codeswitching. In terms of oral codeswitching, the two groups do not statistically differ from each other, for frequency of use $\chi^2(3) = 0.12$, $p = 0.989$ and for exposure to spoken codeswitching $\chi^2(3) = 3.47$, $p = 0.325$. We cannot do a direct comparison between the groups with the groups' given ratings for written codeswitching due to missing cells in the cross-tabulation, i.e. the two groups do not have values in the same categories.

We now compare the two groups to each other on their demographic and self-reported proficiency measures. We found no statistical difference in the distribution of sex between the two groups ($\chi^2(1) = 0.000$, $p = 0.988$). However, the Latin born group was statistically older than the U.S. born group, mean difference[3] = 2.5 years ($t(44) = 2.5362$, $p = 0.015$). For English age of acquisition, even though both groups reported their English age of acquisition as later than Spanish, the age reported for the Latin born group is significantly later than the U.S. born

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[3]In comparisons between the Latin born group and the U.S. born group, mean differences are calculated by Latin born measure – U.S. born measure. Positive values indicate a higher value for the Latin born group.

group, mean difference = 4.87 years ($t(44) = 5.06$, $p < 0.001$). In contrast, both groups did not differ on their reported age of acquisition of Spanish ($t(44) = -1.08$, $p = 0.285$). For the self-reported proficiency measures in English, the groups' rating did not reach a statistical difference for any of the four categories, for speaking ($t(44) = -1.56$, $p = 0.126$), for listening ($t(44) = -1.04$, $p = 0.304$), for reading ($t(44) = -0.74$, $p = 0462$), or for writing ($t(44) = -1.52, p = 0.136$). Alternatively, the Latin born group consistently rated their Spanish higher than the U.S. born group in speaking, listening, and writing and as marginally higher in reading, for speaking, mean difference = 1.19 ($t(44) = 2.79$, $p = 0.008$), for listening, mean difference = 0.81 ($t(44) = 3.27$, $p = 0.002$), for reading, mean difference = 0.96 ($t(44) = 1.92$, $p = 0.061$), and for reading, mean difference = 1.4 ($t(44) = 2.35$, $p = 0.023$).

Table 3.2: Self-reported ratings of frequency of use and exposure to oral and written codeswitching for Latin born participants.

Rating	Oral CS Frequency	Written CS Frequency	Oral CS Exposure	Written CS Exposure
never	-	7	-	5
seldom	2	10	1	8
sometimes	14	8	13	10
most of the time	5	-	9	-
always	4	-	2	2

In summary, both groups are demographically comparable, although the Latin born group is on average 2 years older than the U.S. born group. In addition both gorups of Spanish-English bilinguals reported their age of acquisition of Spanish as earlier than English, but the U.S. born group had an earlier age of acquisition for English than the Latin born group. Despite these differences, both groups rated their proficiency levels similarly in English across four categories: speaking, listening, reading, and writing. However, even though both groups acquired Spanish first, the U.S. born group consistently rates their Spanish proficiency as lower than the Latin born group. Essentially, our splitting of the two groups by place of birth has separated the two groups of Spanish-English bilinguals into a perceived English dominant (U.S. born) and Spanish dominant (Latin born) group. In the

next section, we further investigate both groups' respective proficiency levels via their results on grammar tests and picture naming in English and Spanish.

3.2.2.2 Proficiency Measures

In this section, we first describe the measures of proficiency that we obtained for each group. We follow with a report of the proficiency scores for each test by group (U.S. group first) with a comparison across languages within each group. Finally we close with a between-groups comparison for each measure.

We asked our participants to complete two modified grammar tests, one in English and one in Spanish, and a picture naming test that we adapted for English and Spanish. The Spanish grammar test was based off of the *Diploma de español como lengua extranjera* [Diploma of Spanish as a Foreign Language] (DELE), which is a standardized test of Spanish proficiency. The DELE tests proficiency at seven levels and is issued by the Spanish Ministry of Education, Culture, and Sport. The version that our participants completed is adapted from *Nivel Superior C2*, which is the highest level of proficiency tested (see <`http:diplomas.cervantes.es/en`>). The test consisted of 50 questions divided over three sections: a cloze test (20 questions), a vocabulary test (10 questions), and a grammar test (30 questions). All questions were multiple-choice. Participants received 1 point for each correct answer and 0 points for incorrect answers. The English grammar test was adapted from the *Michigan English Language Institute College English Test* (MELICET, <`http://www.michigan-proficiency-exams.com/melicet.html`>). The ME-LICET also consisted of 50 questions. These questions were divided over two sections: a grammar test (30 questions) and a cloze test (20 questions). Both sections had a multiple-choice format. As for the DELE, participants received 1 point for each correct answer and 0 points for incorrect answers. For both tests, participants completed their answers on a Microsoft Word document. A text field was enabled for each question such that when participants clicked on the field, a drop-down menu would appear, allowing participants to record their answers with a click of the computer mouse. Answers were subsequently extracted for each test and tabulated in a separate Microsoft Excel spreadsheet. Participants took approximately 20 minutes to complete each test. Both tests were completed on a separate day from the experimental session.

We adapted a monolingual picture naming test known as the *Boston Naming Test* (BNT, Kaplan, Goodglass, Weintraub, & Segal, 1983) for our bilingual participants. Originally designed for monolingual speakers, the BNT consists of 60 line picture drawings that gradually increase in difficulty. For example, easier pictures found near the beginning of the series include pictures of a bed, tree, house, and comb. More difficult pictures include examples such as noose, sphinx, palette, and protractor. Participants are instructed to name the pictures in sequence. Because some items are specific to Anglo culture (e.g. pretzel, wreath), the BNT was adapted to Spanish-English bilingual speakers by splitting the task into 2 sets of 30 pictures while preserving the gradual increase in difficulty for each set. In other words, 2 subsets of 30 pictures each were created and our participants were instructed to name one set in English (English BNT) and the other set in Spanish (Spanish BNT). Extra care was taken to ensure that culturally specific items were appropriately placed in the English set. Both the English BNT and Spanish BNT were presented to participants with E-prime software. Presentation for each picture lasted 2 seconds maximum. Participants were manually scored by the experimenter, receiving a 1 for correct responses and a 0 for incorrect responses. Responses were later tabulated in Microsoft Excel.

We now report the results for the U.S. group ($n = 21$). First, we present the mean scores of the English and Spanish BNT, respectively. BNT scores are the total correct out of 30 possible points. On the English BNT, participants had a mean score of 19.95 ($SD = 4.04$). Participants had a mean score of 13.38 for the Spanish BNT ($SD = 3.4$). Thus, the U.S. group had a higher score in the English BNT than in the Spanish BNT, mean difference[4] = 6.57 ($t(20) = 6.4$, $p < 0.001$). Next, we present the scores on the English and Spanish grammar tests, respectively. Grammar test scores are the total correct out of 50 possible points. For the English grammar test, the U.S. born group had a mean score of 41.85 ($SD = 4.28$). In contrast, participants had a mean score of 33.76 for the Spanish grammar test ($SD = 5.8$). Consequently, U.S. born participants scored better on the English grammar test than on the Spanish grammar test, mean difference = 8.1 ($t(20) = 6.32$, $p < 0.001$). Both the BNT scores and the grammar tests confirm

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[4]Mean differences for proficiency measures were calculated by subtracting English value – Spanish value. Positive values indicate a higher score in English.

that the U.S. born group is likely more English-dominant.

We present the mean scores for the Latin group ($n = 25$). For the English BNT, participants had a mean score of 18.76 ($SD = 4.97$). In turn, these participants had a mean score of 18.16 ($SD = 3.8$) for the Spanish BNT. Unlike the U.S. born group, these participants showed no statistical difference between their two scores ($t(24) = 0.458$, $p = 0.651$). For the English grammar test, the Latin born group had a mean score of 40.48 ($SD = 5.28$). Similarly, this group had a mean score of 40.24 for the Spanish grammar test ($SD = 5.04$), again indicative of similar scores across languages ($t(24) = 0.148$, $p = 0.883$). Unlike the U.S. born group, the Latin born group showed balanced scores across both languages in both the picture naming and grammar tests.

Finally, we compare proficiency measures across groups. For the English BNT, we found no statistical difference between the mean scores of the two groups ($t(44) = 0.881$, $p = 0.383$). However, the Latin born group had a higher mean score on the Spanish BNT than the U.S. born group, mean difference = -4.78 ($t(44) = -4.453$, $p < 0.001$). Furthermore, the two groups had similar mean scores on the English grammar test ($t(44) = 0.959$, $p = 0.343$). In contrast, the Latin born group scored a higher mean on the Spanish grammar test than the U.S. born group, mean difference = -6.48 ($t(44) = -4.051$, $p < 0.001$). These group differences further confirm that the two groups of Spansh-English bilinguals have comparable proficiency measures in English yet differ in Spanish with the Latin born group consistently scoring higher in Spanish proficiency measures than the U.S. born group.

As a further indicator of the two groups' proficiency measures across languages, we computed a ratio score for each participant for both the picture naming test and the grammar test. We divided the English scores by the Spanish scores for each type of proficiency test to determine the value for each ratio. For example, we divided the scores of the English BNT by the scores of the Spanish BNT to calculate a BNT ratio score. A ratio close to 1 reflects more balanced proficiency across English and Spanish, a ratio greater than 1 reflects more English dominance, and a ratio less than 1 reflects more Spanish dominance. In Figure 3.1 we plot the histogram of BNT ratio scores for both groups, and in Figure 3.2 we plot the histogram of Grammar test ratio scores for both groups. In both plots, we subset

the ratio scores by group such that the upper panel displays the histogram for the Latin born group and the lower panel for the U.S. born group. Additionally, we overlay a red line which indicates the mean ratio score for each group.
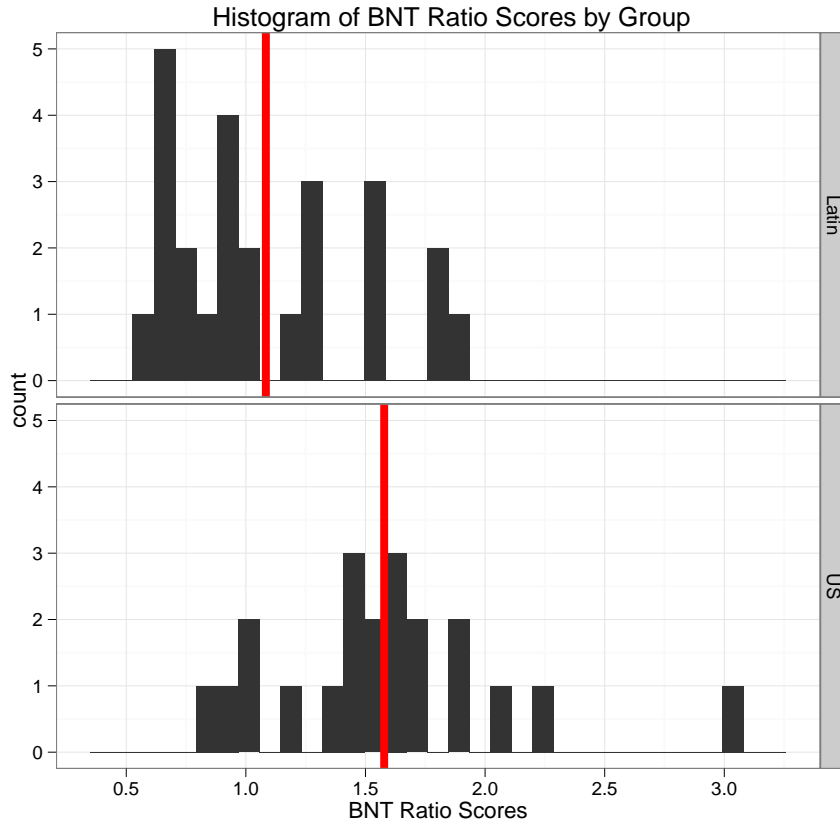
Figure 3.1: Histogram of BNT Ratio Scores split by group.

The mean BNT ratio score for the U.S. born group was 1.58 ($SD = 0.49$), which was significantly higher than 1 ($t(20) = 5.37$, $p < 0.001$). In contrast, the Latin group had a mean BNT ratio score of 1.08 ($SD = 0.41$). Here, the mean BNT ratio score was not different from 1 ($t(24) = 1.02$, $p = 0.316$). In parallel, the U.S. born group had a mean Grammar test ratio of 1.27 ($SD = 0.21$), which was significantly higher than 1 ($t(20) = 5.73$, $p < 0.001$). The mean Grammar test ratio score for the Latin born group was 1.03 ($SD = 0.21$). As in the BNT ratio score, the Grammar test ratio score was not statistically different from 1 ($t(24) = 0.621$, $p = 0.541$). The ratio scores indicate that the Latin born group is more balanced across the two languages as measured by a picture naming test
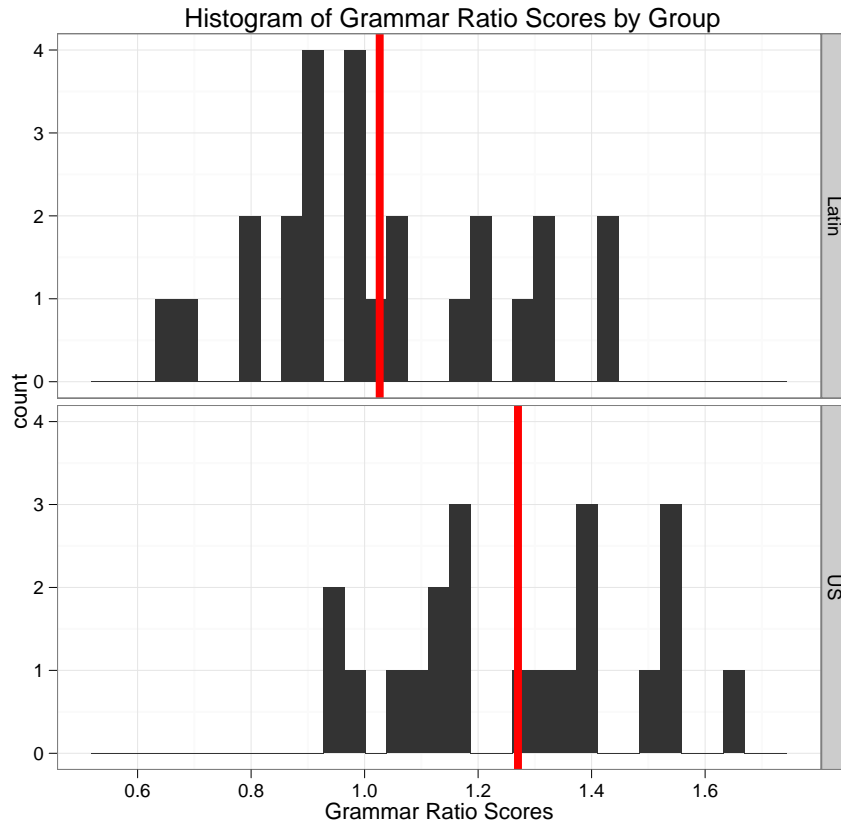
Figure 3.2: Histogram of Grammar Test Ratio Scores split by group.

and a grammar test, whereas the U.S. born group is consistently more English dominant in both measures.

3.3 Materials and Experimental Design

In this section we illustrate the basic experimental design of our three visual world eye-tracking experiments. The three experiments are all adapted from Lew-Williams and Fernald (2007) in that we present a 2-picture display for each trial in our experiments. We adapted this presentation such that both pictures appeared in the center of one computer monitor with a central fixation cross (see Figure 3.3). Our presentation contrasts from Lew-Williams and Fernald who used two monitors presented side by side. Below, we discuss the specific design and the materials used for each experiment. We begin with Spanish, followed by lexical-

level codeswitching , and end with sentence-level codeswitching. All materials and sentential frames are listed in Appendix A.

Figure 3.3: Sample of 2-picture display used in eye-tracking experiments

3.3.1 Visual World Experiment: Spanish Unilingual Block

The Spanish experiment includes a total of 224 highly concrete items. Each item had a corresponding sound and picture file (explained below). We constructed the experimental materials such that half of the items are feminine gender and the other half are masculine gender. We subsequently grouped items into quartets of two feminine and two masculine items. This grouping resulted in 56 possible trials (see Table A.1, Appendix A). Following Lew-Williams and Fernald (2007), each trial consisted of a 2-picture display where items either matched or differed in gender. Because of our grouping, we had four possible variants for each trial. Consequently, we were able to counterbalance our materials such that each item was a target item in two separate lists, once with a same gender distractor and once with a different gender distractor. This resulted in four experimental lists. In addition, we counterbalanced the position of each item. For example, if in one list a target picture of a table appears on the left side position and a distractor picture of a bed on the right side position of the computer screen, then a separate experimental list had these positions reversed. This resulted in a total of eight experimental lists (i.e. 4 variants × 2 position = 8 lists).

For the corresponding sound files, experimental stimuli were embedded in one of two invariant carrier phrases which only differed on the gender of the definite article, *Encuentra el/la* _____ "Find the$_{masc/fem}$ _____." The gender of the definite article always agreed with the gender of the target noun. The experimental design therefore consists of two sub-conditions split by grammatical gender of the article in the carrier phrase. As in Lew-Williams and Fernald (2007), target items were

either paired with a same gender or different gender distractor item. For example, if the target noun *mesa* "table$_{\text{fem}}$" appears with *cama* "bed$_{\text{fem}}$," then it is a feminine same gender trial. In contrast, when the target item *mesa* "table$_{\text{fem}}$" appears with *libro* "book$_{\text{masc}}$" it is a feminine different gender trial. We illustrate the basic condition manipulation in Table 3.3. This experimental manipulation results in 14 trials per sub-condition in each experimental session.

Table 3.3: Experimental manipulation in Spanish experiment

Carrier phrase: *Encuentra el/la* _____, "Find the$_{\text{masc/fem}}$ _____"			
Condition	**Article**	**Target**	**Distractor**
Feminine Same Gender	la	mesa (fem)	cama (fem)
Feminine Different Gender	la	mesa (fem)	libro (masc)
Masculine Same Gender	el	libro (masc)	dinero (masc)
Masculine Different Gender	el	libro (masc)	mesa (fem)

A native female speaker of Spanish from Spain recorded our materials in a two-stage process. Sound recordings were made in a sound-attenuated sound chamber with a Shure SM57 microphone on a Marantz Solid State Recorder PMD670 at a sampling rate of 44.1 kHz. In the first stage, our speaker recorded the two versions of the simple invariant carrier phrase. We instructed the speaker to repeat each carrier phrase in a normal declarative intonation 5 times. From these two master files, we subsequently measured the duration of each definite article in Praat (Boersma & Weenink, 2012). The mean duration for each article was roughly 200 msec. Thus, we subsequently, selected one token from each master file and manipulated the duration of the article to be precisely 200 msec for both tokens, i.e. the duration of the definite articles *el* and *la* were manipulated to be 200 msec. In the second stage, we instructed our speaker to name each experimental stimulus 5 times. From each set of repeated tokens, we selected one token to be inserted into the appropriate carrier phrase (i.e. congruent definite article). A 50 msec pause was inserted between the definite article and the following target noun.

We also created a picture database for our experimental stimuli. For each item, we selected a corresponding color image from Google Images. We attempted to select highly recognizable images that appeared in isolation. Some images were

manually manipulated in Microsoft Paint in order to remove distracting patterns or to crop an image such that the target item was centered. All picture files were.jpg images that were a minimum size of 30 KB and were as close as possible to a square size. Furthermore, we normed the pictures within our research lab with other members who were naive to the research questions of the experiment. We subsequently made any adjustments based on the input from our fellow lab members.

3.3.2 Visual World Experiment: Lexical-level Codeswitching

The materials for the lexical-level codeswitching experiment are composed of 360 concrete items. The experimental design is more complex than that of the Spanish experiment because we introduce two experimental manipulations. First, we include phonological competition, similar to Allopenna et al. (1998). We had 60 experimental pairs that were phonological cohorts in English but were crucially all different gendered items in their Spanish translation equivalents, e.g. *candle* [kændl], Sp. *vela*$_{\text{fem}}$ and *candy* [kændi], Sp. *caramelo*$_{\text{masc}}$. These experimental pairs were further matched with non-phonological cohort distractors. These distractors controls also differed in gender from their matched experimental target item, e.g. *candy* [kændi], Sp. *caramelo*$_{\text{masc}}$ and *boot* [but], Sp. *bota*$_{\text{fem}}$. This resulted in 60 experimental quartets. In addition, we had 60 additional filler pairs that were not phonological competitors but matched in gender in their Spanish translation equivalents, e.g. *coffee* [kafi], Sp. *café*$_{\text{masc}}$ and *glass* [glæs], Sp. *vaso*$_{\text{masc}}$. We present the experimental design in Table 3.4.

As in the Spanish experiment, items were embedded in one of two variants of the Spanish carrier phrase *Encuentra el/la* _____ "Find the$_{\text{masc/fem}}$." However, here we introduce a second experimental manipulation. Unlike the Spanish experiment, we manipulated the gender of the Spanish definite article before target English nouns in experimental conditions. For example, an English noun with a feminine Spanish translation equivalent would appear with both *el* and *la*, e.g. *Encuentra el* **candle** and *Encuentra la* **candle**, "Find the candle." This resulted in four variations for each experimental pair. Additionally, each experimental item appeared in a

separate variation with its matched non-phonological distractor. This combination resulted in a total of six variations per experimental quartet. Subsequently, we had six separate experimental lists to counterbalance all experimental combinations (i.e. 4 experimental pairings with gender article manipulation + 2 control distractor variations). As in the Spanish experiment we also counterbalanced the target position on the computer screen resulting in an additional 6 experimental lists for a total of 12 experimental lists. Each experimental list also included 60 filler trials. Filler trials always had the same target-distractor pairing. Additionally, these filler trials were also counterbalanced for position. In total, there were a total of 120 total trials within an experimental session (see Tables A.2 and A.3, Appendix A).

The process for stimuli creation for the lexical-level codeswitching experiment was similar to that of the Spanish experiment. However, here we asked a Puerto Rican female speaker to record the materials for the codeswitching experiment. The speaker was raised as a Spanish-English bilingual and has grown up habitually codeswitching throughout her daily life. Following the procedure described in the Spanish experiment, we asked the speaker to record up to 5 tokens of each variant Spanish carrier phrase spoken in a natural declarative intonation. We subsequently chose the best token from each pair and manipulated the article duration to 150 msec[5]. Next, the speaker recorded 5 tokens per target noun. One token was selected for each target item from the master file and was inserted into the appropriate Spanish carrier phrase. A 50 msec pause was inserted after the article as in the Spanish experiment.

We followed the same protocol to create an image database for the experiment. That is, we selected full color images from Google Images. We selected .jpg files that were at least 30 KB and were square in size to the best of our ability. Any additional modifications were carried out in Microsoft Paint.

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[5]As in the Spanish experiment, we measured the duration of each article and took a mean value of article duration. Values were close to 150 msec in contrast to our Spanish speaker.

Table 3.4: Experimental manipulation in Lexical-level Codeswitching experiment

Carrier phrase: *Encuentra el/la* _____, "Find the$_{masc/fem}$ _____ "			
Non-experimental Trials			
Condition	**Article**	**Target**	**Distractor**
Feminine Control	la	candy (fem)	balloon (masc)
Feminine Filler	la	table (fem)	letter (fem)
Masculine Control	el	candle (masc)	boot (fem)
Masculine Filler	el	coffee (masc)	glass (masc)
Experimental Trials			
Condition	**Article**	**Target**	**Distractor**
Feminine Match	la	candle (fem)	candy (masc)
Feminine Mismtach	la	candy (masc)	candly (fem)
Masculine Match	el	candy (masc)	candle (fem)
Masculine Mismatch	el	candle (fem)	candy (masc)

3.3.3 Visual World Experiment: Sentence-level Codeswitching

The same materials and design used in the lexical-level experiment were used in the sentence-level codeswitching experiment. Nevertheless, we introduce two key differences. First, items are embedded sentence-medially in variant sentential frames. That is, each trial is a different and content-rich sentence. Our goal was to encourage semantic integration of a codeswitched sentence while investigating the effect of grammatical gender in real-time processing. To that effect, we added a plausibility judgment task at the end of each trial where participants were asked to decide whether the sentence that they just heard was 'logical' or 'illogical' (explained further in Procedure). All sentences that included our experimental words were embedded in plausible sentences (i.e. 60 trials). All of our filler items were embedded in implausible sentence (i.e. 60 trials). The second manipulation that we introduced was the language of the start of each trial. On half of all trials, the sentences began in English. For the other half, sentences began in Spanish. Crucially, we always introduced a codeswitch prior to the target codeswitch. We illustrate both manipulations in Examples (28) and (29). For ease of exposition, our examples are separated by language manipulaton. We further embed an ex-

ample of the plausibility manipulation within each example. As in the lexical-level codeswitching experiment, counterbalancing of conditions and positioning resulted in 12 separate experimental lists. We list all sentential frames with their experimental quartets for the plausible sentence frames and their filler doublets for the implausible sentence frames in Section A.4 in Appendix A.

(28) Codeswitches beginning with English

    a. Plausible sentence trial

The man **dijo que** [**el** garlic] was in the kitchen
The man said that the$_{masc}$ garlic was in the kitchen

"The man said that the garlic was in the kitchen."

    b. Implausible sentence trial

The woman **vio a** **su** **hijo** throwing [**el** lake] to his
The woman saw acc$_{human}$ poss son throwing the$_{masc}$ lake to his
amigo
friend

"The woman saw her son throwing the lake to his friend."

(29) Codeswitches beginning with Spanish

    a. Plausible sentence trial

La **mujer está** ordering [**la** cape] **de** **la** **revista**
The$_{fem}$ woman is ordering the$_{fem}$ cape from the$_{fem}$ magazine

" The woman is ordering the cape from the magazine."

    b. Implausible sentence trial

La **señora** faxed [**la** suitcase] **el** **fin de semana pasado**
The$_{fem}$ woman faxed the$_{fem}$ suitcase the$_{masc}$ end of week last$_{masc}$

"The woman faxed the suitcase last weekend."

We recruited the same speaker as in the lexical-level codeswitching experiment to record our experimental stimuli. The speaker was instructed to read the stimuli in a natural declarative intonation with broad focus so as not to draw attention to the target region of interest. We did, however, take extra caution to make certain that the determiner noun pairing at the target region of interest were not contracted together as is common in a phonological process of Spanish known as *sinalefa* (Barrutia & Schwegler, 1994, pp. 91–93). Because the sentence frame varied for

each each experimental quartet and filler doublet, we conducted the recording all in one stage. Thus, our speaker directly embedded the target nouns into each sentence frame and recorded 5 tokens of each unique sentence frame. We created a master sound file by selecting one token from each set. Because of the large number of unique sentence frames, we automated the article manipulation process that we describe in previous sections. First, we manually marked in a separate text grid file the article onset and the noun onset of each target region (e.g. **el** *garlic*). A Praat script was created that would automatically adjust the time difference between article onset and noun onset to 150 msec $\pm$ 3 msec. In contrast to the previous experiments, we did not insert an additional pause between the article and target noun. Because each item was uniquely embedded in its own sentence frame, we wanted to preserve the coarticulatory information already present in the article with its accompanying noun. We used the exact same pictures as those compiled for the lexical-level codeswitching experiment.

3.4   Procedure

Participants arrived at an isolated room on the fifth floor of the Morris Raphael Cohen Library (NAC) at CCNY. Participants were asked to sit and were given a consent form to read and sign. After signing the consent form, participants were informed that they would be participating in three eye-tracking experiments starting with a Spanish experiment followed by two codeswitching experiments with two intervening behavioral experiments conducted between the two codeswitching experiments. Participants were informed that they would be provided breaks in between experimental blocks and that they were free to inform the experimenter if they needed an additional break at any point. Lastly, they were informed that they would be compensated for their time at a rate of $15 per hour, with experimental sessions typically lasting 1.5 hours.

After providing their consent, participants were seated comfortable in a stable chair behind a chin rest set in front of the eyetracker and computer monitor. For the eye-tracking experiments, we used an Eyelink 1000 eyetracker (SR Research, `www.sr-research.com`) which recorded participants' eye movements from the right eye at 1000 Hz (i.e. one data point per millisecond). Experimental items were

presented on a 17-inch ViewSonic 17PS monitor, which was set approximately 65 cm from the chin rest. Participants were asked to set their chins comfortably on the chin rest. We adjusted the height of the chin rest to each person in order to make certain that he/she was comfortably seated at an adequate height for the eyetracker to be able to record eye movements. At the start of each eye-tracking experiment, we calibrated the eyetracker to each participant. This process involved manually adjusting the position of the camera (but not adjusting the position of the base of the eyetracker) so that it was centered on the right eye of the participant. Next, we adjusted the focus of the camera lens to bring the participant's pupil into focus. Focusing happened at in two stages. First, we focused the camera lens on the global view setting. Then, we switched the view to a local view which allowed for a finer-grained focusing of the camera lens.

The eyetracker determines eye position and whether the eye is in saccadic movement or is blinking by way of an internal algorithm that detects an individual's corneal reflection. In order to increase accuracy, each participant's pupil detection threshold was adjusted. This step is necessary because if the threshold is too high or too low, the eyetracker fails to detect corneal reflection. Once the eyetracker can adequately detect the participant's corneal reflection, we conducted a 9-point calibration, which further reduces error. At the beginning of calibration, a small black dot with a white center appears in the middle of the computer screen. Participants were informed that this dot would "randomly" move to a new position on the computer screen and that they were to focus on the center of the dot once it had stopped. They were asked not to anticipate where the dot would next appear. If calibration was successful, it was followed by a verification stage. We only proceeded if total error was below 0.5°.

Once calibration was completed, participants were given instructions on the experimental task. They were informed that they would see two pictures appear side by side in the center of the computer screen (see Fig. 3.3). While listening to auditory stimuli through headphones, they would hear one of the two pictures named. They were instructed to click on the named picture using a computer mouse. When they were ready, they placed Sony over-the-ear binaural headphones and began the experiment. For the Spanish experiment, they were informed that the speaker was a person from Spain and that all sentences would be presented in

Spanish. The Spanish experiment, consisting of 56 trials and lasted approximately 8 minutes.

After the first block was completed, we informed the participant that the next experiment was similar in task except that they would now hear English words mixed in with Spanish. Furthermore, we informed the participants that the speaker would be different from the previous speaker and was from Puerto Rico. Once ready to begin, we repeated the procedure to focus the camera lens and to calibrate the eyetracker. After the initial focusing and calibration step, very minor modifications were needed to recalibrate the eytracker. Once calibration was achieved with a less than $0.5°$ error, we reminded participants of the instructions after which the next experimental block would begin. The lexical level codeswitching experiment had 120 trials and lasted approximately 12 minutes.

After the second block, participants were encouraged to take a short break. Thereafter, we had participants complete two behavioral tasks that measured cognitive control in order to intervene with a completely different set of tasks between the two codeswitching experiments. Both tasks were completed at a behavioral computer that was set up on the side of the room. The first task was a variant of a task switching paradigm and lasted about 10 minutes. The second task was a stop task that measured participants' ability to inhibit their responses. This task also lasted approximately 10 minutes. Both behavioral tasks consisted non-linguistic stimuli. The results of these separate experimental tasks will not be reported here.

After completion of the behavioral tasks, participants returned to the eyetracker for the sentence-level codeswitching experiment. Following the same procedure as described above, the eyetracker was calibrated to each participant's right eye. After calibration, participants were informed that the instructions were the same as in the previous two eyetracking experiment except that they would now hear full sentences that contained both English and Spanish words. As the sentences differed, we explicitly asked the participants to pay particular attention to the meaning of each sentence and that after clicking on the target object named in each trial, they would see the words 'logical' and 'illogical' appear in the same position as where the pictures appeared. Participants were instructed to make a subsequent plausibility judgment on the meaning of the sentence that they just heard. We explicitly told each participant that the answer was solely dependent on

the meaning of the sentence and not on the 'grammar' or the nature of switching. Furthermore, participants were told that they would be offered a chance to take a break halfway through the experimental block. The experiment had 120 trials and lasted approximately 17 minutes (not including the break halfway through the block). At the end of the experimental session, participants were compensated for their time and completed a receipt acknowledging payment.

Chapter 4

Results

4.1 Introduction

We present the results and analyses for the three eye-tracking experiments in this chapter. We organize the chapter in the following manner. We begin with a description of the statistical analyses and data visualization that we adopt throughout the chapter. Then, we present each experiment in the order of presentation of the experimental session: the Spanish unilingual block, the lexical-level codeswitching block, and the sentence-level codeswitching block. Within each section, we summarize the basic structure of the experiment, then follow with the general predictions. We follow by reporting the results within each group. We point out two variations from this outline. First, for the Spanish experiment, we include a Spanish monolingual control group ($N = 24$). Second, in the final experiment, the sentence-level codeswitching experiment, we further subdivide analyses per group into English-first codeswitches and Spanish-first codeswitches. Finally, we conclude with a descriptive summary of our results.

4.2 Analysis

There is currently no consensus on how best to analyze eye-tracking data collected from visual world studies. Part of the issue is that generally the dependent measure in visual world studies is total proportion of fixations (although see e.g. Altmann,

2011b, for analyses done with saccadic measures). As a consequence, the dependent measure is bounded between 0 and 1 unlike other dependent measures typically used in behavioral studies. Additionally, because proportional data is plotted over time, the independent measure, i.e. time, is continuous. Altmann (2011c) succinctly describes the fundamental issues surrounding analysis.

> An entirely different class of statistical modeling needs to be carried out for analysing *time-course* data...how can one determine that any pair of curves are different from one another? How can one determine where the *peak* is located for any such curve (given that aggregating data for the purposes of such [time-course] plots hides the true underlying distribution of the data across subjects and trials)? And most importantly, perhaps, how can one model the dynamic changes to fixation proportions across time when successive time points are not independent of one another? (Altmann, 2011c, p. 996)

Moreover, these issues are all tempered by the decisions that researchers must make on the mode of presentation of the visual scene, which further impacts how the data are analyzed. In our experiments, we have elected to allow participants free view of the visual scene prior to the target region of interest. This protocol is in contrast to other researchers who require participants to remain fixated on a fixation point or cross until the onset of the target region of interest, i.e. fixed visual presentation.

Both methods have their advantages and disadvantages. Allowing free view of the visual scene represents a more ecological task reflective of what participants would presumably do under non-experimental settings. Therefore, free view presentation offers an ecological advantage over fixed visual presentation. Alternatively, free view presentation aggravates one potentially problematic issue in data analysis that is attenuated in fixed visual presentations. Specifically, because participants are idiosyncratic in the manner in which they view a visual scene prior to hearing a named object, free view presentation greatly increases the likelihood for baseline effects. Briefly, baseline effects are represented on a timecourse plot by the y-intercept (or value of y at $x = 0$). The greater the magnitude of difference between the y-intercept of the target and any distractors, the greater the baseline

effect, which subsequently represents a random effect in eye-tracking data. Because participants do not begin looking at the visual scene until the onset of the target region of interest in fixed visual presentations, baseline effects are nullified. In other words, all proportional data begins at 0 at the onset of the target region of interest. Fixed visual presentations are more tenable in action-based tasks where participants are instructed in the auditory stimuli to manipulate a target item either by moving it to a new location (e.g. Tanenhaus et al., 1995) or by clicking on it with a computer mouse (e.g. Allopenna et al., 1998). Although our first two experiments are action-based tasks, our third experiment involves target recognition in content-full sentences; therefore, a fixed visual presentation would artificially alert participants to target recognition. Consequently, we do not view a fixed view presentation as appropriate for our experiments; thus, we adopted a free view presentation for all three experiments.

Researchers have implemented various strategies as a compromise to take into consideration the issue of baseline effects (see in particular special issue 59 of the *Journal of Memory and Language*, especially Barr, 2008; Mirman et al., 2008) . One such strategy involves a target-contingent based analysis (Tanenhaus, 2007). Here, researchers simply remove any trials in which participants where already fixated on the target item at the onset of the critical region. As in the fixed visual presentation, this technique of data trimming reduces proportional data to 0 albeit by brute force. This technique can result in a high amount of data loss which can be more manageable with a typical 4-picture display. Given that our dissertation experiments employ a 2-picture display, we do not think this method of data trimming is suitable for our data. One other novel approach involves growth curve analysis (Mirman et al., 2008) which fits non-linear (i.e. polynomial) models to timecourse data. Two major advantages of this approach is that the derived models functionally describe change over time while preserving the original data points, i.e. there is no need to aggregate the data over time bins or over trials and participants. Second, because growth curve analyses are essentially a regression technique, models can be hierarchical and subsequently can account for random effects such as the baseline effects described above (Mirman et al., 2008; Baayen, Davidson, & Bates, 2008). However, it remains unclear how interpretable higher order polynomials coefficients derived from the models are.

Finally, in an attempt to simplify analyses, many researchers simply follow the more traditional analyses used in other behavioral tasks, namely t-tests and ANOVAs. Under this strategy, proportional data is aggregated over time regions and subsequent analyses are carried out within each region. Because researchers are interested in the approximate region in time when looks to target items diverge from distractor items, they look for the initial time region when the proportion of fixations to target items is significantly higher than fixations to distractors. Because we have a simple 2-picture display, we analyzed our data following this last strategy. We acknowledge that this method may not address baseline effects. In order to investigate any possible baseline effects, our analyses begin at article onset. That is, we conduct paired-t statistical tests for each condition on target and distractor proportions in sequential 100 msec regions from 0 msec to 800 msec for the Spanish experiment, and from 0 msec to 1000 msec for the codeswitching experiment. Planned eye movements generally take about 150 to 200 msec; therefore, the earliest moment in which our target stimuli could affect real-time processing would be roughly 150 to 200 msec after target onset. Coincidentally, the article duration in each experiment falls at the ends of this range (200 msec for Spanish unilingual block, 150 msec for lexical-level and sentence-level codeswitching blocks). By examining the timecourse from article onset, we will be able to observe if any strong baseline effects are present.

Recall that researchers also confront a critical decision in how to plot this proportional data. As discussed in Section 1.3 of Chapter 1, one option is to plot the timecourse of averaged fixations to the target item and to any distractors that were co-present in the visual scene (e.g. Allopenna et al., 1998). On the other hand, the timecourse of averaged fixations to target items in different conditions can be plotted together in the same panel (e.g. Lew-Williams & Fernald, 2007). Here, we have elected to plot our data following the first option. That is, we present a plot for each separate condition. Accordingly, our plots include the following information. On the y-axis, we plot total proportion of fixations, bounded between 0 and 1. The x-axis represents the timescale presented in milliseconds. Time at $x = 0$ represents article onset of the target region of interest. In the main portion of the plot, three separate timecourse curves represent fixations to separate regions of the visual scene. Lines in red indicate the timecourse of total fixations to the

target item. Green lines reflect the timecourse of total fixations to distractor items. Finally, we plot in blue, the total fixations that occurred outside of both target and distractor regions, i.e. outside looks.

4.3 Spanish Unilingual Block

The Spanish unilingual block consists of 56 trials with 14 trials in four unique conditions. Specifically, target items were either masculine or feminine and were paired with a same gender distractor or a different gender distractor. To that effect, we label our four conditions as feminine same gender trials, feminine different gender trials, masculine same gender trials, and masculine different gender trials.

4.3.1 Predictions

Replicating the results in Lew-Williams and Fernald (2007), we predict that Spanish monolinguals will be faster to orient towards target items in different gender trials v. same gender trials. Furthermore, there should be no modulation by gender. That is, monolinguals should equally show anticipatory effects for both masculine different gender and feminine different gender trials. If the bilingual groups process gender to the same extent as the Spanish monolinguals, then should also show anticipatory effects to different gender trials for both masculine and feminine. However, if they process gender differently or do not utilize gender information in real-time processing, then the bilingual groups may not show anticipatory effects in the Spanish unilingual block. Because the U.S. born group is English dominant, we predict that of our two bilingual groups they are most likely to not show anticipatory effects.

4.3.2 Spanish Monolinguals

We report the results for 24 Spanish monolinguals. We conducted paired-t statistical tests on the difference between mean proportions of fixations to target items minus mean proportions of fixations to distractor items binned in 100 msec time regions. Separate paired t-tests were conducted in sequential 100 msec time windows from article onset to 800 msec. Article duration was 200 msec for all conditions.

We report time window analyses for 8 regions: Region 0 (0 – 100 msec), Region 100 (101 – 200 msec), Region 200 (201 – 300 msec), Region 300 (301 – 400 msec), Region 400 (401 – 500 msec), Region 500 (501 – 600 msec), Region 600 (601–700 msec), and Region 700 (701 – 800 msec).

For the feminine same gender trials, the first four regions showed no significant differences between target and distractor items (Region 0, $t(23) = 0.621$, $p = 0.541$; Region 100, $t(23) = -0.043$, $p = 0.966$; Region 200, $t(23) = -0.722$, $p = 0.478$; Region 300, $t(23) = -0.166$, $0 = 0.87$; Region 400, $t(23) = 0.668$, $p = 0.511$). At Region 500, Spanish monolinguals showed increased looks to target items, mean difference $= 0.245$ ($t(23) = 3.918$, $p < 0.001$). Regions 600 and 700 significantly sustained increasing looks to target items (Region 600 mean difference $= 0.534$, $t(23) = 10.322$, $p < 0.001$; Region 700 mean difference $= 0.737$, $t(23) = 17.766$, $p < 0.001$). For the feminine different gender trials, at Region 0, total proportion of looks to distractor items was significantly higher than to target items, mean difference $= -0.152$ ($t(23) = -2.553$, $p = 0.018$). In Regions 100 and 200, there was no significant difference between looks to target and distractor items (Region 100, $t(23) = -1.558$, $p = 0.133$; Region 200, $t(23) = -0.208$, $p = 0.837$). The initial time region where looks to target items were significantly higher than distractor items occurred in Region 300, mean difference $= 0.134$ ($t(23) = 2.56$, $p = 0.018$). Subsequent regions from Region 400 to Region 700 showed significantly increased looks to target items (Region 400 mean difference $= 0.296$, $t(23) = 5.694, p < 0.001$; Region 500 mean difference $= 0.438$, $t(23) = 8.512$, $p < 0.001$; Region 600 mean difference $= 0.606$, $t(23) = 12.912$, $p < 0.001$; Region 700 mean difference $= 0.736$, $t(23) = 15.93$, $p < 0.001$). The increased looks to distractor items in Region 0 strongly suggest the presence of baseline effects that were quickly resolved once the target stimuli began to affect real-time processing. Because divergence (i.e. initial region where looks to target items were significantly higher than to distractor items) occurred earlier in the different gender trials (Region 300), than the same gender trials (Region 500), the Spanish monolinguals exhibit a strong anticipatory effect for feminine gender in Spanish unilingual processing (see Figure 4.1).

In the masculine same gender trials, Regions 0 through 400 show no differences

between target items and distractor items[1] (Region 0, $t(23) = 1.087$, $p = 0.288$; Region 100, $t(23) = 1.537$, $p = 0.138$; Region 200, $t(23) = 1.436$, $p = 0.164$; Region 300, $t(23) = 1.409$, $p = 0.172$; Region 400, $t(23) = 1.494$, $p = 0.149$). Subsequently, Region 500 was the first region in which participants showed significantly higher proportion of fixations to target items over distractor items, mean difference $= 0.281$ ($t(23) = 4.875$, $p < 0.001$). The remaining regions continued to show statistically higher fixations to target items (Region 600 mean difference $= 0.593$, $t(23) = 11.679$, $p < 0.001$; Region 700 mean difference $= 0.719$, $t(23) = 15.419$, $p < 0.001$). For masculine different gender trials, Spanish monolinguals did not exhibit any differences between target items and distractor items from Region 0 to Region 200 (Region 0, $t(23) = -0.646$, $p = 0.525$; Region 100, $t(23) = -0.936$, $p = 0.359$; Region 200, $t(23) = 0.532$, $p = 0.6$). Region 300 was the initial region in which Spanish monolinguals showed significantly higher looks to target items than to distractor items, mean difference $= 0.174$ ($t(23) = 3.088$, $p = 0.005$). All subsequent regions sustained statistically higher fixations to target items (Region 400 mean difference $= 0.353$, $t(23) = 5.729$, $p < 0.001$; Region 500 mean difference $= 0.448$, $t(23) = 8.762$, $p < 0.001$; Region 600 mean difference $= 0.639$, $t(23) = 13.541$, $p < 0.001$; Region 700 mean difference $= 0.8$, $t(23) = 18.562$, $p < 0.001$). Similar to feminine gender trials, total proportion of fixations towards target items for Spanish monolinguals diverged earlier in different gender trials (Region 300) than for same gender gender trials (Region 500). Here, Spanish monolinguals also show a strong anticipatory effect driven by gender processing (see Figure 4.2).

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[1]P-values for Regions 100, 300, and 400 were $0.1 < p < 0.15$ almost approaching marginal significance. Because this effect was sustained over several regions, we feel that our results reflect sustained consideration of both target and distractor items.
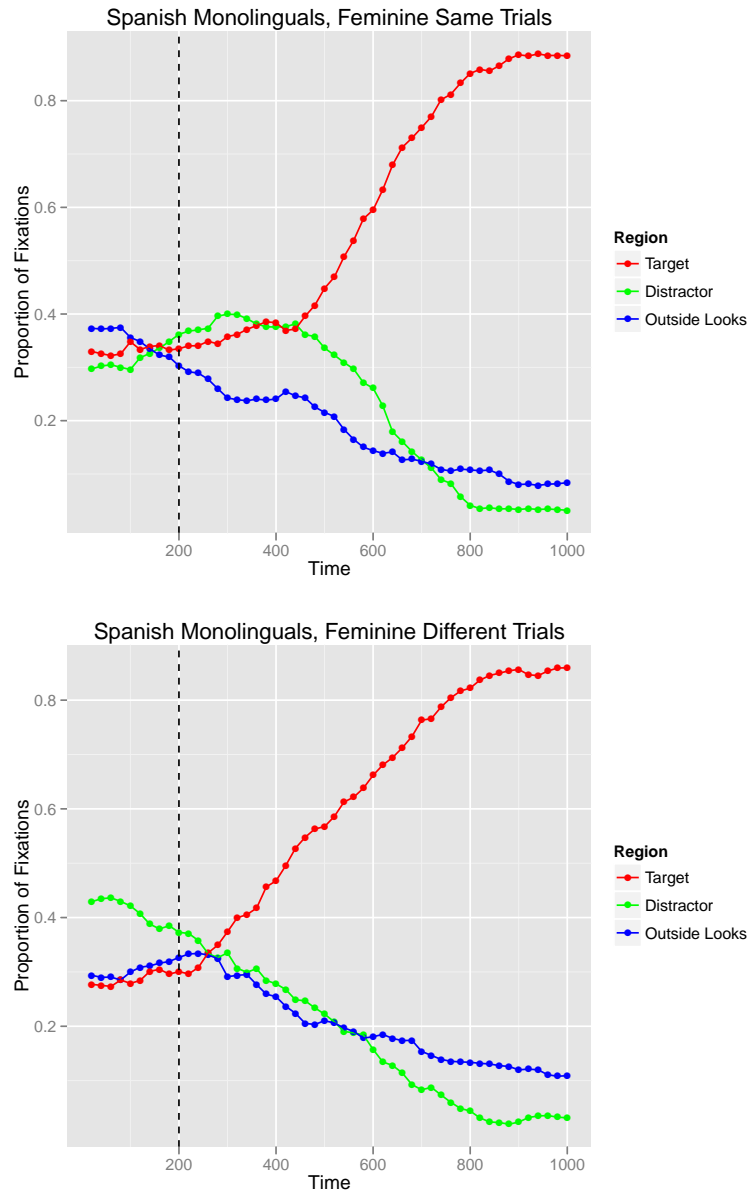
Figure 4.1: Timecourse plots for Spanish monolinguals in feminine target trials

Time is plotted on the x-axis in milliseconds from article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to distractor items. Blue curves are looks that fell outside of target or distractor regions. We plot the feminine same gender trials in the top panel and feminine different gender trials in the bottom panel.
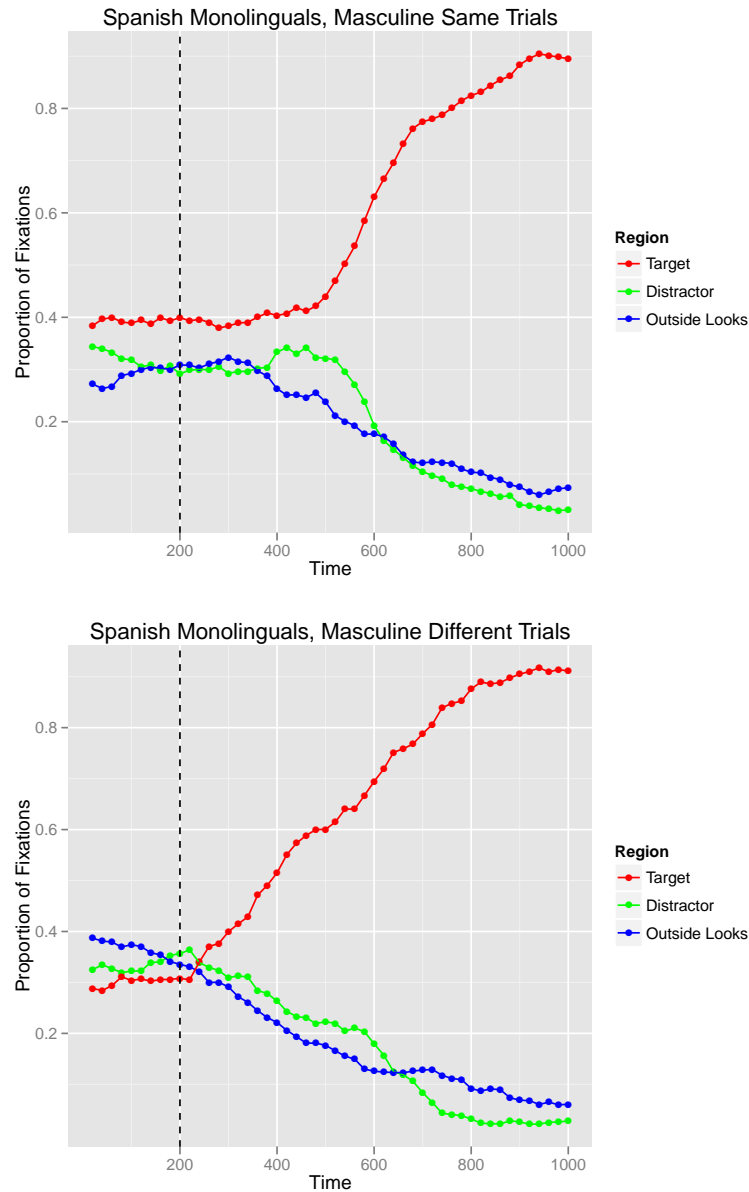
Figure 4.2: Timecourse plots for Spanish monolinguals in masculine target trials

Time is plotted on the x-axis in milliseconds from article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to distractor items. Blue curves are looks that fell outside of target or distractor regions. We plot the masculine same gender trials in the top panel and masculine different gender trials in the bottom panel.

4.3.3   U. S. Born Bilinguals

We report the results for the U.S. born Spanish-English bilinguals ($N = 21$) in the Spanish unilingual block. We follow the same analysis as reported for the Spanish monolinguals.

For feminine same gender trials, the total proportion of fixations to targets and distractors did not differ from each other from Region 0 to Region 500 (Region 0, $t(20) = -0.613$, $p = 0.547$; Region 100, $t(20) = -0.198$, $p = 0.845$; Region 200, $t(20) = 0.406$, $p = 0.689$; Region 300, $t(20) = 0.832$, $p = 0.416$; Region 400, $t(20) = 1.465$, $p = 0.159$). Region 500 was the initial region in which U.S. born bilinguals show significantly higher looks towards target item, mean difference $= 0.158$ ($t(20) = 3.188$, $p = 0.005$). The following regions exhibited sustained higher fixations towards target items (Region 600 mean difference $= 0.294$, $t(20) = 6.642$, $p < 0.001$; Region 700 mean difference $= 0.497$, $t(20) = 9.647$, $p < 0.001$). In the feminine different gender trials, fixations towards target items did not differ from fixations towards distractor items through Region 400 (Region 0, $t(20) = -1.32$, $p = 0.202$; Region 100, $t(20) = -1.62$, $p = 0.121$; Region 200, $t(20) = -1.097$, $p = 0.286$; Region 300, $t(20) = 0.524$, $p = 0.606$; Region 400, $t(20) = 1.252$, $p = 0.225$). The U.S. born bilinguals initially show increased looks towards target items in Region 500, mean difference $= 0.146$ ($t(20) = 2.8$, $p = 0.011$). Subsequent regions continued to exhibit a higher proportion of fixations to target items (Region 600 mean difference $= 0.342$, $t(20) = 6.45$, $p < 0.001$; Region 700 mean difference $= 0.542$, $t(20) = 11.339$, $p < 0.001$). Because divergent looks towards target items happened in the same time region (Region 500), we have no evidence for an anticipatory effect[2] in feminine trials (see Figure 4.3).

In the masculine same gender trials, the U.S. born bilinguals did not show differences between looks to target and distractor items from Region 0 to Region 400 (Region 0, $t(20) = -0.184$, $p = 0.856$; Region 100, $t(20) = -0.769$, $p = 0.451$; Region 200, $t(20) = -1.164$, $p = 0.258$; Region 300, $t(20) = -1.046$, $p = 0.308$; region 400, $t(20) = 0.127$, $p = 0.9$). At Region 500, initial divergent looks towards target items are significantly different from looks to distractor items, mean difference $= 0.163$ ($t(20) = 2.856$, $p = 0.01$). The following regions continued to

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[2]We note that the p-value in Region 0 was $0.1 < p < 0.15$ suggesting that our results may be modulated by an initial baseline effect. Our analysis do not let us investigate this issue further.

exhibit increased looks towards target items (Region 600 mean difference = 0.395, $t(20) = 6.681$, $p < 0.001$; Region 700 mean difference = 0.585, $t(20) = 11.731$, $p < 0.001$). For masculine different gender trials, looks the total proportion of fixations to target and distractor items did not differ from each other through Region 400 (Region 0, $t(20) = 1.219$, $p = 0.237$; Region 100, $(20) = -0.142$, $p = 0.888$; Region 200, $t(20) = -0.101$, $p = 0.921$; Region 300, $t(20) = -0.555$, $p = 0.585$; Region 400, $t(20) = -0.284$, $p = 0.779$). Region 500 was the first region in which looks towards target items were significantly higher, mean difference = 0.155 ($t(20) = 3.104$, $p = 0.006$). Subsequent regions further showed significantly higher looks towards taret items (Region 600 mean difference = 0.409, $t(20) = 7.894$, $p < 0.001$; Region 700 mean difference = 0.565, $t(20) = 11.387$, $p < 0.001$). The U.S. born bilinguals begin to have divergent looks towards target items in the same time region (Region 500) for both masculine same and different gender trials. In contrast to the Spanish monolinguals, we do not have evidence for an anticipatory effect driven by gender processing (see Figure 4.4).

4.3.4   Latin Born Bilinguals

We report the results for the Latin born Spanish-English bilinguals ($N = 25$) in the Spanish unilingual block. We follow the same analysis as reported for the Spanish monolinguals.

For the feminine same gender trials, the Latin born bilinguals did not exhibit significant differences between the proportion of fixations towards target and distractor items from Region 0 through Region 400 (Region 0, $t(24) = 0.228$, $p = 0.821$; Region 100, $t(24) = -0.36$, $p = 0.722$; Region 200, $t(24) = -0.567$, $p = 0.576$; Region 300, $t(24) = 0.179$, $p = 0.86$; Region 400, $t(24) = 0.629$, $p = 0.535$). Participants begin to show significantly higher looks towards target items in Region 500, mean difference = 0.196 ($t(24) = 4.071$, $p < 0.001$). Subsequent regions continued to exhibit significantly higher looks towards target items (Region 600 mean difference = 0.432, $t(24) = 7.936$, $p < 0.001$; Region 700 mean difference = 0.697, $t(24) = 15.205$, $p < 0.001$). In the feminine different gender trials, Latin born bilinguals did not show significant differences between looks towards target items and distractor items through the first three regions (Region

0, $t(24) = -0.507$, $p = 0.617$; Region 100, $t(24) = 0.35$, $p = 0.729$; Region 200, $t(24) = 1.404$, $p = 0.173$). In Region 300, participants first begin to show marginal differences between looks towards target and distractor items, mean difference = 0.102 ($t(24) = 1.934$, $p = 0.065$). Subsequent regions sustained increased looks towards target items (Region 400 mean difference = 0.163, $t(24) = 3.448$, $p = 0.002$; Region 500 mean difference = 0.261, $t(24) = 5.733$, $p < 0.001$; Region 600 mean difference = 0.447, $t(24) = 8.29$, $p < 0.001$; Region 700 mean difference = 0.602, $(24) = 11.641$, $p < 0.001$). Because the Latin born bilinguals begin to show divergent looks towards the target items earlier in different gender trials (Region 300) than in same gender trials (Region 500), we have evidence for a strong anticipatory effect in feminine gender trials (see Figure 4.3).

In the masculine same gender trials, the first two regions show marginally significant looks towards target items, indicating the presence of baseline effects (Region 0 mean difference = 0.118, $t(24) = 1.87$, $p = 0.074$; Region 100 mean difference = 0.096, $t(24) = 1.725$, $p = 0.097$). However, Regions 200 through 400 show no differences between looks towards target items and distractor items (Region 200, $t(24) = 1.148$, $p = 0.262$; Region 300, $t(24) = 0.267$, $p = 0.792$; Region 400, $t(24) = 0.648$, $p = 0.524$). Subsequently, Region 500 was the first region after article offset that shows divergent looks towards target items, mean difference = 0.151 ($t(24) = 2.667$, $p = 0.013$). The following regions continue to show statistically higher proportion of fixations towards target items (Region 600 mean difference = 0.339, $t(24) = 5.801$, $p < 0.001$; Region 700 mean difference = 0.554, $t(24) = 7.447$, $p < 0.001$). For masculine different gender trials, the Latin born bilinguals did not exhibit significantly different looks between target items and distractor items from Region 0 through Region 400 (Region 0, $t(24) = -0.535$, $p = 0.598$; Region 100, $t(24) = 0.64$, $p = 0.528$; Region 200, $t(24) = 1.595$, $p = 0.124$; Region 300, $t(24) = 1.021$, $p = 0.317$; Region 400, $t(24) = 1.571$, $p = 0.129$). The initial region where significantly higher looks were oriented towards target items occurred in Region 500, mean difference = 0.254 ($t(24) = 4.078$, $p < 0.001$). Subsequent regions continued to show increased looks towards target items (Region 600 mean difference = 0.466, $t(24) = 8.841$, $p < 0.001$; Region 700 mean difference = 0.626, $t(24) = 14.351$, $p < 0.001$). Unlike the feminine gender trials but similar to the U.S. born bilinguals, the Latin born

bilinguals exhibited divergent looks towards target items over distractor items in same time region (Region 500), indicating a lack of an anticipatory effect for masculine articles[3] (see Figure 4.4).

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[3]We leave open the possibility that with increased power we may have elicited an anticipatory effect in masculine trials given that in Regions 200 and 400 p-values were $0.1 < p < 0.15$; however, even under this possibility we note that the anticipatory effect is tenuous at best in contrast to Spanish monolinguals.
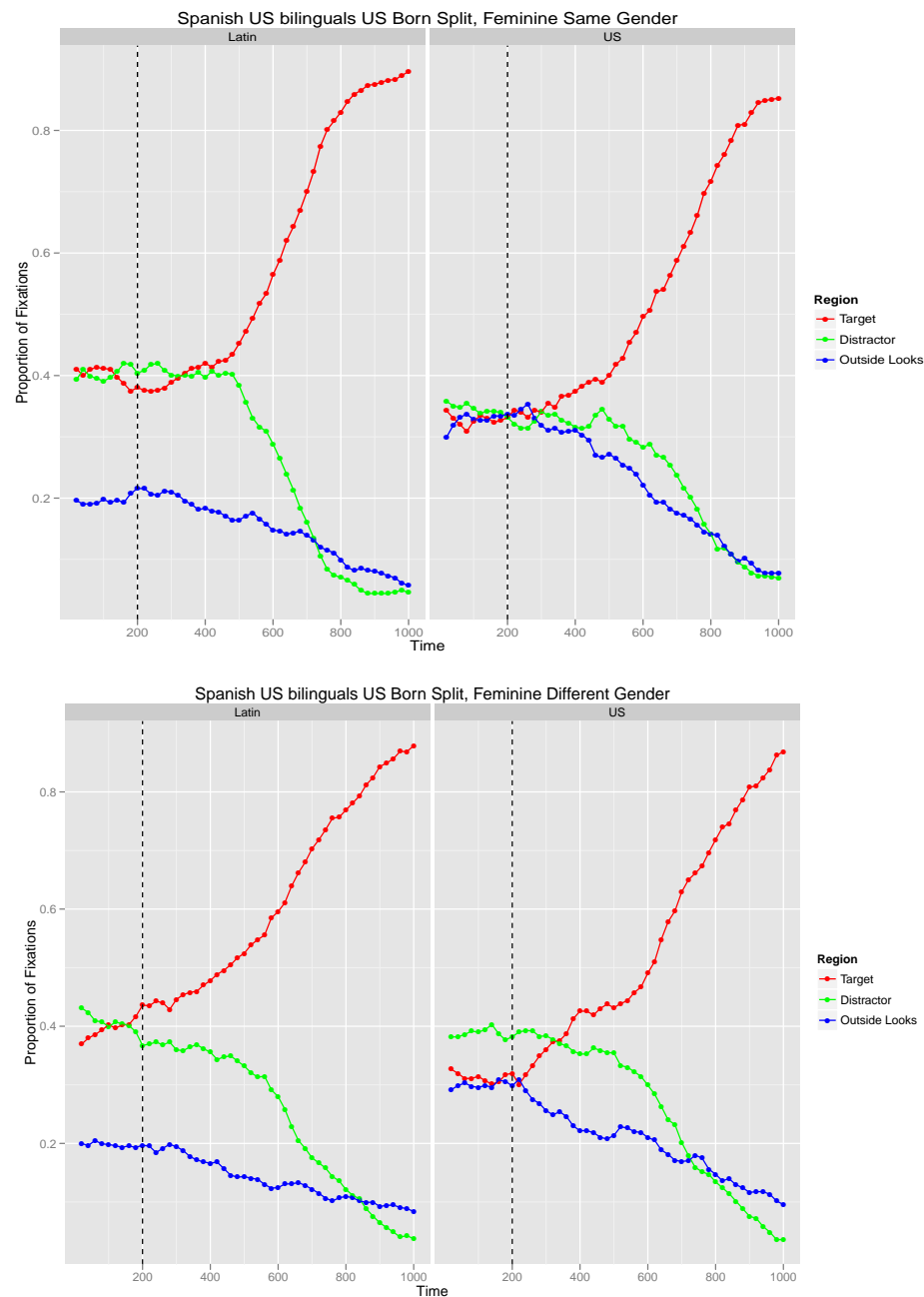
Figure 4.3: Timecourse plots for Spanish-English bilinguals in feminine target trials split by place of birth

Time is plotted on the x-axis in milliseconds from article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by group manipulation, i.e. Latin born (left side) v. U.S. born (right side). We plot the feminine same gender trials in the upper panel and feminine different gender trials in the bottom panel.
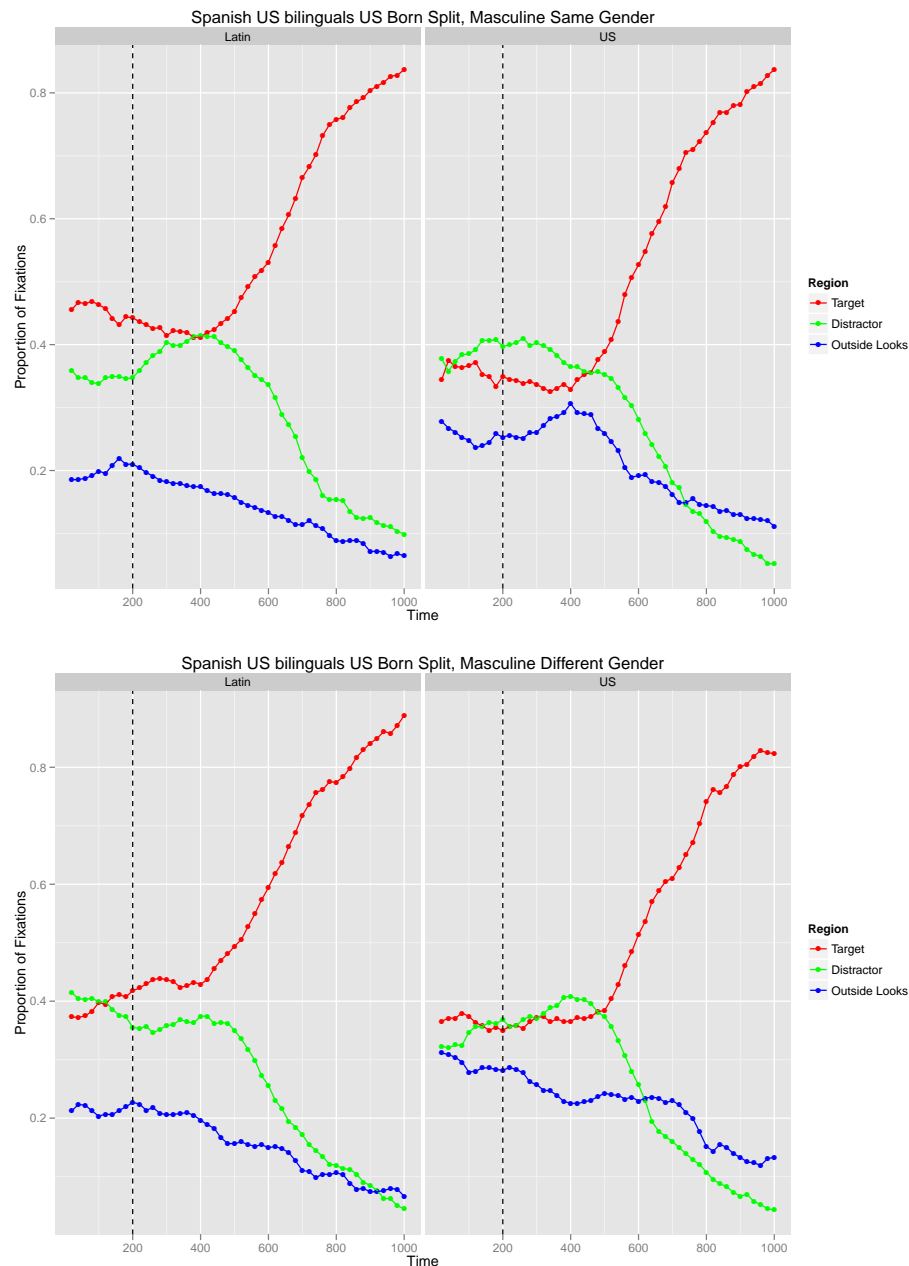
Figure 4.4: Timecourse plots for Spanish-English bilinguals in masculine target trials split by place of birth

Time is plotted on the x-axis in milliseconds from article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by group manipulation, i.e. Latin born (left side) v. U.S. born (right side). We plot the masculine same gender trials in the upper panel and masculine different gender trials in the bottom panel.

4.4 Lexical-level Codeswitching Block

The lexical-level codeswitching block consists of 120 trials across eight conditions. We focus on four experimental conditions consisting of 10 trials each. Our experimental conditions were composed of phonological cohorts with different gender Spanish translation equivalents, e.g. candy [kændi], Sp. caramelo$_{\text{masc}}$ and candle [kændl], Sp. vela$_{\text{fem}}$. We manipulated the gender of the preceding definite article such that each experimental item appeared with both articles and as a target and a distractor. This manipulation resulted in the following four conditions of interest: feminine match (e.g. **la** *candle*), feminine mismatch (e.g. **la** *candy*), masculine match (e.g. **el** *candy*), and masculine mismatch (e.g. **el** *candle*).

For each bilingual group, we plot the timecourse of proportion of fixations towards target items. We start at 300 msec *before* article onset, and extracted through 1200 msec after article onset (total of 1500 msec). We conducted paired t-tests comparing mean proportion of fixations to target items minus mean proportion of fixations to distractor items in 100 msec time bins. We begin at article onset and extend the analysis through 1000 msec resulting in the following time regions: Region 0 (0 – 100 msec), Region 100 (101 – 200 msec), Region 200 (201 – 300 msec), Region 300 (301 – 400 msec), Region 400 (401 – 500 msec), Region 500 (501 – 600 msec), Region 600 (601 – 700 msec), Region 700 (701 – 800 msec), Region 800 (801 – 900 msec), and Region 900 (901 – 1000 msec). We extended the analysis further than the Spanish unilingual block because of the introduction of phonological cohorts which typically elicit competitor effects (i.e. delayed processing).

4.4.1 Predictions

According to the PDC model (Gennari & MacDonald, 2009), if bilinguals process the materials in our experimental block as codeswitching and comprehension is reflective of distributional patterns found in production, then our bilinguals should exhibit a competitor effect for masculine conditions. That is, participants should consider both target and distractor items for a longer period in the timecourse for both masculine match and masculine mismatch conditions. In contrast, feminine conditions should show clear differences in the timecourse. Specifically, feminine

mismatch, which is unattested in Spanish-English codeswitching, should elicit initial looks to the distractor item (which does match in gender) with subsequent looks to the target item. This interaction would reflect costly integration of unattested switches in comprehension. On the other hand, the predictions for the feminine match condition are less clear. For one, feminine codeswitches are exceedingly rare in natural codeswitching (see Chapter 2). Thus, it is possible that bilinguals will not show anticipatory effects towards target items. Alternatively, bilinguals may show anticipatory effects if they are able to use the gender information encoded in the article, or if they treat the experimental block in a Spanish-like way. Nevertheless, we predict that the timecourse of proportion of fixations to feminine match targets should diverge earlier than to feminine mismatch targets. Because the U.S. born bilinguals did not show anticipatory effects in the Spanish unilingual block, we predict that they may show competitor effects for all four conditions. That is, if this group of bilinguals does not use grammatical gender in real-time processing, then we should solely see competitor effects driven by phonological competition.

4.4.2   U. S. Born Bilinguals

We begin with the results for the U.S. born bilinguals ($N = 21$) for the feminine match condition. At Region 0 no significant differences were found between mean proportion of fixations to target items or phonological distractors ($t(20) = -0.553$, $p = 0.586$). In Region 100 participants showed increased looks to the phonological distractor, mean difference = -0.037 ($t(20) = -2.183$, $p = 0.041$). Region 200 continued to show marginally higher looks towards the phonological distractor, mean difference = -0.113 ($t(20) = -1.723$, $p = 0.1$). In contrast, Regions 300 through 600 showed no significant differences between target items and phonological distractors (Region 300, $t(20) = -0.929$, $p = 0.364$; Region 400, $t(20) = -1.325$, $p = 0.2$; Region 500, $t(20) = -1.387$, $p = 0.181$; Region 600, $t(20) = -0.214$, $p = 0.833$). The U.S. born bilinguals first begin to show significantly higher fixations to target items in Region 700, mean difference = 0.184 ($t(20) = 2.506$, $p = 0.021$). Significantly higher looks to target items are sustained throughout the remaining two regions (Region 800 mean dif-

ference = 0.36, $t(20) = 5.186$, $p < 0.001$; Region 900 mean difference = 0.569, $t(20) = 10.807$, $p < 0.001$). For feminine mismatch conditions, the U.S. born bilinguals continue to show competing looks to both target and phonological distractor items from Region 0 through Region 700 (Region 0, $t(20) = 0.395$, $p = 0.697$; Region 100, $t(20) = -0.917$, $p = 0.37$; Region 200, $t(20) = -0.033$, $p = 0.974$; Region 300, $t(20) = 0.556$, $p = 0.584$; Region 400, $t(20) = 0.002$, $p = 0.998$; Region 500, $t(20) = -0.242$, $p = 0.811$; Region 600, $t(20) = 0.039$, $p = 0.97$; Region 700, $t(20) = 0.637$, $p = 0.531$). Participants begin to show marginally higher fixations towards target items in Region 800, mean difference = 0.114 ($t(20) = 1.747$, $p = 0.096$) and continue to show significantly higher looks in the last region, Region 900, mean difference = 0.398 ($t(20) = 6.829$, $p < 0.001$). In sum, we do not find evidence for an anticipatory effect in the feminine match condition as initial divergent looks towards target items occur fairly late in the timecourse (Region 700). This finding may have partially been affected by an initial baseline effects prevalent in Regions 100 and 200. In contrast and contrary to our predictions, U.S. born bilinguals do show increased processing costs to integration of feminine mismatch target items as they only begin to show divergent looks to target items in Region 800. This finding indicates that the U.S. born bilinguals are able to (weakly) use gender information in real-time processing of feminine codeswitches (see Figure 4.5).

For the masculine match condition, the U.S. born bilinguals do not exhibit significant differences between looks to target items and phonological distractors from Regions 0 to 300 (Region 0, $t(20) = 0.73$, $p = 0.474$; Region 100, $t(20) = 0.437$, $p = 0.667$; Region 200, $t(20) = 0.956$, $p = 0.351$; Region 300, $t(20) = 1.654$, $p = 0.114$). Participants initially show significantly higher looks to target items in Region 400, mean difference = 0.195 ($t(20) = 2.965$, $p = 0.008$). They continue to show increased looks to target items in all subsequent regions (Region 500 mean difference = 0.191, $t(20) = 3.204$, $p = 0.004$; Region 600 mean difference = 0.189, $t(20) = 3.438$, $p = 0.003$; Region 700 mean difference = 0.235, $t(20) = 3.971$, $p < 0.001$; Region 800 mean difference = 0.398, $t(20) = 6.829$, $p < 0.001$; Region 900 mean difference = 0.535, $t(20) = 9.932$, $p < 0.001$). In the masculine mismatch condition, no significant differences were found between looks to target items and looks to phonological distractions in Regions 0, 100, and 200 (Re-

gion 0, $t(20) = -0.2273$, $p = 0.823$; Region 100, $t(20) = 1.369$, $p = 0.186$; Region 200, $t(20) = 1.597$, $p = 0.126$). The U.S. born bilinguals begin to show marginally higher fixations towards target items in Region 300, mean difference $= 0.146$ ($t(20) = 1.687$, $p = 0.107$; however, this effect is ephemeral as the difference between the proportion of fixations to target and phonological distractor items is non-significant from Region 400 to Region 800 (Region 400, $t(20) = 0.872$, $p = 0.393$; Region 500, $t(20) = 0.47$, $p = 0.644$; Region 600, $t(20) = -0.262$, $p = 0.796$; Region 700, $t(20) = -0.555$, $p = 0.585$; Region 800, $t(20) = 1.246$, $p = 0.227$). Subsequently, participants only show significant looks to target items in the last region, Region 900, mean difference $= 0.411$ ($t(20) = 7.673$, $p < 0.001$). In contrast to our predictions, the U.S. born bilinguals show two important findings. First, despite not showing anticipatory effects in the Spanish unilingual block, participants exhibit a strong anticipatory effect in the masculine conditions as evidenced by early divergent looks to targets in the masculine match condition (Region 400) in contrast to the masculine mismatch condition (900). This anticipatory effect is stronger for masculine conditions (Region 400 v. Region 900) than for feminine conditions (Region 700v. Region 800). Consequently, the U.S. born bilinguals did not equally consider masculine match and mismatch targets as found in Spanish-English codeswitching and contrary to the PDC (see Figure 4.6).

4.4.3   Latin Born Bilinguals

We now report the results for the Latin born bilinguals ($N = 25$). We follow the same analysis as described in the previous section. In the feminine match condition, there are no significant differences between proportion of fixations to target and phonological distractor item from Region 0 to Region 200 (Region 0, $t(24) = -0.531$, $p = 0.6$, Region 100, $t(24) = -0.025$, $p = 0.98$, Region 200, $t(24) = 0.959$, $p = 0.347$). Participants initially show marginally higher looks to target items in Region 300, mean difference $= 0.112$ ($t(24) = 1.807$, $p = 0.083$). Participants sustain significantly higher looks towards target items throughout all subsequent regions (Region 400 mean difference $= 0.151$, $t(24) = 2.189$, $p = 0.039$; Region 500 mean difference $= 0.168$, $t(24) = 3.094$, $p = 0.005$; Region 600 mean difference $= 0.158$, $t(24) = 2.966$, $p = 0.007$; Region 700 mean differ-

ence $= 0.177$, $t(24) = 3.157$, $p = 0.004$; Region 800 mean difference $= 0.249$, $t(24) = 4.644$, $p < 0.001$; Region 900 mean difference $= 0.458$, $t(24) = 8.85$, $p < 0.001$). In the feminine mismatch condition, Latin born bilinguals show marginally higher looks to target items in the first region, Region 0, mean difference $= 0.112$ ($t(24) = 1.879$, $p = 0.072$), indicating the possible presence of a baseline effect. Nevertheless, this effect is transient as the following regions from Region 100 to Region 700 show no significant differences between proportion of fixations to target and phonological distractor items (Region 100, $t(24) = 1.557$, $p = 0.133$; Region 200, $t(24) = 1.03$, $p = 0.313$; Region 300, $t(24) = 0.866$, $p = 0.395$; Region 400, $t(24) = 0.159$, $p = 0.875$; Region 500, $t(24) = -0.858$, $p = 0.4$; Region 600, $t(24) = -0.937$, $p = 0.358$; Region 700, $t(24) = 0.743$, $p = 0.465$). Participants first exhibit significantly higher looks to target items in Region 800, mean difference $= 0.18$ ($t(24) = 2.53$, $p = 0.018$). They continue to show higher looks to target items in the final region, Region 900, mean difference $= 0.397$ ($t(24) = 5.515$, $p < 0.001$). As in the Spanish unilingual block, the Latin born bilinguals continue to show an anticipatory effect for feminine conditions as evidenced by early divergence of looks to target items in the feminine match condition (Region 300). Moreover, significantly higher looks to the feminine mismatch target occurred late in the timecourse (Region 800), indicative of costlier integration of these target items (see Figure 4.5).

In the masculine match condition, Latin born participants show no significant differences between proportion of fixations to target and phonological distractors from Region 0 to Region 500 (Region 0, $t(24) = -0.547$, $p = 0.589$; Region 100, $t(24) = -0.106$, $p = 0.917$; Region 200, $t(24) = -0.636$, $p = 0.531$; Region 300, $t(24) = 0.372$, $p = .713$; Region 400, $t(24) = 0.786$, $p = 0.44$; Region 500, $t(24) = 0.994$, $p = 0.33$). Participants begin to show marginally higher looks to target items in Region 600, mean difference $= 0.147$ ($t(24) = 1.949$, $p = 0.063$). Subsequent regions sustain increased looks to target items (Region 700 mean difference $= 0.173$, $t(24) = 2.666$, $p = 0.014$; Region 800 mean difference $= 0.284$, $t(24) = 4.668$, $p < 0.001$; Region 900 mean difference $= 0.457$, $t(24) = 9.457$, $p < 0.001$). For masculine mismatch conditions time regions through Region 800 did not show significant differences between target items and phonological distractors (Region 0, $t(24) = -0.276$, $p = 0.785$; Region 100, $t(24) = -0.893$, $p = 0.381$; Re-

gion 200, $t(24) = -0.954$, $p = 0.35$; Region 300, $t(24) = -0.975$, $p = 0.34$; Region 400, $t(24) = -0.691$, $p = 0.496$; Region 500, $t(24) = -0.636$, $p = 0.531$; Region 600, $t(24) = -0.597$, $p = 0.556$; Region 700, $t(24) = -0.309$, $p = 0.76$; Region 800, $t(24) = 1.538$, $p = 0.137$). Only in the last region, Region 900, did Latin born bilinguals show significantly higher looks to the target item, mean difference $= 0.245$ ($t(24) = 3.9$, $p < 0.001$). In sum, Latin born bilinguals show markedly late divergence to masculine mismatch targets (Region 900), indicative of costly integration of these target items. In contrast, participants successfully oriented their eyes towards masculine match targets in an earlier time region (Region 600). However, this region was not as early as for feminine match target (Region 300). These results are in contrast to the PDC model under the view that comprehension of these codeswitched items should have shown a neutralized gender effect for masculine conditions (see Figure 4.6).
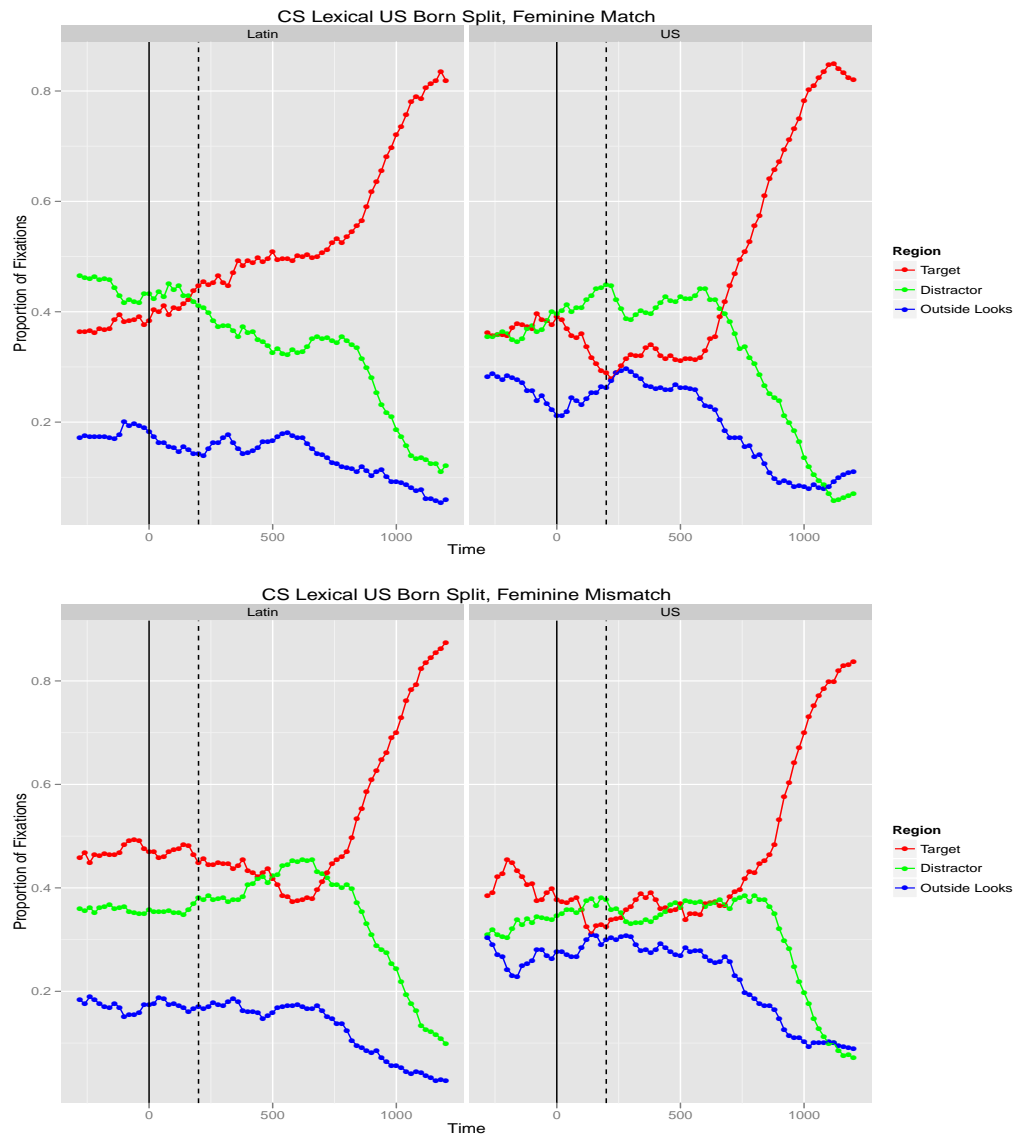
Figure 4.5: Timecourse plots for Spanish-English bilinguals in feminine match and mismatch trials split by place of birth

Time is plotted on the x-axis in milliseconds from 300 msec before article onset. We overlay a solid line to indicate article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to phonological distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by group manipulation, i.e. Latin born (left side) v. U.S. born (right side). We plot the feminine match conditions in the upper panel and feminine mismatch conditions in the bottom panel.
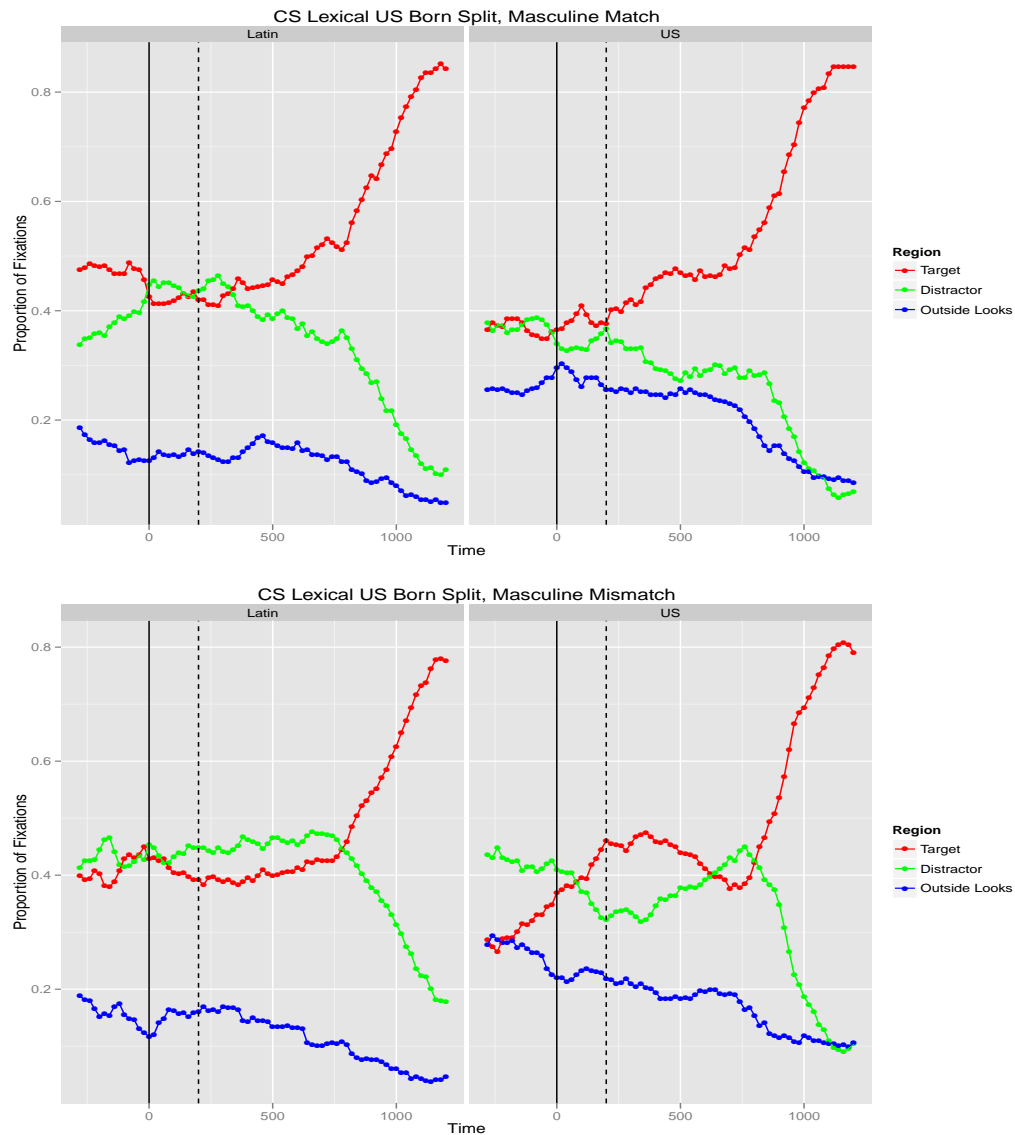
Figure 4.6: Timecourse plots for Spanish-English bilinguals in masculine match and mismatch trials split by place of birth

Time is plotted on the x-axis in milliseconds from 300 msec before article onset. We overlay a solid line to indicate article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by group manipulation, i.e. Latin born (left side) v. U.S. born (right side). We plot the masculine match conditions in the upper panel and masculine mismatch conditions in the bottom panel.

4.5 Sentence-level Codeswitching Block

The sentence-level codeswitching block follows the same basic experimental design of the lexical-level codeswitching block. As a result, the current block consists of 120 trials across eight conditions. We focus on the four experimental conditions described in the previous section: feminine match (e.g. **la** *candle*), feminine mismatch (e.g. **la** *candy*), masculine match (e.g. **el** *candy*), and masculine mismatch (e.g. **el** *candle*). Although the basic design is the same between the two experimental blocks, the sentential contexts that participants heard, differ across the two blocks. Specifically, in the current block, target items are embedded in sentential contexts that varied from trial to trial. Crucially, target items are embedded sentence-medially, and all trials include at least one codeswitch before the target region of interest. We argue that this design guides participants to more likely expect codeswitching and therefore allows us to inspect real-time processing of codeswitched speech more closely than the mode of presentation in the lexical-level block. Furthermore, we introduced a language manipulation such that half of our experimental trials begin with English whereas the other half begin with Spanish. This manipulation allows us to examine whether the language of the start of an utterance strongly guides processing in codeswitched speech.

4.5.1 Predictions

Our prediction closely resemble those we set out in the lexical-level codeswitching block. Notwithstanding our findings in the previous block that run counter to our predictions, we explore whether bilingual participants are more likely to expect a codeswitch in our sentential contexts. If our bilinguals are more likely to expect a codeswitch in the current experimental block, then following the logic of the PDC model, we predict that bilinguals are more likely to expect a codeswitch after the use of the masculine article and subsequently should show a similar timecourse between masculine match and mismtach conditions (i.e. a competitor effect not modulated by gender). In contrast, the feminine conditions should diverge at different points in the timecourse. Namely, feminine mismatch conditions, which are not attested in Spanish-English codeswitching in the U.S. should result in late divergent looks towards target items. If feminine marked codeswitches are not

expected due to their low frequency, then we expect bilinguals to show later divergence towards target items than in the lexical-level block; however, divergence should be earlier than feminine mismatch targets. If the language of the first word of the utterance globally guides processing, then we should find less modulation by gender in English-first codeswitches. Alternatively, Spanish-first codeswitches should increase the likelihood of the gender of the article modulating target identification in a Spanish-like manner, i.e. increased likelihood of anticipatory effects. We follow the same protocol for analysis described in the previous section with the added provision of splitting the analyses by language (i.e. English-first v. Spanish-first codeswitches) . In other words, we conducted paired-t tests on sequential 100 msec regions from article onset (time = 0) to 1000 msec: Region 0 (0 – 100 msec), Region 100 (101 – 200 msec), Region 200 (201 – 300 msec), Region 300 (301 – 400 msec), Region 400 (401 – 500 msec), Region 500 (501 – 600 msec), Region 600 (601 – 700 msec), Region 700 (701 – 800 msec), Region 800 (801 – 900 msec), and Region 900 (901 – 1000 msec).

4.5.2   U.S. Born Bilinguals

We present the results for U.S. born bilinguals ($N = 21$), beginning with English-first codeswitches.

4.5.2.1   English-first Codeswitches

In the feminine match condition, U.S. born bilinguals show no differences between proportion of fixations to target items and phonological distractors between Region 0 and Region 600 (Region 0, $t(20) = 0.433$, $p = 0.67$; Region 100, $t(20) = 0.16$, $p = 0.875$; Region 200, $t(20) = 0.181$, $p = 0.858$; Region 300, $t(20) = -0.296$, $p = 0.77$; Region 400, $t(20) = -0.542$, $p = 0.594$; Region 500, $t(20) = -0.128$, $p = 0.899$; Region 600, $t(20) = 1.048$, $p = 0.307$). Participants initially show significantly increased looks to target items in Region 700, mean difference = 0.297 ($t(20) = 2.571$, $p = 0.018$). They continue to show statistically higher fixations towards target items in the subsequent regions (Region 800 mean difference = 0.484, $t(20) = 6.041$, $p < 0.001$; Region 900 mean difference = 0.6, $t(20) = 6.106$, $p < 0.001$). For the feminine mismatch condition, we find no sta-

tistical difference between looks to target and phonological distractor items in the first region, Region 0 ($t(20) = 0.866$, $p = 0.397$). Participants exhibit marginally higher fixations towards target items in Region 100, mean difference = 0.194 ($t(20) = 1.99$, $p = 0.06$). Increased looks to target items is sustained in the next region, Region 200 mean difference = 0.215 ($t(20) = 2.092$, $p = 0.049$). This effect is attenuated and plateaus in the next three regions but fails to reach significance[4] (Region 300, $t(20) = 1.5$, $p = 0.149$; Region 400, $t(20) = 1.633$, $p = 0.118$; Region 500, $t(20) = 1.596$, $p = 0.126$). In Region 600, participants return to exhibiting marginally increased looks towards target items over phonological distractors, mean difference = 0.169 ($t(20) = 1.897$; $p = 0.072$). This effect continues to numerically be higher in Region 700 but fails to reach significance, mean difference = 0.14 ($t(20) = 1.411$, $p = 0.174$). The final two regions show significantly higher looks to target items (Region 800 mean difference = 0.351, $t(20) = 3.564$, $p = 0.002$; Region 900 mean difference = 0.53, $t(20) = 6.352$, $p < 0.001$).

As partially predicted by the PDC model, we find that the U.S. born bilinguals did not show an anticipatory effect with feminine match trials. Divergent looks towards target items did not occur until later in the timecourse in Region 700. In contrast, the results for the feminine mismatch condition are mixed. We have evidence that an initial baseline effect was present due to significant effects in Regions 100 and 200. We subsequently observe the U.S. born bilinguals engaging in a numerically higher proportion of fixations towards target items in the following three regions; however, the timecourse plot indicates that this potential effect maintained a trajectory with little change (i.e. plateau or stable trajectory), suggesting continuing consideration of the phonological distractor. The next two regions persist in exhibiting weak effects of increased looks towards target items. Participants only reliably shift their eye movements *en masse* towards target items in the last two regions. Although our analyses do not permit us to further investigate the full effects of baseline differences, we suggest that the results of the feminine mismatch condition do fall in line with the predictions of the PDC model. Specifically, if the data do in fact indicate that the U.S. born bilinguals are taking a longer time to

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[4]We note that for these three middle regions p-values are $0.1 < p < 0.15$ suggesting that the effect may have lacked statistical power; nevertheless, we observe that the timecourse plots do not continue a typical increasing trajectory suggesting to us that participant still consider both target and phonological distractors during this middle region.

diverge towards target items under the assumption that baseline effects are influencing the results, then participants are exhibiting a late timecourse of processing for feminine mismatch targets in codeswitched speech (see Figure 4.7).

For the masculine match condition, the U.S. born bilinguals show no differences between looks to target items and phonological distractors between Region 0 and Region 500[5] (Region 0, $t(20) = 1.206$, $p = 0.242$; Region 100, $t(20) = 1.504$, $p = 0.148$; Region 200, $t(20) = 0.487$, $p = 0.632$; Region 300, $t(20) = 1.592$, $p = 0.127$; Region 400, $t(20) = 1.48$, $p = 0.155$; Region 500, $t(20) = 0.997$, $p = 0.331$). Participants show marginally higher looks to target items in Region 600, mean difference $= 0.133$ ($t(20) = 2.058$, $p = 0.053$). Participants continue to show significantly higher looks towards target items in subsequent regions (Region 700 mean difference $= 0.231$, $t(20) = 2.9$, $p = 0.009$; Region 800 mean difference $= 0.383$, $t(20) = 3.49$, $p = 0.002$; Region 900 mean difference $= 5.242$, $t(20) = 5.242$ $p < 0.001$). In the masculine mismatch condition, the U.S. born bilinguals do not exhibit any differences between proportion of fixations towards target items in comparison to distractor items from Region 0 to Region 600 (Region 0, $t(20) = -0.833$, $p = 0.415$; Region 100, $t(20) = -0.414$, $p = 0.684$; Region 200, $t(20) = 0.301$, $p = 0.766$; Region 300, $t(20) = 0.041$, $p = 0.968$; Region 400, $t(20) = -0.633$, $p = 0.534$; Region 500, $t(20) = 0.347$, $p = 0,733$; Region 600, $t(20) = 0.609$, $p = 0.549$). Participants initially show marginally higher looks to target items in Region 700, mean difference $= 0.201$ ($t(20) = 1.807$, $p = 0.086$). Increasing looks to target items continue through the last two regions (Region 800 mean difference $= 0.446$, $t(20) = 4.276$, $p < 0.001$; Region 900 mean difference $= 0.522$, $t(20) = 5.222$, $p < 0.001$).

Although similar, the masculine match and mismatch conditions do not fully overlap in timecourse, contrary to our predictions. For the U.S. bilinguals, masculine match conditions do not result in an anticipatory effect. They begin to show divergent looks to target items in Region 600 and reliably continue to do so from Region 700 onwards. The masculine mismatch condition followed a similar trajectory; however, divergent looks towards target items occurred in the following

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[5]We acknowledge that Regions 300 and 400 have p-values between $0.1 < p < 0.15$ indicating a trend towards showing marginally higher looks towards target items. However, this potentially anticipatory effect later interacts with strong consideration between target items and phonological distractors in Region 500.

100 msec time region from the masculine match condition (Region 700) and was reliable from Region 800 onwards (see Figure 4.8).

4.5.2.2 Spanish-first Codeswitches

We now examine experimental trials which began in Spanish. For feminine match trials, U.S. bilinguals do not show significant differences between target items and phonological distractors in the first region ($t(20) = 1.39$, $p = 0.18$). In Region 100, participants begin to show significantly higher looks towards target items, mean difference $= 0.186$ ($t(20) = 2.38$, $p = 0.027$). This effect continues reliably in Region 200, mean difference $= 0.176$ ($t(20) = 2.102$, $p = 0.048$). The effect becomes marginally significant for the next two regions (Region 300 mean difference $= 0.155$, $t(20) = 1.725$, $p = 0.1$; Region 400 mean difference $= 0.216$, $t(20) = 1.859$, $p = 0.078$). Subsequently, looks to phonological distractors increase such that U.S. born bilinguals show no statistical difference fixations to target items and phonological distractors from Region 500 to Region 700 (Region 500, $t(20) = 0.745$, $p = 0.465$; Region 600, $t(20) = 1.061$, $p = 0.301$; Region 700, $t(20) = 1.601$, $p = 0.125$). Participants return to showing significantly higher fixations to target items in Region 800 which continues through Region 900 (Region 800 mean difference $= 0.294$, $t(20) = 3.057$, $p = 0.006$; Region 900 mean difference $= 0.468$, $t(20) = 4.547$, $p < 0.001$). For feminine mismatch trials, the U.S. born bilinguals show no differences between looks to target items and phonological distractors in the first two regions (Region 0, $t(20) = 0.082$, $p = 0.935$; Region 100, $t(20) = 1.649$, $p = 0.115$). Looks to target items are marginally higher for the next two regions (Region 200 mean difference $= 0.167$, $t(20) = 1.975$, $p = 0.062$; Region 300 mean difference $= 0.162$, $t(20) = 1.98$, $p = 0.062$). Participants show significantly higher looks to target items in Region 400 which continues through remaining time regions (Region 400 mean difference $= 0.229$, $t(20) = 2.868$, $p = .01$; Region 500 mean difference $= 0.304$, $t(20) = 3.977$, $p < 0.001$; Region 600 mean difference $= 0.315$, $t(20) = 4.295$, $p < 0.001$; Region 700 mean difference $= 0.43$, $t(20) = 4.653$, $p < 0.001$; Region 800 mean difference $= 0.569$, $t(20) = 7.681$, $p < 0.001$; Region 900 mean difference $= 0.711$, $t(20) = 9.325$, $p < 0.001$).

In sum, the results for the feminine conditions are mixed. We have initial evidence that U.S. born bilinguals may have begun with an anticipatory effect in

feminine match trials. However, this effect is hard to disentangle from a possible baseline effect present from Region 100. The effect may be anticipatory because looks to target items were significantly higher in Region 200 which is the first time region where the onset of the article would begin to impact processing. This trend continues as a marginal effect for subsequent two regions. However, from Region 500, increasing looks to phonological distractor indicates that any anticipatory effect driven by feminine gender is tenuous in the face of phonological competition. Consequently, reliable convergence to target items does not happen until the last two time regions. In contrast, bilinguals show a strong anticipatory effect for feminine mismatch trials which is not explainable by the PDC model. An anticipatory effect is evident from initial divergent looks to target items occurring marginally as early as Region 200, through Region 300, and becoming significantly reliable from Region 400 onwards (see Figure 4.7).

In the masculine match condition, U.S. born bilinguals do not show significant differences between mean proportion of fixations to target items and phonological distractors from Region 0 to Region 700 (Region 0, $t(20) = -1.021$, $p = .32$; Region 100, $t(20) = 0.519$, $p = 0.609$; Region 200, $t(20) = 1.01$, $p = 0.324$; Region 300, $t(20) = 0.819$, $p = 0.422$; Region 400, $t(20) = 0.035$, $p = 0.973$; Region 500, $t(20) = -0.224$, $p = 0.825$; Region 600, $t(20) = 0.201$, $p = 0.842$; Region 700, $t(20) = 1.193$, $p = 0.247$). Participants show initial looks to target items that are significantly higher in Region 800, mean difference $= 0.36$ ($t(20) = 2.889$, $p = 0.009$). Significantly higher looks continue through the last region, Region 900, mean difference $= 0.606$ ($t(20) = 6.29$, $p < 0.001$). For masculine mismatch trials, we find no difference between looks to target items and phonological distractors from Region 0 to Region 600 (Region 0, $t(20) = 0.435$, $p = 0.668$; Region 100, $t(20) = 0.654$, $p = 0.521$; Region 200, $t(20) = -0.106$, $p = 0.916$; Region 300, $t(20) = -0.251$, $p = 0.804$; Region 400, $t(20) = -0.4744$, $p = 0.64$; Region 500, $t(20) = -0.727$, $p = 0.476$; Region 600, $t(20) = -0.716$, $p = 0.482$). Participants exhibit marginally higher looks to target items in Region 700, mean difference $= 0.176$ ($t(20) = 2.059$, $p = 0.053$). This effect becomes significant in Region 800 and continues through Region 900 (Region 800 mean difference $= 0.487$, $t(20) = 6.517$, $p < 0.001$; Region 900 mean difference $= 0.589$, $t(20) = 8.439$, $p < 0.001$). Although U.S. born bilinguals show marginally significant looks to target items one

time region earlier than masculine match trials (Region 700 v. Region 800), these results are the most compatible with the PDC model for this group of bilinguals (see Figure 4.8).

Figure 4.7: Timecourse plots for U.S. born bilinguals in feminine match and mismatch trials split by language of first word

Time is plotted on the x-axis in milliseconds from 300 msec before article onset. We overlay a solid line to indicate article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to phonological distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by language manipulation, i.e. English-first (left side) v. Spanish-first (right side). We plot the feminine match conditions in the upper panel and feminine mismatch conditions in the bottom panel.

Figure 4.8: Timecourse plots for U.S. born bilinguals in masculine match and mismatch trials split by language of first word

Time is plotted on the x-axis in milliseconds from 300 msec before article onset. We overlay a solid line to indicate article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by language manipulation, i.e. English-first (left side) v. Spanish-first (right side). We plot the masculine match conditions in the upper panel and masculine mismatch conditions in the bottom panel.

4.5.3 Latin Born Bilinguals

We turn now to the Latin born bilinguals ($N = 25$). We present analyses and results in the same manner as for the U.S. born group, starting with English-first codeswitches.

4.5.3.1 English-first Codeswitches

For the feminine match condition, Latin born bilinguals did not show differences between looks to target items and phonological distractors from Region 0 to Region 300 (Region 0, $t(24) = -0.337$, $p = 0.739$; Region 100, $t(24) = -0.81$, $p = 0.426$; Region 200, $t(24) = -1.111$, $p = 0.2778$; Region 300, $t(24) = -1.122$, $p = 0.273$). In Region 400, Latin born bilinguals show marginally higher looks to phonological distractors, mean difference = -0.167 ($t(24) = -2.055$, $p = 0.051$). However, in Region 500, looks between target items and phonological distractors return to being non-significant ($t(24) = -1.424$, $p = 0.167$). Region 600 switches to showing significantly higher fixations to target items, mean difference = 0.151 ($t(24) = 2.145$, $p = 0.042$). Participants continue to show significantly higher looks to target items in subsequent regions (Region 700 mean difference = 0.233, $t(24) = 2.764$, $p = 0.011$ Region 800 mean difference = 0.356, $t(24) = 4.409$, $p < 0.001$; Region 900 mean difference = 0.521, $t(24) = 8.731$, $p < 0.001$). In the feminine mismatch condition, Latin born bilinguals show no differences between target items and phonological distractors from Region 0 to Region 700 (Region 0, $t(24) = 1.076$, $p = 0.293$; Region 100, $t(24) = 0.847$, $p = 0.406$; Region 200, $t(24) = 0.731$, $p = 0.472$; Region 300, $t(24) = 078$, $p = 0.443$; Region 400, $t(24) = 0.383$, $p = 0.705$; Region 500, $t(24) = 0.103$, $p = 0.919$; Region 600, $t(24) = -0.915$, $p = 0.369$; Region 700, $t(24) = 1.373$, $p = 0.182$). Participant begin to show higher looks to target items in Region 800, mean difference = 0.314 ($t(24) = 3.385$, $p = 0.002$). This effect is sustained in the last region, Region 900, mean difference = 0.547 ($t(24) = 6.614$, $p < 0.001$). Following the predictions of the PDC, Latin born bilinguals show a later cost to integration for feminine mismatch trials as evidenced by a later time region for divergent looks to target items (Region 800). In contrast, participants initially showed higher looks to target items in Region 500 in feminine match trials. We note that the feminine match trials may

have also shown an interaction such that looks to phonological distractors were initially higher in Region 400. This effect was short and quickly turned over to significant looks to target items in 2 time regions (see Figure 4.9).

In the masculine match condition, participants did not exhibit differences between looks to target items and phonological distractors from Region 0 to Region 700 (Region 0, $t(24) = 0.989$, $p = 0.333$; Region 100, $t(24) = 1.227$, $p = 0.232$; Region 200, $t(24) = 1.566$, $p = 0.13$; Region 300, $t(24) = 0.969$, $p = 0.342$; Region 400, $t(24) = 0.408$, $p = 0.687$; Region 500, $t(24) = 0.176$, $p = 0.862$; Region 600, $t(24) = 0.12$, $p = 0.906$; Region 700, $t(24) = 1.195$, $p = 0.244$). Latin born bilinguals begin to show significantly higher looks to target items in Region 800 which continues through Region 900 (Region 800 mean difference $= 0.352$, $t(24) = 5.251$, $p < 0.001$; Region 900 mean difference $= 0.515$, $t(24) = 7.893$, $p < 0.001$). For masculine mismatch trials, there were no significant differences between fixations to target items and phonological distractors from Region 0 to Region 400 (Region 0, $t(24) = -0.645$, $p = 0.525$; Region 100, $t(24) = -0.647$, $p = 0.524$; Region 200, $t(24) = -1.158$, $p = 0.258$; Region 300, $t(24) = -0.637$, $p = 0.53$; Region 400, $t(24) = -1.163$, $p = 0.256$). In Region 500, participants show higher looks to phonological distractors, mean difference $= $ -0.196 ($t(24) = -2.427$, $p = 0.023$). This effect is short-lived as participants return to showing no difference between target items and phonological distractors in Region 600 ($t(24) = -0.962$, $p = 0.346$). Participants begin to show increased looks to target items in Region 700, mean difference $= 0.157$ ($t(24) = 2.174$, $p = 0.04$). This effect continues through subsequent regions (Region 800 mean difference $= 0.433$, $t(24) = 5.097$, $p < 0.001$; Region 900 mean difference $= 0.583$, $t(24) = 6.291$, $p < 0.001$). Latin born bilinguals show a competitor effect for masculine match trials such that participants equally considered both target items and phonological distractors until late in timecourse (Region 800). In contrast, the masculine mismatch condition exhibits a temporary bias towards the phonological distractor in Region 500 that later interacts with subsequent looks to correct target items in Region 700. Although this interaction is present, the Latin born bilinguals are able to recover fairly quickly as they are able to significantly orient their eyes towards target items in a 100 msec time region earlier than in masculine match conditions (see Figure 4.10).

4.5.3.2 Spanish-first Codeswitches

Turning to the feminine match trials in the Spanish-first codeswitches subset, Latin born bilinguals show no differences between looks to target items and phonological distractors between Region 0 and Region 600 (Region 0, $t(24) = -1.239$, $p = 0.227$; Region 100, $t(24) = -0.833$, $p = 0.413$; Region 200, $t(24) = -1.085$, $p = 0.289$; Region 300, $t(24) = -0.522$, $p = 0.607$; Region 400, $t(24) = -0.165$, $p = 0.87$; Region 500, $t(24) = -0.444$, $p = 0.661$; Region 600, $t(24) = 0.634$, $p = 0.53$). In Region 700, Latin born bilinguals begin to show marginally higher looks to target items, mean difference $= 0.205$ ($t(24) = 1.938$, $p = 0.064$). This effect reaches significance in Region 800 and continues through Region 900 (Region 800 mean difference $= 0.39$, $t(24) = 4.929$, $p < 0.001$; Region 900 mean difference $= 0.544$, $t(24) = 9.173$, $p < 0.001$). Similarly, feminine mismatch trials do not exhibit differences between fixations to target items and phonological distractors between Regon 0 and Region 600 (Region 0, $t(24) = 0.19$, $p = 0.851$; Region 100, $t(24) = 1.376$, $p = 0.182$; Region 200, $t(24) = 1.376$, $p = 0.182$; Region 300, $t(24) = 0.308$, $p = 0.761$; Region 400, $t(24) = -0.372$, $p = 0.713$; Region 500, $t(24) = -1.066$, $p = 0.297$; Region 600, $t(24) = 0.089$, $p = 0.93$). Region 700 shows marginally higher looks towards target items, mean difference $= 0.183$ ($t(24) = 1.978$, $p = 0.06$). Latin born bilinguals exhibit significantly higher fixations to target items in Region 800 which continues through Region 900 (Region 800 mean difference $= 0.364$, $t(24) = 4.616$, $p < 0.001$; Region 900 mean difference $= 0.45$, $t(24) = 6.358$, $p < 0.001$). In contrast to predictions by the PDC, feminine match and mismatch conditions show similar processing in that both conditions initially show divergent looks towards the target item in Region 700 (see Figure 4.9).

In the masculine match condition, Latin born bilinguals show no significant difference between looks to target and phonological distractors from Region 0 to Region 700 (Region 0, $t(24) = 1.259$, $p = 0.22$; Region 100, $t(24) = 0.855$, $p = 0.401$; Region 200, $t(24) = 0.223$, $p = 0.825$; Region 300, $t(24) = -0.522$, $p = 0.606$; Region 400, $t(24) = -0.412$, $p = 0.684$; Region 500, $t(24) = 0.811$, $p = 0.425$; Region 600, $t(24) = 1.175$, $p = 0.252$; Region 700, $t(24) = 1.294$, $p = 0.208$). Participants first show significant looks to target items in Region 800 which continue through Region 900 (Region 800 mean difference $= 0.278$, $t(24) = 3.064$, $p = 0.005$; Region 900 mean difference $= 0.489$, $t(24) = 5.624$, $p < 0.001$).

Similarly, for masculine mismatch trials, we did not find significant differences between the proportion of fixations for target items or phonological distractors from Region 0 to Region 700 (Region 0, $t(24) = 0.172$, $p = 0.865$; Region 100, $t(24) = -0.014$, $p = 0.989$; Region 200, $t(24) = -0.834$, $p = 0.412$; Region 300, $t(24) = -1.262$, $p = 0.219$; Region 400, $t(24) = -1.216$, $p = 0.236$; Region 500, $t(24) = -1.519$, $p = 0.142$; Region 600, $t(24) = -0.13$, $p = 0.117$; Region 700, $t(24) = 0.214$, $p = 0.832$). Latin born bilinguals initially show marginally higher looks to target items in Region 800, mean difference $= 0.18$ ($t(24) = 1.984$, $p = 0.059$). This effect is significant in the last region, Region 900, mean difference $= 0.4$ ($t(24) = 4.131$, $p < 0.001$). Similar to the feminine conditions in the Spanish-first codeswitching block, Latin born bilinguals show a similar timecourse for both masculine match and mismatch trials. In both conditions, bilinguals begin to show divergent looks to target items in Region 800 (see 4.10).
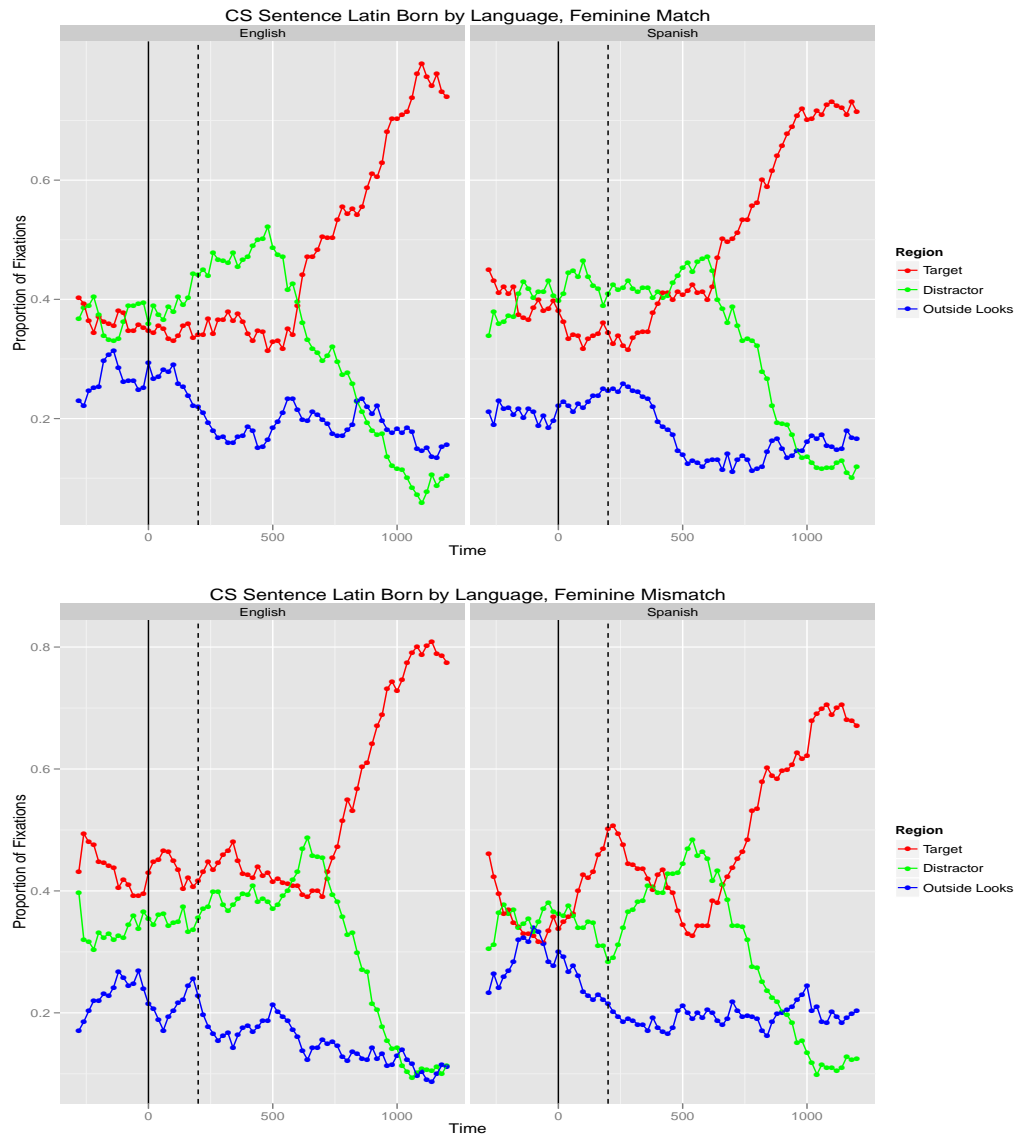
Figure 4.9: Timecourse plots for Latin born bilinguals in feminine match and mismatch trials split by language of first word

Time is plotted on the x-axis in milliseconds from 300 msec before article onset. We overlay a solid line to indicate article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to phonological distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by language manipulation, i.e. English-first (left side) v. Spanish-first (right side). We plot the feminine match conditions in the upper panel and feminine mismatch conditions in the bottom panel.

Figure 4.10: Timecourse plots for Latin born bilinguals in masculine match and mismatch trials split by language of first word

Time is plotted on the x-axis in milliseconds from 300 msec before article onset. We overlay a solid line to indicate article onset. Total proportion of fixations are plotted on the y-axis. Red curves represent looks to target items. Green curves indicate looks to distractor items. Blue curves are looks that fell outside of target or distractor regions. Plots are split by language manipulation, i.e. English-first (left side) v. Spanish-first (right side). We plot the masculine match conditions in the upper panel and masculine mismatch conditions in the bottom panel.

4.6 Summary of Results

In this chapter we reported the results from three visual world experiments in which bilingual participants split by place of birth (U.S. born v. Latin born) heard simple invariant phrases (i.e. "Find the _____") in Spanish and with single word switches in the first two blocks, and with variant codeswitched sentential contexts in the last block. Below, we provide a descriptive summary of the results presented by experimental block. Each section ends with a table that visually summarizes our statistical results.

4.6.1 Spanish Unilingual Block

A previous study (Lew-Williams & Fernald, 2007) had observed that Spanish-speaking children and adults were able to use grammatical gender as a facilitatory morpho-syntactic cue in informative contexts. Participants were presented with a 2-picture display while listening to a simple Spanish carrier phrase which named one of the two pictures. Crucially, paired items either matched in gender (same gender trials) or differed in gender (different gender trials). In different gender trials, because the Spanish definite article carries grammatical gender, participants were able to orient their eyes towards target items earlier than in same gender trials (i.e. an anticipatory effect). In our first experimental block, we set out to replicate these findings. However, before we tested our bilingual participants, we analyzed the results from a monolingual control group recruited for a separate study (Perrotti, 2012). This control group was included because we first had to establish that we would be able to replicate the results of Lew-Williams and Fernald, given that our methodology is different in several respects from the one employed in Lew-Williams and Fernald and our materials and procedure were also different. Similarly, we also were compelled to control for any effects that might arise from exposure to English—a language which lacks grammatical gender.

Our control group consisted of 24 Spanish monolinguals who were university students in Granada, Spain. Spanish monolingual showed anticipatory effects in both feminine and masculine conditions replicating the results from Lew-Williams and Fernald (2007). This is evidenced by earlier divergent looks towards target items in the different gender trials as compared to the same gender trials. In both

feminine and masculine different gender trials, monolinguals initially exhibited significantly higher looks to target items in Region 300. In contrast, monolinguals began to show increased looks to target items in same gender trials in Region 500. The results of our control group confirm the reliability of our Spanish materials and the use of a desk-mounted eyetracker in our experiments.

Having replicated the different gender anticipatory effect with monolingual controls, we then investigated the nature of gender processing in two groups of Spanish-English bilinguals. We first presented the results from our U.S. born group, which consisted of 21 participants. Unlike the monolingual group, our analyses of the U.S. born bilinguals did not reveal any evidence for anticipatory effects in either feminine or masculine conditions. In all four conditions, U.S. born bilinguals exhibited a remarkably similar timecourse, as divergent looks towards target items only began in Region 500 from article onset. Interestingly, despite our failure to elicit an anticipatory effect in this group of bilinguals, they exhibited a similar timecourse in processing as the monolinguals in same gender trials. In other words, the U.S. born bilinguals were able to process Spanish at a similar timescale to monolingual speakers, yet still did not exhibit gender facilitation in informative contexts (different gender trials).

In the Latin born group, 25 participants completed the Spanish unilingual block. In the feminine conditions, participants exhibited a similar timecourse in processing as the Spanish monolinguals, resulting in an anticipatory effect for feminine gender. In different gender trials, participants begin to marginally show higher fixations towards target items in Region 300 which subsequently became a reliable effect from Region 400 onwards. In contrast, participants only showed divergent looks to target items from Region 500. However, unlike the Spanish monolinguals and like the U.S. born bilinguals, the results of the Latin born bilinguals in the masculine conditions did not reveal an anticipatory effect. In both same gender and different gender trials, participants began to show significantly divergent looks towards target items in Region 500.

In sum, our three groups of participants exhibit three different patterns of processing. For the monolinguals, both masculine and feminine gender are facilitatory, for the U.S. born bilinguals, neither feminine or masculine gender is facilitatory, and for the Latin born group, only feminine gender is facilitatory. We summarize

our results for the Spanish unilingual block in Table 4.1.

Table 4.1: Summary of the Spanish Unilingual Block.

		Time Region							
		0	100	200	300	400	500	600	700
Spanish Monolinguals									
Feminine	Same Gender	-	-	-	-	-	***	***	***
	Different Gender	d*	-	-	*	***	***	***	***
Masculine	Same Gender	-	-	-	-	-	***	***	***
	Different Gender	-	-	-	**	***	***	***	***
U.S. born Bilinguals									
Feminine	Same Gender	-	-	-	-	-	**	***	***
	Different Gender	-	d‡	-	-	-	*	***	***
Masculine	Same Gender	-	-	-	-	-	*	***	***
	Different Gender	-	-	-	-	-	**	***	***
Latin born Bilinguals									
Feminine	Same Gender	-	-	-	-	-	***	***	***
	Different Gender	-	-	-	†	**	***	***	***
Masculine	Same Gender	†	†	-	-	-	*	***	***
	Different Gender	-	-	‡	-	‡	***	***	***

We present results for each group by time region. We use standard statistical notation to indicate significance, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, † $p < 0.10$, ‡ $p < 0.15$. If significance was in the direction of the distractor item, we notate with a small 'd'.

4.6.2 Lexical-level Codeswitching

Having established the nature of grammatical gender processing in both bilingual groups, we set out to investigate whether grammatical gender modulates how bilinguals process Spanish-English codeswitches that occur at the article–noun juncture, e.g. **el** *candy*. In the first of our two codeswitching experimental blocks, we replicated the design of the Spanish block (and Lew-Williams and Fernald, 2007). That is, we embedded single English nouns in a simple Spanish carrier phrase, i.e. *Encuentra el/la* _____ "Find the$_{\text{masc/fem}}$ _____." As in the Spanish case, the gender encoded in the Spanish definite article directly preceding the target English noun is potentially informative. For our codeswitching experiments, we introduced

a new experimental manipulation not present in the Spanish block. All of our experimental pairs were phonological competitors that had Spanish translation equivalents that differed in grammatical gender, e.g. *candy* [kændi], Sp. *caramelo*$_{masc}$ and *candle* [kændl̩], Sp. *vela*$_{fem}$. Previous findings in the monolingual literature have indicated that speakers show delayed processing (i.e. competitor effects) when presented with phonological competitors (Allopenna et al., 1998). Thus, following the predictions of the PDC model, we reasoned that due to the production asymmetry of grammatical gender in codeswitching, participants should not rely upon the masculine gender as a facilitatory cue in processing but instead should show a competitor effects, which should manifest itself by exhibiting a similar timecourse of processing for both match and mismtach trials. In contrast, feminine gender can be potentially informative, although feminine marked codeswitches are exceedingly rare in production. Subsequently, we predicted that feminine mismatch trials would be particularly difficult to integrate, incurring a large processing cost due to their unattested status in production, whereas the feminine match condition should show an earlier timecourse of looks to target items.

Moreover, we noted that the results of the lexical-level codeswitching block should further corroborate our results in the Spanish block. In other words, because the U.S. born bilinguals did not appear to utilize grammatical gender as a facilitatory cue, we predicted that they were more likely to not show any gender modulation in our codeswitching block for masculine or feminine conditions. In contrast, the results for the Latin born bilinguals are largely compatible with our expected predictions. That is, even though Latin born bilinguals did not exhibit an anticipatory effect for masculine conditions, this pattern is exactly what is predicted if production is reflected in comprehension in codeswitching. Likewise, because the Latin born group did show an anticipatory effect for feminine gender, we predicted that this group was most likely to show increased costs to the integration of feminine mismatch targets.

For the U.S. born bilinguals, feminine conditions only partially matched our predictions. Specifically, we found that U.S. born bilinguals exhibited increased difficulty in integrating feminine mismatch targets as looks to feminine mismatch targets only began to marginally diverge in Region 800, an effect which was reliably significant in the last region, Region 900. Feminine match target did not exhibit

a strongly anticipatory effect as we predicted based on the results of the Spanish block, but looks to feminine match targets were earlier than feminine mismatch targets, diverging in Region 700. In contrast, and somewhat surprisingly, U.S. born bilinguals showed a strongly anticipatory effect in masculine conditions. This was evidenced by the early divergent looks towards masculine match target items in Region 400 and very late divergent looks towards masculine mismatch target items, which occurred in Region 900. The results for the masculine conditions are counter to the predictions set forth by the PDC model and are largely incompatible with the findings in the Spanish unilingual block. In other words, even though U.S. born bilinguals failed to show an anticipatory effect for gender in Spanish, they exhibit an anticipatory effect for masculine gender in single noun switches.

The results for the Latin born bilinguals more closely resembled our predictions but also with some variation. Here, Latin born bilinguals revealed a strongly anticipatory effect for feminine conditions as they did in the Spanish block. This is evidenced by the early time region of divergent looks towards feminine match targets (Region 300). In comparison, Latin born bilinguals only showed increased looks towards feminine mismatch targets in Region 800. Masculine conditions were more similar than not but masculine match trials demonstrated an earlier divergent time region (marginal significance in Region 600 and significance in Region 700). However, Latin born bilinguals only showed significantly higher fixations towards masculine mismatch targets in the last region, Region 900. We present a summary of the results of our statistical analyses in Table 4.2.

Table 4.2: Summary of the Lexical-level Codeswitching Block.

		Time Region									
		0	100	200	300	400	500	600	700	800	900
U.S. born Bilinguals											
Feminine	Match	-	d*	d†	-	-	-	-	*	**	**
	Mismatch	-	-	-	-	-	-	-	-	†	***
Masculine	Match	-	-	-	‡	**	**	**	***	***	***
	Mismatch	-	-	‡	†	-	-	-	-	-	***
Latin born Bilinguals											
Feminine	Match	-	-	-	†	*	**	**	**	***	***
	Mismatch	†	‡	-	-	-	-	-	-	*	***
Masculine	Match	-	-	-	-	-	-	†	*	***	***
	Mismatch	-	-	-	-	-	-	-	-	‡	***

We present results for each group by time region. We use standard statistical notation to indicate significance, $*\ p < 0.05$, $**\ p < 0.01$, $***\ p < 0.001$, $†\ p < 0.10$, $‡\ p < 0.15$. If significance was in the direction of the distractor item, we notate with a small 'd'.

4.6.3 Sentence-level Codeswitching

We further explored the grammatical gender processing in codeswitched speech in our final experimental block. Unlike the previous two blocks, we embedded the experimental items that we used in the lexical-level codeswitching block in variant sentential frames. We added this design manipulation in order to explore whether processing with single word switches is comparable to multi-word codeswitched contexts. To that effect, all of our sentential frames contained a codeswitch prior to our target codeswitch. Furthermore, we investigated the extent to which the language at the beginning of a codeswitched utterance influences the expectation of our codeswitched items. Moreover, to increase listening for comprehension, we added a plausibility judgment for each trial. All of our experimental items were embedded in plausible sentence contexts. Filler items that were embedded in implausible sentence contexts are not analyzed here.

Our predictions are mainly those that we laid out in the previous section. That is, we expected masculine conditions to exhibit little to no difference in the timecourse of processing. In contrast, we predicted a costly integration of feminine

mismatch targets such that divergent looks towards target items would occur in a late time region. In terms of the language manipulation, the PDC model does not directly make a prediction concerning how language may influence processing in codeswitching; nevertheless, we predicted that Spanish-first codeswitches would elicit more Spanish-like processing in gender. That is, we expected an anticipatory effect for feminine match targets to be more likely with Spanish-first codeswitches. Additionally, this effect should be more strongly observable in the Latin born bilingual group. Conversely, the U.S. born group is more likely to not show gender modulation in any condition based on their results from the Spanish block.

Partially matching our predictions, the U.S. born bilinguals did not show strong gender modulation in the English-first codeswitching conditions. In the feminine match condition, significant looks towards feminine match targets occurred in Region 700. Similarly, U.S. born bilinguals show significant looks to feminine mismatch targets in the last two region of analysis, Region 800 and Region 900. We also observed a potential influence from baseline effects for the feminine mismatch condition as evidenced by marginal looks to target items in Region 100 and subsequent significant looks to target items in the next region, Region 200. The timecourse of fixations to target items sustained little to no change over the next 4 time regions indicating difficulty to integration of feminine mismatch targets. For masculine conditions, U.S. born bilinguals show marginally higher looks to masculine match targets in Region 600 with the effect becoming reliably significant in the following region, Region 700. Similarly, participants exhibited marginally higher fixations towards masculine mismatch targets in Region 700, an effect which became reliably significant in the next region, Region 800.

As in the English-first masculine codeswitches, U.S. born bilinguals show little difference between masculine match and mismatch conditions in the Spanish-first codeswithes. Significant looks towards masculine match targets began in Region 800. For masculine mismatch targets, participants showed marginally higher looks to targets in Region 700, continuing with a reliably significant effect in Region 800. In contrast, the results for the Spanish-first feminine codeswitches are opposite to what we predicted. Namely, we see a strong anticipatory effect for feminine mismatch targets. U.S. born bilinguals begin to show marginally higher looks to feminine mismatch targets in Region 200 and Region 300, with reliably significant

looks from Region 400 onwards. In contrast, the feminine match condition exhibits an interaction that may be influenced by an early baseline effect. Participants exhibit significantly higher looks to target items early in Region 100 and Region 200 which consequently stabilizes to a marginal effect in Region 300 and Region 400. The difference is non-significant for the following three regions, Region 500, Region 600, and Region 700. Participants show significantly higher looks again towards feminine match targets in the last two regions, Region 800 and Region 900.

The Latin born bilinguals show a different pattern of results from the U.S. group. The results for the English-first codeswitches appear compatible with the predictions we set forth based on the PDC model. Latin born bilinguals show a slight anticipatory effect for feminine codeswitches. Divergent looks towards feminine match targets begin in Region 600. In contrast, significant looks to feminine mismatch targets occur in Region 800. The masculine conditions only show small differences between each other. Divergent fixations to masculine match targets are first significantly higher in Region 800. Similarly, Latin born bilinguals begin to show significantly higher looks to masculine mismatch targets slightly earlier, in Region 700. We also observed a transient interaction in the masculine mismatch condition. Specifically, bilinguals exhibited significantly higher looks to the phonological distractor that was also a gender match distractor but only in Region 500.

For the Spanish-first codeswitches, Latin born bilinguals show little gender modulation and no anticipatory effects for both feminine and masculine conditions. Both feminine match and mismatch trials begin to reveal marginally higher looks to target items in Region 700 with subsequently reliable effects from Region 800. Similarly, participants show initial higher looks to masculine match targets in Region 800. Latin born bilinguals also show higher marginal looks to masculine mismatch targets in the same region, Region 800. This effect is statistically reliable in the following region, Region 900. These results lead to the interesting finding that the Latin born bilinguals match our predictions for the feminine conditions in English-first codeswitches but not Spanish-first codeswitches. Furthermore, masculine conditions mainly follow our predictions in both English-first and Spanish-first codeswitches. That is, they exhibit a slight anticipatory effect

for feminine conditions in the English-first codeswitches only. We summarize the results in Table 4.3.

Table 4.3: Summary of the Sentence-level Codeswitching Block.

		Time Region									
		0	100	200	300	400	500	600	700	800	900
U.S. born Bilinguals – *English-first*											
Feminine	Match	-	-	-	-	-	-	-	*	***	***
	Mismatch	-	†	*	‡	‡	‡	†	-	***	***
Masculine	Match	-	‡	-	‡	-	-	†	**	**	***
	Mismatch	-	-	-	-	-	-	-	†	***	***
U.S. born Bilinguals – *Spanish-first*											
Feminine	Match	-	*	*	†	†	-	-	‡	**	***
	Mismatch	-	‡	†	†	*	***	***	***	***	***
Masculine	Match	-	-	-	-	-	-	-	-	**	***
	Mismatch	-	-	-	-	-	-	-	†	***	***
Latin born Bilinguals – *English-first*											
Feminine	Match	-	-	-	-	d†	-	*	*	***	***
	Mismatch	-	-	-	-	-	-	-	-	**	***
Masculine	Match	-	‡	-	-	-	-	-	-	***	***
	Mismatch	-	-	-	-	-	d*	-	*	***	***
Latin born Bilinguals – *Spanish-first*											
Feminine	Match	-	-	-	-	-	-	-	†	***	***
	Mismatch	-	-	-	-	-	-	-	†	***	***
Masculine	Match	-	-	-	-	-	-	-	-	**	***
	Mismatch	-	-	-	-	-	d‡	d‡	-	†	***

We present results for each group by time region. We use standard statistical notation to indicate significance, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, † $p < 0.10$, ‡ $p < 0.15$. If significance was in the direction of the distractor item, we notate with a small 'd'.

Chapter 5

Discussion and Conclusions

5.1 Introduction

In this dissertation, we investigated the comprehension of Spanish-English code-switching using the visual world paradigm, an increasingly useful eye-tracking technique used in the study of auditory comprehension. In so doing, we attempted to place the insights learned from the psycholinguistics of bilingualism within the context of a uniquely bilingual linguistic skill as described by structural linguists and sociolinguists, thus, bridging two largely separate disciplines. In Chapter 1, we contextualized the phenomenon of codeswitching, which by definition requires exquisite control of a bilingual's two languages and a high degree of proficiency across the two languages, within the major psycholinguistic finding of interactivity (i.e. non-selectivity) between the two languages. We noted that in light of this constant co-activation of the two languages in both production and comprehension, the central goal for psycholinguistic research has been to answer how a bilingual ultimately produces and comprehends in a single language. We postulated that codeswitching provides a unique perspective and thus a fuller complement to our understanding of the fundamentals underlying non-selectivity. Codeswitching afforded us this opportunity because bilinguals must maintain both languages maximally and efficiently co-active in order to successfully integrate phonological, lexical, syntactic, and discourse information across two languages.

In addition, we stated that codeswitching was an ideal empirical data set for testing the predictions of a prominent sentence processing model termed the

Production-Distribution-Comprehension (PDC) model (Gennari & MacDonald, 2009). Broadly, the PDC model suggests a tight link between production and comprehension such that when speakers confront surface alternations (i.e. two seemingly equivalent structures), the distribution of these alternations should be reflected in comprehension. Therefore, the more frequent alternation should result in facilitated comprehension. We reviewed the findings of several researchers who have observed a production asymmetry in Spanish-English codeswitching such that Spanish masculine articles surface with English nouns frequently and regardless of the grammatical gender of the Spanish translation equivalent (Jake et al., 2002a; Otheguy & Lapidus, 2003). In contrast, Spanish feminine articles appear rarely in spoken language corpora. Moreover, these articles surface restrictively with English nouns that have feminine Spanish translation equivalents. Following the logic of the PDC model, we predicted that this production asymmetry should broadly be reflected in comprehension. That is, we predicted that feminine marked codeswitches with English nouns that have masculine Spanish translation equivalents should be particularly difficult to process for bilinguals who have learned the distributional patterns of Spanish-English codeswitching. In parallel, masculine marked codeswitches with English nouns that have feminine Spanish translation equivalents should not result in difficulty in processing because these codeswitches are frequently documented in the production of Spanish-English codeswitching.

In Chapter 1 we raised the issue of the obstacles researchers face in applying experimental techniques to the investigation of the comprehension of codeswitching. One major obstacle that has confronted researchers is the minimal cross-communication between experimental psycholinguists and structural linguists and sociolinguists (c.f. Dussias, 2003; Myers-Scotton, 2006; Gullberg et al., 2009; Guzzardo Tamargo, 2012). We highlighted three issues that we argue were at the core of this miscommunication. First, many researchers have conflated the differences between language switching paradigms as studied by psycholinguists and codeswitching as described by linguists. Second, due to methodological challenges, experimental approaches that putatively investigate codeswitching have in fact, mainly focused on embedded single lexical items from inserted in an otherwise unilingual context, thereby circumventing the broad repertoire of codeswitching patterns found in bilingual corpora of many distinct language pairs. Third, exper-

imental approaches have generally not taken into account the linguistic profiles of bilingual participants in codeswitching experiments, i.e. are the participants themselves codeswitchers and what are the prevalent codeswitching patterns found in the language pairing studied? Further compounding these challenges is the stigmatized status attached to codeswitching even by speakers themselves. Due to this socially driven construct, we argued that traditional measures of comprehension such as grammaticality judgments and overt reaction measures are particularly ill-suited to the study of codeswitching.

We tackled these issues in the current dissertation along the following lines. We adopted an experimental technique that uses eyetracking known as the visual world paradigm (Cooper, 1974; Tanenhaus et al., 1995). We reviewed the central findings discovered through this technique as it has mainly been applied to monolingual speakers. We postulated that this experimental technique would have beneficial applications to investigate the comprehension of codeswitching due to the use of fixations (an action that is covertly under the control of the individual) to target and distractor items as a dependent measure. This dependent measure circumnavigated the need to directly ask participants for grammaticality judgments and thus largely avoided the socio-linguistic perceptions which have made the study of the comprehension of codeswitching so difficult. Moreover, this methodology allowed us to use recorded stimuli produced by a habitual codeswitcher. In sum, the visual world paradigm allowed us to apply a technique broadly used in spoken language comprehension to a linguistic phenomenon that is mainly spoken. In addition, we specifically recruited a group of Spanish-English bilinguals from New York City, a large metropolitan center that has been a bedrock of descriptive linguistic analyses of Spanish-English codeswitching (e.g. Poplack, 1980; Zentella, 1997; Otheguy & Lapidus, 2003). Within our language history questionnaire, we explicitly asked a battery of questions concerning participants' habitual use of and exposure to codeswitching in both speaking and writing. Based on these demographic measures and a host of proficiency measures, we further split our group of bilinguals into two groups on the basis of place of birth (U.S. born v. Latin born). This split allowed us to compare two groups of bilinguals with similar linguistic profiles in terms of their exposure and use of codeswitching but who differed in their level of proficiency in their first language, Spanish. Finally, we explored how the the

presentation of codeswitched stimuli affected sentence processing. Specifically, we included two experimental blocks of codeswitched materials. In the first of the two blocks, participants listened to simple Spanish carrier phrases with an embedded single English noun switch. This design mirrored the experimental design of other studies that have putatively studied codeswitching. We contrasted this experimental block with a separate block that used the same experimental materials but embedded target items in variant sentential contexts. These sentential contexts involved multi-word constituents in both languages. Crucially, participants encountered a codeswitch before the target region. We argued that this experimental design would likely more closely reflect the types of codeswitching that bilingual speakers encountered in natural settings.

In order to fully contextualize our results from the three visual world experiments, we first conducted a quantitative study of how Mixed NPs were produced in a corpus of Spanish-English bilingual speech (Deuchar et al., 2012). We reported the results of this study in Chapter 2 of the dissertation. Replicating previous studies, we found an overwhelming preference (97%) for the use of Spanish masculine articles with English nouns regardless of the gender of the Spanish translation equivalent. Not only were feminine marked Mixed NPs exceedingly rare ($< 3\%$) but they were less prevalent than English articles with Spanish nouns (5%), which are generally thought to be an infrequent Mixed NP construction (Jake et al., 2002a). We further explored the nature of gender assignment in our Mixed NPs. Namely, we found that contrary to some theories, biological gender did not categorically constrain feminine gender assignment in Mixed NPs. Thus, even when referring to discourse-established feminine human referents, speakers continued to show preferences for use of masculine articles in Mixed NPs. We demonstrated that the results from the quantitative study highlighted the exceptional status of feminine marked Mixed NPs in codeswitching. We cited as further evidence for this hypothesis the prevalence of disfluencies and single word switches when feminine marked Mixed NPs were produced. Following this observation, we proposed viewing codeswitching from an emergentist perspective, suggesting that the preference for the use of masculine article in codeswitching was likely a learned pattern and therefore, bilinguals must be situated in a community of codeswitchers in order to learn this pattern. Subsequently, differences in linguistic profile, i.e. whether a

bilingual is a codeswitcher, should result in group differences in the comprehension of codeswitched speech and specifically in the manner that grammatical gender is processed in codeswitched speech.

Having established a quantitative foundation for the use of grammatical gender in the production of Spanish-English codeswitching, we directed our attention to the main experiments of the dissertation, specifically, the three visual world experiments. To summarize, these experiments were designed to test the extent to which grammatical gender, a morpho-syntactic feature present in Spanish and absent in English, modulates the real-time processing of Spanish-English codeswitching in two groups of Spanish (L1) – English (L2) bilinguals split on the basis of place of birth (U.S. born v. Latin born). Using codeswitching as the empirical dataset, we argued that we directly test the predictions set forth by the PDC model. In Chapter 3, we describe the linguistic profile of our participants and the experimental design of or three experiments. Demographic and proficiency measures broadly revealed that our U.S. born bilingual group ($N = 21$) are English dominant even though they all describe Spanish as their first language. In contrast, the Latin born group ($N = 25$) which on average arrived in the U.S. at the age of 9, are balanced across their two languages as measured by a picture naming test and a grammar test conducted in each language.

Next, we described the basic experimental design of all three visual world experiments. The design was based off of the 2-picture design used in Lew-Williams and Fernald (2007). The first experimental block, the Spanish unilingual block, was conducted in order to replicate the results reported in Lew-Williams and Fernald. In their study they tested children and adults to examine whether speakers use grammatical gender encoded on the definite article as a facilitatory morpho-syntactic cue in real-time processing. They presented 2 pictures to participants while they heard a simple Spanish carrier phrase, e.g. *Encuentra el/la* _____ "Find the$_{masc/fem}$ _____." We embedded our items in the same carrier phrase. Lew-Williams and Fernald discovered that speakers were able to use the gender encoded in the definite article to orient their eyes more quickly towards target items in different gender contexts, thus, eliciting anticipatory effects. We viewed that it was necessary to replicate these results for two reasons. The first issue concerned methodological differences with Lew-Williams and Fernald. The Lew-Williams

and Fernald study was primarily aimed at testing young children and therefore repeated a small subset of items. In addition, the study made use of a similar but not equivalent experimental technique known as the looking-while-listening procedure. In our own experiment, we had 56 unique trials and used a desk-mounted eyetracker. Second, we analyzed the results from a control group of Spanish monolinguals ($N = 24$) recruited for a separate study (Perrotti, 2012). Our logic was that we would necessarily first have to demonstrate the presence of anticipatory effects (i.e. facilitatory effects) in a group of monolingual speakers in order to have a high degree of confidence that our method would tap into the processing of gender. We further hypothesized that because our group of participants were bilingual speakers immersed in the U.S. and who codeswitch frequently, that the way they process gender in Spanish may have bee impacted through bilingualism. Without a control monolingual group, the question would have remained open as to whether a null effect (i.e. no anticipatory effect) was due to our experimental materials or due to their bilingual profile.

The second experimental block, the lexical-level codeswitching block, investigated how grammatical gender influences the processing of single word codeswitches. As in the Spanish block, we used simple invariant carrier phrases and included single English noun switches. Furthermore, we introduced a new experimental manipulation not present in the Spanish block. All experimental items were phonological competitors. Previous research has revealed that phonological competition typically elicits a competitor effect, reflecting delayed processing relative to a neutral baseline (Allopenna et al., 1998). Additionally, although all experimental items were phonological competitors, their translation equivalents differed in gender. We crossed phonological competition with Spanish articles such that all experimental items appeared once with its gender match article and once with its gender mismatch article. Following the predictions of the PDC model, we hypothesized that masculine conditions should equally elicit competitor effects for both match and mismatch conditions, given the observed preference for masculine articles in the production of codeswitching. In contrast, we predicted that the feminine conditions should be markedly different from each other. Specifically, feminine mismatch targets which are unattested in production should elicit pronounced late convergence of fixations.

In the third experimental block, we followed the basic design of the the lexical level codeswitching block, with the addition of two features. First, we embedded experimental items in variant sentential contexts. We rationalized that this manipulation would more closely mirror codeswitching as it would be heard in natural settings (e.g. Myers-Scotton, 2006). Furthermore, we introduced a previous codeswitch before our target region of interest in order to cue the participant to the impending presence of codeswitches. Moreover, as a means to encourage listening for comprehension, we also added a plausibility judgment to the end of each trial. Finally, as an additional manipulation, we counterbalanced the language of the beginning of each trial. This manipulation permitted us to explore whether initial language influences how codeswitching is processed. Although the PDC model does not directly make predictions on the basis of language presentation, we hypothesized that bilinguals were more likely to show Spanish-like behavior in Spanish-first codeswitches. That is, participants were more likely to show anticipatory effects for masculine conditions contra what has been observed in the production of codeswitching.

In Chapter 4 we reported the results of the three experimental blocks. We began with a description of the complexities surrounding the data analysis of visual world studies and how we selected our statistical analysis, which utilized a simple and more traditional approach to behavioral measures analysis. Specifically, we aggregated the eye-tracking data that we obtained from participants in 100 msec time regions starting at the article onset. We extended this analysis through 800 msec for the Spanish block and through 1000 msec for the codeswitching blocks. We then conducted paired-t tests on each region between fixations to target items and fixations to distractor items. For the Spanish block, in order to determine the presence of an anticipatory effect, we tested for an earlier divergence of significantly higher looks to target items in the timecourse for different gender trials as compared to same gender trials. For the codeswitching blocks, the analysis was more complex as both the potential for anticipatory and competitor effects was possible. As in the Spanish block, an anticipatory effect was indicated by the presence of significantly higher looks towards target items that were driven by the grammatical gender of the Spanish article and would likely only arise for gender match conditions. In contrast, divergent looks that happened late in the timecourse indicated the

presence of a competitor effect due to phonological competition. Furthermore, we hypothesized competitor effects should result in similar timecourses between match and mismatch conditions of the same gender. Although linguistic stimuli can only begin to affect eye movements 150 – 200 msec after presentation, we started from the article onset in order to better account for possible baseline effects, which are random effects present in many eye-tracking data (e.g. Barr, 2008). Due to our target stimuli being embedded in sentential contexts (and variant contexts in the last block), the use of a 2-picture display, and the fact that participants were allowed free view of the visual display before the target region of interest, we anticipated possible baseline effects in our data.

The results from the Spanish block presented three key findings. First, we confirmed the applicability of our procedure and our materials as we replicated the original findings of Lew-Williams and Fernald (2007). Second, the U.S. born bilinguals showed no evidence for the use of grammatical gender as a facilitatory cue in sentence processing. However, their timecourse to processing was similar to Spanish monolinguals in same gender trials. Third, the Latin born bilinguals only revealed evidence for an anticipatory effect in feminine conditions. In the lexical-level codeswitching block, both bilingual groups revealed strong anticipatory effects but in contrasting patterns. Specifically, the U.S. born bilinguals revealed an anticipatory effect for masculine conditions whereas the Latin born group exhibited an anticipatory effect in processing for feminine conditions. In addition, the U.S. group showed weak modulation of gender in the feminine conditions. Although feminine match trials diverged earlier than feminine mismatch conditions, this divergence happened late in the timescale, thus indicating an effect of phonological competition. In contrast, the Latin born group showed weak modulation of gender but for the masculine conditions. Masculine match trials exhibited earlier divergence towards target items than mismatch conditions, but this divergence occurred late in the timescale, thus, revealing an effect of phonological competition. Finally, in the sentence-level codeswitching block, the U.S. born group exhibited little to no modulation due to the article in all conditions except for the feminine mismatch condition in the Spanish-first codeswitching trials. Somewhat puzzlingly, this group showed a strongly anticipatory effect for feminine mismatch trials. In contrast, the results of the Latin born bilinguals showed differing pat-

terns of processing for the feminine conditions dependent on the language of the first word of the codeswitched sentence. In English-first codeswitches, the Latin group exhibited a tenuously weak anticipatory effect for feminine conditions. In the Spanish-first codewitches, this transient anticipatory effect is neutralized in feminine match conditions. Masculine match conditions showed little modulation due to the language of the first word of the codeswitched utterance. On the other hand, the masculine mismatch conditions showed weak modulation due to the language manipulation such that Spanish-first codeswitches revealed costlier integration for masculine mismatch targets than English-first codeswitches.

In the next section, we discuss our results in the broader context of experimental approaches to codeswitching, dynamic changes to the processing of gender in a bilingual context, and the Production-Distribution-Comprehension (PDC) model. We end the chapter with future directions and concluding remarks

5.2   General Discussion

5.2.1   Gender Processing and Bilingualism

Throughout all of the experiments described in this dissertation, the main morpho-syntactic structure of focus has been grammatical gender. We focused on this feature due to its extensive study in theoretical and experimental domains and because it represents a cross-linguistic difference between Spanish and English. Consequently, one question that arises is how a bilingual negotiates cross linguistic differences that arise between their two languages. Moreover, this structure is all-the-more of interest given its prevalence in Spanish-English codeswitching. Several researchers have noted that switches between the Spanish article and a following English noun are fairly common in Spanish-English codeswitching (e.g. Poplack, 1980), yet researchers continue to debate the main factors involved in gender assignment of these Spanish article – English noun switches.

The results reported in Chapter 2 add to the growing body of evidence that suggests that masculine is generally preferred as the default article in the production of codeswitching. Consequently, we observed that our bilingual groups did not process grammatical gender in Spanish, their first language, in the same man-

ner as a group of Spanish monolinguals, who replicated the gender anticipatory effect first described in Lew-Williams and Fernald (2007). In contrast, the Latin born Spanish-English bilinguals only showed an anticipatory effect for feminine conditions. The U.S. born Spanish-English group differed from both groups in that participants did not show any gender anticipatory effect for either feminine or masculine conditions.

These results further our understanding of the dynamic nature of bilingualism and the informativeness of grammatical gender in real-time processing. Specifically, we note that had we conducted an experiment only in the Spanish unilingual block, we would have simply concluded that Spanish-English bilinguals do not process gender in the same way as Spanish monolinguals. In addition, we would have stated that U.S. born bilinguals who are largely English-dominant, i.e. heritage language speakers (Montrul, 2008), lack the ability to use grammatical gender as a facilitatory cue in sentence processing. However, the results from the lexical-level codeswitching block challenge this view. Here, we found that both groups of bilinguals exhibited the gender anticipatory effect; however, this effect was qualified by gender and group. Namely, the Latin born group continued to show an anticipatory effect in feminine conditions whereas the U.S. born group, the group that previously had failed to show any anticipatory effects, demonstrated the use of grammatical gender in real-time processing for masculine conditions.

These findings are thought-provoking in light of the observation that both groups of bilinguals are Spanish (L1) - English (L2) bilinguals. Interestingly, on self-reported demographic information, both groups did not differ in age of acquisition of Spanish, and both reported their age of acquisition of English as later than Spanish. Nevertheless, the key difference between the two groups was place of birth. Consequently, the Latin born group reported an even later age of acquisition for English than the U.S. born group. Some researchers would argue that this demographic difference point towards a case of incomplete acquisition of core morpho-syntactic features such as grammatical gender in Spanish (Anderson, 1999; Montrul, 2008). On the one hand, the performance of the U.S. born group in Spanish would support this claim as the group appears to identify target items without regard to grammatical gender. However, the same group strongly demonstrated the presence of an anticipatory effect for masculine gender with a similar

albeit not equivalent task which includes Spanish articles paired with English target items. Although both the Spanish unilingual and lexical-level codeswitching block experimentally investigate the influence of grammatical gender in processing, in the Spanish unilingual block this is manifested through correct identification of target items that *always* matched in gender and varied on whether the distractor matched in gender or not. In contrast, the lexical-level codeswitching block (and the sentence-level codeswitching block) *manipulated* the Spanish article used with each target item. Therefore, in half of the experimental conditions, the mismatch conditions, the task involved correct identification of a target item that translated into Spanish would result in an agreement error. Here, if gender is operant in guiding sentence processing, then gender mismatch trials should have resulted in difficult integration of target items. Conversely, match trials, which were always paired with different gender distractors, were potentially informative contexts where grammatical gender could facilitate target identification. Thus, we suggest that the results of the U.S. born bilingual group indicate that they are at least partially able to use gender in online processing but they exhibit this online use at a different timescale than Spanish monolinguals.

Furthermore, we point out that the original study by Lew-Williams and Fernald (2007) used a young group of children who are likely to grow up to become the same type of participants as in our U.S. born group. Specifically, the children who participated in the Lew-Williams and Fernald study were from East Palo Alto, California. These children ranged in age from 3 to 3.5 years yet they exhibited an anticipatory effect for different gender trials[1]. This observation leads us to speculate on the dynamic processes that have occurred in how the U.S. group utilize grammatical gender information. If indeed the children recruited in Lew-Williams and Fernald are members of the same population as our U.S. born group but at an earlier developmental stage, the results of their study would offer indirect evidence that the U.S. group in fact exhibited anticipatory effects in Spanish at an earlier age and subsequently, experienced developmental changes. This observations leads to a further question. Why did the U.S. bilinguals show an anticipatory effect for masculine conditions in the lexical-level block in contrast to the Latin-born group?

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[1]Grammatical gender was collapsed across trials; thus, we cannot be certain if any gender differences exist as in, for example, the case of our Latin born participants.

Further research is needed to investigate what may be underlying this finding but we posit that the finding that masculine is privileged over feminine for this group of bilinguals is a finding that is compatible with previous studies on heritage speakers. Specifically, heritage speakers of Spanish have been shown to perform more accurately on masculine than feminine on a host of tasks (e.g. Montrul, Foote, & Perpiñán, 2008; Eddington, 2002).

We turn then to the finding that the Latin-born group consistently exhibits an anticipatory effect for feminine conditions in both the Spanish unilingual and lexical-level codeswitching block. The differences between the two bilingual groups point towards possible different processes driving their results. Based on the consistent results for the masculine match condition across the lexical-level and the English-first and Spanish-first codeswitches of the sentence-level codeswitch block in which we found little modulation of processing due to gender (significant divergent looks at Regions 700, 800, and 800, respectively), we hypothesize that the reliance upon masculine as an informative cue has changed for this group of bilinguals. That is, we argue that, unlike the U.S. bilinguals, the timecourse of gender processing has not changed for this group but rather their reliance on masculine as an informative cue has changed. The results do not allow us to definitively place the locus of this effect on the act of learning English alone, as due to increased use of and exposure to codeswitching, or as a conjunction of the two. In the case of English exposure changing the informativeness of masculine, there is certainly a growing tradition of psycholinguistic research that shows how the second language can influence the first language (e.g. Dussias & Sagarra, 2007; Dussias & Cramer Scaltz, 2008; Brown & Gullberg, 2008). Here, of interest is that English lacks gender but this exposure only differentially affects masculine gender in Spanish. Possibly, this differential effect is compatible with hypotheses that suggest that masculine is the unmarked gender in Spanish (e.g. Eddington, 2002). Conversely, as the more marked gender, potentially feminine is more preserved in the face of English exposure. In other words, the feminine gender is least English-like and therefore is not affected. On the other hand, if the shift in how masculine is processed is due to codeswitching, then it may suggest that bilinguals have dynamically changed how they process masculine gender because masculine gender no longer uniquely identifies masculine only items from Spanish. Rather, masculine as the preferred

article in codeswitching, can also potentially signal an impending codeswitch. Under this view, the fact that feminine maintains an anticipatory effect highlights its mainly exclusive use in Spanish and also corroborates our hypothesis that the highly infrequent feminine marked codeswitches discussed in Chapter 2 are exceptional codeswitches.

Nevertheless, that all of this hypotheses presented in this section are subject to further investigations. We remain optimistic, however, in promoting the view that investigating codeswitching is a promising endeavor that can help fill critical gaps of our understanding of bilingualism more generally.

5.2.2   Implications for the PDC Model

One of our primary goals in this dissertation was to use codeswitching as a means to test the predictions of the Production-Distribution-Comprehension (PDC) model (Gennari & MacDonald, 2009). We argued that codeswitching presents an ideal test case for verifying the model due to its unique status as a spoken language phenomenon that derives from a bilingual's knowledge of her two languages. Working within an emergentist perspective, we hypothesize that the choices that bilingual speakers make in the production of codeswitching should result in observable consequences in the comprehension of codeswitched speech.

In focusing on grammatical gender, we made use of an observed production asymmetry which according to the PDC model should subsequently be empirically observable in comprehension. Because the model is an emergentist framework, we advocated for the necessity to investigate comprehension in a self-reported group of habitual codeswitchers. Interestingly, both groups of bilinguals did not differ in terms of their use of and exposure to spoken codeswitching (both groups reported less experience with written codeswitching both in writing and reading). On the one hand, this self-reported measured would predict that the two groups of bilinguals should behave similarly as they both are exposed to a learnable system. However, the results of the codeswitching blocks point towards group differences. Here, we present the summarized results of the two groups in both the lexical-level and sentence-level blocks with the further subdivision of English-first and Spanish-first conditions for the sentence-level block. We present the results in this

format in order to investigate how the same condition is affected by experimental manipulation.

Table 5.1: Summary of Results for Codeswitching Block

		Lexical-level	English-first	Spanish-first
U.S. born	Feminine Match	700	700	800
	Feminine Mismatch	900	800	400
	Masculine Match	400	700	800
	Masculine Mismatch	900	800	800
Latin born	Feminine Match	400	600	800
	Feminine Mismatch	800	800	800
	Masculine Match	700	800	800
	Masculine Mismatch	900	700	900

We present the first time region in which participants significantly diverged towards target items over phonological distractors. Time regions represent the time bin from article onset.

The results for the U.S. born group are not fully compatible with the predictions of the PDC model. The feminine match condition showed little differences across experimental blocks. That is, U.S. bilinguals exhibited no modulation of gender processing for feminine match trials across all experimental presentations. This suggests that feminine gender provides no benefit to the U.S. group in processing of codeswitched utterances. Similarly, masculine mismatch trials indicated that there was little modulation of how this group processed these items. Both of these findings on their own would simply suggest that these bilinguals are not using gender in real-time processing.

However, the results for the remaining conditions do not support this view. Even more vexing, the results for the masculine match and the feminine mismatch show mirror patterns of results. Namely, masculine match conditions show a cline of decreasing facilitation from lexical-level to sentence-level codeswitching. In the lexical-level block, bilinguals exhibited an anticipatory effect which runs counter to the predictions of the PDC model. Unexpectedly, the feminine mismatch condition exhibited a decreasing cost of integration across the three presentation modes. Here, the U.S. born group showed late integration in both the lexical-level and the

English-first codeswitching presentations; however, they showed a robust anticipatory effect in the Spanish-first codeswitching trials. We cannot account for this finding which is incompatible to both the predictions of the PDC model and to our understanding of gender processing.

In contrast to the U.S. born group, the results for the Latin group were more compatible with the PDC model. First, we observe that the feminine match condition reflected a cline of increasing difficulty from lexical-level codeswitching, to English-first codeswitches, to Spanish-first codeswitches. In contrast, the feminine mismatch condition revealed no modification based on presentation. In effect, the feminine mismatch targets were equally difficult to integrate across all three presentations. Coupled with the finding that the Latin born group exhibited anticipatory effects for the feminine gender in the Spanish block, these observed changes across presentation that only affected the feminine match trials indicate that feminine gender modulated how the Latin born group processed codeswitching. Furthermore, this cline of integration reflects a dynamic change in the informativeness of feminine gender across the three experimental presentations. In the lexical-level block, the presentation mode remains similar to the Spanish block; furthermore, this anticipatory effect reflects this group's performance in Spanish. In the English-first codeswitching trials, we observe that the feminine gender becomes less reliable as an informative cue. Finally, in the Spanish-first codeswitching trials, there is no facilitation due to feminine gender.

We interpret the results for the feminine conditions as suggesting that the Latin born bilinguals least expected a feminine marked codeswitch in the Spanish-first trials. We suggest two alternatives for why the Spanish-first codeswitching trials resulted in less expectation for feminine codeswitches in this group. The first alternative is driven by an expectancy-based account. Potentially, the language of the first word of an utterance sets expectations for upcoming codeswitches. As we discussed in Chapter 2, we hypothesize that the feminine marked codeswitches are exceptional and represent unplanned switches. Potentially, the Spanish-first trials also enhanced expectations that feminine articles be followed by Spanish words due to their low probability as codeswitches (Altarriba et al., 1996). However, under this view, we would have expected a similar difficulty to integration for the lexical-level codeswitching block as the language of the first word was invariably Spanish.

Alternatively, we note that our language manipulation necessarily resulted in an extra codeswitch for Spanish-first codeswitches as compared to English-first codeswitches. Recall the structure of our trials in the sentence-level codeswitching block:

(30) English-first codeswitching trial

The man **dijo que** [**el** garlic] was in the kitchen
The man said that the$_{\text{masc}}$ garlic was in the kitchen

"The man said that the garlic was in the kitchen."

(31) Spanish-first codeswitching trial

La mujer está ordering [**la** cape] **de la revista**
The$_{\text{fem}}$ woman is ordering the$_{\text{fem}}$ cape from the$_{\text{fem}}$ magazine

" The woman is ordering the cape from the magazine."

The English-first codeswitching trials followed an alternational pattern of codeswitching such that the utterance began with an English multi-word constituent, followed by a Spanish multi-word constituent, and a final switch back to English (e.g. A B A structure, Muysken, 2000). In contrast, due to our constraint that a previous switch occur before the target codeswitch, the Spanish-first codeswitching trials resulted in one extra switch, which generally occured before the target switch (e.g. A B A B structure). Potentially, the number of codeswitches in the trial may have inadvertently affected and lowered the probability of a codeswitch and hence may have resulted in a lower expectation for a codeswitched item for the participants. Alternatively, the extra may have induced a switching cost.

For the feminine mismatch trials, the lack of modulation across all experimental manipulation pointed towards a dispreference for feminine gender paired with English nouns that have masculine Spanish translation equivalents. This finding was fully compatible with the predictions of the PDC model. We attribute this finding to its unattested status in production. For the masculine match condition, we observed little to no modulation across the three presentations, suggesting no masculine gender facilitation. This finding was also predicted by the PDC model and supports the hypothesis that masculine gender is the preferred default article in codeswitching. However, we reported modest differences in the processing of the masculine mismatch condition across all three experimental presentations.

Nevertheless, this modulation was always in the predicted direction. That is, in contrast to the puzzling results from the U.S. group, we did not observe any facilitation that resulted in anticipatory effects for the masculine mismatch targets. Rather, we saw shifts in how late in the timecourse a competitor effect driven by phonological competition emerged.

We conclude that comprehension in codeswitching reflects the production patterns found in spoken codeswitching, thus supporting the PDC model. This result is qualified by linguistic profile such that heritage speakers do not exhibit this production asymmetry in comprehension.

5.3 Future Directions

The results of the eye-tracking experiments leave several promising avenues for future experiments. Here, we briefly outline a few. First, we return to the results of the quantitative study in Chapter 2. In addition to the production asymmetry between masculine and feminine gender, we also found that Mixed NPs that have an English determiner and a Spanish noun are infrequent. The visual world paradigm allows us to explore whether the switch direction affects processing. As noted in our literature review, the studies that experimentally investigate codeswitching have mainly investigated codeswitching from one language into another. This follow-up experiment would allow us to explore whether the direction of switching is also a part of the distributional patterns that emerge in production.

Second, we advocate for a comparative approach to codeswitching. We have begun the first steps in this direction as we compared two Spanish-English bilingual groups that differed based on their language dominance (English-dominant v. balanced). A comparative approach allows us to broaden our base of participants and build a continuum. Specifically, we can further our understanding of codeswitching in terms of its learnability as a specialized bilingual skill. The inclusion of at least two more groups of bilinguals will better elucidate this issue. On the one side, Spanish-dominant bilinguals will help our understanding of the dynamic effects of English on the processing of gender, both in Spanish and in codeswitching. Specifically, this group will help us better understand whether the shifting informativeness of masculine gender is due principally to codeswitching or if it is

a result of language contact with English. On the other end, we can ask whether English-Spanish bilinguals can also learn the patterns used in codeswitching. Research that bilinguals who are highly proficient in an L2 are capable of utilizing gender in a native-like fashion (Dussias, Valdes Kroff, Guzzardo Tamargo, & Gerfen, n.d.; Foucart & Frenck-Mestre, 2011; Hopp, 2012). We can further investigate whether English-Spanish bilinguals will learn the production asymmetry of gender use in codeswitching.

Finally, we suggest a new avenue of research based on the view that codeswitching is a specialized bilingual skill. As reviewed in Chapter 1, psycholinguists have observed non-selectivity in bilinguals both in production and comprehension. One provocative hypothesis that has emerged from this finding is that bilingualism confers cognitive advantages due to the extensive use of cognitive control (Kroll et al., 2012; Bialystok, 2005). More recently, evidence from neuroimaging has supported the implication of cognitive control in bilingualism. Researchers have identified a complex network of brain regions associated with cognitive control primarily (but not exclusively) associated with the prefrontal cortex cortex in bilinguals (e.g. Abutalebi & Green, 2007). Similarly, a group of researchers have recently proposed a unifying account that links conflict resolution both in linguistic and non-linguistic tasks. These researcher have implicated the left inferior frontal gyurs (LIFG) as a region of the brain associated with conflict resolution (Novick, Trueswell, & Thompson-schill, 2005, 2010). We suggest that bilingualism can be considered a unique case of conflict resolution due to potentially competing language representations across the two languages. Additionally, codeswitching occurs in situations where cross-lingusitic differences can arise, as in the case of the focus of this dissertation—grammatical gender. We therefore hypothesize that the comprehension of codeswitched speech may reveal increased activation to the LIFG, due to heightened engagement of cognitive control. As we have argued throughout this dissertation, if codeswitching is learned, then this increased activation should differ based on the linguistic profile of the bilingual speaker.

In sum, we are encouraged by the number of research avenues that codeswitching provides. We believe that the study of codeswitching has the potential to complement several inter-disciplinary perspectives. Apart from the future directions that we have listed here, we advocate that codeswitching is unique in its

ability to link several different fields. Although it has not been the intense focus of study, we believe that the study of codeswitching has implications for traditional fields such as language contact and syntactic theory, and new approaches such as the role of cognitive control in language.

5.4   Conclusions

In this dissertation, we set out to employ an eye-tracking technique known as the visual world paradigm to study the role of grammatical gender in the processing of Spanish-English codeswitching. To that extent, we recruited two groups of Spanish-English bilinguals from New York City. These two groups shared some features in their linguistic profiles such as Spanish being their first language and their use of and exposure to codeswitching. Nevertheless, they differed in one crucial respect—language dominance. Although both groups acquired Spanish first, the group of bilinguals born in the U.S. were English dominant as measured by picture naming and grammar tests. On the other hand, the group born abroad arrived in the U.S. as children and performed equally in their two languages in the same proficiency measures. By comparing these two groups of bilinguals, we were able to explore how grammatical gender is affected by language dominance and proficiency. The results of our experiments highlight the applicability of this experimental paradigm for the study of a socially stigmatized speech register that is also mainly a spoken language phenomenon. Furthermore, we used codeswitching as a test case to investigate the link between production and comprehension thus contributing to debates in sentence processing. We utilized the insights brought forth from structural linguistics and sociolinguistics to investigate comprehension from an experimental perspective.

Broadly speaking, the studies conducted in this dissertation make significant contributions to our understanding of how bilinguals process multiple languages both in unilingual and dual-language contexts. The field of experimental approaches to codeswitching is a relatively new approach to bilingualism. The studies described herein constitute the first systematic investigation of the processing of codeswitched speech in the auditory domain using multi-word constituents in each language. In addition to revealing group differences based on language dominance,

these studies further our understanding of the dynamic nature of bilingualism. Specifically, the studies in conjunction indicate that a second language can influence the manner in which the first language is processed. Moreover, the studies confirm that distributional patterns found in production impact comprehension. We utilized a novel approach to investigate this link by harnessing a cross-lingusitic difference between Spanish and English that nevertheless is prominent in Spanish-English codeswitching. Besides applying codeswitching as an innovative empirical data set to further contribute to debates on emergentism and langauge contact, our studies highlight the importance of understanding how language is used in order to study sentence processing, thus bridging quantitative studies utilized in corpus studies with experimental approaches in controlled laboratory settings.

Experimental Materials

A.1 Introduction

This appendix includes the materials used in our visual world experiments. We subdivide the experimental stimuli into three sections following the presentation order of the three experiments in our experimental session. We begin with the Spanish experiment, followed by lexical-level codeswitching, and end with sentence-level codeswitching. Although the experimental stimuli used in the two codeswitching experiments are identical, we list them separately because the sentence-level codeswitching experiment includes variant sentential frames. Accordingly, we list the experimental stimuli in this last experiment with their sentential frame.

A.2 Spanish Materials

We list the materials used in the Spanish experiment by experimental quartet. That is, each item in a quartet was paired with each other item in the quartet to create 4 experimental conditions. One pair of each quartet appeared in only one experimental list. Consequently, 4 experimental lists were created. A mirror version of each experimental list was also created in order to counterbalance position on the 2-picture display. Each experimental item is presented with its English translation listed directly below.

Table A.1: Spanish materials used in the Spanish visual world experiment.

Quartet	Feminine	Feminine	Masculine	Masculine
1	calabaza	tetera	semáforo	ajo
	pumpkin	kettle	stoplight	garlic
2	vaca	lata	teclado	vestido
	cow	can	keyboard	dress
3	aguja	cuna	ladrillo	queso
	needle	cradle	brick	cheese
4	bandeja	taza	periódico	lazo
	tray	cup	newspaper	ribbon
5	basura	rueda	hueso	cuchillo
	garbage	wheel	bone	spoon
6	bolsa	jaula	cuaderno	pañuelo
	bag	cage	notebook	handkerchief
7	cerveza	vela	cuadro	espejo
	beer	candle	notebook	mirror
8	tarjeta	langosta	nido	regalo
	card	lobster	nest	gift
9	pirámide	torre	barril	diamante
	pyramid	tower	barrel	diamond
10	cárcel	miel	limn	tenedor
	jail	honey	lemon	fork
11	nube	llave	peine	lápiz
	cloud	key	comb	pencil
12	flor	cruz	cinturón	aceite
	flower	cross	belt	oil
13	nariz	leche	café	jamón
	nose	milk	coffee	ham
14	televisión	carne	avión	pie
	television	meat	airplane	foot
15	nieve	nuez	botón	maquillaje
	snow	walnut	button	make-up

Table A.1 – *Continued from previous page*

Quartet	Feminine	Feminine	Masculine	Masculine
16	luz	frente	jardín	corazón
	light	forehead	garden	heart
17	tarántula	banana	estéreo	canguro
	tarantula	banana	stereo	kangaroo
18	jirafa	dinamita	dinsoaurio	hipopótamo
	giraffe	dynamite	dinosaur	hippopotamus
19	perla	pizza	pingüino	helicóptero
	pearl	pizza	penguin	helicopter
20	calculadora	cucaracha	acuario	camello
	calculator	cockroach	acquarium	camel
21	motocicleta	ambulancia	búfalo	gorila
	motorcycle	ambulance	buffalo	gorilla
22	ensalada	cebra	telescopio	panda
	salad	zebra	telescope	panda
23	computadora	bota	dominó	cocodrilo
	computer	boot	domino	crocodile
24	hamaca	trompeta	micrófono	cono
	hammock	trumpet	microphone	cone
25	cabaña	patata	calendario	insecto
	cabin	potato	calendar	insect
26	pirata	medalla	microscopio	átomo
	pirate	medal	microscope	atom
27	jarra	tortuga	círculo	catálogo
	pitcher	turtle	circle	catalogue
28	pera	bicicleta	diccionario	estadio
	pear	bicycle	dictionary	stadium
29	fruta	blusa	templo	circo
	fruit	blouse	temple	circus
30	guitarra	bomba	aluminio	aeropuerto
	guitar	bomb	aluminum	airport
31	pipa	cortina	monstruo	océano

Table A.1 – *Continued from previous page*

Quartet	Feminine	Feminine	Masculine	Masculine
	pipe	curtain	monster	ocean
32	lámpara	pasta	disco	castillo
	lamp	pasta	disk	castle
33	medicina	tumba	piano	tabaco
	medicine	tomb	piano	tabacco
34	planta	montaña	plato	estómago
	plant	mountain	plate	stomach
35	cámara	rosa	planeta	banco
	camera	rose	planet	bank
36	escuela	botella	palacio	teléfono
	school	bottle	palace	telephone
37	tirita	piña	boleto	faro
	bandage	pineapple	ticket	lighthouse
38	langosta	zanahoria	caramelo	pato
	lobster	carrot	candy	duck
39	cereza	mochila	horno	ajo
	cherry	backpack	oven	garlic
40	olla	mantequilla	semáforo	murciélago
	pot	butter	stoplight	bat
41	cesta	servilleta	loro	cepillo
	basket	napkin	parrot	brush
42	uña	mariposa	teclado	pino
	nail	butterfly	keyboard	pinetree
43	tarjeta	bala	pavo	lazo
	card	bullet	turkey	bow
44	lata	manzana	ladrillo	queso
	can	apple	brick	cheese
45	aguja	vaca	veneno	nido
	needle	cow	poison	nest
46	jaula	paloma	cerdo	zapato

Table A.1 – *Continued from previous page*

Quartet	Feminine	Feminine	Masculine	Masculine
	cage	pigeon	pig	shoe
47	almohada	toalla	burro	helado
	pillow	towel	donkey	ice cream
48	campana	alfombra	anillo	hueso
	bell	carpet	ring	bone
49	taza	bata	oso	cuchillo
	cup	robe	bear	knife
50	rueda	vela	mono	huevo
	wheel	candle	monkey	egg
51	basura	cerveza	cuaderno	pañuelo
	garbage	beer	notebook	handkerchief
52	bolsa	barba	pájaro	desayuno
	bag	beard	bird	breakfast
53	pierna	hoja	sombrero	regalo
	leg	leaf	hat	gift
54	cola	llave	edificio	gato
	tail	key	building	cat
55	iglesia	luna	perro	cuadro
	church	moon	dog	painting
56	mesa	cama	libro	dinero
	table	bed	book	money

A.3   Lexical-level Codeswitching Materials

We adopt a slightly different presentation for our lexical-level codeswitching experiment due to the complex design. We first present the materials used with the experimental words. Recall that experimental words consisted of phonological competitors with Spanish translation equivalents that differed in grammatical gender. Furthermore, we paired each experimental word with a non-phonological competitor that also differed in gender. Therefore, we present experimental materials as

quartets as in the Spanish experiment; however, unlike the Spanish experiment, control materials always appeared as distractors and only with the appropriate experimental target word, e.g. stapler (fem) with cheese (masc). After the experimental quartets, we present the filler doublets. For economy of space we list two doublets per row. Fillers always appeared in the same pairing in all experimental lists. There were 6 unique experimental lists for a total of 12 lists with the inclusion of the counterbalancing of position in the 2-picture display.

Table A.2: English materials used in the lexical-level codeswitching visual world experiment.

Quartet	Feminine Experimental	Masculine Experimental	Masculine Control	Feminine Control
1	stapler	stadium	cheese	tarantula
	grapadora	estadio	queso	tarántula
2	backpack	bank	telephone	chalk
	mochila	banco	teléfono	tiza
3	bag	bat	duck	pearl
	bolsa	murciélago	pato	perla
4	beach	beak	crocodile	guitar
	playa	pico	cocodrilo	guitarra
5	braid	brain	stoplight	tombstone
	trensa	cerebro	semáforo	tumba
6	buckle	bucket	camel	crib
	hebilla	cubo	camello	cuna
7	butter	bumper	cigarette	lamp
	mantequilla	parachoques	cigarrillo	lámpara
8	cabin	cabinet	barrel	beard
	cabaña	gabinete	barril	barba
9	cake	cane	painting	flower
	torta	bastón	cuadro	flor
10	calculator	cactus	domino	blanket
	calculadora	cacto	dominó	cesta
11	camera	castle	gift	bed

Table A.2 – *Continued from previous page*

Quartet	Feminine Experimental	Masculine Experimental	Masculine Control	Feminine Control
	cámara	castillo	regalo	cama
12	can	cabbage	squid	school
	lata	col	calamar	escuela
13	candle	candy	balloon	boot
	vela	caramelo	globo	bota
14	cape	cable	dictionary	frying pan
	capa	cable	diccionario	sartén
15	carrot	cannon	truck	cherry
	zanahoria	cañón	camión	cereza
16	chalkboard	chocolate	forest	door
	pizarra	chocolate	bosque	puerta
17	cloud	clown	bra	snake
	nube	payaso	sujetador	culebra
18	curtain	curler	lighthouse	pasta
	cortina	rulo	faro	pasta
19	dynamite	dinosaur	glove	butterfly
	dinamita	dinosaurio	guante	mariposa
20	fireplace	firetruck	diamond	nail
	chimenea	camión de bomberos	diamante	uña
21	garbage	garden	fork	pipe
	basura	jardí	tenedor	pipa
22	gargoyle	garlic	lemon	carpet
	gárgola	ajo	limón	alfombra
23	green bean	greenhouse	comb	church
	judía verde	invernadero	peine	iglesia
24	hammock	hammer	notebook	leaf
	hamaca	martillo	cuaderno	hoja
25	label	ladle	tablecloth	chimney
	etiqueta	cucharón	mantel	chimenea
26	lid	lip	helicopter	basket

Table A.2 – *Continued from previous page*

Quartet	Feminine Experimental	Masculine Experimental	Masculine Control	Feminine Control
	tapa	labio	helicóptero	cesta
27	magazine	magnet	cone	base
	revista	imán	cono	base
28	marble	market	car	bell
	canica	mercado	carro	campana
29	mask	mattress	necklace	honey
	máscara	colchón	collar	miel
30	mermaid	mercury	pirate	robe
	sirena	mercurio	pirata	bata
31	muffin	muffler	hairbrush	pear
	magdalena	tubo de escape	cepillo	pera
32	mug	muscle	calendar	blouse
	taza	músculo	calendario	blusa
33	mustard	mustache	earring	pillow
	mostaza	bigote	pendiente	almohada
34	net	nest	tooth	house
	red	nido	diente	casa
35	paintbrush	paper	fire	bottle
	brocha	papel	fuego	botella
36	pineapple	pine tree	briefcase	bullet
	piña	pino	maletín	bala
37	plant	planet	mirror	skin
	planta	planeta	espejo	piel
38	plum	plug	bridge	key
	ciruela	enchufe	puente	llave
39	pot	pocket	belt	nose
	olla	bolsillo	cinturón	nariz
40	ribbon	river	tree	medal
	cinta	rio	árbol	medalla
41	rocking chair	rocket	hat	kitchen

Table A.2 – *Continued from previous page*

Quartet	Feminine Experimental	Masculine Experimental	Masculine Control	Feminine Control
	silla mecedora	cohete	gorro	cocina
42	root	roof	bread	battery
	raíz	techo	pan	pila
43	sausage	saw	bill	kettle
	salchicha	serrucho	billete	tetera
44	seagull	seahorse	buffalo	giraffe
	gaviota	caballito de mar	búfalo	jirafa
45	staircase	stereo	dress	pumpkin
	escalera	estéreo	vestido	calabaza
46	strawberry	straw hat	brick	forehead
	fresa	sombrero de paja	ladrillo	frente
47	surfboard	circus	telescope	bandage
	tabla de surf	circo	telescopio	tirita
48	tray	train	foot	potato
	bandeja	tren	pie	patata
49	turtle	turkey	monkey	lobster
	tortuga	pavo	mono	langosta
50	window	windmill	clock	meatball
	ventana	molino	reloj	albóndiga
51	sheet	shield	ticket	rose
	sábana	escudo	boleto	rosa
52	puppet	puzzle	heel	bicycle
	marioneta	rompecabezas	tacón	bicicleta
53	pigeon	pig	donkey	cow
	paloma	cerdo	burro	vaca
54	pork chop	porcupine	kangaroo	towel
	chuleta	puercoespín	canguro	toalla
55	cracker	crab	pelican	needle
	galleta	cangrejo	pelícano	aguja
56	dollhouse	dolphin	panda	napkin

Table A.2 – *Continued from previous page*

Quartet	Feminine Experimental	Masculine Experimental	Masculine Control	Feminine Control
	casita de muñecas	delfín	panda	servilleta
57	bee	beetle	fish	zebra
	abeja	escarabajo	pez	cebra
58	shell	shelf	cotton	printer
	concha	estante	algodón	impresora
59	trumpet	trombone	pacifier	cage
	trompeta	trombón	chupete	jaula
60	vein	vase	microscope	salad
	vena	florero	microscopio	ensalada

Table A.3: Fillers used in the lexical-level codeswitching visual world experiment.

Doublet	Feminine Filler	Feminine Filler	Doublet	Masculine Filler	Masculine Filler
1	mosquito	charcoal	31	squirrel	bonfire
	mosquito	carbón		ardilla	fogata
2	gorilla	parrot	32	walnut	bathtub
	gorila	loro		nuez	tina
3	barber	penguin	33	sandal	pizza
	peluquero	pingüino		sandalia	pizza
4	carpenter	aquarium	34	palm tree	flight attendant
	carpintero	acuario		palmera	azafata
5	pencil	atom	35	carpet	skirt
	lápiz	átomo		alfombra	falda
6	microphone	oven	36	flag	tongue
	mirófono	horno		bandera	lengua
7	palace	microwave	37	milk	salt
	palacio	microondas		leche	sal
8	sofa	poison	38	bomb	sword

Table A.3 – *Continued from previous page*

Doublet	Feminine Filler	Feminine Filler	Doublet	Masculine Filler	Masculine Filler
	sofá	veneno		bomba	espada
9	shoe	aluminum foil	39	wheel	snow
	zapato	aluminio		rueda	nieve
10	ham	knife	40	chain	tower
	jamón	cuchillo		cadena	torre
11	grass	rat	41	beer	cross
	pasto	ratón		cerveza	cruz
12	stomach	bull	42	moon	whale
	estómago	toro		luna	ballena
13	mailbox	sugar	43	sign	blood
	buzón	azucar		señal	sangre
14	snail	plate	44	table	letter
	caracol	plato		mesa	carta
15	sink	chess	45	watermelon	eyebrow
	lavaplatos	ajedrez		sandía	seja
16	airport	wine	46	street	wall
	avión	vino		calle	pared
17	rice	newspaper	47	grape	city
	arroz	periódico		uva	ciudad
18	coffee	glass	48	card	hand
	café	vaso		tarjeta	mano
19	circle	ice cream	49	apple	computer
	círculo	helado		manzana	computadora
20	lake	horse	50	arrow	crown
	lago	caballo		flecha	corona
21	arm	hill	51	fountain	seal
	brazo	cerro		fuente	foca
22	oil	keyboard	52	sheep	witch

Table A.3 – *Continued from previous page*

Doublet	Feminine Filler	Feminine Filler	Doublet	Masculine Filler	Masculine Filler
	aceite	teclado		oveja	bruja
23	finger	egg	53	onion	toaster
	dedo	huevo		cebolla	tostadora
24	ring	heart	54	gun	washing machine
	anillo	corazón		pistola	lavadora
25	building	ship	55	canoe	sponge
	edificio	barco		canoa	esponja
26	record	sun	56	blender	lettuce
	disco	sol		licuadora	lechuga
27	book	money	57	magnifying glass	chair
	libro	dinero		lupa	silla
28	cat	fan	58	nurse	spoon
	gato	abanico		enfermera	cuchara
29	tomato	scorpion	59	orange	coffee pot
	tomate	escorpión		naranja	cafetera
30	rabbit	elephant	60	suitcase	refrigerator
	conejo	elefante		maleta	nevera

A.4   Sentence-level Codeswitching Materials

We list the experimental materials for the sentence-level codeswitching experiment differently from the previous sections because of the inclusion of variant sentential frames. Therefore, we list each sentential frame with its experimental quartet. Recall that only the experimental items are target items in the experimental quartet, as in the lexical-level codeswitching experiment. In non-experimental trials, experimental items were paired non-phonological competitors with Spanish translation equivalents of different grammatical gender. As a result, after each sentential

frame we list the experimental quartet in the following order: **feminine experimental, masculine experimental, feminine filler,** and **masculine filler**. We further subdivide the experimental quartets by language, beginning with English-first codeswitched sentences. After we list the experimental quartets, we provide the filler doublets, also split by language.

A.4.1   Experimental Quartets

A.4.1.1   English-first codeswitches

1. The man **dijo que el/la** _____ was in the kitchen
   "The man said that the _____ was in the kitchen"

   > gargoyle
   >
   > garlic
   >
   > carpet
   >
   > lemon

2. The two children **colorearon juntos el/la** _____ in their coloring book
   "The two children colored the _____ in their coloring book"

   > braid
   >
   > brain
   >
   > tombstone
   >
   > stoplight

3. The girl in the white dress **está mirando el/la** _____ with interest
   "The girl in the white dress is looking at the _____ with interest"

   > bee
   >
   > beetle
   >
   > zebra
   >
   > fish

4. The boy waited **mientras su papá fue a buscar el/la** _____ in the kitchen

   "The boy waited while his father went to look for the _____ in the kitchen"

   > sausage
   >
   > saw
   >
   > kettle
   >
   > bill

5. The teacher **le pidió al niño que dibujara el/la** _____ in his notebook

   "The teacher asked the boy to draw for him/her the _____ in his notebook"

   > beach
   >
   > beak
   >
   > guitar
   >
   > crocodile

6. The artist **está pintando el/la** _____ for his new exhibition

   "The artist is painting the _____ for his new exhibition"

   > cake
   >
   > cane
   >
   > flower
   >
   > painting

7. The girl **está pintando el/la** _____ for her art class

   "The girl is painting the _____ for her art class"

   > greenbean
   >
   > greenhouse
   >
   > church
   >
   > comb

8. The young girl **le dijo a su mamá que había dibujado el/la _____** at
   school
   "The young girl told her mother that she had drawn the _____ at school"

   lid

   lip

   basket

   helicopter

9. All of the scientists **querían ir a ver el/la _____** up close
   "All of the scientists want to go to see the _____ up close"

   pot

   pocket

   nose

   belt

10. The kids **encontraron el/la _____** while they were cleaning their room
    "The kids found the _____ while they were cleaning their room"

    candle

    candy

    boot

    balloon

11. The art student **mostró el/la _____** that she drew yesterday in school
    "The art student showed the _____ that she drew yesterday in school"

    dynamite

    dinosaur

    butterfly

    glove

12. The museum security guard caught **la niña tocando el/la** _____ in the exhibition hall

"The museum security guard caught the girl touching the _____ in the exhibition hall"

  mermaid

  mercury

  robe

  pirate

13. The young man **no quizo mostral el/la** _____ to his neighbor

"The young man did not want to show the _____ to his neighbor"

  cabin

  cabinet

  beard

  barrel

14. The husband **le dijo a su esposa que necesitaba el/la** _____ for the auction

"The husband told his wife that he needed the _____ for the auction"

  trumpet

  trombone

  cage

  pacifier

15. The daughter **estaba dibujando el/la** _____ while her mother was talking on the phone

"The daugher was drawing the _____ while her mother was talking on the phone"

  cracker

  crab

needle

pelican

16. The girl was sitting **en la sala cuando vio el/la** _____ on TV
    "The girl was sitting in the room when she saw the _____ on TV"

    buckle

    bucket

    crib

    camel

17. The boy **le pidió a su madre que fotografiara el/la** _____ for the
    website
    "The boy asked his mother to photograph the _____ for the website"

    stapler

    stadium

    tarantula

    cheese

18. The high school student **señaló el/la** _____ in the hall
    "The high school student pointed to the _____ in the hall"

    mustard

    mustache

    pillow

    earring

19. The boy read **un artículo sobre el/la** _____ in the magazine that the
    teacher gave him
    "The boy read an article about the _____ in the magazine that the teacher
    gave him"

    plum

plug

key

bridge

20. The girl thought **que alguien perdió el/la** _____ in the field
"The girl though that someone had lost the _____ in the field"

muffin

muffler

pear

hairbrush

21. One of his brothers **encontró el/la** _____ in the field
"One of his brother found the _____ in the field"

magazine

magnet

base

cone

22. The children **sacaron el/la** _____ that was inside the box
"The children took out the _____ that was inside the box"

puppet

puzzle

bicycle

heel

23. The clown **jugaba con el/la** _____ during the circus act
"The clown played with the _____ during the circus act"

paintbrush

paper

bottle

fire

24. My friends **piensan que el/la** _____ is a bad birthday gift
"My friends think that the _____ is a bad birthday gift"

    bag

    bat

    pearl

    duck

25. No one noticed **que el hombre escondió el/la** _____ behind the tree
"No one noticed that the man hid the _____ behind the tree"

    mask

    mattress

    honey

    necklace

26. The man from across the street **le está mostrando el/la** _____ to his girlfriend
"The man from across the street is showing the _____ to his girlfriend"

    mug

    muscle

    blouse

    calendar

27. The nurse **le dijo a su esposo que buscara el/la** _____ during his free time
"The nurse told her husband to look for the _____ during his free time"

    marble

    market

    bell

car

28. The researchers **estaban mostrando el/la** _____ to the scientific committee

   "The researchers were showing the _____ to the scientific committee"

   plant

   planet

   skin

   mirror

29. The girl **le pidió a su papá que fuera a fotografiar el/la** _____ for her collage

   "The girl asked her father to go take a picture of the _____ for her collage"

   strawberry

   straw hat

   forehead

   brick

30. The kindergarten kids **no querían pintar el/la** _____ during the break

   "The kindergarten kids did not want to paint the _____ during the break"

   fireplace

   firetruck

   nail

   diamond

A.4.1.2 Spanish-first codeswitches

1. **La esposa del vecino** was able to find **el/la** _____ **que había perdido**

   "The neighbor's wife was able to find the _____ that she had lost"

   sheet

   shield

rose

ticket

2. **La enfermera** wanted to know about **el/la _____ que mencionaron en las noticias**

   "The nurse wanted to know about the _____ that was mentioned on the news"

   rocking chair

   rocket

   kitchen

   hat

3. **La profesora explicó por qué** it was difficult to paint **el/la _____ en clase**

   "The teacher explained why it was difficult to paint the _____ in class"

   staircase

   stereo

   pumpkin

   dress

4. **La mujer está** ordering **el/la _____ de la revista**

   "The woman is ordering the _____ from the magazine"

   cape

   cable

   frying pan

   dictionary

5. **La guía turística** saw **el/la _____ más grande que había visto en su vida**

   "The tourist guide saw the biggest _____ that he/she had seen in his/her life"

pigeon

pig

cow

donkey

6. **La hija vio** the commercial about **el/la _____ en la televisión**

   "The daughter saw the commercial about the _____ on the television"

   cake

   cane

   flower

   painting

7. **El comediante** told the joke about **el/la _____ que le contó ayer su vecino**

   "The comedian told the joke about the _____ that his/her neighbor had told him/her yesterday"

   root

   roof

   battery

   bread

8. **El fotógrafo** sketched **el/la _____ antes de tomarle una foto**

   "The photographer sketched the _____ before taking its picture"

   can

   cabbage

   school

   squid

9. **El niño** told his mother that he didn't like **el/la _____ que le regalaron**

   "The boy told his mother that he didn't like the _____ that he was given"

camera

castle

bed

gift

10. Los estudiantes found it difficult to hide **el/la _____ que estaba en el baño**
   "The students found it difficult to hide the _____ that was in the bathroom"

   hammock

   hammer

   leaf

   notebook

11. **Los arqueólogos** admired **el/la _____ en la exposición**
   "The archeologists admired the _____ in the exhibition"

   dynamite

   dinosaur

   butterfly

   glove

12. **La secretaria** saw her neighbor while he was sketching **el/la _____ en el patio**
   "The secretary saw her neighbor while he was sketching the _____ on the patio"

   window

   windmill

   meatball

   clock

13. **El niño malcriado** destroyed **el/la _____ para llamar la atenció de sus padres**

"The misbehaved boy destroyed the _____ to get his parents' attention"

garbage

garden

pipe

fork

14. **Esta mañana** the woman insisted that **el/la _____ estaba detrás de la caja**

"This morning the woman insisted that the _____ was behind the box"

butter

bumper

lamp

cigarette

15. **El señor** asked his son if he saw **el/la _____ en el album de fotos**

"The man asked his son if he saw the _____ in the photo album"

dollhouse

dolphin

napkin

panda

16. **El muchachito** stole **el/la _____ que estaba en el jardín**

"The young man stole the _____ that was in the garden"

pineapple

pine tree

bullet

briefcase

17. **El pintor** looked at **el/la _____ antes de empezar a pintar el cuadro**
"The painter looked at the _____ before he began to paint the painting"

  surfboard

  circus

  bandage

  telescope

18. **La maestra dijo** that the student should imagine **el/la _____ antes de pintar**
"The teacher said that the student should imagine the _____ before painting"

  pork chop

  porcupine

  towel

  kangaroo

19. **La pareja piensa que** a nice gift would be **el/la _____ que vieron en la tienda**
"The couple thinks that a nice gift would be the _____ that they saw in the shop"

  calculator

  cactus

  blanket

  domino

20. **La niña** saw **el/la _____ y le dio asco**
"The girl saw the _____ and she was disgusted"

  net

  nest

  house

tooth

21. **El hombre** didn't want to sell **el/la _____ a la mitad de precio**
"The man didn't want to sell the _____ for half price"

    chalkboard

    chocolate

    door

    forest

22. **La muchacha** found **el/la _____ que vio ayer en el aviso del periódico**
"The girl found the _____ that she saw in the newspaper announcement"

    backpack

    bank

    chalk

    telephone

23. **Mi amiga** showed me **el/la _____ que dibujó para su clase**
"My friend showed me the _____ that she drew for her class"

    curtain

    curler

    pasta

    lighthouse

24. **El padre** thought that his daughter went to check out **el/la _____ con sus amigos**
"The father thought that his daughter went to check out the _____ with her friends"

    cloud

    clown

    snake

bra

25. **La niñita** traced **el/la** _____ **en su cuaderno**
    "The little girl traced the _____ in her notebook"

    vein

    vase

    salad

    microscope

26. **La empleada** needed to clean **el/la** _____ **antes de irse a su casa**
    "The maid needed to clean the _____ before going to her house"

    label

    ladle

    chimney

    tablecloth

27. **Los niños** wanted to feel **el/la** _____ **en el zoológico**

    seagull

    seahorse

    giraffe

    buffalo

28. **Mi amigo nos dijo que** he really didn't want to pick up **el/la** _____ **en el piso**
    "My friend told us that he really didn't want to pick up the _____ on the floor"

    shell

    shelf

    printer

cotton

29. **La niña** wanted to touch **el/la _____ cuando fue a la feria**
    "The girl wanted to touch the _____ when she went to the fair"

    turtle

    turkey

    lobster

    monkey

30. **Mi amigo** realized that **el/la _____ tenía un color raro**
    "My friend realied that the _____ had a strange color"

    carrot

    cannon

    cherry

    truck

A.4.2   Filler Doublets

A.4.2.1   English-first Codeswitches

1. The young man **pudo desactivar la** _____ last night
   "The young man was able to deactivate the _____ last night"

   carpet

   skirt

2. The woman **compró la** _____ for her neighbor
   "The woman bought the _____ for her neighbor"

   moon

   whale

3. The girl **cerró el** _____ that she bought yesterday
   "The girl closed the _____ that she bought yesterday"

      ring

      heart

4. The old woman **perdió la** _____ that she kept in her pocket
   "The old woman lost the _____ that she kept in her pocket"

      flag

      tongue

5. The young man **construyó el** _____ for his girlfriend's birthday
   "The young man built the _____ for his girlfriend's birthday"

      finger

      egg

6. The old man **recogió el** _____ that had fallen on the floor
   "The old man picked up the _____ that had fallen on the floor"

      carpenter

      acquarium

7. The lawyer **contrató la** _____ to help him with the case
   "The lawyer contracted the _____ to help him with the case"

      watermelon

      eyebrow

8. The girl **trató de hervir el** _____ that she saw yesterday
   "The girl tried to boil teh _____ that she saw yesterday"

      palace

      microwave

9. The girl **se comió todo el** _____ that her mother bought
   "The girl ate all of the _____ that her mother bought"

      pencil

atom

10. The engineer **no quizó donar el** _____ to the church
    "The engineer did not want to donate the _____ to the church"

    rabbit

    elephant

11. The mechanic saw his neighbor **mientras arreglaba la** _____ in the garage
    "The mechanic saw his neighbor while he was fixing the _____ in the garage"

    milk

    salt

12. The man **tiene que comprar el** _____ for the dinner party
    "The man has to buy the _____ for the dinner party"

    barber

    penguin

13. One of my daughters **se olvidó de devolver el** _____ that her friend lent her
    "One of my daughters forgot to return the _____ that her friend lent her"

    arm

    hill

14. The father **le pidió a su hija que pusiera el** _____ in the washing machine
    "The father asked his daughter to put the _____ in the washing machine"

    sink

    chess

15. The high school student **que acaba de beber la** _____ is feeling happy
    "The high school student who just finished drinking the _____ is feeling happy"

chain

tower

16. The woman **vio a su hijo** throwing **el** _____ to his **amigo**
    "The woman saw her son throwing the _____ to his friend"

    lake

    horse

17. The judge **quería hablar con la** _____ that he met the other day
    "The judge wanted to talk to the _____ that he met the other day"

    orange

    coffee pot

18. The teacher **dijo que los estudiantes podían celebrar el** _____ after the exam
    "The teacher said that the students could celebrate the _____ after the exam"

    grass

    rat

19. After leaving the house the man **encontró la** _____ on the sidewalk
    "After leaving the house the man found the _____ on the sidewalk"

    street

    wall

20. The journalist met a girl **que trató de apuñalar la** _____ on the table
    "The journalist met a girl who tried to punch the _____ on the table"

    walnut

    bathtub

21. The woman **vio que su esposo estaba abrazando el** _____ with happiness
    "The woman saw that her husband was hugging the _____ with happiness"

oil

keyboard

22. The boy **bebió la** _____ that he bought in the supermarket
    "The boy drank the _____ that he bought in the supermarket"

    sheep

    witch

23. The high school student **acaba de planchar la** _____ on the table
    "The high school student just ironed the _____ on the table"

    onion

    toaster

24. The girl **escondió el** _____ so that her dog would not find it
    "The girl hid the _____ so that her dog would not find it"

    building

    ship

25. The movie start **guardó la** _____ in her purse
    "The movie star put away the _____ in her purse"

    squirrel

    bonfire

26. The secretary from across the street **está cocinando la** _____ for the dinner party
    "The secretary from across the street is cooking the _____ for the dinner party"

    wheel

    snow

27. The woman **buscó por toda la habitación la** _____ that she got for Christmas

"The woman searched the entire room for the _____ that she got for Christmas"

   fountain

   seal

28. The boy **le dio el** _____ to his friend

"The boy gave the _____ to his friend"

   stomach

   bull

29. The architect **le regaló la** _____ to her client

"The architect gave the _____ to her client"

   arrow

   crown

30. The carpenter **vio que su vecino estaba lavando el** _____ in the sink

"The carpenter saw that his neighbor was washing the _____ in the sink"

   airport

   wine

A.4.2.2 Spanish-first Codeswitching

1. **El padre** noticed that his daughter cancelled **el** _____ **el otro día**

"The father noticed that his daughter cancelled the _____ the other day"

   microphone

   oven

2. **Mi tío** asked that his daughter call **la** _____ **el fin de semana**

"My uncle asked that his daughter call the _____ this weekend"

      card

      hand

3. **El estudiante** met a girl who poured **el _____ en la jarra**
   "The student met a girl who poured the _____ in the jar"

      record

      sun

4. **La mujer** watched her son while he watered **la _____ con la manguera**
   "The woman watched her son while he watered the _____ with the hose"

      magnifying glass

      chair

5. **La doctora** said that the patient should swallow **la _____ para alimentarse**
   "The doctor said that the patient should swallow the _____ to become healthy"

      gun

      washing machine

6. **La señora** slapped **el _____ con la mano**
   "The woman slapped the _____ with her hand"

      tomato

      scorpion

7. **La instructora** told the students to drive **el _____ por varias millas**

      mailbox

      sugar

8. **La mujer** helped the kids wash **el _____ para recaudar dinero**
   "The woman helped the kids wash the _____ to collect money"

rice

newspaper

9. **Mi hermana** met a girl who eats **el _____ todos los días**
'My sister met a girl who eats the _____ every day"

coffee

glass

10. **El hombre** saw his wife chewing **el _____ que estaba en el sofá**
"The man saw his wife chewing the _____ that was one the sofa"

cat

fan

11. **La mujer** from the store is kicking **la _____ con el pie**
"The woman from the store is kicking the _____ with her foot"

circle

ice cream

12. **La banquera** lent **la _____ a un cliente para que se comprara una casa**
"The banker lent the _____ to a client so that he/she could buy a house"

sandal

pizza

13. **La señora** told her husband to prepare **el _____ para el desayuno**
"The woman told her husband to prepare the _____ for breakfast"

mosquito

charcoal

14. **El niño** has been petting **el _____ por varias horas**
"The boy has been petting the _____ for several hours"

ham

knife

15. **El chef** asked his employee to fry **el _____ para la fiesta**
    "The chef asked his employee to fry the _____ for the party"

    sofa

    poison

16. **El veterinario** said that the student could bathe **la _____ en el fregadero**
    "The veterinarian said that the student could bathe the _____ in the sink"

    blender

    lettuce

17. **El estudiante** left **la _____ en su país mientras estudiaba en Portugal**
    "The student left the _____ in his country while he was studying in Portugal"

    grape

    city

18. **El chico** is combing **la _____ para su hermanita**
    "The boy is combing the _____ for his younger sister"

    beer

    cross

19. **Los alumnos** needed to buy **el _____ para limpiar la casa**
    "The students needed to buy the _____ "

    gorilla

    parrot

20. **Mi vecino** greeted **la _____ mientras cortaba el césped en el jardín**
    "My neighbor greeted the _____ while he cut the grass in the garden"

bomb

sword

21. **La señora** faxed **la _____ el fin de semana pasado**
    "The woman faxed the _____ las weekend"

    suitcase

    refrigerator

22. **La enfermera** caught the patient about to eat **el _____ con un tenedor**
    "The nurse caught the patient about to eat the _____ with a fork"

    shoe

    aluminum foil

23. **Los novios** wanted to rent **la _____ para la boda**
    "The fiancees wanted to rent the _____ for the wedding"

    sign

    blood

24. **El electricista** brought **la _____ para repara la nevera**
    "The electrician brought the _____ to fix the refrigerator"

    table

    letter

25. **El cocinero** opened **la _____ para prepara la salsa**
    "The cook opened the _____ to make the salsa"

    canoe

    sponge

26. **El cartero** bought **la _____ para entregar el correo**
    "The mailman bought the _____ to deliver the mail"

    nurse

spoon

27. **El empleado** saw that his co-worker stole **la _____ mientras todos dormían**

    "The employee saw that his co-worker stole the _____ while the others slept"

    palm tree

    flight attendant

28. **El contable** called **la _____ para decirle que debía impuestos**

    "The accountant called the _____ to inform him/her/it that he/she/it owed taxes"

    apple

    computer

29. **La señora que limpia** bought **el _____ para limpiar los baños**

    "The woman who cleans bought the _____ to clean the bathrooms"

    snail

    plate

30. **El jardinero dijo que** he had to plant **el _____ en el jardín**

    "The gardener said that he had to plant the _____ in the garden"

    book

    money

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